Response to EPA's December 1, 2020 E-mail Information Request, Legacy Fan Restart Information Follow-up

Enclosure 1	Responses to E-mail Questions from Lea Veal, EPA to CBFO Regarding Restarting One of the Legacy Fans
Enclosure 2	TBD 20-003, Sampling Plan for 700C Fan Startup and Testing

Enclosure 1

Responses to E-mail Questions From Lee Veal, EPA to CBFO Regarding Restarting One of the Legacy Fans

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Attachments

Response to EPA Ventilation Questions,

1) Question

What levels of contamination have been observed in recent air samples taken at Station A (prior to HEPA filtration)?

RESPONSE

The current point of compliance (POC) for periodic confirmatory monitoring associated with implementing the DOE/EPA 1995 Memorandum of Understanding/NESHAP requirements in 40 CFR Part 61 and for demonstrating compliance with applicable requirements in 40 CFR Part 191 is Station B. Because of this, Station A has not been routinely maintained since 2014. However, gross alpha/beta data has been routinely obtained from Station A for informational purposes. Recent (January 1, 2019 through August 14, 2019) Station A gross alpha/beta data are presented in Attachment 1. Although Station A is not the current POC, action levels were previously established for Station A (DOE/WIPP 97-2238). The observed values typically are about an order of magnitude below the previously established action levels for Station A. Pursuant to these data, there were no values detected above action level thresholds. The action level for gross alpha activity on the filter is 27 dpm/day (1.11E-12 µCi/ml). The gross beta activity action level on the filter is 509 dpm/day (2.08E-11 µCi/ml). Emissions at or above these action levels for 365 days would result in an Effective Dose Equivalent equal to 1% of the 10 mrem/yr to the maximally exposed member of the public (0.1 mrem/yr) which include occupants of the Safety Significant Confinement Ventilation System (SSCVS) construction office.

2) Question

Has there been an effort to characterize the source term that could potentially be present in the facility's exhaust system, and might be mobilized by a higher airflow?

RESPONSE

Surface radiological swipes had been taken, prior to 2019, of the fan and duct downstream of the isolation dampers and the 700C fan housing access hatch. There were no detects above clean surface area limits (i.e., less than 20 dpm/100 cm^2 gross alpha). Direct frisks were also conducted on the inside of the access doors and some reachable interior surfaces and were less than background.

On October 26, 2019, Radiological Control Technicians entered the horizontal ventilation ductwork adjacent to the 700C fan and retrieved removable contamination swipes, took fixed and airborne radioactivity readings, and retrieved salt samples to be analyzed at the WIPP laboratory. The removable activity results as ascertained from swipe samples inside the applicable portion of the above ground ventilation system were analyzed statistically in a conservative manner to calculate the quantity of radioactivity that might be expelled to the atmosphere during the testing phase of the 700C fan.

Based on Radiological Engineering Paper TE 20-002, Radiological Assessment of the Startup and Testing of the 700C Fan (Attachment 2), an estimated maximum of 5.92E-6 curies of radioactivity, mostly Am-241, might be expelled during the startup and 4-hour initial testing period of the 700C Fan.

For the purposes of calculating the EDE for NESHAP 114 mCi was used as the source term in the ductwork. The 114 mCi was calculated based on two filters that were collected at Station A that were sampling upstream of the HEPA exhaust filters during the February 2014 event, IDs A230214140742 and A2302151400630. The first had a gross alpha reading of 8.2E+06 dpm and the second read 2.13E+05 dpm. These filters were sampling the exhaust stream prior to shift to filtration at 23:14 on 2/14/2014 and also after the shift to filtration. Assuming all of the activity was collected after the shift to filtration, the exhaust flowrate would be about 60,000 cfm. The sample flow rate is 2 cfm. The first filter sampled from 07:42 on 2/14 until 06:30 on 2/15 (1,368 minutes) however only 436 minutes of that time was after the shift to filtration. The second filter sampled from 06:30 on 2/15 until 08:44 on 2/15 (134 minutes). Based on the Station A filters approximately 114 mCi of alpha material passed from the underground to the above ground ductwork. All but 1.7 mCi (as measured at the Station B sampler, downstream of the HEPA exhaust filters) was either deposited in the ducts or collected on the filtration system (Attachment 3, BC-RP-0129, Radiological Air Emissions Evaluation of the Restart of The 700 Fans for 40 CFR 61 Subpart H).

3) Question

Has DOE used CAP-88 or any other model to calculate potential doses due to mobilizing contamination in the exhaust circuit? What are the results? Do they approach the 10 mrem/yr standard or even the DOE administrative limit (0.1 mrem/annually)?

RESPONSE

Yes, DOE has used CAP-88 to calculate bounding doses from potential re-entrainment of contaminants downstream of the Station A sampling probe. The bounding source term used was approximately 114 mCi.

CAP-88 has been run by a sub-contractor as an independent evaluation of the 700C fan restart.

From a 40 CFR Part 61 Subpart H, air emission perspective, restart of the 700 fans will result in emissions well below regulatory thresholds. The estimated dose due to resuspension of deposited material is conservatively estimated to be 4.89E-03 mrem/yr. which is less than the 10 mrem/yr. standard. This dose is also less than the EPA regulatory categorization limit of 0.1 mrem/annum for facilities using periodic confirmatory measurement for compliance monitoring (Attachment 3, BC-RP-0129).

1. Resuspension of material deposited in the ducts can be addressed by sampling at the 700-fan exit duct with two external open face samplers, two shrouded probes or continuous monitors. Station A should also be operated during the initial restart. Sampling required for long-term operations, required to meet regulatory requirements, will be determined based on the result of restart sampling. For long- term operations, periodic sampling with Station A along with regular (at least monthly) smears of or other measurement at the fan exhaust screen for possible estimated radionuclide emissions to the atmosphere for dose calculations would meet the regulatory sampling requirements.

4) Question

Has DOE considered that the restart of the 700 fan may call for DOE to qualify the sampling system at Station A for NESHAP purposes as was done at Station B in 2016 following the addition of the Interim Ventilation System?

RESPONSE

Restart of the 700C fan would not require DOE to re-qualify the present sampling system. The 700C fan configuration and sampling system design has not been modified. Furthermore, the unfiltered 700C fan will not operate with filtered surface fans in operation [e.g., 860 fans or Interim Ventilation System (IVS) fans). Based on the current Title 40 CFR Part 61 definitions and allowances, Station A and the 700C fan configuration are not being "modified." Long-term operation may require an additional air sampling point at the 700C fan shroud outlet, but shrouded probes or smear surveys or another method that would provide equivalent empirical measurement may be used as additional interim indication of low levels of radioactive emissions, subject to technical evaluation. The increase in dose to a member of the public is calculated to be less than 1% of the 10 mrem/yr standard, which does allow operation under the pre-existing authorizations.

5) Question

Post-accident investigations found that the ventilation system, and specifically the capability to shift to HEPA filtration, should have been designed and maintained at a higher level of safety significance. We realize that DOE is planning to address these nuclear safety concerns in the long-term by designing and constructing the new ventilation building (SSCVS), but has DOE addressed the safety issues for the ventilation configuration that DOE is currently proposing?

RESPONSE

The current approach is to prohibit waste handling activities until an automatic shift-to- filtration system can be designed that meets current standards for safety instrumented systems. The restriction of waste handling activities eliminates the majority of the radiological event initiators. The current CAM configuration will also be upgraded to be three CAMs in service instead of one CAM. See response to question six below.

6) Question

If a 700 fan is successfully restarted, we assume that the unfiltered 200,000+ cubic feet per minute airflow would allow DOE to stop using the HEPA filtration on a continuing basis. Would the facility retain the ability to rapidly shift to a fully-filtered mode? Will the underground monitoring system be robust enough to identify a release quickly and automatically switch to filtration? What information and action levels would be used to make that determination? Would there be additional administrative controls on activities that could take place while the facility exhaust is unfiltered?

RESPONSE

During initial startup of the 700C fan, a rapid shift-to-filtration will not be required. Waste handling operations in the UG will be prohibited while operating in an unfiltered mode. The only requirement will be to secure unfiltered ventilation should a radiological release be detected. Filtered ventilation will only resume with an operator-initiated shift to filtration on a manual basis. Prior to allowing any waste handling activities in the UG while the ventilation is configured for unfiltered operation, a rapid shift-to-filtration system will be required to be in place and operational. This is anticipated to take significant time to design and install, therefore the ventilation system will be reconfigured to filtered ventilation prior to any waste handling activities being performed in the UG.

7) Question

Would additional air sampling or monitoring take place on the surface of the site for either environmental or worker protection purposes? The position of the 700 fan exhaust is toward the interior of the site and buildings.

RESPONSE

Station A will be maintained in accordance with ANSI N13.1, 1969 and is intended to be the point of compliance for the 700C fan operations.

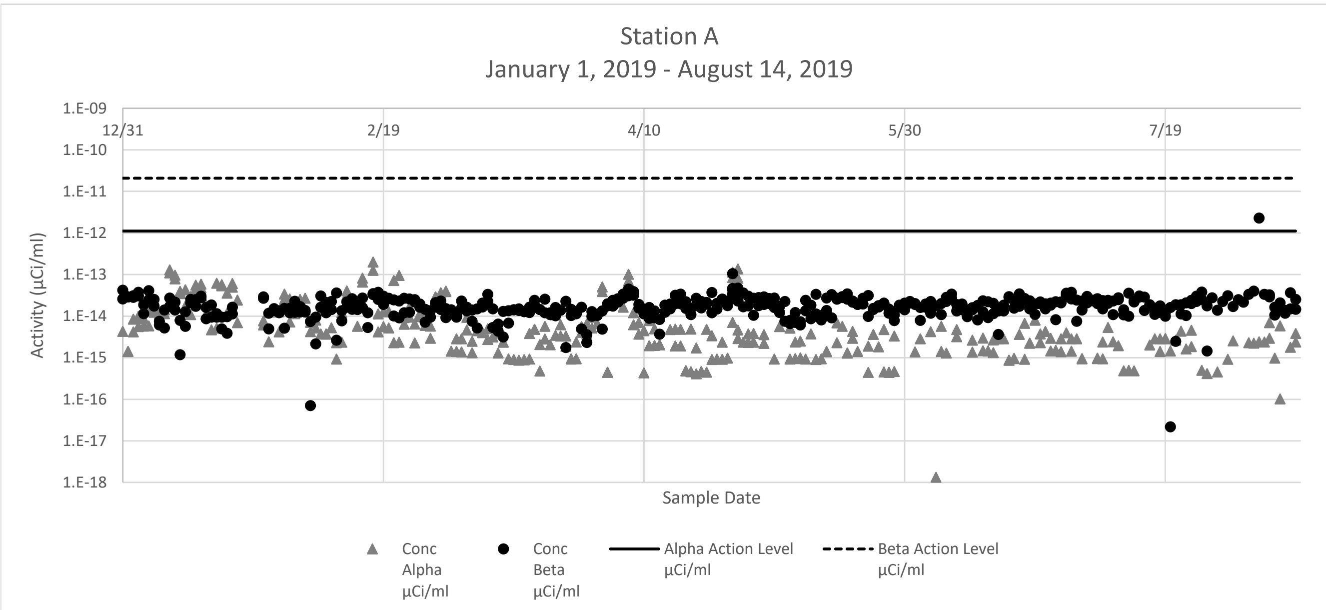
A surface startup air sampling and monitoring plan has been developed, 700C Fan Startup & Testing: Air Emissions and Ambient Environmental Air Surveillance Sampling Plan (Attachment 4). A shrouded probe sampling system has been placed at the 700C fan shroud outlet, (Attachment 5). An ambient particulate low- volume (2 CFM) air sampler will also be operated at the maximum receptor location (SSCVS Office) for the duration of its occupancy by members of the public.

Attachment 1

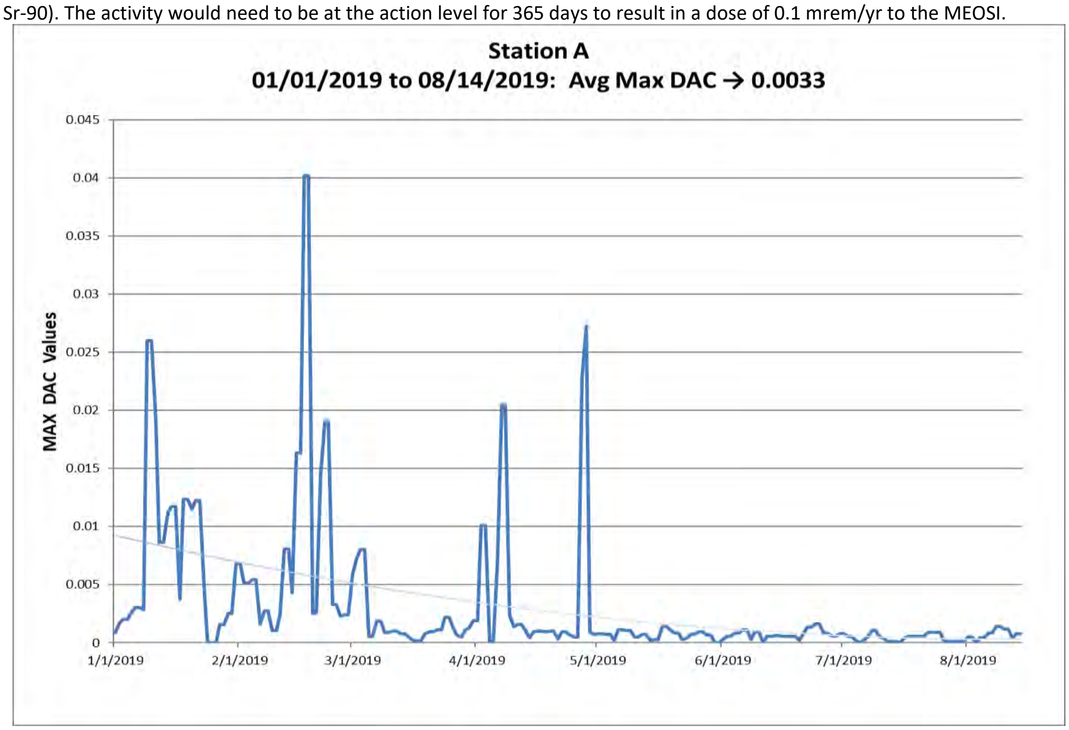
Station A Data January 1, 2019 through August 14, 2019

Station A gross alpha/beta data (January 1, 2019 through August 14, 2019)

Concentration values that are listed as being exactly equal to zero typically come from results that are mathematically less than zero, due to statistical fluxuation in counting results. They are recorded as zero as the most probable statistical value for the specific result.



Note: Graphed using log scale. Zero values are not graphed. Action levels are based on the limiting radionuclides for Gross Alpha and Beta (Pu-239/240 and Sr-90). The activity would need to be at the action level for 365 days to result in a dose of 0.1 mrem/yr to the MEOSI.



Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A23123118	12/31/2018	1/1/2019	0	4.20E-14	1.11E-12	2.08E-11	6.00E-06
A33123118	12/31/2018	1/1/2019	4.30E-15	2.59E-14	1.11E-12	2.08E-11	8.64E-04
A23010119	1/1/2019	1/2/2019	1.41E-15	2.91E-14	1.11E-12	2.08E-11	2.86E-04
A33010119	1/1/2019	1/2/2019	1.41E-15	2.92E-14	1.11E-12	2.08E-11	2.86E-04
A23010219	1/2/2019	1/3/2019	8.45E-15	2.84E-14	1.11E-12	2.08E-11	1.69E-03
A33010219	1/2/2019	1/3/2019	4.19E-15	3.09E-14	1.11E-12	2.08E-11	8.42E-04
A23010319	1/3/2019	1/4/2019	9.93E-15	3.06E-14	1.11E-12	2.08E-11	1.99E-03
A33010319	1/3/2019	1/4/2019	5.62E-15	3.74E-14	1.11E-12	2.08E-11	1.13E-03
A23010419	1/4/2019	1/5/2019	8.61E-15	1.89E-14	1.11E-12	2.08E-11	1.72E-03
A33010419	1/4/2019	1/5/2019	5.74E-15	1.14E-14	1.11E-12	2.08E-11	1.15E-03
A23010519	1/5/2019	1/6/2019	1.32E-14	2.46E-14	1.11E-12	2.08E-11	2.64E-03
A33010519	1/5/2019	1/6/2019	5.80E-15	4.09E-14	1.11E-12	2.08E-11	1.17E-03
A23010619	1/6/2019	1/7/2019	1.51E-14	1.75E-14	1.11E-12	2.08E-11	3.02E-03
A33010619	1/6/2019	1/7/2019	1.24E-14	2.52E-14	1.11E-12	2.08E-11	2.48E-03
A23010719	1/7/2019	1/8/2019	1.13E-14	7.48E-15	1.11E-12	2.08E-11	2.26E-03
A33010719	1/7/2019	1/8/2019	0	6.12E-15	1.11E-12	2.08E-11	8.74E-07
A23010819	1/8/2019	1/9/2019	1.43E-14	5.18E-15	1.11E-12	2.08E-11	2.86E-03
A33010819	1/8/2019	1/9/2019	1.14E-14	1.41E-14	1.11E-12	2.08E-11	2.28E-03
A23010919	1/9/2019	1/10/2019	1.30E-13	1.72E-14	1.11E-12	2.08E-11	2.60E-02
A33010919	1/9/2019	1/10/2019	1.10E-13	2.72E-14	1.11E-12	2.08E-11	2.20E-02
A23011019	1/10/2019	1/11/2019	9.69E-14	1.40E-14	1.11E-12	2.08E-11	1.94E-02
A33011019	1/10/2019	1/11/2019	7.83E-14	2.18E-14	1.11E-12	2.08E-11	1.57E-02
A23011119	1/11/2019	1/12/2019	3.97E-14	7.94E-15	1.11E-12	2.08E-11	7.94E-03
A33011119	1/11/2019	1/12/2019	3.50E-14	1.18E-15	1.11E-12	2.08E-11	7.00E-03
A23011219	1/12/2019	1/13/2019	4.31E-14	5.65E-15	1.11E-12	2.08E-11	8.62E-03
A33011219	1/12/2019	1/13/2019	1.75E-14	1.27E-14	1.11E-12	2.08E-11	3.50E-03
A23011319	1/13/2019	1/14/2019	2.95E-14	2.10E-14	1.11E-12	2.08E-11	5.90E-03
A33011319	1/13/2019	1/14/2019	1.09E-14	2.52E-14	1.11E-12	2.08E-11	2.18E-03
A23011419	1/14/2019	1/15/2019	4.45E-14	1.73E-14	1.11E-12	2.08E-11	8.90E-03
A33011419	1/14/2019	1/15/2019	5.58E-14	2.51E-14	1.11E-12	2.08E-11	1.12E-02
A23011519	1/15/2019	1/16/2019	5.87E-14	3.04E-14	1.11E-12	2.08E-11	1.17E-02
A33011519	1/15/2019	1/16/2019	4.76E-14	2.75E-14	1.11E-12	2.08E-11	9.52E-03
A23011619	1/16/2019	1/17/2019	1.88E-14	1.62E-14	1.11E-12	2.08E-11	3.76E-03
A33011619	1/16/2019	1/17/2019	1.10E-14	8.68E-15	1.11E-12	2.08E-11	2.20E-03
A23011719	1/17/2019	1/18/2019	1.04E-14	9.48E-15	1.11E-12	2.08E-11	2.08E-03
A33011719	1/17/2019	1/18/2019	4.69E-15	1.86E-14	1.11E-12	2.08E-11	9.41E-04
A23011819	1/18/2019	1/19/2019	5.15E-15	1.14E-14	1.11E-12	2.08E-11	1.03E-03
A33011819	1/18/2019	1/19/2019	6.17E-14	9.52E-15	1.11E-12	2.08E-11	1.23E-02
A23011919	1/19/2019	1/20/2019	5.76E-14	4.91E-15	1.11E-12	2.08E-11	1.15E-02
A33011919	1/19/2019	1/20/2019	5.34E-14	9.48E-15	1.11E-12	2.08E-11	1.07E-02
A23012019	1/20/2019	1/21/2019	3.55E-14	9.74E-15	1.11E-12	2.08E-11	7.10E-03
A33012019	1/20/2019	1/21/2019	1.17E-14	3.87E-15	1.11E-12	2.08E-11	2.34E-03
A23012119	1/21/2019	1/22/2019	6.12E-14	1.13E-14	1.11E-12	2.08E-11	1.22E-02
A33012119	1/21/2019	1/22/2019	4.98E-14	1.64E-14	1.11E-12	2.08E-11	9.96E-03
A23012219	1/22/2019	1/23/2019	2.45E-14	0	1.11E-12	2.08E-11	4.90E-03
A33012219	1/22/2019	1/23/2019	6.93E-15	0	1.11E-12	2.08E-11	1.39E-03
A23012719 1310	1/27/2019	1/28/2019	7.70E-15	2.90E-14	1.11E-12	2.08E-11	1.54E-03
A33012719 1330	1/27/2019	1/28/2019	6.13E-15	2.70E-14	1.11E-12	2.08E-11	1.23E-03
A23012819	1/28/2019	1/29/2019	0	1.17E-14	1.11E-12	2.08E-11	1.67E-06
A33012819	1/28/2019	1/29/2019	2.42E-15	4.94E-15	1.11E-12	2.08E-11	4.85E-04
A33012919	1/29/2019	1/30/2019	0	1.38E-14	1.11E-12	2.08E-11	1.97E-06
A23012919	1/29/2019	1/30/2019	1.25E-14	1.51E-14	1.11E-12	2.08E-11	2.50E-03
A23013019	1/30/2019	1/31/2019	1.27E-14	1.36E-14	1.11E-12	2.08E-11	2.54E-03
A33013019	1/30/2019	1/31/2019	4.19E-15	1.20E-14	1.11E-12	2.08E-11	8.40E-04
A23013119	1/31/2019	2/1/2019	3.39E-14	1.54E-14	1.11E-12	2.08E-11	6.78E-03
A33013119	1/31/2019	2/1/2019	2.54E-14	5.12E-15	1.11E-12	2.08E-11	5.08E-03
A23020119	2/1/2019	2/2/2019	2.61E-14	1.53E-14	1.11E-12	2.08E-11	5.22E-03
A33020119	2/1/2019	2/2/2019	7.22E-15	1.21E-14	1.11E-12	2.08E-11	1.45E-03
A23020219	2/2/2019	2/3/2019	1.88E-14	1.24E-14	1.11E-12	2.08E-11	3.76E-03
A33020219	2/2/2019	2/3/2019	1.15E-14	2.29E-14	1.11E-12	2.08E-11	2.30E-03
A23020319	2/3/2019	2/4/2019	1.60E-14	1.26E-14	1.11E-12	2.08E-11	3.20E-03

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A33020319	2/3/2019	2/4/2019	2.54E-14	1.71E-14	1.11E-12	2.08E-11	5.08E-03
A23020419	2/4/2019	2/5/2019	1.42E-14	1.25E-14	1.11E-12	2.08E-11	2.84E-03
A33020419	2/4/2019	2/5/2019	2.71E-14	1.38E-14	1.11E-12	2.08E-11	5.42E-03
A23020519	2/5/2019	2/6/2019	7.03E-15	7.46E-15	1.11E-12	2.08E-11	1.41E-03
A33020519	2/5/2019	2/6/2019	4.23E-15	7.05E-17	1.11E-12	2.08E-11	8.46E-04
A23020619	2/6/2019	2/7/2019	5.19E-15	2.15E-15	1.11E-12	2.08E-11	1.04E-03
A33020619	2/6/2019	2/7/2019	7.99E-15	9.52E-15	1.11E-12	2.08E-11	1.60E-03
A23020719	2/7/2019	2/8/2019	3.75E-15	1.63E-14	1.11E-12	2.08E-11	7.52E-04
A33020719	2/7/2019	2/8/2019	1.36E-14	3.08E-14	1.11E-12	2.08E-11	2.72E-03
A23020819	2/8/2019	2/9/2019	3.74E-15	1.20E-14	1.11E-12	2.08E-11	7.50E-04
A33020819	2/8/2019	2/9/2019	3.70E-15	2.15E-14	1.11E-12	2.08E-11	7.43E-04
A23020919	2/9/2019	2/10/2019	5.28E-15	1.44E-14	1.11E-12	2.08E-11	1.06E-03
A33020919	2/9/2019	2/10/2019	0	2.27E-14	1.11E-12	2.08E-11	3.24E-06
A23021019	2/10/2019	2/11/2019	2.30E-15	3.61E-14	1.11E-12	2.08E-11	4.65E-04
A33021019	2/10/2019	2/11/2019	9.32E-16	2.63E-15	1.11E-12	2.08E-11	1.87E-04
A23021119	2/11/2019	2/12/2019	1.22E-14	1.35E-14	1.11E-12	2.08E-11	2.44E-03
A33021119	2/11/2019	2/12/2019	2.35E-15	7.77E-15	1.11E-12	2.08E-11	4.71E-04
A23021219	2/12/2019	2/13/2019	4.04E-14	1.65E-14	1.11E-12	2.08E-11	8.08E-03
A33021219	2/12/2019	2/13/2019	3.21E-14	2.19E-14	1.11E-12	2.08E-11	6.42E-03
A23021319	2/13/2019	2/14/2019	1.87E-14	1.47E-14	1.11E-12	2.08E-11	3.74E-03
A33021319	2/13/2019	2/14/2019	2.16E-14	2.64E-14	1.11E-12	2.08E-11	4.32E-03
A23021419	2/14/2019	2/15/2019	5.69E-15	1.44E-14	1.11E-12	2.08E-11	1.14E-03
A33021419	2/14/2019	2/15/2019	0	1.93E-14	1.11E-12	2.08E-11	2.76E-06
A23021519	2/15/2019	2/16/2019	6.60E-14	2.72E-14	1.11E-12	2.08E-11	1.32E-02
A33021519	2/15/2019	2/16/2019	8.17E-14	1.60E-14	1.11E-12	2.08E-11	1.63E-02
A23021619	2/16/2019	2/17/2019	0	1.20E-14	1.11E-12	2.08E-11	1.71E-06
A33021619	2/16/2019	2/17/2019	0	5.34E-15	1.11E-12	2.08E-11	7.63E-07
A23021719	2/17/2019	2/18/2019	1.27E-13	3.30E-14	1.11E-12	2.08E-11	2.54E-02
A33021719	2/17/2019	2/18/2019	2.01E-13	3.47E-14	1.11E-12	2.08E-11	4.02E-02
A23021819	2/18/2019	2/19/2019	4.21E-15	2.52E-14	1.11E-12	2.08E-11	8.46E-04
A33021819	2/18/2019	2/19/2019	1.13E-14	3.76E-14	1.11E-12	2.08E-11	2.27E-03
A23021919	2/19/2019	2/20/2019	5.60E-15	3.03E-14	1.11E-12	2.08E-11	1.12E-03
A33021919	2/19/2019	2/20/2019	1.27E-14	1.91E-14	1.11E-12	2.08E-11	2.54E-03
A23022019	2/20/2019	2/21/2019	1.28E-14	2.63E-14	1.11E-12	2.08E-11	2.56E-03
A33022019	2/20/2019	2/21/2019	5.21E-15	2.70E-14	1.11E-12	2.08E-11	1.05E-03
A23022119	2/21/2019	2/22/2019	7.18E-14	1.01E-14	1.11E-12	2.08E-11	1.44E-02
A33022119	2/21/2019	2/22/2019	2.30E-15	2.46E-14	1.11E-12	2.08E-11	4.64E-04
A23022219	2/22/2019	2/23/2019	2.37E-15	2.31E-14	1.11E-12	2.08E-11	4.77E-04
A33022219	2/22/2019	2/23/2019	9.50E-14	9.11E-15	1.11E-12	2.08E-11	1.90E-02
A23022319	2/23/2019	2/24/2019	9.26E-15	1.21E-14	1.11E-12	2.08E-11	1.85E-03
A33022319	2/23/2019	2/24/2019	6.40E-15	2.70E-14	1.11E-12	2.08E-11	1.28E-03
A23022419	2/24/2019	2/25/2019	9.49E-15	1.24E-14	1.11E-12	2.08E-11	1.90E-03
A33022419	2/24/2019	2/25/2019	1.66E-14	2.60E-14	1.11E-12	2.08E-11	3.32E-03
A23022519	2/25/2019	2/26/2019	2.27E-15	2.21E-14	1.11E-12	2.08E-11	4.57E-04
A33022519	2/25/2019	2/26/2019	6.46E-15	2.51E-14	1.11E-12	2.08E-11	1.30E-03
A23022619	2/26/2019	2/27/2019	1.14E-14	1.63E-14	1.11E-12	2.08E-11	2.28E-03
A33022619	2/26/2019	2/27/2019	9.76E-15	1.95E-14	1.11E-12	2.08E-11	1.95E-03
A23022719	2/27/2019	2/28/2019	1.19E-14	1.47E-14	1.11E-12	2.08E-11	2.38E-03
A33022719	2/27/2019	2/28/2019	5.95E-15	7.15E-15	1.11E-12	2.08E-11	1.19E-03
A23022819	2/28/2019	3/1/2019	5.75E-15	1.35E-14	1.11E-12	2.08E-11	1.15E-03
A33022819	2/28/2019	3/1/2019	2.92E-15	9.49E-15	1.11E-12	2.08E-11	5.85E-04
A23030119	3/1/2019	3/2/2019	2.93E-14	2.11E-14	1.11E-12	2.08E-11	5.86E-03
A33030119	3/1/2019	3/2/2019	2.93E-14	1.99E-14	1.11E-12	2.08E-11	5.86E-03
A23030219	3/2/2019	3/3/2019	2.86E-14	2.30E-14	1.11E-12	2.08E-11	5.72E-03
A33030219	3/2/2019	3/3/2019	3.65E-14	1.44E-14	1.11E-12	2.08E-11	7.30E-03
A23030319	3/3/2019	3/4/2019	4.01E-14	1.52E-14	1.11E-12	2.08E-11	8.02E-03
A33030319	3/3/2019	3/4/2019	3.91E-14	9.25E-15	1.11E-12	2.08E-11	7.82E-03
A23030419	3/4/2019	3/5/2019	1.44E-15	1.40E-14	1.11E-12	2.08E-11	2.90E-04
A33030419	3/4/2019	3/5/2019	0	1.43E-14	1.11E-12	2.08E-11	2.04E-06
A23030519	3/5/2019	3/6/2019	2.87E-15	1.15E-14	1.11E-12	2.08E-11	5.76E-04
A33030519	3/5/2019	3/6/2019	1.42E-15	9.42E-15	1.11E-12	2.08E-11	2.85E-04

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A23030619	3/6/2019	3/7/2019	1.38E-15	2.32E-14	1.11E-12	2.08E-11	2.79E-04
A33030619	3/6/2019	3/7/2019	2.84E-15	1.56E-14	1.11E-12	2.08E-11	5.70E-04
A23030719	3/7/2019	3/8/2019	9.33E-15	1.64E-14	1.11E-12	2.08E-11	1.87E-03
A33030719	3/7/2019	3/8/2019	4.65E-15	1.33E-14	1.11E-12	2.08E-11	9.32E-04
A23030819	3/8/2019	3/9/2019	2.47E-15	1.40E-14	1.11E-12	2.08E-11	4.96E-04
A33030819	3/8/2019	3/9/2019	1.31E-15	7.51E-15	1.11E-12	2.08E-11	2.63E-04
A23030919	3/9/2019	3/10/2019	4.44E-15	1.49E-14	1.11E-12	2.08E-11	8.90E-04
A33030919	3/9/2019	3/10/2019	0	5.23E-15	1.11E-12	2.08E-11	7.47E-07
A23031019	3/10/2019	3/11/2019	4.04E-15	1.66E-14	1.11E-12	2.08E-11	8.10E-04
A33031019	3/10/2019	3/11/2019	4.02E-15	2.07E-14	1.11E-12	2.08E-11	8.07E-04
A23031119	3/11/2019	3/12/2019	5.02E-15	3.35E-14	1.11E-12	2.08E-11	1.01E-03
A33031119	3/11/2019	3/12/2019	2.76E-15	2.26E-14	1.11E-12	2.08E-11	5.55E-04
A23031219	3/12/2019	3/13/2019	3.17E-15	5.32E-15	1.11E-12	2.08E-11	6.35E-04
A33031219	3/12/2019	3/13/2019	0	1.49E-14	1.11E-12	2.08E-11	2.13E-06
A23031319	3/13/2019	3/14/2019	3.95E-15	4.33E-15	1.11E-12	2.08E-11	7.91E-04
A33031319	3/13/2019	3/14/2019	1.30E-15	6.48E-15	1.11E-12	2.08E-11	2.61E-04
A23031419	3/14/2019	3/15/2019	2.40E-15	3.15E-15	1.11E-12	2.08E-11	4.80E-04
A33031419	3/14/2019	3/15/2019	2.37E-15	1.31E-14	1.11E-12	2.08E-11	4.76E-04
A23031519	3/15/2019	3/16/2019	9.40E-16	1.35E-14	1.11E-12	2.08E-11	1.90E-04
A33031519	3/15/2019	3/16/2019	0	6.82E-15	1.11E-12	2.08E-11	9.74E-07
A23031619	3/16/2019	3/17/2019	9.10E-16	1.42E-14	1.11E-12	2.08E-11	1.84E-04
A33031619	3/16/2019	3/17/2019	0	1.43E-14	1.11E-12	2.08E-11	2.04E-06
A23031719	3/17/2019	3/18/2019	8.75E-16	1.37E-14	1.11E-12	2.08E-11	1.77E-04
A33031719	3/17/2019	3/18/2019	0	1.49E-14	1.11E-12	2.08E-11	2.13E-06
A23031819	3/18/2019	3/19/2019	8.90E-16	1.28E-14	1.11E-12	2.08E-11	1.80E-04
A33031819	3/18/2019	3/19/2019	8.90E-16	1.28E-14	1.11E-12	2.08E-11	1.80E-04
A23031919	3/19/2019	3/20/2019	9.33E-16	1.22E-14	1.11E-12	2.08E-11	1.88E-04
A33031919	3/19/2019	3/20/2019	3.85E-15	1.65E-14	1.11E-12	2.08E-11	7.72E-04
A23032019	3/20/2019	3/21/2019	4.81E-15	1.85E-14	1.11E-12	2.08E-11	9.65E-04
A33032019	3/20/2019	3/21/2019	4.79E-15	2.40E-14	1.11E-12	2.08E-11	9.61E-04
A23032119	3/21/2019	3/22/2019	2.07E-15	1.44E-14	1.11E-12	2.08E-11	4.16E-04
A33032119	3/21/2019	3/22/2019	4.80E-16	1.45E-14	1.11E-12	2.08E-11	9.81E-05
A23032219	3/22/2019	3/23/2019	5.67E-15	2.57E-14	1.11E-12	2.08E-11	1.14E-03
A33032219	3/22/2019	3/23/2019	2.83E-15	1.20E-14	1.11E-12	2.08E-11	5.68E-04
A23032319	3/23/2019	3/24/2019	2.06E-15	1.20E-14	1.11E-12	2.08E-11	4.14E-04
A33032319	3/23/2019	3/24/2019	0	1.09E-14	1.11E-12	2.08E-11	1.56E-06
A23032419	3/24/2019	3/25/2019	3.46E-15	1.02E-14	1.11E-12	2.08E-11	6.93E-04
A33032419	3/24/2019	3/25/2019	1.08E-14	1.62E-14	1.11E-12	2.08E-11	2.16E-03
A23032519	3/25/2019	3/26/2019	6.18E-15	1.39E-14	1.11E-12	2.08E-11	1.24E-03
A33032519	3/25/2019	3/26/2019	3.31E-15	1.41E-14	1.11E-12	2.08E-11	6.64E-04
A23032619	3/26/2019	3/27/2019	1.88E-15	1.75E-15	1.11E-12	2.08E-11	3.76E-04
A33032619	3/26/2019	3/27/2019	3.32E-15	2.29E-14	1.11E-12	2.08E-11	6.67E-04
A23032719	3/27/2019	3/28/2019	9.42E-16	1.04E-14	1.11E-12	2.08E-11	1.90E-04
A33032719	3/27/2019	3/28/2019	9.32E-16	1.46E-14	1.11E-12	2.08E-11	1.88E-04
A23032819	3/28/2019	3/29/2019	9.43E-16	1.15E-14	1.11E-12	2.08E-11	1.90E-04
A33032819	3/28/2019	3/29/2019	2.39E-15	1.14E-14	1.11E-12	2.08E-11	4.80E-04
A23032919	3/29/2019	3/30/2019	5.62E-15	4.96E-15	1.11E-12	2.08E-11	1.12E-03
A33032919	3/29/2019	3/30/2019	4.06E-15	1.65E-14	1.11E-12	2.08E-11	8.14E-04
A23033019	3/30/2019	3/31/2019	3.73E-15	3.58E-15	1.11E-12	2.08E-11	7.47E-04
A33033019	3/30/2019	3/31/2019	6.54E-15	2.34E-15	1.11E-12	2.08E-11	1.31E-03
A23033119	3/31/2019	4/1/2019	9.45E-15	1.28E-14	1.11E-12	2.08E-11	1.89E-03
A33033119	3/31/2019	4/1/2019	5.20E-15	9.91E-15	1.11E-12	2.08E-11	1.04E-03
A23040119	4/1/2019	4/2/2019	0	1.03E-14	1.11E-12	2.08E-11	1.47E-06
A33040119	4/1/2019	4/2/2019	6.60E-15	1.08E-14	1.11E-12	2.08E-11	1.32E-03
A23040219	4/2/2019	4/3/2019	5.05E-14	4.86E-15	1.11E-12	2.08E-11	1.01E-02
A33040219	4/2/2019	4/3/2019	3.91E-14	1.34E-14	1.11E-12	2.08E-11	7.82E-03
A23040319	4/3/2019	4/4/2019	4.49E-16	1.76E-14	1.11E-12	2.08E-11	9.23E-05
A33040319	4/3/2019	4/4/2019	4.45E-16	1.98E-14	1.11E-12	2.08E-11	9.18E-05
A23040419	4/4/2019	4/5/2019	0	1.74E-14	1.11E-12	2.08E-11	2.49E-06
A33040419	4/4/2019	4/5/2019	0	2.40E-14	1.11E-12	2.08E-11	3.43E-06
A23040519	4/5/2019	4/6/2019	0.00E+00	2.18E-14	1.11E-12	2.08E-11	3.11E-06

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A33040519	4/5/2019	4/6/2019	0	2.62E-14	1.11E-12	2.08E-11	3.74E-06
A23040619	4/6/2019	4/7/2019	3.51E-14	2.70E-14	1.11E-12	2.08E-11	7.02E-03
A33040619	4/6/2019	4/7/2019	1.65E-14	3.41E-14	1.11E-12	2.08E-11	3.30E-03
A23040719	4/7/2019	4/8/2019	7.04E-14	3.10E-14	1.11E-12	2.08E-11	1.41E-02
A33040719	4/7/2019	4/8/2019	1.02E-13	4.51E-14	1.11E-12	2.08E-11	2.04E-02
A23040819	4/8/2019	4/9/2019	1.20E-14	3.20E-14	1.11E-12	2.08E-11	2.40E-03
A33040819	4/8/2019	4/9/2019	6.23E-15	3.90E-14	1.11E-12	2.08E-11	1.25E-03
A23040919	4/9/2019	4/10/2019	6.93E-15	1.91E-14	1.11E-12	2.08E-11	1.39E-03
A33040919	4/9/2019	4/10/2019	3.68E-15	1.55E-14	1.11E-12	2.08E-11	7.38E-04
A23041019	4/10/2019	4/11/2019	4.31E-16	1.13E-14	1.11E-12	2.08E-11	8.78E-05
A33041019	4/10/2019	4/11/2019	4.47E-15	1.50E-14	1.11E-12	2.08E-11	8.96E-04
A23041119	4/11/2019	4/12/2019	7.79E-15	1.61E-14	1.11E-12	2.08E-11	1.56E-03
A33041119	4/11/2019	4/12/2019	1.94E-15	8.93E-15	1.11E-12	2.08E-11	3.89E-04
A23041219	4/12/2019	4/13/2019	4.95E-15	1.33E-14	1.11E-12	2.08E-11	9.92E-04
A33041219	4/12/2019	4/13/2019	1.97E-15	9.09E-15	1.11E-12	2.08E-11	3.95E-04
A23041319	4/13/2019	4/14/2019	2.06E-15	8.31E-15	1.11E-12	2.08E-11	4.13E-04
A33041319	4/13/2019	4/14/2019	2.06E-15	3.70E-15	1.11E-12	2.08E-11	4.13E-04
A23041419	4/14/2019	4/15/2019	0	1.84E-14	1.11E-12	2.08E-11	2.63E-06
A33041419	4/14/2019	4/15/2019	0	1.24E-14	1.11E-12	2.08E-11	1.77E-06
A23041519	4/15/2019	4/16/2019	0	1.97E-14	1.11E-12	2.08E-11	2.81E-06
A33041519	4/15/2019	4/16/2019	4.75E-15	1.49E-14	1.11E-12	2.08E-11	9.52E-04
A23041619	4/16/2019	4/17/2019	1.93E-15	1.99E-14	1.11E-12	2.08E-11	3.89E-04
A33041619	4/16/2019	4/17/2019	4.88E-15	3.19E-14	1.11E-12	2.08E-11	9.81E-04
A23041719	4/17/2019	4/18/2019	1.92E-15	1.99E-14	1.11E-12	2.08E-11	3.87E-04
A33041719	4/17/2019	4/18/2019	4.83E-15	3.38E-14	1.11E-12	2.08E-11	9.71E-04
A23041819	4/18/2019	4/19/2019	4.90E-16	1.53E-14	1.11E-12	2.08E-11	1.00E-04
A33041819	4/18/2019	4/19/2019	4.78E-16	2.23E-14	1.11E-12	2.08E-11	9.88E-05
A23041919	4/19/2019	4/20/2019	4.88E-15	1.09E-14	1.11E-12	2.08E-11	9.78E-04
A33041919	4/19/2019	4/20/2019	4.60E-16	1.55E-14	1.11E-12	2.08E-11	9.42E-05
A23042019	4/20/2019	4/21/2019	1.72E-15	2.68E-14	1.11E-12	2.08E-11	3.48E-04
A33042019	4/20/2019	4/21/2019	4.09E-16	1.80E-14	1.11E-12	2.08E-11	8.44E-05
A23042119	4/21/2019	4/22/2019	4.67E-16	1.58E-14	1.11E-12	2.08E-11	9.57E-05
A33042119	4/21/2019	4/22/2019	4.57E-16	2.25E-14	1.11E-12	2.08E-11	9.46E-05
A32042219	4/22/2019	4/23/2019	4.79E-15	2.15E-14	1.11E-12	2.08E-11	9.61E-04
A33042219	4/22/2019	4/23/2019	4.48E-16	1.97E-14	1.11E-12	2.08E-11	9.24E-05
A23042319	4/23/2019	4/24/2019	9.02E-16	3.73E-14	1.11E-12	2.08E-11	1.86E-04
A33042319	4/23/2019	4/24/2019	3.37E-15	1.20E-14	1.11E-12	2.08E-11	6.76E-04
A23042419	4/24/2019	4/25/2019	9.26E-16	1.48E-14	1.11E-12	2.08E-11	1.87E-04
A33042419	4/24/2019	4/25/2019	0	2.03E-14	1.11E-12	2.08E-11	2.90E-06
A23042519	4/25/2019	4/26/2019	2.36E-15	2.57E-14	1.11E-12	2.08E-11	4.76E-04
A33042519	4/25/2019	4/26/2019	9.14E-16	2.57E-14	1.11E-12	2.08E-11	1.86E-04
A23042619	4/26/2019	4/27/2019	0	2.26E-14	1.11E-12	2.08E-11	3.23E-06
A33042619	4/26/2019	4/27/2019	9.75E-16	1.80E-14	1.11E-12	2.08E-11	1.98E-04
A23042719	4/27/2019	4/27/2019	8.54E-14	1.06E-13	1.11E-12	2.08E-11	1.71E-02
A33042719	4/27/2019	4/27/2019	1.14E-13	4.65E-14	1.11E-12	2.08E-11	2.28E-02
A23042719 1455	4/27/2019	4/28/2019	0	4.34E-14	1.11E-12	2.08E-11	6.20E-06
A33042719 1500	4/27/2019	4/28/2019	7.05E-15	3.41E-14	1.11E-12	2.08E-11	1.41E-03
A23042819	4/28/2019	4/28/2019	1.36E-13	3.42E-14	1.11E-12	2.08E-11	2.72E-02
A33042819	4/28/2019	4/28/2019	8.20E-14	4.72E-14	1.11E-12	2.08E-11	1.64E-02
A23042819 1430	4/28/2019	4/29/2019	2.89E-15	2.47E-14	1.11E-12	2.08E-11	5.82E-04
A33042819 1435	4/28/2019	4/29/2019	4.64E-15	2.32E-14	1.11E-12	2.08E-11	9.31E-04
A23042919	4/29/2019	4/30/2019	2.36E-15	1.69E-14	1.11E-12	2.08E-11	4.74E-04
A33042919	4/29/2019	4/30/2019	0	3.63E-14	1.11E-12	2.08E-11	5.19E-06
A23043019	4/30/2019	5/1/2019	2.33E-15	1.78E-14	1.11E-12	2.08E-11	4.69E-04
A33043019	4/30/2019	5/1/2019	3.72E-15	3.03E-14	1.11E-12	2.08E-11	7.48E-04
A23050119	5/1/2019	5/2/2019	3.84E-15	1.05E-14	1.11E-12	2.08E-11	7.70E-04
A33050119	5/1/2019	5/2/2019	2.36E-15	2.68E-14	1.11E-12	2.08E-11	4.76E-04
A23050219	5/2/2019	5/3/2019	0	2.81E-14	1.11E-12	2.08E-11	4.01E-06
A33050219	5/2/2019	5/3/2019	0	1.80E-14	1.11E-12	2.08E-11	2.57E-06
A23050319	5/3/2019	5/4/2019	3.60E-15	1.90E-14	1.11E-12	2.08E-11	7.23E-04
A33050319	5/3/2019	5/4/2019	2.20E-15	2.91E-14	1.11E-12	2.08E-11	4.44E-04

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A23050419	5/4/2019	5/5/2019	0	2.02E-14	1.11E-12	2.08E-11	2.89E-06
A33050419	5/4/2019	5/5/2019	0	2.66E-14	1.11E-12	2.08E-11	3.80E-06
A23050519	5/5/2019	5/6/2019	0	1.62E-14	1.11E-12	2.08E-11	2.31E-06
A33050519	5/5/2019	5/6/2019	9.28E-16	2.73E-14	1.11E-12	2.08E-11	1.90E-04
A23050619	5/6/2019	5/7/2019	0	1.72E-14	1.11E-12	2.08E-11	2.46E-06
A33050619	5/6/2019	5/7/2019	5.61E-15	1.22E-14	1.11E-12	2.08E-11	1.12E-03
A23050719	5/7/2019	5/8/2019	0	2.26E-14	1.11E-12	2.08E-11	3.23E-06
A33050719	5/7/2019	5/8/2019	0	7.51E-15	1.11E-12	2.08E-11	1.07E-06
A23050819	5/8/2019	5/9/2019	5.16E-15	6.60E-15	1.11E-12	2.08E-11	1.03E-03
A33050819	5/8/2019	5/9/2019	9.32E-16	7.97E-15	1.11E-12	2.08E-11	1.88E-04
A23050919	5/9/2019	5/10/2019	9.51E-16	7.05E-15	1.11E-12	2.08E-11	1.91E-04
A33050919	5/9/2019	5/10/2019	2.38E-15	1.22E-14	1.11E-12	2.08E-11	4.78E-04
A23051019	5/10/2019	5/11/2019	2.50E-15	6.13E-15	1.11E-12	2.08E-11	5.01E-04
A33051019	5/10/2019	5/11/2019	9.92E-16	7.35E-15	1.11E-12	2.08E-11	1.99E-04
A23051119	5/11/2019	5/12/2019	9.30E-16	2.41E-14	1.11E-12	2.08E-11	1.89E-04
A33051119	5/11/2019	5/12/2019	0	1.36E-14	1.11E-12	2.08E-11	1.94E-06
A23051219	5/12/2019	5/13/2019	3.71E-15	8.70E-15	1.11E-12	2.08E-11	7.43E-04
A33051219	5/12/2019	5/13/2019	0	1.83E-14	1.11E-12	2.08E-11	2.61E-06
A23051319	5/13/2019	5/14/2019	9.08E-16	3.34E-14	1.11E-12	2.08E-11	1.86E-04
A33051319	5/13/2019	5/14/2019	0	1.13E-14	1.11E-12	2.08E-11	1.61E-06
A23051419	5/14/2019	5/15/2019	9.45E-16	8.08E-15	1.11E-12	2.08E-11	1.90E-04
A33051419	5/14/2019	5/15/2019	0	1.03E-14	1.11E-12	2.08E-11	1.47E-06
A23051519	5/15/2019	5/16/2019	1.40E-15	2.74E-14	1.11E-12	2.08E-11	2.84E-04
A33051519	5/15/2019	5/16/2019	1.41E-15	1.37E-14	1.11E-12	2.08E-11	2.84E-04
A23051619	5/16/2019	5/17/2019	0	9.13E-15	1.11E-12	2.08E-11	1.30E-06
A33051619	5/16/2019	5/17/2019	0	3.31E-14	1.11E-12	2.08E-11	4.73E-06
A23051719	5/17/2019	5/18/2019	6.92E-15	2.70E-14	1.11E-12	2.08E-11	1.39E-03
A33051719	5/17/2019	5/18/2019	2.29E-15	2.57E-14	1.11E-12	2.08E-11	4.62E-04
A23051819	5/18/2019	5/19/2019	5.66E-15	2.80E-14	1.11E-12	2.08E-11	1.14E-03
A33051819	5/18/2019	5/19/2019	0	2.95E-14	1.11E-12	2.08E-11	4.21E-06
A23051919	5/19/2019	5/20/2019	1.30E-15	2.56E-14	1.11E-12	2.08E-11	2.64E-04
A33051919	5/19/2019	5/20/2019	1.29E-15	3.44E-14	1.11E-12	2.08E-11	2.63E-04
A23052019	5/20/2019	5/21/2019	2.93E-15	2.16E-14	1.11E-12	2.08E-11	5.89E-04
A33052019	5/20/2019	5/21/2019	4.28E-15	2.31E-14	1.11E-12	2.08E-11	8.59E-04
A23052119	5/21/2019	5/22/2019	0	1.93E-14	1.11E-12	2.08E-11	2.76E-06
A33052119	5/21/2019	5/22/2019	1.42E-15	1.92E-14	1.11E-12	2.08E-11	2.87E-04
A23052219	5/22/2019	5/23/2019	0	1.96E-14	1.11E-12	2.08E-11	2.80E-06
A33052219	5/22/2019	5/23/2019	0	2.70E-14	1.11E-12	2.08E-11	3.86E-06
A23052319	5/23/2019	5/24/2019	1.90E-15	9.86E-15	1.11E-12	2.08E-11	3.81E-04
A33052319	5/23/2019	5/24/2019	4.44E-16	3.14E-14	1.11E-12	2.08E-11	9.33E-05
A23052419	5/24/2019	5/25/2019	3.63E-15	1.53E-14	1.11E-12	2.08E-11	7.28E-04
A33052419	5/24/2019	5/25/2019	0	1.45E-14	1.11E-12	2.08E-11	2.07E-06
A23052519	5/25/2019	5/26/2019	1.82E-15	1.67E-14	1.11E-12	2.08E-11	3.66E-04
A33052519	5/25/2019	5/26/2019	0	1.80E-14	1.11E-12	2.08E-11	2.57E-06
A23052619	5/26/2019	5/27/2019	4.55E-16	2.07E-14	1.11E-12	2.08E-11	9.40E-05
A33052619	5/26/2019	5/27/2019	4.75E-15	1.93E-14	1.11E-12	2.08E-11	9.53E-04
A23052719	5/27/2019	5/28/2019	4.44E-16	1.48E-14	1.11E-12	2.08E-11	9.09E-05
A33052719	5/27/2019	5/28/2019	4.47E-16	1.17E-14	1.11E-12	2.08E-11	9.11E-05
A23052819	5/28/2019	5/29/2019	3.33E-15	1.08E-14	1.11E-12	2.08E-11	6.68E-04
A33052819	5/28/2019	5/29/2019	4.66E-16	7.78E-15	1.11E-12	2.08E-11	9.43E-05
A23052919	5/29/2019	5/30/2019	0	1.84E-14	1.11E-12	2.08E-11	2.63E-06
A33052919	5/29/2019	5/30/2019	0	1.63E-14	1.11E-12	2.08E-11	2.33E-06
A23053019	5/30/2019	5/31/2019	0	1.42E-14	1.11E-12	2.08E-11	2.03E-06
A33053019	5/30/2019	5/31/2019	0	2.06E-14	1.11E-12	2.08E-11	2.94E-06
A23053119	5/31/2019	6/1/2019	0	2.07E-14	1.11E-12	2.08E-11	2.96E-06
A33053119	5/31/2019	6/1/2019	0	2.27E-14	1.11E-12	2.08E-11	3.24E-06
A23060119	6/1/2019	6/2/2019	0	1.92E-14	1.11E-12	2.08E-11	2.74E-06
A33060119	6/1/2019	6/2/2019	1.38E-15	2.02E-14	1.11E-12	2.08E-11	2.79E-04
A23060219	6/2/2019	6/3/2019	2.84E-15	1.62E-14	1.11E-12	2.08E-11	5.70E-04
A33060219	6/2/2019	6/3/2019	0	7.97E-15	1.11E-12	2.08E-11	1.14E-06
A23060319	6/3/2019	6/4/2019	0	1.63E-14	1.11E-12	2.08E-11	2.33E-06

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A33060319	6/3/2019	6/4/2019	0	1.95E-14	1.11E-12	2.08E-11	2.79E-06
A23060419	6/4/2019	6/5/2019	0	2.26E-14	1.11E-12	2.08E-11	3.23E-06
A33060419	6/4/2019	6/5/2019	4.24E-15	1.17E-14	1.11E-12	2.08E-11	8.50E-04
A23060519	6/5/2019	6/6/2019	0	1.76E-14	1.11E-12	2.08E-11	2.51E-06
A33060519	6/5/2019	6/6/2019	1.33E-18	0	1.11E-12	2.08E-11	2.66E-07
A23060619	6/6/2019	6/7/2019	1.42E-15	1.09E-14	1.11E-12	2.08E-11	2.86E-04
A33060619	6/6/2019	6/7/2019	5.70E-15	2.02E-14	1.11E-12	2.08E-11	1.14E-03
A23060719	6/7/2019	6/8/2019	0	2.84E-14	1.11E-12	2.08E-11	4.06E-06
A33060719	6/7/2019	6/8/2019	1.29E-15	2.25E-14	1.11E-12	2.08E-11	2.61E-04
A23060819	6/8/2019	6/9/2019	0	3.38E-14	1.11E-12	2.08E-11	4.83E-06
A33060819	6/8/2019	6/9/2019	0	2.71E-14	1.11E-12	2.08E-11	3.87E-06
A23060919	6/9/2019	6/10/2019	4.78E-15	1.91E-14	1.11E-12	2.08E-11	9.59E-04
A33060919	6/9/2019	6/10/2019	3.19E-15	1.33E-14	1.11E-12	2.08E-11	6.40E-04
A23061019	6/10/2019	6/11/2019	0	1.95E-14	1.11E-12	2.08E-11	2.79E-06
A33061019	6/10/2019	6/11/2019	0	1.43E-14	1.11E-12	2.08E-11	2.04E-06
A23061119	6/11/2019	6/12/2019	0	9.72E-15	1.11E-12	2.08E-11	1.39E-06
A33061119	6/11/2019	6/12/2019	0	1.41E-14	1.11E-12	2.08E-11	2.01E-06
A23061219	6/12/2019	6/13/2019	1.37E-15	1.59E-14	1.11E-12	2.08E-11	2.76E-04
A33061219	6/12/2019	6/13/2019	2.66E-15	1.42E-14	1.11E-12	2.08E-11	5.34E-04
A23061319	6/13/2019	6/14/2019	0	8.09E-15	1.11E-12	2.08E-11	1.16E-06
A33061319	6/13/2019	6/14/2019	0	1.82E-14	1.11E-12	2.08E-11	2.60E-06
A23061419	6/14/2019	6/15/2019	1.47E-15	1.27E-14	1.11E-12	2.08E-11	2.96E-04
A33061419	6/14/2019	6/15/2019	2.95E-15	2.35E-14	1.11E-12	2.08E-11	5.93E-04
A23061519	6/15/2019	6/16/2019	1.45E-15	2.22E-14	1.11E-12	2.08E-11	2.93E-04
A33061519	6/15/2019	6/16/2019	1.45E-15	9.20E-15	1.11E-12	2.08E-11	2.91E-04
A23061619	6/16/2019	6/17/2019	1.33E-15	1.14E-14	1.11E-12	2.08E-11	2.68E-04
A33061619	6/16/2019	6/17/2019	2.68E-15	2.03E-14	1.11E-12	2.08E-11	5.39E-04
A23061719	6/17/2019	6/18/2019	2.85E-15	3.66E-15	1.11E-12	2.08E-11	5.71E-04
A33061719	6/17/2019	6/18/2019	0	1.33E-14	1.11E-12	2.08E-11	1.90E-06
A23061819	6/18/2019	6/19/2019	2.84E-15	1.84E-14	1.11E-12	2.08E-11	5.71E-04
A33061819	6/18/2019	6/19/2019	0	1.33E-14	1.11E-12	2.08E-11	1.90E-06
A23061919	6/19/2019	6/20/2019	8.73E-16	2.95E-14	1.11E-12	2.08E-11	1.79E-04
A33061919	6/19/2019	6/20/2019	8.76E-16	2.84E-14	1.11E-12	2.08E-11	1.79E-04
A23062019	6/20/2019	6/21/2019	9.58E-16	2.37E-14	1.11E-12	2.08E-11	1.95E-04
A33062019	6/20/2019	6/21/2019	9.67E-16	1.55E-14	1.11E-12	2.08E-11	1.96E-04
A23062119	6/21/2019	6/22/2019	3.65E-15	1.72E-14	1.11E-12	2.08E-11	7.32E-04
A33062119	6/21/2019	6/22/2019	0	3.42E-14	1.11E-12	2.08E-11	4.89E-06
A23062219	6/22/2019	6/23/2019	6.71E-15	2.66E-14	1.11E-12	2.08E-11	1.35E-03
A33062219	6/22/2019	6/23/2019	9.13E-16	2.37E-14	1.11E-12	2.08E-11	1.86E-04
A23062319	6/23/2019	6/24/2019	2.25E-15	1.50E-14	1.11E-12	2.08E-11	4.52E-04
A33062319	6/23/2019	6/24/2019	2.23E-15	2.33E-14	1.11E-12	2.08E-11	4.49E-04
A23062419	6/24/2019	6/25/2019	8.05E-15	1.10E-14	1.11E-12	2.08E-11	1.61E-03
A33062419	6/24/2019	6/25/2019	8.03E-15	1.96E-14	1.11E-12	2.08E-11	1.61E-03
A23062519	6/25/2019	6/26/2019	2.31E-15	2.20E-14	1.11E-12	2.08E-11	4.65E-04
A33062519	6/25/2019	6/26/2019	3.73E-15	1.98E-14	1.11E-12	2.08E-11	7.49E-04
A23062619	6/26/2019	6/27/2019	0	1.49E-14	1.11E-12	2.08E-11	2.13E-06
A33062619	6/26/2019	6/27/2019	4.28E-15	1.99E-14	1.11E-12	2.08E-11	8.59E-04
A23062719	6/27/2019	6/28/2019	2.92E-15	1.83E-14	1.11E-12	2.08E-11	5.87E-04
A33062719	6/27/2019	6/28/2019	1.45E-15	2.06E-14	1.11E-12	2.08E-11	2.93E-04
A23062819	6/28/2019	6/29/2019	1.50E-15	2.24E-14	1.11E-12	2.08E-11	3.03E-04
A33062819	6/28/2019	6/29/2019	0	8.25E-15	1.11E-12	2.08E-11	1.18E-06
A23062919	6/29/2019	6/30/2019	2.84E-15	2.21E-14	1.11E-12	2.08E-11	5.71E-04
A33062919	6/29/2019	6/30/2019	1.40E-15	2.10E-14	1.11E-12	2.08E-11	2.83E-04
A23063019	6/30/2019	7/1/2019	3.96E-15	3.23E-14	1.11E-12	2.08E-11	7.97E-04
A33063019	6/30/2019	7/1/2019	0	3.58E-14	1.11E-12	2.08E-11	5.11E-06
A23070119	7/1/2019	7/2/2019	2.87E-15	3.75E-14	1.11E-12	2.08E-11	5.79E-04
A33070119	7/1/2019	7/2/2019	1.43E-15	2.58E-14	1.11E-12	2.08E-11	2.90E-04
A23070219	7/2/2019	7/3/2019	0	7.50E-15	1.11E-12	2.08E-11	1.07E-06
A33070219	7/2/2019	7/3/2019	2.87E-15	2.44E-14	1.11E-12	2.08E-11	5.77E-04
A23070319	7/3/2019	7/4/2019	9.58E-16	2.31E-14	1.11E-12	2.08E-11	1.95E-04
A33070319	7/3/2019	7/4/2019	9.46E-16	1.41E-14	1.11E-12	2.08E-11	1.91E-04

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A23070419	7/4/2019	7/5/2019	0	2.10E-14	1.11E-12	2.08E-11	3.00E-06
A33070419	7/4/2019	7/5/2019	0	2.98E-14	1.11E-12	2.08E-11	4.26E-06
A23070519	7/5/2019	7/6/2019	0	2.35E-14	1.11E-12	2.08E-11	3.36E-06
A33070519	7/5/2019	7/6/2019	0	2.45E-14	1.11E-12	2.08E-11	3.50E-06
A23070619	7/6/2019	7/7/2019	9.55E-16	2.64E-14	1.11E-12	2.08E-11	1.95E-04
A33070619	7/6/2019	7/7/2019	9.74E-16	2.01E-14	1.11E-12	2.08E-11	1.98E-04
A23070719	7/7/2019	7/8/2019	9.37E-16	1.50E-14	1.11E-12	2.08E-11	1.90E-04
A33070719	7/7/2019	7/8/2019	2.38E-15	2.36E-14	1.11E-12	2.08E-11	4.79E-04
A23070819	7/8/2019	7/9/2019	0	2.40E-14	1.11E-12	2.08E-11	3.43E-06
A33070819	7/8/2019	7/9/2019	5.30E-15	2.03E-14	1.11E-12	2.08E-11	1.06E-03
A23070919	7/9/2019	7/10/2019	2.41E-15	1.09E-14	1.11E-12	2.08E-11	4.84E-04
A33070919	7/9/2019	7/10/2019	0	2.30E-14	1.11E-12	2.08E-11	3.29E-06
A23071019	7/10/2019	7/11/2019	1.95E-15	2.50E-14	1.11E-12	2.08E-11	3.94E-04
A33071019	7/10/2019	7/11/2019	0	2.76E-14	1.11E-12	2.08E-11	3.94E-06
A23071119	7/11/2019	7/12/2019	4.86E-16	1.08E-14	1.11E-12	2.08E-11	9.87E-05
A33071119	7/11/2019	7/12/2019	0	1.43E-14	1.11E-12	2.08E-11	2.04E-06
A23071219	7/12/2019	7/13/2019	4.97E-16	9.92E-15	1.11E-12	2.08E-11	1.01E-04
A33071219	7/12/2019	7/13/2019	0	3.55E-14	1.11E-12	2.08E-11	5.07E-06
A23071319	7/13/2019	7/14/2019	0	2.21E-14	1.11E-12	2.08E-11	3.16E-06
A33071319	7/13/2019	7/14/2019	4.85E-16	2.30E-14	1.11E-12	2.08E-11	1.00E-04
A23071419	7/14/2019	7/15/2019	0	2.87E-14	1.11E-12	2.08E-11	4.10E-06
A33071419	7/14/2019	7/15/2019	0	3.05E-14	1.11E-12	2.08E-11	4.36E-06
A23071519	7/15/2019	7/16/2019	0	1.38E-14	1.11E-12	2.08E-11	1.97E-06
A33071519	7/15/2019	7/16/2019	0	2.88E-14	1.11E-12	2.08E-11	4.11E-06
A23071619	7/16/2019	7/17/2019	0	1.74E-14	1.11E-12	2.08E-11	2.49E-06
A33071619	7/16/2019	7/17/2019	2.01E-15	1.88E-14	1.11E-12	2.08E-11	4.05E-04
A23071719	7/17/2019	7/18/2019	2.84E-15	1.10E-14	1.11E-12	2.08E-11	5.70E-04
A33071719	7/17/2019	7/18/2019	0	1.55E-14	1.11E-12	2.08E-11	2.21E-06
A23071819	7/18/2019	7/19/2019	1.42E-15	1.23E-14	1.11E-12	2.08E-11	2.86E-04
A33071819	7/18/2019	7/19/2019	2.85E-15	1.76E-14	1.11E-12	2.08E-11	5.73E-04
A23071919	7/19/2019	7/20/2019	2.88E-15	1.00E-14	1.11E-12	2.08E-11	5.77E-04
A33071919	7/19/2019	7/20/2019	2.87E-15	1.22E-14	1.11E-12	2.08E-11	5.76E-04
A23072019	7/20/2019	7/21/2019	1.45E-15	2.17E-17	1.11E-12	2.08E-11	2.90E-04
A33072019	7/20/2019	7/21/2019	0	1.61E-14	1.11E-12	2.08E-11	2.30E-06
A23072119	7/21/2019	7/22/2019	2.63E-15	2.47E-15	1.11E-12	2.08E-11	5.26E-04
A33072119	7/21/2019	7/22/2019	0	1.89E-14	1.11E-12	2.08E-11	2.70E-06
A23072219	7/22/2019	7/23/2019	0	1.13E-14	1.11E-12	2.08E-11	1.61E-06
A33072219	7/22/2019	7/23/2019	4.37E-15	1.89E-14	1.11E-12	2.08E-11	8.77E-04
A23072319	7/23/2019	7/24/2019	1.63E-15	1.03E-14	1.11E-12	2.08E-11	3.27E-04
A33072319	7/23/2019	7/24/2019	0	2.08E-14	1.11E-12	2.08E-11	2.97E-06
A23072419	7/24/2019	7/25/2019	1.84E-15	2.39E-14	1.11E-12	2.08E-11	3.71E-04
A33072419	7/24/2019	7/25/2019	4.57E-15	2.02E-14	1.11E-12	2.08E-11	9.17E-04
A23072519	7/25/2019	7/26/2019	0	3.03E-14	1.11E-12	2.08E-11	4.33E-06
A33072519	7/25/2019	7/26/2019	0	2.26E-14	1.11E-12	2.08E-11	3.23E-06
A23072619	7/26/2019	7/27/2019	0	3.80E-14	1.11E-12	2.08E-11	5.43E-06
A33072619	7/26/2019	7/27/2019	4.97E-16	2.51E-14	1.11E-12	2.08E-11	1.03E-04
A23072719	7/27/2019	7/27/2019	0	1.46E-15	1.11E-12	2.08E-11	2.09E-07
A33072719	7/27/2019	7/28/2019	4.16E-16	1.78E-14	1.11E-12	2.08E-11	8.57E-05
A33072819	7/28/2019	7/29/2019	0	2.75E-14	1.11E-12	2.08E-11	3.93E-06
A33072919	7/29/2019	7/30/2019	4.57E-16	1.39E-14	1.11E-12	2.08E-11	9.34E-05
A33073019	7/30/2019	7/31/2019	0	2.26E-14	1.11E-12	2.08E-11	3.23E-06
A33073119	7/31/2019	8/1/2019	9.13E-16	3.11E-14	1.11E-12	2.08E-11	1.87E-04
A33080119	8/1/2019	8/2/2019	2.54E-15	1.70E-14	1.11E-12	2.08E-11	5.10E-04
A33080219	8/2/2019	8/3/2019	0	2.50E-14	1.11E-12	2.08E-11	3.57E-06
A33080319	8/3/2019	8/4/2019	0	2.17E-14	1.11E-12	2.08E-11	3.10E-06
A33080419	8/4/2019	8/5/2019	2.29E-15	3.34E-14	1.11E-12	2.08E-11	4.63E-04
A33080519	8/5/2019	8/6/2019	2.25E-15	4.02E-14	1.11E-12	2.08E-11	4.56E-04
A33080619	8/6/2019	8/7/2019	2.43E-15	2.29E-12	1.11E-12	2.08E-11	8.13E-04
A33080719	8/7/2019	8/8/2019	2.38E-15	3.33E-14	1.11E-12	2.08E-11	4.81E-04
A23080819	8/8/2019	8/9/2019	2.92E-15	3.27E-14	1.11E-12	2.08E-11	5.89E-04
A33080819	8/8/2019	8/9/2019	6.94E-15	2.93E-14	1.11E-12	2.08E-11	1.39E-03

Air Sample ID	Beginning Date	Ending Date	Conc Alpha µCi/ml	Conc Beta µCi/ml	Alpha Action Level µCi/ml	Beta Action Level µCi/ml	Total DACs
A23080919	8/9/2019	8/10/2019	9.71E-16	1.06E-14	1.11E-12	2.08E-11	1.96E-04
A33080919	8/9/2019	8/10/2019	0	1.63E-14	1.11E-12	2.08E-11	2.33E-06
A23081019	8/10/2019	8/11/2019	1.02E-16	2.08E-14	1.11E-12	2.08E-11	2.34E-05
A33081019	8/10/2019	8/11/2019	5.83E-15	1.59E-14	1.11E-12	2.08E-11	1.17E-03
A23081119	8/11/2019	8/12/2019	0	1.37E-14	1.11E-12	2.08E-11	1.96E-06
A33081119	8/11/2019	8/12/2019	0	1.17E-14	1.11E-12	2.08E-11	1.67E-06
A23081219	8/12/2019	8/13/2019	1.79E-15	3.66E-14	1.11E-12	2.08E-11	3.63E-04
A33081219	8/12/2019	8/13/2019	0	1.50E-14	1.11E-12	2.08E-11	2.14E-06
A23081319	8/13/2019	8/14/2019	3.83E-15	2.54E-14	1.11E-12	2.08E-11	7.70E-04
A33081319	8/13/2019	8/14/2019	2.40E-15	1.47E-14	1.11E-12	2.08E-11	4.82E-04

Attachment 2

TE 20-002, Radiological Assessment of the Startup and Testing of the 700C Fan

ISSUED

RADIOLOGICAL CONTROL TECHNICAL BASIS DOCUMENT OR TECHNICAL EVALUATION

Title: Radiological Assessment of the Startup and Testing of the 700C Fan	☐ **TBD** ☑ **TE**
	TBD/TE Number: TE 20-002
	Revision Number: 0
	Effective Date: 5/7/20

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Approval: RCDM (or designee): (Print/Sign) — Date

Evaluation Summary:

This document provides a description of the radiological evaluation and technical requirements connected with the startup of the 700C fan. Requirements are established to help in providing assurance that radiological impacts to site personnel are minimized and controlled, and compliance with 10 CFR 835 is maintained as outlined in WIPP's radiological procedures, including exposure to site personnel, site airborne radioactivity, and contamination control. The consideration of the possible erosion of salt to layers of much higher contamination concentration with the subsequent expulsion of associated activity is outside the scope of this document.

Radiological Assessment of the Startup and Testing of the 700C Fan

TE 20-002

This document provides a description of the radiological evaluation and technical requirements for the startup of the 700C fan. Requirements are established to help in providing assurance that radiological impacts to site personnel are minimized and controlled, and compliance with 10 CFR 835 is maintained as outlined in WIPP's radiological procedures, including exposure to site personnel, site airborne radioactivity, and contamination control. A Total Effective Dose (TED) of 100 mrem (from the summed internal and external doses) per year is the limit allowed to non-radiological workers and to the public. A Total Effective Dose (TED) of ≤ 150 mrem per year is WIPP's current administrative control limit for radiological workers on site. Typically, when the total DAC fraction is ≤ 0.02 DAC, protection of personnel from such low levels of airborne activity is not applicable. This is because individuals exposed to levels ≤ 0.02 DAC would be expected to receive ≤ 100 mrem Committed Effective Dose (CED) within a year.[1] However, over the first four hours of operation, the airborne concentration is calculated to be approximately 0.04 DAC, which is above the preferred level for non-radiological workers and the public. In addition the equilibrium re-dispersible soil deposition for an assumed 1E-04 resuspension and deposition constant is calculated to be about 7.6 dpm/100 cm^2. This includes other surfaces such as the surfaces of buildings. Since the 1E-04 factor is not well known but a best conservative estimate, the actual equilibrium re-dispersible soil deposition (dpm/100 cm^2) may be higher or lower than this value. Sporadic sprays and pieces of contaminated salt being expelled from the 700C fan exit point is neither included in this estimate nor in the other calculations in this document. The consideration of the possible erosion of salt to layers of much higher contamination concentration with the subsequent expulsion of associated activity is also not accounted for in the calculations nor is mitigation made for this possibility via radiological safety recommendations contained within this document.

On October 26, 2019 Radiological Control Technicians entered the horizontal ventilation duct adjacent to the 700C fan and performed surveys for fixed and removable contamination, collected air samples, and also collected salt samples that were analyzed at the WIPP Laboratory.

In compliance with 10 CFR 835, areas on the WIPP site are required to be posted as Airborne Radioactivity Areas (ARAs) when the levels reach ≥ 0.3 DAC. This evaluation shows that the predicted DAC levels outside the 700C fan will be less than or equal to 0.04 DAC within 100 feet of the exit point of 700C during the first four hours of operation. If the operation is hypothetically extrapolated to a year, the predicted DAC levels are less than 0.02 DAC within 100 feet of the exit point of the 700C fan.

See Attachment 1, Table 2. The calculated CED to an individual working without respiratory protection for 2,000 hours in an area with a DAC concentration of 0.02 DAC is 100 mrem CED. Regarding the calculation for a *time period of a year*, because no individual should be working around the 700 fans for anytime close to 2,000 hours, it is considered that no respiratory protection is needed under the present working conditions when the airborne radioactivity is ≤ 0.02 DAC. Monitoring around the exit point of the 700C fan will be done to ensure this. These calculations and the calculations in general contained within this document DO NOT APPLY if the surface contamination concentration increases (possibly through salt surfaces being eroded

[1] Committed Effective Dose (CED) is internal dose, which generally occurs from inhaling or ingesting radioactive material. Total Effective Dose (TED) is the summation of internal and external dose.

away to unknown concentrations beneath the present surface) or sprays or pieces of contaminated salt are expelled from the system.

This evaluation of the potential for surface contamination or personnel contamination is that the potential for contamination above the limits prescribed within 10 CFR 835 is small if there is no increase in surface contamination concentration (possibly through salt surfaces being eroded away to unknown concentrations beneath the present surface) AND if there are no sprays or pieces of salt are expelled from the system that are contaminated above the limits defined in 10 CFR 835. For unchanging conditions, the potential will be evaluated by assuming reasonable resuspension factors given the expected upper values predicted for airborne radioactivity. Verification will be done via appropriate sampling (for both airborne radioactivity and surface contamination) during the testing of the 700C fan for a minimum of 4 hours (total run time). However, this verification (or even longer term operations of several weeks) cannot be used to reliably predict long-term results. This is because of changing conditions, including increased moisture and subsequent gradual effects on the salt and increased air flow speed, resulting from the operation of the 700C fan. After the evaluation of the results are complete, further decisions will be made regarding further testing or operation of the 700C fan, and long-term monitoring and assessments to be done.

Any variation from the assumptions and requirements stated in this document will require a reevaluation of the radiological impacts and requirements as stated in this document.

Technical Discussion

During start-up and throughout the testing of the 700C fan, the exhaust will be redirected from the filter bank to an unfiltered exit from the system at the 700C fan effluent exhaust housing. The source term comes from the exhaust air which passes by Station A (the radioactivity from underground) and the radioactivity from entrainment of surface contamination deposited in the above ground duct system.

During testing, activities in the underground will be limited to ensure no upset condition could occur from operations. The Control Monitor Room (CMR) will be monitoring for any natural events (i.e. rock falls on emplaced waste) to ensure that any released airborne radioactivity would be detected in time to make the switch to filtered exhaust on the surface before contaminants reach the surface ventilation ducts.

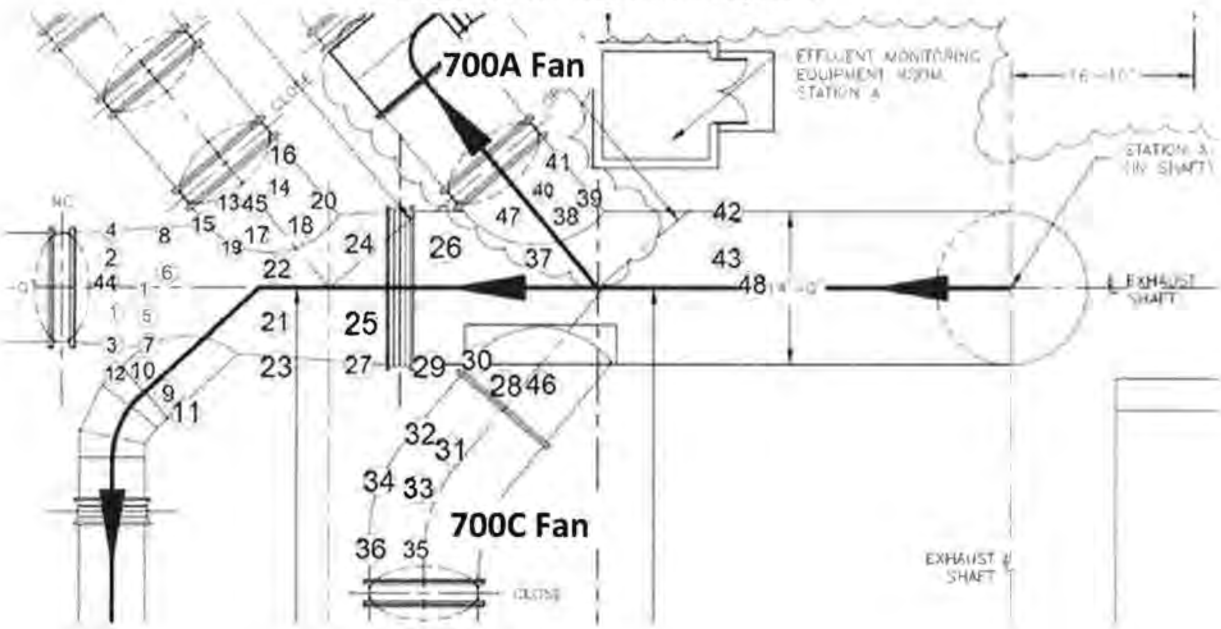
During operations, continuous air monitors and administrative protocols will be in place and functioning to detect any increase in airborne radioactivity in the underground, and that would alert operations to make the switch to filtered ventilation at the surface.

Activity from Residual Material in the Horizontal Duct

The removable activity results, as ascertained from swipe samples inside the applicable portion of the above ground ventilation system, were analyzed statistically in a conservative manner to calculate the quantity of radioactivity that might be expelled to the atmosphere during the testing phase of the 700C fan. There also exists a large amount (estimated to be approximately 60 tons) of salt that has built up over the years in the ventilation system, and it is known to contain a bounded, but as-yet-unquantified amount of radioactive contamination. This refers to the fact that the quantity of activity in the salt is not fully known because it has not all been sampled. The samples collected are primarily related to the surface contamination existing presently. However, the activity in the salt must be less than the calculated source term (around 0.114 Curies transuranic activity) known to have come from the underground and up the exhaust shaft (ascertained from the sampling results of Station A from the event in 2014).

Figure 1 shows the locations that were sampled.

Figure 1
Layout of the Ventilation System



A "smart" sampling technique was utilized for sample locations deemed to be more likely to be contaminated and yet still cover the areas of concern. Some areas could not be sampled and/or were too physically hazardous to be sampled.

> Most swipe samples were collected from the sides of the ducts with the expectation that those locations would be more representative of the contamination that occurred from the February 2014 incident. The reason for this is that the sides of the ducts have typically thinner salt buildup than the bottom of the ducts. The bottom of the ducts might have a lot of buildup of salt of lesser contamination since the 2014 event.

A total of 96 swipe samples were collected from 48 locations, including some directly on the salt buildup in the lower areas of the ducts. The higher of the two swipe samples from each location was selected for the data set that was statistically analyzed, to better ascertain the possible removable contamination. It is considered that salt of lesser contamination concentration might be on the surface layers covering those layers that are more representative of the salt contaminated as a result of the radiological incident in February 2014.

Swipe samples 7A, 7B, 9B, and 11B were not only counted on a Tennelec, but also analyzed via gamma spectroscopy by WIPP Laboratory. Using this method, the activities detected and measured were predominantly Am-241, as expected from the assumed nuclide distribution of the contamination. The total alpha activity for each of the samples was determined by comparing the gamma spectroscopy Am-241 dpm to the assumed nuclide distribution listed in Table 1.

The nuclide distribution being referred to here is the nuclide distribution, as determined by WIPP Laboratory, of a Station A air sample from the day of the event on February 14, 2014. The percentage of the total activity on the air filter was more than 92 percent Am-241.

Table 1
Station A Air Sample Data

Nuclide	Yield from Parent (if applicable)	pCi/sample	Most Important of Alpha or Beta Emission
U-233/234		2.12E+00	Alpha
U-235		1.23E-01	Alpha
U-238		3.30E-02	Alpha
Pu-238		5.58E+02	Alpha
Pu-239/240		1.29E+05	Alpha
Pu-241		1.72E+05	Beta
Am-241		3.56E+06	Alpha
Sr-90		1.20E+00	Beta
Y-90		1.20E+00	Beta
Co-60		3.58E+00	Beta
Cs-134		8.31E+00	Beta
Cs-137		8.96E+00	Beta
Ba-137m	9.46E-01	8.48E+00	
Th-228		7.38E+01	Alpha
Th-230		6.33E-01	Alpha
Th-232		5.79E-03	Alpha

The WIPP Laboratory results for swipe samples 7A, 7B, 9B, and 11B (corrected for total alpha dpm) were compared to the Tennelec results for the same samples to determine a reasonable self-absorption correction constant to apply to the Tennelec results for all the samples.

These four samples were of higher radioactivity, and therefore, could provide statistically better results. Since all the contamination was assumed to have the same nuclide distribution, the sampling location within the duct was of little importance for the determination of self-absorption. The fact that these samples were of higher activity and greater statistical significance was important for determining the degree of self-absorption.

Both parametric and nonparametric statistical analyses were performed to make a reasonable estimate of the top of the single-sided 99.5 percent confidence level of the average removable activity. Table 2 summarizes the results from samples numbered 24 and higher, deemed to be more applicable to the startup and testing of the 700C fan. (Also, see Figure 1.)

Table 2
Summary of Swipe Data Results Pertaining to 700C and Analysis (dpm/100 cm^2)

Maximum	Minimum	Median	Average	Top of Single-sided 99.5% Confidence Level for Average
295	0	23	60	280.1

Potential Activity Expelled Due to Resuspension

The single-sided top of the 99.5 percent confidence level for the estimate of the average was used as the contamination level for the leading surface of the dampers for the 700A and 700C fans. The damper surfaces are metal with an assumed thin layer of contaminated salt rather than inches or feet thick layers of salt found in other areas of the duct, in which contamination is encapsulated. Because of this, currently a resuspension factor of 1E-06 is applied to the possible contamination on the 700A and 700C dampers. The leading surface area of the dampers for the 700A and 700C fans are assumed to be about 5 feet in radius each, making a total effective surface area of about 157.1 square feet. The top of the single-sided 99.5 percent confidence level is estimated to be about 280 dpm/100 cm^2 (as listed in Table 2 above) for the evaluation of the radiological impact of the operation of the 700C fan. The area considered to be applicable to this evaluation is the area approximately between the center of exhaust shaft to the furthest edge of 700C and 700A ducts, along with the 700A and 700C branches to their respective dampers. (Also, see Attachment 3, Table 6.)

Selection of Resuspension Factors

Regarding the selection of the resuspension factor, the Radiation Protection Programs Guide (DOE G 441.1-1C) states that NUREG-1400, Air Sampling in the Workplace should be consulted to obtain pertinent technical information concerning regulatory guidance provided in the Radiation Protection Programs Guide. This guide states that air monitoring should be based on consideration of both actual and potential radiological conditions (DOE G 441.1-1C).

The DOE-HDBK-3010-94, "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities," provides a compilation of resuspension values based on experimental data from which airborne release fractions can be derived. NUREG/CR-2651, "Accident Generated Particulate Materials and Their Characteristics –A review of Background Information," discusses the characteristics of accident-generated particles to use in quantifying the airborne radioactivity released. The User's

Manual for RESRAD Version 6 (ANL/EAD-4) provides default parameters and calculations that are used in the RESRAD modeling for determining inhalation dose from airborne radioactivity generated from resuspension using EPA's Federal Guidance Report No. 11 dose conversion factors. (Note: the dose coefficients in this EDF were obtained from ICRP-68.)

Brock et al. (2002)[2] presented a study of resuspension activities at the Hanford site, under various decommissioning activities, which determined that the average resuspension factor was $5x10^{-5}$ m^{-1} for lapel air samplers, and $2.3x10^{-4}$ m^{-1} for grab samples (Brock et al. 2002). The activities reviewed included mechanical cutting, drilling, maintenance, and occasional jack hammering, with transuranic contamination levels as great as 17 million dpm/100 cm^2. The study demonstrated that the resuspension factor of $1x10^{-5}$ m^{-1} was adequate for estimating airborne radioactivity based on the null hypothesis.

Benchmarking with Mound's former air monitoring program, MD-80042, Op 2010 published in October 2000, specified resuspension factors as defined in the following table:

Degree of Disturbance	Example of Activities[3]	Resuspension Factor (m^{-1})
Low	Walking tours, inspections	1.0E-06
Moderate	Touching/handling contaminated objects (e.g.,	1.0E-05
High	Mechanical surface agitation via aggressive work	1.0E-04
Very High	Flame or plasma cutting	1.0E-03

Using the surface contamination concentration (dpm/100 cm^2) and assuming that the entire surface area is contaminated at that level, a total removable activity is calculated. Then using the resuspension factor, a total activity above the surface is calculated.

The resuspension factor (R) is defined by the ratio of the concentration of radioactive material in air (C_{air}) to the concentration (or level) of removable surface contamination (C_{surf}) (Brodsky 1980; Sutter 1982):

$$R(m^{-1}) = \frac{C_{air}(\ activity/m^3)}{C_{surf}(\ activity/m^2)}$$

This ratio may be affected by the chemical and physical properties of the contaminant and surface, the manner of deposition on the surface, the frequency and intensity of activities that physically disturb the surface, and the *humidity*.

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[2] Brock, TA, Strom, DJ, Stansbury, PS, An investigation of resuspension factors during the decommissioning, decontamination, and demolition of a U.S. Department of Energy facility. Quantitative Evaluation of Contamination Consequences under US DOE contract DE-AC06- 76RLO 1830, presented at the American Radiation Safety Conference and Exposition 16-20 June 2002.

[3] WIPP utilizes the principles in this table as a conservative measure for controlling day-to-day work.

Using the above equation we can estimate the equilibrium airborne radioactivity concentration (C_{air}) by:

$$C_{air} = C_{surf} \times R$$

Since the units of the resuspension factor are in terms of per meter, the assumption (for the calculation) is that all the activity is confined to a volume of air up to 1 meter from the contaminated surface, assuming equilibrium, so that if ventilation removes part of it, airborne activity is replaced so that the airborne activity concentration remains constant. Knowing that, an airborne activity concentration may be calculated considering the volume of air above the surface up to 1 meter. Using the total volume of air of concern (the CFM times the number of minutes) and knowing the airborne activity concentration, a total expelled activity may be calculated.

Potential Activity Expelled Due to Airborne Radioactivity as Measured by Station A

The average Total DAC from 1/1/2019 through 12/25/2019, as determined by Station A results, was about 0.003 DAC. (This was determined by using the highest total DAC for each day from all Station A sampling filter results entered into Radiological Control and Dosimetry's airborne concentration database.) With 240,000 CFM flowrate, the activity expelled per year would be about 5.3E-05 Curies. (This calculation makes the assumption that the airborne activity concentration does not decrease with increased airflow.)

Total DAC and Activity Expelled by the 700C Fan

The total DAC concentration within the plume being expelled is simply the sum of the contributions from resuspended activity and the activity coming from the exhaust shaft as measured by Station A. However, the resuspended activity is considered in four components, that is:

1. The chronic resuspension from the contaminated salt and surfaces encountered in the duct (other than the dampers),
2. The chronic resuspension from the contaminated salt on surfaces of the dampers,
3. The "puff release" from the contaminated salt and surfaces in the duct (other than the dampers), and
4. The "puff release" from surfaces of the dampers.

"Puff releases" are considered single occurances in which some activity is released almost immediately (within 15 minutes) after the 700C fan is first started.

Hypothetically, if the conditions did not change, the calculated activity expelled per year from the 700C fan is expected to be approximately 4.61E-03 Curies.

Attachment 1, Table 1 provides information regarding the total activity that might be expelled by 700C for over both a year[4] and over a 4 hour startup and testing period. A resuspension factor of 1E-04 was

[4] This is a hypothetical calculation that assumes that conditions do not change.

used for all surfaces other than the two dampers, for which a resuspension factor of 1E-06 was used. The activity on the dampers is assumed to be far less re-dispersible than the activity on the salt buildup within the ducts. In addition, the dampers have a small combined surface area when compared to the surface area of the ducts. (See also the section entitled "Selection of Resuspension Factors.")

Attachment 1, Table 2 lists the implied DAC fraction inside the duct, the calculated equilibrium DAC fraction within 100 feet of the exit point of the 700C fan, and the estimated equilibrium soil deposition (dpm/100 cm^2) for a 1E-04 resuspension and deposition constant.

Total DAC Concentration within the General Vicinity of the 700C Fan

The average exit velocity from the exhaust duct is about 1310 feet per minute (FPM), assuming a 240,000 CFM throughput.[5] The output is at an approximate 45 degree angle upward with the horizontal. More air comes out of the upper portion of the grid (the exit port) than the lower portion. A calculation is performed to determine the dilution factor within around 100 feet of the exit point of the 700C fan.

In Table 3 it can be seen that the center of the exit port is about 31.81 feet above grade.

Table 3
Physical Dimensions of 700C Exhaust Duct

Top of Screen elevation (ft)	3,449.98
Bottom of Screen elevation (ft)	3,434.05
Exhaust duct length (ft)	15.93
Width from Permit (ft)	11.5
Exhaust Area (ft^2)	183.195
Top of Fan Foundation elevation (ft)	3,410.21
Top of Screen above Grade (ft)	39.77
Bottom of Screen above grade (ft)	23.83
Center of exit (ft)	31.81
Equivalent Diameter (ft)	15.27

To roughly determine the DAC fraction in the general vicinity of the exit port of the 700C fan, a mathematical construct around the exit point of the 700C fan (an imaginary solid cylinder large enough to be representative of the area within 100 feet of the exit port) is conservatively used in this analysis. Therefore, it has a 100 foot radius (or a 200 foot diameter) and a height determined by the speed of the air being ≥ the minimum typical wind speed at the site.

> This was used because greater wind speeds than the minimum typical wind speed would characteristically remove and dilute the air from the 700C fan more than minimum typical wind speeds, and it is expected that the upward direction of the air from the 700C fan would cause

[5] See also Attachment 3, Equations 10 and 11.

much of the air to penetrate to this level or above. Reference is made to the most prevalent wind speeds from 2018 data, and at 32.8 feet above ground level, the wind speeds varied from about 3.71 (730 feet per minute) to 6.30 meters per second (1,240 feet per minute). See DOE/WIPP-19-3591 Waste Isolation Pilot Plant Annual Site Environmental Report for 2018 (Revision 0), Section 5.3.2, page 125.

To determine an effective height, the use of the central point from the 700C exit point is conservative since more air exits through the top portion than the lower portion. Slot push calculations show that even at 40 feet from the exhaust point, the centerline peak push jet velocity is between approximately 800 FPM and 1600 FPM, depending upon where (at a 45 degree upward angle) within the vertical centerline point in the plume, the peak velocity is calculated. (See also Attachment 2, Equation 2.) At a 45 degree upward angle, 40 feet from the central exit point amounts to about a 28.28 foot vertical height increase. Therefore, the top of the cylinder with a radius of 100 feet (or 200 feet in diameter) is 31.81 feet (that is, the center point of the exit) plus 28.28 feet, or 60.09 feet to the top of the solid cylinder. The vertical rectangular cross-sectional area is about 200 feet wide X 60.09 feet high, or about 12018 square feet. Using the most prevalent wind speeds from 2018 data at 32.8 feet above ground level, the wind speeds varied from about 3.71 to 6.30 meters per second.[6] The more conservative number for this calculation is 3.71 meters per second, or about 730.31 feet per minute. Through a cross-sectional area of 12,018 square feet, the wind provides about 8,776,925 CFM. For equilibrium mixing, the DAC concentration of the plume is reduced by 240,000/(240,000 + 8,776,925) ≈ 0.02662. (The assumption of equilibrium mixing is a conservative assumption since most of the plume from the 700C would typically be carried off by the outside wind currents above.) For the use of this factor, please also note the section *Calculation of Re-Dispersible Ground Deposition*.

Calculation of Re-Dispersible Ground Deposition

Since the output of the fan is strongly upward at an estimated 45 degree angle, it is expected that in most cases that most of the radioactive particles will be broadly dispersed considerably above ground level. To make a rough estimation of the degree of re-dispersible ground deposition, the conservative assumption is made that the mix of radioactive particles within the solid cylinder defined above is homogenous and that the rate of particle deposition and particle resuspension are in equilibrium, as is the assumption in typical resuspension calculations. Again, using the most prevalent wind speeds from 2018 data at 32.8 feet above ground level (varying from about 3.71 to 6.30 meters per second), it is expected that a resuspension factor of 1E-04 is appropriate, especially since the method assumes homogeneity for the calculation of the DAC fraction directly contributed to by the 700C fan. (Note that the particle size distribution is both unknown and may not be constant. A best estimate of 1E-04 was used for the resuspension factor. See also Attachment 3, Equation 12.) To calculate the expected re-dispersible ground deposition, the expected DAC concentration within the solid cylinder (100 feet radius and 60.09 feet high) around the 700C exit point is calculated first, as discussed previously. The output of the fan can be viewed as a process where the airborne concentration is being produced at a constant

[6] See DOE/WIPP-19-3591 Waste Isolation Pilot Plant Annual Site Environmental Report for 2018 (Revision 0), Section 5.3.2, page 125.

rate and "feeding" the process of deposition where the process of deposition and resuspension are in equilibrium. If equilibrium between ground deposition and resuspension is assumed, then the re-dispersible ground deposition would give rise to an activity concentration (due to resuspension) equal to the airborne activity that it was being exposed to because of the operation of the fan. Therefore, after equilibrium has been established, an individual near ground level would be exposed to approximately twice the airborne concentration predicted from the output of the fan alone. Utilization of the reduction factor calculated in the section Total DAC Concentration within the General Vicinity of the 700C Fan will predict about half of the airborne radioactivity concentration to which an individual at ground level would be exposed, and the doubling effect produced by re-dispersible ground deposition is considered in the values listed in Attachment 1, Table 2.

Attachment 1

Table 1
Activity Expelled by the 700C Fan
(over a year[7] and the initial 4 hours of operation[8])

Station A Chronic (Curies/year)	Station A Chronic (Curies/4 hours)
5.30E-05	2.42E-08
Resuspension Chronic (Curies/year)	**Resuspension Chronic (Curies/4 hours)**
4.56E-03	2.08E-06
Puff Release for Dampers (Curies/Year)	**Puff Release for Dampers (Curies/4 hours)**
1.84E-07	1.84E-07
Puff Release for Duct (Curies/Year)	**Puff Release for Duct (Curies/4 hours)**
3.63E-06	3.63E-06
Station A plus Resuspension plus Puff Releases (Curies/Year)	**Station A plus Resuspension plus Puff Releases (Curies/4 hours)**
4.61E-03	5.92E-06

[7] This is a hypothetical calculation which assumes that the conditions do not change.

[8] However, the four hour testing (or even longer term operations of several weeks) cannot be used to reliably predict long-term results. This is because of changing conditions, including increased moisture and subsequent gradual effects on the salt and increased air flow speed, resulting from the operation of the 700C fan.

Attachment 1

Table 2
DAC Fractions and Soil Deposition
(over a year[9] and the initial 4 hours of operation)

Implied DAC Fraction Inside Duct (Average Over 1 Year)	Implied DAC Fraction Inside Duct (Average Over 4 Hours)
0.258	0.726
Calculated Equilibrium DAC Fraction within 100 feet (Average Over 1 Year)	**Calculated Equilibrium DAC Fraction within 100 feet (Average Over 4 Hours)**
0.014	0.04
Equilibrium Re-dispersible Soil Deposition[10] for a 1E-04 Resuspension and Deposition Constant ($dpm/100\ cm^2$)	
7.6	

[9] This is a hypothetical calculation which assumes that the conditions do not change.
[10] This assumes an equilibrium state that is assumed exist over the time period of a year.

Equation 1

$$DAC_R = \frac{(C_{dpm/100\,cm^2})R_{m^{-1}}}{(H_{cm})(DAC_{Value})(2.22\,X\,10^8{}_{dpm/\mu Ci})}$$

Where:

- DAC_R = the equilibrium DAC concentration above a large surface due to resuspension.
- $C_{dpm/100\,cm^2}$ = the average contamination level on the surface being considered in terms of dpm/100 cm^2.
- $R_{m^{-1}}$ = the resuspension factor (per meter) chosen as per TBD 2017-002 "Technical Basis for Determining Air Sampling Requirements in Support of WP 12-RE0352." In NUREG 1400, the assumption (from a mathematical point of view) is that this resuspension factor is applicable to the airborne *equilibrium* concentration for the volume above the surface 1 meter in height.
- H_{cm} = the height in centimeters of the volume being considered. Using this method of calculation, the entire equilibrium activity is assumed to be confined to a volume of this height. This results in an increased calculated value (for heights less than 100 centimeters) than would be calculated from NUREG 1400 methodology. For heights greater than 100 centimeters, the calculated value would be less than that calculated from NUREG 1400 methodology.
- DAC_{Value} = the DAC value (for 1 DAC concentration) given in terms of µCi/ml by 10 CFR 835 for the nuclide being considered.
- $2.22\,X\,10^8{}_{dpm/\mu Ci}$ is a combined conversion factor.

  Since the contamination level on the surface is assumed to be in terms of dpm/100 cm^2, then to assess the total contamination on the surface being considered, the area of the surface in cm^2 must be divided by 100 to find the number of 100 cm^2 sections that make up the surface. The total number of 100 cm^2 sections may be multiplied times the average contamination level (in terms of dpm/100 cm^2) to find the total activity (or dpm) that exists on the surface. Also, the conversion factor includes the conversion from dpm to µCi, which is, 2.22 X 10^6 dpm/µCi. Finally, (2.22 X 10^6 dpm/µCi) (100) = 2.22 X 10^8 dpm/µCi, as a combined conversion constant.

Regarding Equation 1, note the following:

$$Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)} = \frac{(C_{dpm/100\,cm^2})\left({}^{A_{cm^2}}/{}_{100}\right)(R_{m^{-1}})}{(A_{cm^2})(H_{cm})(2.22\,X\,10^6{}_{dpm/\mu Ci})}$$

A_{cm^2} (the total contaminated surface area) is divided by 100 to calculate the number of 100 cm^2 surface elements within A_{cm^2}. When this is multiplied times $C_{dpm/100\,cm^2}$ (the average contamination level on the contaminated surface), the result is the total dpm on the contaminated surface. Upon multiplication of this result times $R_{m^{-1}}$ (which is the equilibrium resuspension fraction), the result is the total equilibrium dpm in the volume of air under consideration above the contaminated surface. When this result is divided by2.22 $X\ 10^6{}_{dpm/\mu Ci}$, the result is the total equilibrium µCi (due to resuspension) in the volume of air under consideration above the contaminated surface. $(A_{cm^2})(H_{cm})$ is simply the volume of air under consideration above the contaminated surface, where H_{cm} is the height of the volume above the surface, measured in centimeters. For these calculations, this distance from the surface was assumed to be 100 cm to conform to NUREG 1400 protocol.

When the airborne concentration $[Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)}]$ is divided by the DAC value (DAC_{Value}) for the radionuclide under consideration, the result is the equilibrium DAC concentration above a large surface due to resuspension, which has been designated as DAC_R in Equation 1.

Equation 2, for Slot Push Calculations[11]

$$V_x = \frac{1.2V_0}{\sqrt{\frac{aX}{B_0} + 0.41}}$$

V_0 = the push average exit air velocity
V_x = the peak push jet velocity at a distance X from the exit point
a = a coefficient characteristic of device expelling the air (generally about 0.13 for slots and pipes)
X = distance from the point of exit
B_0 = one of the following:

½ the total slot width (for free plane jet) if it is freely suspended well away from surfaces,
Equal to the slot width if next to a plane surface
For pipes with holes, B_0 is the width of a slot with equivalent area

[11] From section 3.8, starting page 3-19 ACGIH Industrial Ventilation Manual, 23rd Edition, 1998.

Radiological Assessment of the Startup and Testing of the 700C Fan
Rationale, Methods, Data, and Results

Attachment 3

TE 20-002

This attachment explains, in some detail, the rationale and methods utilized in this document.

Potential Activity Expelled Due to Airborne Radioactivity as Measured by Station A

The average Total DAC Fraction from 1/1/2019 through 12/25/2019, as determined by Station A results, was about 0.003 DAC (0.002964 DAC as used in the calculations in this document). (This was determined by using the highest total DAC for each day from all Station A sampling filter results entered into Radiological Control and Dosimetry's airborne concentration database.) With 240,000 CFM flowrate, the activity expelled per year would be about 5.3E-05 Curies within a year. (This calculation makes the assumption that the airborne activity concentration does not decrease with increased airflow.) Note that the DAC value being used is that for Pu-239, Pu-240, and Am-241, that is, 5E-12 μCi/ml.

A method for calculating this is to first calculate the number of milliliters per year expeled by the 700C fan.

Total ml/year expelled = 240,000 ft^3/min X 60 min/hr X 24 hrs/day X 365.24 days/year X $(12 \times 2.54)^3$ ml/ft^3 = 3.574E+15 ml/year

Then calculate the number of Curies within that volume expeled in a year.

Curies/year = 3.57435E+15 ml/year X the DAC value 5E-12 μCi/ml X Total DAC Fraction 0.002964 X 1E-06 Ci/μCi = 5.3E-05 Ci/year

Because this chronic activity expelled is considered a continuous process, the resuspended values may be calculated for any other time period by just dividing the time period in days by 365.24 days and then multiplying the result times the yearly value.

For example, for a four hour time period, it would be {(4/24) days/(365.24 days)} X 5.3E-05 = 2.4E-08 Curies.

Attachment 3

Calculating the Estimate for the Single-sided Top of the 99.5 Percent Confidence Level for the Average

There was a need to find a reasonable estimate of the surface contamination concentration in the duct. Therefore, sampling was performed inside the duct. An alpha self-absorption constant was calculated by comparing gamma spectroscopy results[12] (for some of the samples) for Am-241, correcting the Am-241 results for total alpha, and then comparing them to the Tennelec gross alpha results for the same samples.

Table 1 presents the assumed nuclide distribution[13] for the contamination.

Table 1

Station A DATA Total pCi → 3.862E+06		Based on Activity—NOT Weight			
Nuclide	pCi/ sample	Most Important of Alpha or Beta Emission	Fraction of Total	% of Total	Activity Ratios (Nuclide/Am-241)
U-233/234	2.12E+00	Alpha	5.49E-07	5.49E-05	5.96E-07
U-235	1.23E-01	Alpha	3.19E-08	3.19E-06	3.46E-08
U-238	3.30E-02	Alpha	8.55E-09	8.55E-07	9.27E-09
Pu-238	5.58E+02	Alpha	1.44E-04	1.44E-02	1.57E-04
Pu-239/240	1.29E+05	Alpha	3.34E-02	3.34E+00	3.62E-02
Pu-241	1.72E+05	Beta	4.45E-02	4.45E+00	4.83E-02
Am-241	3.56E+06	Alpha	9.22E-01	9.22E+01	1.00E+00
Sr-90	1.20E+00	Beta	3.11E-07	3.11E-05	3.37E-07
Y-90	1.20E+00	Beta	3.11E-07	3.11E-05	3.37E-07
Co-60	3.58E+00	Beta	9.27E-07	9.27E-05	1.01E-06
Cs-134	8.31E+00	Beta	2.15E-06	2.15E-04	2.33E-06

[12] From WIPP Laboratory
[13] Assumed nuclide distribution from WIPP Lab analysis results of a Station A filter from February 14, 2014.

Attachment 3

TE 20-002

Table 1

Station A DATA Total pCi → 3.862E+06		Based on Activity—NOT Weight			
Nuclide	pCi/ sample	Most Important of Alpha or Beta Emission	Fraction of Total	% of Total	Activity Ratios (Nuclide/Am-241)
Cs-137	8.96E+00	Beta	2.32E-06	2.32E-04	2.52E-06
Ba-137m	8.48E+00		2.19E-06	2.19E-04	2.38E-06
Th-228	7.38E+01	Alpha	1.91E-05	1.91E-03	2.07E-05
Th-230	6.33E-01	Alpha	1.64E-07	1.64E-05	1.78E-07
Th-232	5.79E-03	Alpha	1.50E-09	1.50E-07	1.63E-09
Sum of Alpha Emitters →	3.69E+06				

In Table 1, the significant alpha emitters within the assumed nuclide distribution were identified and their percentages computed. Since Am-241 represented more than 92 percent of the activity, the sum of the alpha emitters (dpm), including the value for Am-241 in Table 1 was divided by the Am-241 value, which is approximately 1.0364. This is the correction factor that was applied to the Am-241 gamma spectroscopy results to correct them for gross alpha dpm.

When the fraction 1.0364 is multiplied times the Am-241 activity, an approximation can be made for the total alpha activity of any sample for which the Am-241 activity is known. This is especially important if the activities of the other primary transuranics are not known.

The WIPP Laboratory results and their derived total alpha results from using the 1.0364 multiplier constant are listed in Table 2.

Attachment 3

Table 2

WIPP Laboratory Results Gamma Spec (2019-336)

Sample	Am-241 dpm	Total alpha corrected
7A	3,090	3,203
7B	2,790	2,892
11B	853	884.1
9B	1,610	1,669

The sums of the Tennelec results and the alpha corrected WIPP Laboratory results were computed to calculate cumulative correction factors for both division and multiplication, as follows:

Table 3

Swipe Sample	Tennelec Alpha dpm/sample	WIPP Lab Am-241 Results (Corrected for Total Alpha Activity) dpm/sample	Self-Absorption Correction Division Fraction for Wipe Sample	Self-Absorption Correction Multiplicative Value for Wipe Sample
7A	1,626.88	3,203	0.5080	1.969
7B	1,681.13	2,892	0.5814	1.720
11B	507.65	884.1	0.5742	1.741
9B	1,355.64	1,669	0.8124	1.231
SUMS →	**5,171.3**	**8,647**		

Cumulative Correction Factor (Division) → 0.5981 **Cumulative Correction Factor (Multiplicative) →** 1.672

Attachment 3

Equations 1

$$\frac{T}{C_D} = L \quad \rightarrow \quad C_D = \frac{T}{L}$$

$$C_M * T = L \quad \rightarrow \quad C_M = \frac{L}{T}$$

Where:
C_D = Cumulative Correction Factor (Division)
C_M = Cumulative Correction Factor (Multiplicative)
T = Tennelec Result (sum over comparison samples)
L = WIPP Lab Destructive Analysis Results (sum over comparison samples, corrected for total alpha according to assumed nuclide distribution from WIPP Lab analysis results of Station A filter from February 14, 2014)

The table below lists the higher of the Tennelec swipe sample results from each of the 48 locations sampled. **(Please note that sample numbers 24 through 48 were used in connection with contamination estimates in connection with the 700C fan.)** This led to the following sample corrections (using the cumulative correction factors previously calculated):

Table 4
(Final Corrected Results)

Sample Number	Tennelec Alpha dpm/sample	Corrected Tennelec Results Alpha dpm/sample
1	122.2	204.33
2	56.53	94.52
3	464.82	777.2

Attachment 3

Table 4
(Final Corrected Results)

Sample Number	Tennelec Alpha dpm/sample	Corrected Tennelec Results Alpha dpm/sample
4	307.79	514.6
5	133.62	223.4
6	47.97	80.21
7	1,681.13	2811
8	122.2	204.33
9	1,355.64	2267
10	30.84	51.57
11	507.65	848.8
12	227.84	381.0
13	79.37	132.7
14	27.98	46.78
15	45.11	75.43
16	207.86	347.6
17	50.82	84.97
18	13.7	22.91
19	102.22	170.9
20	127.91	213.9
21	19.42	32.47
22	13.7	22.91
23	187.87	314.1
24	53.68	89.76
25	5.14	8.594

Attachment 3

Table 4
(Final Corrected Results)

Sample Number	Tennelec Alpha dpm/sample	Corrected Tennelec Results Alpha dpm/sample
26	-0.57	-0.9531
27	42.26	70.66
28	5.14	8.594
29	19.42	32.47
30	42.26	70.66
31	176.45	295.0
32	136.48	228.2
33	13.7	22.91
34	82.23	137.5
35	36.55	61.11
36	119.35	199.6
37	2.28	3.812
38	5.14	8.594
39	65.1	108.9
40	2.28	3.812
41	33.69	56.33
42	2.28	3.812
43	2.28	3.812
44	7.99	13.36
45	16.56	27.69
46	10.85	18.14
47	7.99	13.36

Table 4

(Final Corrected Results)

Sample Number	Tennelec Alpha dpm/sample	Corrected Tennelec Results Alpha dpm/sample
48	2.28	3.812

To make better sense of the results, the Sign test non-parametric analysis and Gaussian parametric analysis (using the T-distribution) were performed with p = 0.005, to find the single-sided top of the 99.5 percent confidence level for the median and mean, respectively. Since the data has an unknown distribution, both types of analyses were performed. Sometimes, the values *roughly* predicted by the Sign test are higher than the values predicted by use of the T-distribution. It should be observed that the median was not a good predictor of the mean for this data set. The higher of the values from each analysis was chosen. For the 700C fan, sample points 24 through 48 were selected as being representative.

> The DCGLw value within the Sign Test[14] was not derived. Rather, it was chosen until the number of positive results (for the Sign test) are two greater (as a conservative action) than the critical value for the confidence level chosen. In this way, if the single-sided top of the 99.5 percent confidence level estimate for the value for the median is greater than the top of the confidence level (assuming a Gaussian distribution), then that value will be chosen rather than the value calculated assuming a Gaussian distribution.

However, the top of the confidence level was much greater assuming a Gaussian distribution, so it was chosen. **For the 700C fan, sample points 24 through 48 were selected as being representative.**

[14] See the MULTI-AGENCY RADIATION SURVEY AND SITE INVESTIGATION MANUAL, that is, NUREG-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1.

Table 5[15]

Summary of Swipe Data Results Pertaining to 700C and Analysis (dpm/100 cm^2)

Maximum	Minimum	Median	Average	Top of Single-sided 99.5% Confidence Level for Average
295	0	23	60	280.1

The contamination level, as used in this document, for the top of the single-sided 99.5 percent confidence level for the estimate of the average (via use of the T-distribution) is approximately 280.1 dpm/100 cm^2.

Surface Areas

The surface area of each Damper is described by the following equation:

Equation 2

$$A = \pi r^2$$

[15] Identical to Table 2 from the main text.

$$Area_{sq\ ft} = 3.14159\ (5^2) \approx 78.54\ sq\ ft$$

Where:

A is the area in square feet.

π is a constant approximately equal to 3.14159.

r is the radius in feet.

Therefore, the surface area of the two dampers combined is 2 X 78.54 sq ft = 157.1 sq ft.

The surface area in cm^2 of the remainder of the applicable ducts is described by the following equation:

Equation 3

$$Surface\ Area\ of\ an\ Open\ Cylinder = 2\pi rh$$

Where:

r is the radius of the cylinder (or duct) in feet.

π is a constant approximately equal to 3.14159.

h is the height in feet (or length in feet).

The dimensions of the ducts being considered are the following:

Table 6
Length, Radius, and Surface Area of Ducts

Duct Description	Length (ft)	Radius (ft)	Surface Area (ft^2)
Center of Shaft to Furthest Edge of 700A and 700C Branches	50.65	7	2 * π * 7 * 50.65 = 2,227.7
700A Branch (Center Line) to First Damper	4.4	5	2 * π * 5 * 4.4 = 138.2
700C Branch (Center Line) to First Damper	23.25	5	2 * π * 5 * 23.25 = 730.4
		Sum of Areas for Ducts:	**3,096.4 ft^2**

Total Removable Contamination and Puff Releases

The total removable activity on the applicable surfaces is the activity that is considered to be subject to the "puff" release. As a conservative measure, an activity equal to the total removable activity is regarded to be released within the first 15 minutes. (Also, the activity concentration just beneath the previous removable activity is considered to be of the same value and subject to resuspension evaluated via resuspension calculations.) Puff releases are the same for different time periods because they are singular events that happen when the fan first starts.

Attachment 3

The removable activity on applicable surfaces is calculated as follows:

Equation 4

$$Removable\ Activity_{dpm} = \frac{\left(Activity\ Concentration_{dpm}/_{100\ cm^2}\right)\left\{(A)(12 * 2.54)^2\ cm^2/_{ft^2}\right\}}{100\ cm^2\ units\ for\ activity\ concentration}$$

Activity Concentration is the activity concentration of concern, such as 280.1 dpm/100 cm^2.

A is the area in ft^2 with surface activity on it, such as 157.1 ft^2 for the two dampers or 3,096.3 ft^2 for the ducts.

The 100 cm^2 units for activity concentration in the surface area is needed because the contamination is defined in units of 100 cm^2.

Table 7

Puff Releases in Curies for Ducts and Dampers

Dampers (157.1 ft^2)	Ducts (3096.4 ft^2)
1.84E-07	3.63E-06

Resuspension Calculations

The total DAC concentration within the plume being expelled is simply the sum of the contributions from resuspended activity and the activity coming from the exhaust shaft as measured by Station A. However, the resuspended activity is considered in four components, that is:

1. The chronic resuspension from the contaminated salt and surfaces encountered in the duct (other than the dampers),
2. The chronic resuspension from the contaminated salt on surfaces of the dampers,
3. The "puff release" from the contaminated salt and surfaces in the duct (other than the dampers), and
4. The "puff release" from surfaces of the dampers.

The puff releases and the chronic activity expelled due to airborne radioactivity (as measured by Station A) have already been discussed. This section will detail the calculations regarding items 1 and 2 in the list above. Equations 6 or 7 (of this attachment) and variants are used extensively in the calculations in this document. The resuspension calculations utilize information that is known, rather than assuming that which is unknown. From the sampling and surveys that were performed within the duct, certain information is known about the surface contamination. Calculations based upon volumetric source term of the estimated 60 tons of salt cannot be meaningful when there is so much uncertainty regarding the level of the source term, and the source term (which includes volumetric contamination) cannot be reliably estimated via surface contamination samples. Calculations based upon an equilibrium airborne concentration existing above or at a specified distance from a contaminated surface (using NUREG 1400 protocol) do not consider the worst case, but rather a very conservative one (and a responsible way of handling these circumstances) that is appropriate for this situation in which there is uncertainty regarding the total source term within the salt and also regarding its dispersibility—but something is known about the surface contamination concentration.[16]

> This refers to the fact that the quantity of activity in the salt is not fully known because it has not all been sampled, nor have meaningful volumetric surveys been performed. However, the activity in the salt must be less than the calculated source term (around 0.114 Curies transuranic activity) known to have come from the underground and up the exhaust shaft. The samples collected are primarily related to the surface contamination existing presently. The volumetric contamination underneath the surface contamination is largely unknown. There is estimated to be around 60 tons of salt in the above ground ducts.

Please observe Equations 6 and 7. Calculations will follow.

Equation 6[17]

$$DAC_R = \frac{(C_{dpm/100\,cm^2})R_{m^{-1}}}{(H_{cm})(DAC_{Value})(2.22\,X\,10^8{}_{dpm/\mu Ci})}$$

Where:

- DAC_R = the equilibrium DAC concentration above a large surface due to resuspension.
- $C_{dpm/100\,cm^2}$ = the average contamination level on the surface being considered in terms of dpm/100 cm^2.
- $R_{m^{-1}}$ = the resuspension factor (per meter) chosen as per TBD 2017-002 "Technical Basis for Determining Air Sampling Requirements in Support of WP 12-RE0352." In NUREG 1400, the assumption (from a mathematical point of view) is that this resuspension factor is applicable to the airborne *equilibrium* concentration for the volume above the surface 1 meter in height.
- H_{cm} = the height in centimeters of the volume being considered. Using this method of calculation, the entire equilibrium activity is assumed to be confined to a volume of this height. This results in an increased calculated value (for heights less than 100 centimeters)

[16] In addition, testing of 4 hours (or even longer term operations of several weeks) cannot be used to reliably predict long-term results. This is because of changing conditions, including increased moisture and subsequent gradual effects on the salt and increased air flow speed, resulting from the operation of the 700C fan.
[17] For convenience, this equation and the notes following are repeated here (from Attachment 2, Equation 1).

circumstances) that is appropriate for this situation in which there is uncertainty regarding the total source term within the salt and also regarding its dispersibility—but something is known about the surface contamination concentration.[16]

> This refers to the fact that the quantity of activity in the salt is not fully known because it has not all been sampled, nor have meaningful volumetric surveys been performed. However, the activity in the salt must be less than the calculated source term (around 0.114 Curies transuranic activity) known to have come from the underground and up the exhaust shaft. The samples collected are primarily related to the surface contamination existing presently. The volumetric contamination underneath the surface contamination is largely unknown. There is estimated to be around 60 tons of salt in the above ground ducts.

Please observe Equations 6 and 7. Calculations will follow.

Equation 6[17]

$$DAC_R = \frac{(C_{dpm/100\ cm^2})R_{m^{-1}}}{(H_{cm})(DAC_{Value})(2.22\ X\ 10^8{}_{dpm/\mu Ci})}$$

Where:

- DAC_R = the equilibrium DAC concentration above a large surface due to resuspension.
- $C_{dpm/100\ cm^2}$ = the average contamination level on the surface being considered in terms of dpm/100 cm^2.
- $R_{m^{-1}}$ = the resuspension factor (per meter) chosen as per TBD 2017-002 "Technical Basis for Determining Air Sampling Requirements in Support of WP 12-RE0352." In NUREG 1400, the assumption (from a mathematical point of view) is that this resuspension factor is applicable to the airborne *equilibrium* concentration for the volume above the surface 1 meter in height.

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[16] In addition, testing of 4 hours (or even longer term operations of several weeks) cannot be used to reliably predict long-term results. This is because of changing conditions, including increased moisture and subsequent gradual effects on the salt and increased air flow speed, resulting from the operation of the 700C fan.

[17] For convenience, this equation and the notes following are repeated here (from Attachment 2, Equation 1).

- H_{cm} = the height in centimeters of the volume being considered. Using this method of calculation, the entire equilibrium activity is assumed to be confined to a volume of this height. This results in an increased calculated value (for heights less than 100 centimeters) than would be calculated from NUREG 1400 methodology. For heights greater than 100 centimeters, the calculated value would be less than that calculated from NUREG 1400 methodology.
- DAC_{Value} = the DAC value (for 1 DAC concentration) given in terms of µCi/ml by 10 CFR 835 for the nuclide being considered.
- $2.22\ X\ 10^8{}_{dpm/\mu Ci}$ is a combined conversion factor.

  Since the contamination level on the surface is assumed to be in terms of dpm/100 cm^2, then to assess the total contamination on the surface being considered, the area of the surface in cm^2 must be divided by 100 to find the number of 100 cm^2 sections that make up the surface. The total number of 100 cm^2 sections may be multiplied times the average contamination level (in terms of dpm/100 cm^2) to find the total activity (or dpm) that exists on the surface. Also, the conversion factor includes the conversion from dpm to µCi, which is, 2.22 X 10^6 dpm/µCi. Finally, (2.22 X 10^6 dpm/µCi) X 100) = 2.22 X 10^8 dpm/µCi, as a combined conversion constant.

Regarding Equation 6, note the following:

Equation 7

$$Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)} = \frac{(C_{dpm/100\ cm^2})\left({}^{A_{cm^2}}/_{100}\right)(R_{m^{-1}})}{(A_{cm^2})(H_{cm})(2.22\ X\ 10^6{}_{dpm/\mu Ci})} = \frac{(C_{dpm/100\ cm^2})(R_{m^{-1}})}{(H_{cm})(100)(2.22\ X\ 10^6{}_{dpm/\mu Ci})}$$

A_{cm^2} (the total contaminated surface area) is divided by 100 to calculate the number of 100 cm^2 surface elements within A_{cm^2}. When this is multiplied times $C_{dpm/100\ cm^2}$ (the average contamination level on the contaminated surface), the result is the total dpm on the contaminated surface. Upon multiplication of this result times $R_{m^{-1}}$ (which is the equilibrium resuspension fraction), the result is the total equilibrium dpm in the volume of air under consideration above the contaminated surface. When this result is divided by $2.22\ X\ 10^6{}_{dpm/\mu Ci}$, the result is the total equilibrium µCi (due to resuspension) in the volume of air under consideration above the contaminated surface. $(A_{cm^2})(H_{cm})$ is simply the volume of air under consideration above the contaminated surface, where H_{cm} is the height of the volume above the surface, measured in centimeters. For these calculations, this distance from the surface is assumed to be 100 cm to conform to NUREG 1400 protocol.

When the airborne concentration [$Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)}$] is divided by the DAC value (DAC_{Value}) for the radionuclide under consideration, the result is the equilibrium DAC concentration above a large surface due to resuspension, which has been designated as DAC_R in Equation 6.

Calculation of the resuspension activity from the dampers is as follows:

The resuspension factor is considered to be 1E-06 for the dampers. (The damper surfaces are metal with an assumed thin layer of contaminated salt rather than inches or feet thick layers of salt found in other areas of the duct, in which contamination is encapsulated. Because of this, currently a resuspension factor of 1E-06 is applied to the possible contamination on the 700A and 700C dampers.) To conform to NUREG 1400 protocol, H_{cm} = 100 cm. The DAC value is 5E-12 µCi/ml for Pu-239, Pu-240, and Am-241.

Then from Equation 7:

$$Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)} = \frac{(C_{dpm/100\ cm^2})(R_{m^{-1}})}{(H_{cm})(100)(2.22\ X\ 10^6{}_{dpm/\mu Ci})} = \frac{(280.1343)(1E{-}06)}{(100)(100)(2.22\ X\ 10^6{}_{dpm/\mu Ci})} = 1.262E\text{-}14\ \mu Ci/ml$$

As illustrated previously:

Total ml/year expelled = 240,000 ft^3/min X 60 min/hr X 24 hrs/day X365.24 days/year X (12 X 2.54)^3 ml/ft^3 = 3.574E+15 ml/year.

Then calculate the number of Curies within that volume expeled in a year.

Curies/year = 3.57435E+15 ml/year X the Airborne Concentration 1.2619E-14 µCi/ml X 1E-06 Ci/µCi = 4.51E-05 Ci/year. (When resuspension from the duct is greater than that from the dampers, the addition of this source term is a conservative measure.)

Attachment 3

Calculation of the resuspension activity from the ducts is as follows:

The resuspension factor is considered to be 1E-04 for the ducts.

Airborne Concentration:

From Equation 7:

$$Airborne\ Concentration_{\mu Ci/(ml\ or\ cm^3)} = \frac{(280.1343)(1E-04)}{(100)(100)(2.22\ X\ 10^6{}_{dpm/\mu Ci})} = 1.26\text{E-12 } \mu\text{Ci/ml}$$

As illustrated previously:

Total ml/year expelled = 240,000 ft^3/min X 60 min/hr X 24 hrs/day X365.24 days/year X $(12 \text{ X } 2.54)^3$ ml/ft^3 = 3.57435E+15 ml/year.

Then calculate the number of Curies within that volume expeled in a year.

Curies/year = 3.57435E+15 ml/year X the Airborne Concentration 1.26E-12 µCi/ml X 1E-06 Ci/µCi = 4.51E-03 Ci/year.

Table 8
Resuspension

Item	Curies per Year
Dampers	4.51E-05
Duct	4.51E-03
Totals	**4.56E-03**

Because resuspension of activity is considered a continuous process, the resuspended values may be calculated for any other time period by just dividing the time period in days by 365.24 days and then multiplying the result times the yearly value.

For example, for a four hour time period, it would be {(4/24) days/(365.24 days)} X 4.56E-03 = 2.08E-06 Curies.

Total Activity Expelled by the 700C Fan

At this point the total activity expelled may be determined by simply adding up the various source terms already calculated.

Table 9

Curies per Time Period

Time Period	Station A	Resuspension	Damper Puff	Duct Puff	Totals
Year	5.30E-05	4.56E-03	1.84E-07	3.63E-06	4.61E-03
4 Hours	2.42E-08	2.08E-06	1.84E-07	3.63E-06	5.92E-06

Airborne Radioactivity Concentration and DAC Fraction inside the Duct

Equations 8 and 9 of this attachment may be used to calculate the airborne radioactivity concentration and the DAC fraction inside the duct just before the air exits the duct. Both are of interest, but DAC Fraction is directly related to easily calculating Committed Effective Dose to anyone breathing air in which there is a specific known DAC fraction. In the case of Pu-239, Pu-240, and Am-241 (and a number of other nuclides), the DAC value is designed (per 10 CFR 835) to prevent anyone from exceeding the deterministic (or non-stochastic) dose limit of 50 rem before they reach a calculated stochastic dose of 5 rem. For internal dosimetry, the two types of doses would be distinguished and the actual stochastic and deterministic doses calculated.

Attachment 3

Equation 8

$$Airborne\ Concentration = \frac{Total\ Activity\ within\ the\ Volume\ of\ Air}{Volume\ of\ Air}$$

Where:

Total Activity within the Volume of Air is in terms of µCi.

Volume of Air is in terms of milliliters

Equation 9

$$DAC\ Fraction = \frac{Airborne\ Concentration}{DAC\ Value} = \frac{Total\ Activity\ within\ Volume\ of\ Air}{(DAC\ Value)(Volume\ of\ Air)}$$

Where:

Airborne Concentration is in terms of µCi/ml.

DAC Value is that value appropriate for the nuclides of concern, such as 5E-12 µCi/ml for Pu-239, Pu-240, and Am-241.

From Table 9, the Curie totals may be found. The conversion from Curies to microcuries is:

Microcuries (µCi) = Curies X 1E+06 µCi/Curie

Attachment 3

From this relationship the column entitled "Totals (µCi)" may be completed in Table 10.

The DAC fraction then is calculated as follows for the entries in Table 9. The first entry requires the volume for a year, and the last entry requires the volume for a four hour time frame.

As illustrated previously:

Total ml/year expelled = 240,000 ft^3/min X 60 min/hr X 24 hrs/day X365.24 days/year X $(12 \text{ X } 2.54)^3$ ml/ft^3 = 3.57435E+15 ml/year.

Microcuries (µCi) = Curies X 1E+06 µCi/Curie = 4.61E-03 Ci X 1E+06 = 4.61E+03 µCi

$$DAC\ Fraction = \frac{4.61E+03\ \mu Ci}{(5E-12\ \mu Ci/ml\ )(3.57435E+15\ ml)} = 0.258\ DAC$$

And also, total ml/4 hours expelled = 240,000 ft^3/min X 60 min/hr X 4 hrs X $(12 \text{ X } 2.54)^3$ ml/ft^3 = 1.631E+12 ml

Microcuries (µCi) = Curies X 1E+06 µCi/Curie = 5.92E-06 Ci X 1E+06 = 5.92 µCi

$$DAC\ Fraction = \frac{5.92\ \mu Ci}{(5E-12\ \mu Ci/ml)(1.63105E+12\ ml)} = 0.726$$

Table 10
Activity and DAC in Duct Time Period

Time Period	Totals (Ci)	Totals (µCi)	DAC Fraction in Duct
Year	4.61E-03	4.61E+03	0.258
4 Hours	5.92E-06	5.92	0.726

Total DAC Fraction within the General Vicinity of the 700C Fan

To roughly determine the DAC fraction in the general vicinity of the exit port of the 700C fan, a mathematical construct around the exit point of the 700C fan (an imaginary solid cylinder large enough to be representative of the area within 100 feet of the exit port) is conservatively used in this analysis. The effective throughput (CFM) of air from wind going through the area could be compared to the volume of air being expelled by the 700C fan to see what the dilution factor would be if equilibrium was assumed. To assume equilibrium is considered conservative because the fan delivers air upwardly at approximately 45 degrees with the horizontal, and upper wind currents would be expected to carry away *most of the particulate contamination* and disperse it before very much of it could reach the ground within a 100 foot radius or anywhere else on site.

Using the most prevalent wind speeds from 2018 data at 32.8 feet above ground level, the wind speeds varied from about 3.71 to 6.30 meters per second.[18] The more conservative number was used for this calculation, that is, 3.71 meters per second, because by use of this factor, the calculated effective throughput (CFM) of air from wind going through the area and the corresponding dilution factor would be reduced. The speed 3.71 meters per second is equivalent to 730.31 feet per minute.

$$Feet/min = (3.71\ meters/sec)(60\ sec/min)\left(\frac{100}{12 * 2.54}\right) feet/meter = \ 730.31\ feet/min$$

However, to calculate the effective volume throughput (CFM) of air from wind going through the area, an effective height of the cylinder must be estimated. To accomplish this, an analysis of how the air is blown upwardly was done, and from this when outside wind speed and the speed of the air exiting the 700C fan are compared, an effective "top" of the cylinder may be estimated. Slot push calculations show that even at 40 feet from the exhaust point, the centerline peak push jet velocity is between approximately 800 feet per minute (FPM) and 1,600 FPM, depending upon where (at a 45 degree upward angle) within the vertical centerline point in the plume, the peak velocity is calculated. Notice that 800 FPM is greater than the assumed wind speed of 730 feet per minute. The air from the 700C fan would be expected to penetrate at least this far, especially since much of the air at 40 feet would have a calculated centerline peak push jet velocity of 1,600 FPM. However, higher wind speeds would also be expected to dilute the output of the 700C even more. Therefore, this method of determining the effective height is considered conservative. Many of these calculations (around 120) were performed to get a sense of the airflow from the 700C exit point.

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[18] See DOE/WIPP-19-3591 Waste Isolation Pilot Plant Annual Site Environmental Report for 2018 (Revision 0), Section 5.3.2, page 125.

Attachment 3

Equation 10, for Slot Push Calculations[19]

$$V_x = \frac{1.2V_0}{\sqrt{\frac{aX}{B_0} + 0.41}}$$

V_0 = the push average exit air velocity
V_x = the peak push jet velocity at a distance X from the exit point
a = a coefficient characteristic of device expelling the air (generally about 0.13 for slots and pipes)
X = distance from the point of exit
B_0 = one of the following:

- ½ the total slot width (for free plane jet) if it is freely suspended well away from surfaces (and this constant was used for these calculations since the 700C exit point fits this criterion),
- Equal to the slot width if next to a plane surface
- For pipes with holes, B_0 is the width of a slot with equivalent area

It was observed that because of the design of the fan, more air goes out of the top of the 700C exit point than the lower portion of the exit. Therefore, it was assumed that 2/3 of the air goes out of the upper portion and 1/3 goes out of the lower portion. Centerline peak push jet velocities were performed for many distances using several categories.

[19] From section 3.8, starting page 3-19 ACGIH Industrial Ventilation Manual, 23rd Edition, 1998.

Attachment 3

A calculation was performed to find the average air speed at the 700C exit point as follows:

Equation 11

$$Average\ Air\ Speed = \frac{Flow\ Volume_{CFM}}{Exit\ Area_{ft^2}} = \frac{Flow\ Volume_{CFM}}{Exit\ Length_{ft} * Exit\ Width_{ft}}$$

$$= \frac{240{,}000_{ft^3}/_{min}}{15.93_{ft} * 11.5_{ft}} = 1310_{ft}/_{min}$$

Three Considerations for Evaluating the Airflow

1. The peak push jet velocity from the top half of the 700C exit.
   Most of the air is expected to come out of the top half of the exit and the assumed direction is approximately 45 degrees with the horizontal. Therefore, the peak push jet velocity calculated will likely be underestimated and may be better representative of an "effective" peak push jet velocity.
2. The peak push jet velocity from the 700C exit as a whole, as though the same amount of air comes out of the top half as the bottom half. This was done to get a better sense of the average peak push jet velocity, and to be able to make a better decision regarding the possible height of the mathematical cylinder.
3. The peak push jet velocity from the bottom half of the 700C exit.
   Since most of the air comes out of the top half of the exit and the assumed direction is approximately 45 degrees with the horizontal, it is expected that more air comes out of the top part of the bottom half of the exit point. Therefore, the peak push jet velocity calculated will likely be underestimated and may be better representative of an "effective" peak push jet velocity.

These three scenarios are calculated differently. Although around 120 cases were calculated, three of them were chosen as being particularly pertinent, and they were the ones for X = 40 feet, and calculated with slightly different parameters. The smallest of the peak push jet velocities determine the extremely conservative method of determining how far out the plume would penetrate the external air stream (wind). At 40 feet out it was still faster than the assumed external air speed. Therefore, the set of peak push jet velocities at 40 feet from the exit point apply. The calculation is illustrated, as follows:

Parameters and Calculations for the Top Half of the 700C Exit Point

The 700C exit point is about 15.93 feet long and 11.5 feet wide. When the top half is considered, the width (11.5 feet) becomes the length, and the width becomes ½ the length, or about 7.965 feet. The peak push jet velocity calculation from the top half of the 700C exit has the following parameters (see Equation 10):

$$V_0 = Average\ Air\ Speed = \frac{Flow\ Volume_{CFM}}{Exit\ Length_{ft} * Exit\ Width_{ft}} = \frac{\frac{2}{3} * 240{,}000_{CFM}}{11.5_{ft} * 7.965_{ft}} = 1{,}746.8\ FPM$$

- V_x = the peak push jet velocity at a distance X from the exit point (feet per minute)
- a = 0.13
- X = distance in feet from the point of exit = 40 feet
- B_0 = ½ times 7.965 feet = 3.9825 feet

$$V_x = \frac{1.2V_0}{\sqrt{\frac{aX}{B_0} + 0.41}} = \frac{1.2 * 1746.8}{\sqrt{\frac{0.13 * 40}{3.9825} + 0.41}} = 1{,}600.3\ FPM$$

Attachment 3

Parameters and Calculations for the Entire 700C Exit Point

The 700C exit point is about 15.93 feet long and 11.5 feet wide. The calculated peak push jet velocity calculation has the following parameters:

- V_0 = the push average exit air velocity = 1,310 feet/minute, as previously calculated
- V_x = the peak push jet velocity at a distance X from the exit point (feet per minute)
- a = 0.13
- X = distance in feet from the point of exit = 40 feet
- B_0 = ½ times 11.5 feet = 5.75 feet

$$V_x = \frac{1.2V_0}{\sqrt{\frac{aX}{B_0}} + 0.41} = \frac{1.2 * 1310}{\sqrt{\frac{0.13 * 40}{3.9825}} + 0.41} = 1{,}371\ FPM$$

Parameters and Calculations for the Bottom Half of the 700C Exit Point

The 700C exit point is about 15.93 feet long and 11.5 feet wide. When the bottom half is considered, the width (11.5 feet) becomes the length, and the width becomes ½ the length, or about 7.965 feet. The peak push jet velocity calculation from the bottom half of the 700C exit has the following parameters (see Equation 10):

$$V_0 = Average\ Air\ Speed = \frac{Flow\ Volume_{CFM}}{Exit\ Length_{ft} * Exit\ Width_{ft}} = \frac{\frac{1}{3} * 240{,}000_{CFM}}{11.5_{ft} * 7.965_{ft}} = 873.4\ FPM$$

- V_x = the peak push jet velocity at a distance X from the exit point (feet per minute)
- a = 0.13
- X = distance in feet from the point of exit = 40 feet
- B_0 = ½ times 7.965 feet = 3.9825 feet

Attachment 3

$$V_x = \frac{1.2V_0}{\sqrt{\frac{aX}{B_0} + 0.41}} = \frac{1.2 * 873.39}{\sqrt{\frac{0.13 * 40}{3.9825} + 0.41}} = 800.1\ FPM$$

Table 11

Peak Push Jet Velocities (feet/min) at 40 feet from 700C Exit, and Assumed Wind Speed (feet/min)

Top Half of 700C Exit	Whole 700C Exit	Bottom Half of 700C Exit	Assumed Wind Speed
1,600	1,371	800.1	730.3

As can be seen from Table 11, the peak push jet velocity calculated from the bottom half of the 700C exit was the least of the peak push velocities calculated for a distance of 40 feet (about 800 FPM), which is greater than wind velocity selected as being appropriate. Therefore, 40 feet upwardly from the 700C exit point (at 45 degrees with the horizontal) was used as a conservative factor. Using the trigonometric relationship y = r cos(Θ) for right triangles, where y = the vertical increase distance, r = 40 feet from the 700C exit point at a 45 degree angle with the horizontal, and Θ = 45 degrees, y may be calculated as y = 40 feet * cos(Θ) = 40 feet * 0.7071068 = 28.28 feet vertical increase in distance.

Since the air from the 700C exit is assumed to leave the exit at around a 45 degree angle, 40 feet at that angle would represent a change in height of about 28.28 feet upwardly.

In Table 12 it can be seen that the center of the exit port is about 31.81 feet above grade. Therefore, the top of the cylindrical mathematical construct is about 31.81 feet + 28.28 ft = 60.09 feet, as a conservative estimate for the effective top of the cylinder.

Table 12[20]

Physical Dimensions of 700C Exhaust Duct

Top of Screen elevation (ft)	3,449.98
Bottom of Screen elevation (ft)	3,434.05
Exhaust duct length (ft)	15.93
Width from Permit (ft)	11.5
Exhaust Area (ft^2)	183.195
Top of Fan Foundation elevation (ft)	3,410.21
Top of Screen above Grade (ft)	39.77
Bottom of Screen above grade (ft)	23.83
Center of exit (ft)	31.81
Equivalent Diameter (ft)	15.27

The dilution factor is not directly related to the volume of the cylinder, but rather the vertical cross-sectional area through which the outside wind blows. The CFM from the wind is compared to the CFM from the 700C fan to calculate the dilution factor. Through a cross-sectional area (200 feet wide X 60.09 feet high) of 12,018 square feet (that is, 200 feet X 60.9 feet X 730.31 feet/min for wind), the wind provides about 8,776,866 CFM. For equilibrium mixing, the DAC concentration of the plume is reduced by 240,000/(240,000 + 8,776,866) ≈ 0.02662.

The assumption of equilibrium mixing is a conservative assumption since most of the plume from the 700C would typically be carried off by the outside wind currents above.

This is the **dilution factor.** It may be multiplied times the DAC fraction in the duct (see Table 10 within this attachment) to find the conservative contribution to the airborne radioactivity that comes directly from the output of the 700C fan within about 100 feet of the fan (especially near

[20] Same as Table 3 from the front part of this document, and repeated here for convenience.

the ground surface), but not close to being within the plume. However, to better estimate the DAC fraction at ground level, deposition to and resuspension from the ground surface should be considered.

Re-dispersible Ground Deposition

Since the output of the fan is strongly upward at an estimated 45 degree angle, it is expected that in most cases that much of the radioactive plume will be broadly dispersed considerably above ground level. To make a rough estimation of the degree of re-dispersible ground deposition, the conservative assumption is made that the mix of radioactive particles within the solid cylinder defined above is homogenous and that the rate of particle deposition and particle resuspension are in equilibrium, as is the assumption in typical resuspension calculations. Again, using the most prevalent wind speeds from 2018 data at 32.8 feet above ground level (varying from about 3.71 to 6.30 meters per second), it is expected that a resuspension factor of 1E-04 is appropriate, especially since the method assumes homogeneity for the calculation of the DAC fraction directly contributed to by the 700C fan. (Note that the particle size distribution is both unknown and may not be constant. A best estimate of 1E-04 was used for the resuspension factor.) To calculate the expected ground deposition, the expected DAC concentration within the solid cylinder (100 feet radius and 60.09 feet high) around the 700C exit point is calculated first, as discussed previously. The output of the fan can be viewed as a process where the airborne concentration is being produced at a constant rate and "feeding" the process of deposition where the process of deposition and resuspension are in equilibrium at ground level. (This refers only to that activity that is removable and re-dispersible by the wind.)

It is assumed in this special case that the activity resuspended is carried away by the wind and not immediately deposited again. However, a situation of equilibrium exists because the 700C fan provides a constant small airborne activity above the ground very much like the situation of an equilibrium existing in which the activity resuspended is also deposited again to the same or nearby surface.

If equilibrium between re-dispersible ground deposition and resuspension is assumed, then the re-dispersible ground deposition would give rise to an activity concentration (due to resuspension) equal to the airborne activity that it was being exposed to because of the operation of the fan. Therefore, after equilibrium has been established, an individual near ground level would be exposed to approximately twice the airborne concentration predicted from the output of the fan alone. Utilization of the reduction factor (0.02662) alone provides the DAC fraction within 100 feet directly contributed to by the 700C fan. However, at ground level this calculation will predict about half of the airborne radioactivity concentration to which an individual at ground level would be exposed, and the doubling effect produced by ground deposition would double the predicted airborne concentration.

Table 13
DAC Fraction in Duct and within 100 Feet of 700C

Time Period	DAC Fraction in Duct	DAC Fraction Directly Contributed by 700C within 100 Feet	DAC Fraction at Ground Level within 100 Feet of 700C Fan
Year	0.258	0.0069	0.014
4 Hours	0.726	0.019	0.04

Calculation of Equilibrium Re-dispersible Activity Deposition

The equilibrium activity (in the context of this document) is that activity that is deposited on the soil surface (and other surfaces such as building surfaces) and is removable and subject to re-dispersion from the surface, typically by the wind. Equation 12 may be used, which is Equation 6 solved for the average dispersible contamination level on the surface (such as the soil, pavement, or building surfaces). (The particle sizes for this calculation are both unknown and are probably not constant. A best estimate of 1E-04 was used for the resuspension factor.)

Equation 12

$$C_{dpm/100\ cm^2} = \frac{(DAC_R)(H_{cm})(DAC_{Value})(2.22\ X\ 10^8{}_{dpm/\mu Ci})}{R_{m^{-1}}}$$

Where:

- DAC_R = the equilibrium DAC concentration above a large surface due to resuspension.
- $C_{dpm/100\ cm^2}$ = the average dispersible contamination level on the surface being considered in terms of dpm/100 cm^2.
- $R_{m^{-1}}$ = the resuspension factor (per meter) chosen as per TBD 2017-002 "Technical Basis for Determining Air Sampling Requirements in Support of WP 12-RE0352." In NUREG 1400, the assumption (from a mathematical point of view) is that this resuspension factor is applicable to the airborne *equilibrium* concentration for the volume above the surface 1 meter in height.
- H_{cm} = the height in centimeters of the volume being considered. Using this method of calculation, the entire equilibrium activity is assumed to be confined to a volume of this height. This results in an increased calculated value (for heights less than 100 centimeters) than would be calculated from NUREG 1400 methodology. For heights greater than 100 centimeters, the calculated value would be less than that calculated from NUREG 1400 methodology.
- DAC_{Value} = the DAC value (for 1 DAC concentration) given in terms of µCi/ml by 10 CFR 835 for the nuclide being considered.
- $2.22\ X\ 10^8{}_{dpm/\mu Ci}$ is a combined conversion factor.

  Since the contamination level on the surface is assumed to be in terms of dpm/100 cm^2, then to assess the total contamination on the surface being considered, the area of the surface in cm^2 must be divided by 100 to find the number of 100 cm^2 sections that make up the surface. The total number of 100 cm^2 sections may be multiplied times the average contamination level (in terms of dpm/100 cm^2) to find the total activity (or dpm) that exists on the surface. Also, the conversion factor includes the conversion from dpm to µCi, which is, 2.22 X 10^6 dpm/µCi. Finally, (2.22 X 10^6 dpm/µCi) X 100) = 2.22 X 10^8 dpm/µCi, as a combined conversion constant.

The DAC fraction (the average over a year) within 100 feet of 700C and directly contributed by the output of 700C is utilized in the calculation.

Attachment 3

Table 15 may be completed for $C_{dpm/100\ cm^2}$, that is, the Ground Deposition Subject to Resuspension, as follows:

$$C_{dpm/100\ cm^2} = \frac{(0.0069)(100)(5E-12)(2.22\ X\ 10^8{}_{dpm/\mu Ci})}{1E-04} = 7.6$$

Table 14
DAC Fraction in Duct, DAC Fraction within 100 Feet of 700C, and Dispersible Ground Deposition

Time Period	DAC Fraction in Duct	DAC Fraction Directly Contributed by 700C within 100 Feet	DAC Fraction at Ground Level within 100 Feet of 700C Fan	Ground Deposition Subject to Resuspension (dpm/100 cm^2)
Year	0.258	0.0069	0.014	7.6

Attachment 3

BC-RP-0129, Radiological Air Emissions Evaluation of the Restart of the 700 Fans for 40 CFR 61 Subpart H

Doc. ID Number	BC-RP-0129
Revision Number	Rev 2

Radiological Air Emissions Evaluation of the Restart of The 700 Fans for 40 CFR 61 Subpart H

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Revision History

Revision	Changes	Date
A	Issued for review	09/11/2019
0	Initial Issue	09/20/2019
1	Only address Subpart H. Create new document for other requirements.	01/17/2020
2	Incorporate comments	4/22/2020

1.0 Purpose

As a result of a radiological incident that occurred in February 2014, the existing Waste Isolation Pilot Plant (WIPP) underground ventilation system is operating in the filtration mode. In this mode the ventilation system is able to support only limited operations in both the "clean" and contaminated underground areas. In an effort to increase the underground air flow, project personnel are considering restarting of the 700 fans during periods when non-waste handling operations are being undertaken. This document provides an evaluation of such operations as they relate to radiological air emissions regulated under 40 CFR Part 61 Subpart H, "*National Emissions Standard for Emissions of Radionuclides other than Radon from Department of Energy Facilities",* hereafter referred to as Subpart H.

2.0 Discussion

The following discussion provides an overview of the air regulatory requirements and sampling considerations for restarting the 700 fans as required under Subpart H. More detailed analysis is provided in later sections.

There is a concern for exposure during the restart due to resuspension of residual contamination that was deposited in the duct upstream of the 700-fans when the dampers are opened. There is also a concern that the increased air flow approaching the flow rates that were available prior to the February 2014 incident will entrain residual contamination from the underground. However, it is believed that re-entrainment would be insignificant. One factor that would limit such re-entrainment is the fact that the mine is a salt mine and the salt tends to cover contamination and essentially fix it in place.

As written, Subpart H does not apply to disposal facilities subject to 40 CFR Part 191[1] such as the WIPP facility. However, the DOE and the EPA entered into a Memorandum of Understanding (MOU) in 1995, which stated that DOE will implement the requirements of Subpart H for WIPP until such time as the facility has completely closed.

The 700 fans are existing source equipment and have not been modified. However, as a result of the February 2014 incident the emissions from the 700-fans are expected to increase. Therefore, the fans would be considered new sources[2] due to an operational change. The monitoring criteria

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1 40 CFR 61.90

2 40 CFR 61.15(a) & (b) states that any physical or operation change which results in an increase in the rate of emissions is a modification and upon modification an existing source becomes a new source.

for a new source are those defined in 40 CFR 61.93(c), "radionuclide emissions from new point sources…" and which are:

- Radionuclide air emissions with a potential to emit[3] radionuclides greater than 1% of the 10 mrem/yr. Standard (0.1 mrem/yr.) conduct continuous sampling of these sources in accordance with ANSI N13.1-1999, *Sampling and Monitoring of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*.
- Radionuclide air emissions with a potential to emit radionuclides less than 1% of the 10 mrem/yr. Standard (0.1 mrem/yr.) conduct periodic confirmatory measurements to verify low emissions.

The Department of Energy (DOE) also implements the requirements in 40 CFR Part 191, Subpart A, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Wastes*, Subpart A, *Environmental Standards for Management and Storage*. The Environmental Protection Agency (EPA) developed and issued a Subpart A Guidance document to address 40 CFR 191 Subpart A. Section 3.0, *Emissions and Environmental Monitoring*, requires sampling in accordance with ANSI N13.1-1969. However, EPA, in Subpart H has allowed sources that still must comply with the 1969 version to upgrade to the 1999 version which generally provides a better (more representative) sample. The 1999 version of the Standard is a performance-based approach to selecting a representative sample location and installing a sampling system that meets the performance needs of the source. The 1969 version is a cook-book type approach where one set of requirements is applied to all sources regardless of the source's characteristics

Per 40 CFR 61.96, DOE is exempt from submitting an application for approval and startup of any new construction or modification to a source within an existing facility when the emissions from the new construction or modification is less than 0.1 mrem/yr. (1% of the Subpart H Standard). However, section 4.3 of the 40 CFR 191 Subpart A guidance[4] states that advance notification is not expected for construction or modification if the radiation dose caused by all the emissions from the new construction or modification is less than 1% of the Subpart A dose limits.[5] This report does not specifically address the 40 CFR 191 dose Standards.

Project personnel will also need to consider the on-site worker and 10 CFR 835. This regulation limits worker dose based on the Derived Air Concentration (DAC) method. This regulation is not

3 40 CFR 61.93 defines potential to emit radionuclides as the discharge of the effluent stream that would result if all pollution control equipment did not exist, but the facilities operations were otherwise normal.

4 EPA 402-R-97-001, "Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40CFR Part 191, Subpart A) at the Waste Isolation Pilot Plant (WIPP)"

5 40 CFR 191.03 Standards are 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other critical organs. There is no Standard in Part 191 that is directly related to air emissions.

included in the scope of this document.

3.0 Source Physical Characteristics

Both Subpart H and 40 CFR 191 require that dose determinations be made with EPA approved software. In the case of the 700 fans version 4 of CAP-88[6] will be utilized. To utilize the CAP-88 model, various source characteristics are needed. This section provides those characteristics.

The exhaust duct of the fans is rectangular in shape. Survey data was used to calculate the vertical length of the duct opening as well as the mid-point height of the release point. The survey data was transmitted via email; a copy is provided in Appendix A. The width of the fans is taken from the original NESHAP permit, as provided by email; a copy of the email is provided in Appendix A. From this information the area of the exhaust outlet, and the height at the center of the exhaust outlet have been calculated and are presented in Table 1. The equivalent diameter of a round duct with the same area as the rectangular duct is calculated as

$$Equivalent\ Diameter = 2\left(\sqrt{\frac{Area}{\pi}}\right)$$

And is also presented in Table 1.

Table 1: Physical Dimension of Exhaust Ducts

Fan	700 A	700 B	700 C
Top of Screen elevation (ft)	3446.29	3446.24	3449.98
Bottom of Screen elevation (ft)	3430.77	3430.72	3434.05
Exhaust duct length (ft)	15.52	15.52	15.93
Width from Permit (ft)	11.5	11.5	11.5
Exhaust Area (ft^2)	178.48	178.48	183.195
Top of Fan Foundation elevation (ft)	3411.62	3411.63	3410.21
Top of Screen above Grade (ft)	34.67	34.61	39.77
Bottom of Screen above grade (ft)	19.15	19.09	23.83
Center of exit (ft)	26.91	26.85	31.81
Equivalent Diameter (ft)	15.07	15.07	15.27

[6] CAP-88 is a dose model developed by EPA and recommended for calculating dose to the MEOSI in both 40 CFR 61 Subpart H and 40 CFR 191 Subpart A.

Using the Table 1 dimensions, a flowrate of 250,000 cfm and knowing that the fans exhaust at a 45 degree angle the vertical exhaust moment can be calculated. The following calculation is for the 700-C fan.

$$Exit\ velocity = \left(\frac{250{,}000\ \frac{ft^3}{min.}}{183.195\ ft^2} \right) = 1364.7\ \frac{ft}{min}$$

The upward or vertical momentum is the sin(45 deg) times the exit velocity.

$$upward\ momentum = \sin(45) \left(1364.7\ \frac{ft}{min} \right)$$

$$upward\ momentum = (0.707) \left(1364.7\ \frac{ft}{min} \right) = 964.96\ \frac{ft}{min}$$

The results for all three 700 fans are presented in Table 2.

Table 2: Physical Dimension of Exhaust Ducts

Fan	**700 A**	**700 B**	**700 C**
Flowrate (cfm)	250,000	250,000	250,000
Exhaust Area (ft^2)	178.48	178.48	183.195
Exit velocity (fpm)	1400.7	1400.7	1364.7
Upward momentum (fpm)	990.46	990.46	964.96

4.0 Dose to the Maximally Exposed Offsite Individual (MEOSI)

The dose at the maximally exposed offsite individual (MEOSI) from routine operations will be much less than the 10 mrem/yr. Standard of 40 CFR 61 Subpart H and the 25 mrem/yr. Standard in 40 CFR 191 Subpart A. Even though EPA 402-R-97-001, *Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40 CFR Part 191, Subpart*

A) at the Waste Isolation Pilot Plant, allows for consideration of occupancy factors for business, 40 CFR 61 Subpart H does not. 40 CFR 61 Subpart H includes the most limiting dose standard and the most conservative calculation approach and will therefore be used for the remainder of this section.

4.1 CAP-88 Input Values and Dose Conversion Factor Determination

The CAP-88 input values used in this evaluation are those selected by the WIPP site and used for the preparation of the site's compliance reports. Although the site is located in a Rural area, the Local default agricultural values are selected. These values assume that all the agriculture products consumed by the local population are home grown. The higher the percent of home grown agricultural consumed by the local population, the higher the estimated dose.

The Nuclide tab in the CAP-88 software provides defaults values for the Chemical Form (particulate or gas), lung clearance type (S, M and F) and particle size. For some radionuclides CAP-88 only presents one option (e.g. Pu-239 can only be modeled as a particulate), while for other radionuclides there maybe other options available. When DOE has site specific data to support changes from the default values, EPA allows these changes, but requires that the changes be discussed in the compliance reports[7]. When site specific data is not available the default values are used.

The lung clearance class is another variable that can affect the MEOSI dose. The lung clearance class, which is related to the chemical form of the radionuclide released from the process. The chemical form is generally a mixture. As with the particle size, lacking site specific data, the default value is selected.

Using the parameters given in Tables 1 and 2, dose conversion factors (DCF) were calculated using version 4 of CAP-88[8]. The CAP-88 file input and output files for a run with the isotopic matrix presented in Table 4 is provided in Appendix C. With the exception of the isotope selected and the radionuclide quantity released, which was set to 1 curie, all of the inputs remained the same for the DCF CAP-88 runs. To account for dose contributions resulting from ingrowth and daughter produces, the DCF CAP-88 runs were made with a single radionuclide, i.e. each radionuclide was modelled as a separate CAP-88 run. The results are tabulated in Table 3 for the primary isotopes of concern based on CAM alpha spectroscopic data from Station A. The DCFs were used to calculate the dose to a MEOSI located on the construction site for the

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[7] 40CFR61.94(7) states "The values used for all other user-supplied input parameters for the computer models (e.g., meteorological data) and the source of these data."

[8] CAP-88 is a dose model developed by EPA and recommended for calculating dose to the MEOSI in both 40 CFR 61 Subpart H and 40 CFR 191 Subpart A.

Safety Significant Confinement Ventilation System (SSCVS), which office space is located 335 meters East Southeast of the 700 fans.

Table 3: Dose Conversion Factors

Radionuclide	DCF (mrem/Ci)
Am-241†	4.45E+01
Cs-134	2.35E+00
Cs-137 1) †	5.12E+00
Pu-238†	4.92E+01
Pu-239/240†	5.37E+01
Pu-241	9.85E-01
Sr-90 2) †	4.11E+00
U-233/234†	3.38E+00
U-235	4.36E+00
U-238†	3.80E+00
Co-60	2.38E+00
Th-228	3.70E+01
Th-230	1.57E+01
Th-232	4.30E+01
1) Includes Ba-137m 2) Includes Y-90 † Nine anthropologic-linked radionuclides selected for routine rad NESHAPs tracking are based on underground repository inventory and dose contribution potential.	

4.2 Material at Risk Determination

As a conservative measure, the best estimate of the maximum quantity of contamination that may have been deposited during the February 2014 in the ducts leading to the 700 fans is found using the data for filters collected during that event. This extremely conservative approach assumes that all of the radiological material was deposited in the ducts and that none was emitted or collected on the HEPA filtration trains. In reality, it can be assumed that a major portion of the activity measured at the Station A filters was captured by the HEPA filters and was not deposited in the isolated ducts leading to the 700 fans.

Two filters were collected at Station A that were sampling upstream of the HEPA exhaust filters during the February 2014 event, IDs A230214140742 and A2302151400630. The first had a gross alpha reading of 8.2E+06 dpm and the second read 2.13E+05 dpm. These filters were sampling the exhaust stream prior to shift to filtration at 23:14 on 2/14/2014 and also after the shift to filtration. Assuming all of the activity was collected after the shift to filtration, the exhaust flowrate would be about 60,000 cfm. The sample flow rate is 2 cfm. The first filter sampled from 07:42 on 2/14 until 06:30 on 2/15 (1368 minutes) however only 436 minutes of that time was after the shift to filtration. The second filter sampled from 06:30 on 2/15 until 08:44 on 2/15 (134 minutes). Based on the Station A filters approximately 0.114 Ci of alpha material passed from the underground to the above ground ductwork (see the calculation below). All but 0.0017 Ci (as measured at the Station B sampler, downstream of the HEPA exhaust filters) was either deposited in the ducts or collected on the filtration system.

Filter A230214140742:

$$\frac{\left[\dfrac{8.20\text{E+06 } dpm}{2.22\text{E+12 } Ci/dpm}\right]}{(2\ cfm)(436\ min)} = 4.24\text{E-09 } Ci/ft^3$$

$$(4.24\text{E-09 } Ci/ft^3)(60{,}000 cfm)(436\ min) = 0.111\ Ci$$

Filter A230214140742:

$$\frac{\left[\dfrac{2.13\text{E+05 } dpm}{2.22\text{E+12 } Ci/dpm}\right]}{(2\ cfm)(134\ min)} = 3.58\text{E-10 } Ci/ft^3$$

$$(3.58\text{E-10 } Ci/ft^3)(60{,}000 cfm)(134\ min) = 0.003\ Ci$$

Sum of the two filters: 0.111 Ci + 0.003 Ci = 0.114 Ci

4.3 Source Term Calculation

Subpart H requires that dose determinations be made with EPA approved methods. For evaluations of emissions from new sources, EPA has provided an acceptable calculation method in Appendix D to 40 CFR 61. Using Appendix D, the estimated source emissions are found with the following equation

$$E = Q\ P_s\ C_f$$

Where E = Emissions (source term), curies

Q = Source inventory, curies

P_s = Physical State factor, dimensionless

C_f = Effluent Control Factor adjustment, dimensionless.

The Appendix D physical state factors (P_s) are given as:

a. 1 for gases;
b. 10^{-3} for liquids or particulate solids;
c. 10^{-6} for solids; and
d. If any nuclide is heated to a temperature of 100 degrees Celsius or more, boils at a temperature of 100 degrees Celsius or less, or is intentionally dispersed into the environment, it must be considered to be a gas.

In the case of the 700-fans there are no effluent controls, and the physical state factor would be that of a particulate solid or 10^{-3}. The source inventory is 0.114 curies. Upon substitution,

$$E = Q\ P_s\ C_f$$

$$E = (0.114\ \text{Ci})(1.0\text{E-}03)(1)$$

$$E = 1.14\text{E-}04\ \text{Ci}$$

Using Continuous Air Monitor (CAM) data, the site has developed a typical activity fraction which can be used to estimate the radionuclide specific activity that contributes to the curies remaining in the ducts, and which could be expected during future operations. A copy of the activity fraction provided by WIPP Radiological Control & Dosimetry group is provided in Appendix B. This radionuclide distribution is consistent with but does not necessarily replicate the anthropogenic-linked suite of routine air emission filter compliance sample analyses. The resulting activity breakdown for a release of 1.14E-04 curies is presented in Table 4.

Table 4: Release and Dose Estimate

Radionuclide	Activity Fraction [See App C]	Radionuclide Activity (Curies)	Dose Conversion Factor [From Table 3] (mrem/Ci)	Potential Dose (mrem)
U-233/234†	5.49E-07	6.258E-11	3.38	2.12E-10
U-235	3.19E-08	3.631E-12	4.36	1.58E-11
U-238†	8.55E-09	9.742E-13	3.8	3.70E-12
Pu-238†	1.44E-04	1.647E-08	49.2	8.10E-07
Pu-239/240†	3.34E-02	3.808E-06	53.7	2.05E-04
Pu-241†	4.45E-02	5.078E-06	0.985	5.00E-06
Am-241†	9.22E-01	1.051E-04	44.5	4.68E-03
Sr-90†	3.11E-07	3.543E-11	4.11	1.46E-10
Y-90	3.11E-07	3.543E-11	NA	0.00E+00
Co-60	9.27E-07	1.057E-10	2.38	2.52E-10
Cs-134	2.15E-06	2.453E-10	2.35	5.76E-10
Cs-137†	2.32E-06	2.645E-10	5.12	1.35E-09
Ba-137m	2.19E-06	2.502E-10	NA	0.00E+00
Th-228	1.91E-05	2.179E-09	37	8.06E-08
Th-230	1.64E-07	1.869E-11	15.7	2.93E-10
Th-232	1.50E-09	1.709E-13	43	7.35E-12
	Total	1.14E-04		4.89E-03

† Nine anthropologically linked radionuclides selected for routine rad NESHAPs tracking are based on underground repository inventory and dose contribution potential

4.4 Dose Calculation

Dose estimates at the MEOSI were performed with two methods. The first method is to apply the DCFs to the radionuclide specific activity and then sum the resulting mrem values. This method is presented Table 4.

A second method is to input each of the radionuclide specific activities from Table 4 into the CAP-88 software and then execute that run. The input and output files for this method are presented in Appendix C.

The results from both methods each yielded a total estimated dose to a MEOSI located 335 meters East Southeast of the 700 fans of 4.89E-03 mrem.

Using a highly unlikely but conservative assumption, that all 0.114 Ci was deposited in the ducts, the dose at the MEOSI using the EPA approved Appendix D method for estimating source term would be 4.89E-03 mrem, which is less than the 10 mrem/yr. standard. This dose is also less than 0.1 mrem and as a result:

- The source will remain a minor source requiring periodic confirmatory measurements to verify low emissions, and
- Prior EPA approval to operate the new source is not required under either Subpart H
- Under 40 CFR Part 191, notification is only required when a dose limit in Subpart A will be exceeded by the modification. This report only addresses the air pathway. There is no limit in Subpart A of 40CFR191 that is specific to air emissions.

5.0 Sampling Requirements

Based on the evaluation presented in the previous sections, the source will remain a minor source with a MEOSI dose less than 0.1 mrem/yr. Under the Subpart H regulations such a source would be required to perform periodic confirmatory measurements to ensure emissions remain low. There is no requirement for minor sources to upgrade to the ANSI N13-1999 Standard.

Since the Station A samplers will not measure any material that has been deposited in the ducts branching to the 700 fans, provisions should be made to sample the exhaust of the 700 fans when each fan is restarted. This can be accomplished with open faced samplers or continuous monitors, provided that monitor filtration media is radio-chemically analyzed for routine rad NESHAP isotopes. Since the 700 fans are minor sources Subpart H would not impose ANSI N13.1-1999. The 40 CFR 191 Subpart A Guidance document[9] allows for the use of the shrouded probe and ANSI N13.1-1969. Basically N13.1-1969 requires a representative sample. Air exiting the 700 fans should be well mixed, however because of the centrifugal nature of the fans there may be some particle separation. Therefore, it is suggested that two samplers be utilized, placing one near the top of the exhaust exit and the other near the bottom. Both should be placed

[9] EPA 402-R-97-001, "Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40CFR Part 191, Subpart A) at the Waste Isolation Pilot Plant (WIIP)"

horizontally near the center of the exhaust duct.

For long term operations, the periodic confirmatory measures criteria can be met with Station A, operated in accordance with the site's periodic confirmatory measurements program and periodic sampling of 700 fan exhaust air (e.g., monthly or more frequent smears of the face of the fan exhaust screen). Using these measures, Station A sampling results can be used to estimate emissions from the underground operations and the periodic smears would provide assurance that the resuspension and release of the material deposited in the ducts remains low. Since the smears will only provide an indication that the emissions remined low, it is suggested that an ambient sampler be place at the MEOSI location to provide a definitive indication of the MEOSI exposure.

6.0 Conclusions

From a 40 CFR 61 Subpart H air emission perspective, restart of the 700 fans will result in emissions well below any regulatory thresholds. The estimated dose due to resuspension of deposited material is conservatively estimated to be 4.89E-03 mrem/yr.

Resuspension of material deposited in the ducts can be addressed by sampling at the 700-fan exit duct with two open face samplers or continuous monitors. Station A should be operated during the initial restart. For long term operations, periodic sampling with Station A along with regular (at least monthly) smears of the fan exhaust screen would meet the regulatory sampling requirements.

Appendix A
Data Transmittals

FW: 700-Series Fan Exhaust Screens

FW: 700-Series Fan Exhaust Screens

Urquidez, Ashley - RES
Sent: Monday, June 03, 2019 11:38 AM
To: Picazo, Esteban - RES; Jones, Stewart - RES; Farnsworth, Jill - WRES; Vajda, Josh - RES; Madl, Larry - WRES

FYI.

Thank you,

Ashley Urquidez
Permitting and Technical Services
AECOM Management Services – Regulatory Environmental Services
A Nuclear Waste Partnership LLC Affiliate Company
Contractor to the U.S. Department of Energy
400-2 Cascades #203
Carlsbad, NM 88220
Office (Cascades): 575.234.3229
Cell: 575.302.3857
Fax: 575.234.3331
Email: ashley.urquidez@wipp.ws
Web: http://www.wipp.energy.gov/

This message was made with recycled electrons.

From: Zimmerly, Ben (Ty) - NWP <BenTy.Zimmerly@wipp.ws>
Sent: Monday, June 03, 2019 9:53 AM
To: Urquidez, Ashley - RES <Ashley.Urquidez@wipp.ws>
Cc: Davis, Jaci - NWP <Jaci.Davis@wipp.ws>; Carrasco, Rey - NWP <Rey.Carrasco@wipp.ws>
Subject: 700-Series Fan Exhaust Screens

Ashley,

We were finally able to survey the 700-Series fan exhaust screens. The elevations are as shown below.

700-A Top of screen = 3446.29
Bottom of screen = 3430.77
Top of fan foundation = 3411.62

700-B Top of screen = 3446.24
Bottom of screen = 3430.72
Top of fan foundation = 3411.63

700-C Top of screen = 3449.98
Bottom of screen = 3434.05
Top of fan foundation = 3410.21

The screen shots were to the northeast sides for 700-A and B and to the west side of 700-C.

FW: 700-Series Fan Exhaust Screens

Please let me know if you have any questions.

Ben "Ty" Zimmerly
Mine Engineering
575-234-8927
Waste Isolation Pilot Plant
Nuclear Waste Partnership LLC
Contractor to the U.S. Department of Energy

Tuesday, September 10, 2019 at 2:15:15 PM Eastern Daylight Time

Subject: RE: [EXTERNAL] Re: [EXTERNAL] Re: Contact info
Date: Friday, August 30, 2019 at 11:16:35 AM Eastern Daylight Time
From: Urquidez, Ashley - RES
To: Brent Blunt, Farnsworth, Jill - WRES
CC: Davis, Jaci - NWP, Chavez, Rick - RES

All,
According to the original NESHAP Permit Application, the dimensions of the fans were estimated at 11.5 ft x 15.5 ft at a height above grade of 34.5 ft.

I believe this estimate was for the 700-A and 700-B fans though, before 700-C fans was added.

Thank you,

Ashley Urquidez
Permitting and Technical Services
AECOM Management Services – Regulatory Environmental Services
A Nuclear Waste Partnership LLC Affiliate Company
Contractor to the U.S. Department of Energy
400-2 Cascades #203
Carlsbad, NM 88220
Office (Cascades): 575.234.3229
Cell: 575.302.3857
Fax: 575.234.3331
Email: ashley.urquidez@wipp.ws
Web: http://www.wipp.energy.gov/

This message was made with recycled electrons.

From: Brent Blunt <brentblunt@me.com>
Sent: Friday, August 30, 2019 7:56 AM
To: Farnsworth, Jill - WRES <Jill.Farnsworth@wipp.ws>
Cc: Davis, Jaci - NWP <Jaci.Davis@wipp.ws>; Urquidez, Ashley - RES <Ashley.Urquidez@wipp.ws>; Chavez, Rick - RES <Rick.Chavez@wipp.ws>
Subject: [EXTERNAL] Re: [EXTERNAL] Re: Contact info

If we can't find a drawing, can some take a straight on picture. I can scale from that. The exhaust exit will determine the exit velocity and thus the plume rise.

Sent from my iPhone

On Aug 30, 2019, at 9:01 AM, Farnsworth, Jill - WRES <Jill.Farnsworth@wipp.ws> wrote:

Appendix B
Activity Fraction

More Accurate Distribution Below

Total pCi: 3.862E+06

Activity Units for Estimation Calculation: dpm

Units for Sample: Sample

CAM A DATA	
Nuclide	pCi/sample
U-233/4	2.12E+00
U-235	1.23E-01
U-238	3.30E-02
Pu-238	5.58E+02
Pu-239/240	1.29E+05
Pu-241	1.72E+05
Am-241	3.56E+06
Sr-90	1.20E+00
Co-60	3.58E+00
Cs-134	8.31E+00
Cs-137	8.96E+00
Th-228	7.38E+01
Th-230	6.33E-01
Th-232	5.79E-03
Total:	**3.86E+06**

CAM A DATA				Based on Activity—NOT Weight			Estimation of Activities Based on Am-241 Sample Result		
Nuclide	Yield from Parent (if applicable)	pCi/sample	Most Important of Alpha or Beta Emission	Fraction of Total	% of Total	Activity Ratios (Nuclide/Am-241)	Nuclide	Calculated Activities from Known Am-241 Activity (dpm/Sample)	
U-233/234		2.12E+00	Alpha	5.49E-07	5.49E-05	5.96E-07	U-233/234	9.59E-04	
U-235		1.23E-01	Alpha	3.19E-08	3.19E-06	3.46E-08	U-235	5.56E-05	
U-238		3.30E-02	Alpha	8.55E-09	8.55E-07	9.27E-09	U-238	1.49E-05	
Pu-238		5.58E+02	Alpha	1.44E-04	1.44E-02	1.57E-04	Pu-238	2.52E-01	
Pu-239/240		1.29E+05	Alpha	3.34E-02	3.34E+00	3.62E-02	Pu-239/240	5.83E+01	
Pu-241		1.72E+05	Beta	4.45E-02	4.45E+00	4.83E-02	Pu-241	7.78E+01	
Am-241		3.56E+06	Alpha	9.22E-01	9.22E+01	1.00E+00	Am-241	1.61E+03	← Am-241 Result Here
Sr-90		1.20E+00	Beta	3.11E-07	3.11E-05	3.37E-07	Sr-90	5.43E-04	
Y-90		1.20E+00	Beta	3.11E-07	3.11E-05	3.37E-07	Y-90	5.43E-04	
Co-60		3.58E+00	Beta	9.27E-07	9.27E-05	1.01E-06	Co-60	1.62E-03	
Cs-134		8.31E+00	Beta	2.15E-06	2.15E-04	2.33E-06	Cs-134	3.76E-03	
Cs-137		8.96E+00	Beta	2.32E-06	2.32E-04	2.52E-06	Cs-137	4.05E-03	
Ba-137m	9.46E-01	8.48E+00		2.19E-06	2.19E-04	2.38E-06	Ba-137m	3.83E-03	
Th-228		7.38E+01	Alpha	1.91E-05	1.91E-03	2.07E-05	Th-228	3.34E-02	
Th-230		6.33E-01	Alpha	1.64E-07	1.64E-05	1.78E-07	Th-230	2.86E-04	
Th-232		5.79E-03	Alpha	1.50E-09	1.50E-07	1.63E-09	Th-232	2.62E-06	
Sum of Alpha Emitters →		3.69E+06					Sum of Alpha Emitters →	1.67E+03	dpm/Sample

Appendix C
Typical CAP88 Input and Output Files

Synopsis Report

```
                     C A P 8 8 - P C

                      Version 4.0

          Clean Air Act Assessment Package - 1988


                S Y N O P S I S   R E P O R T

               Non-Radon Individual Assessment
                   Mon Jan 13 21:38:05 2020



      Facility:  Waste Isolation Pilot Plant
       Address:  26 Miles (42 km) East of Carlsbad, NM 88220
                Lat. 32.372, Long. -103.792
          City:  Carlsbad
         State:  NM        Zip:  88220


      Source Category:  Stack
          Source Type:  Stack
        Emission Year:  2020
       DOSE Age Group:  Adult

      Comments:  700 Fan Restart
                SSCVS Office

             Committed Effective Dose Equivalent
                          (mrem)
             ___________________________________

                         4.89E-03
             ___________________________________

      At This Location:   335 Meters East Southeast


 Dataset Name:  700F_Rev1.
 Dataset Date:  Jan 13, 2020 09:37 PM
    Wind File:  \\Mac\Home\Desktop\WIPP Rev 1\CAP88 bcb\5YR_WND.WND
```

```
Mon Jan 13 21:38:05 2020                                  SYNOPSIS
                                                        Page  1

               MAXIMALLY EXPOSED INDIVIDUAL

     Location Of The Individual:   335 Meters East Southeast
     Lifetime Fatal Cancer Risk:        3.71E-10

               ORGAN DOSE EQUIVALENT SUMMARY
            (RN-222 Working Level Calculations Excluded)
```

Organ	Dose Equivalent (mrem)
Adrenal	3.54E-04
UB_Wall	3.56E-04
Bone_Sur	2.02E-01
Brain	3.54E-04
Breasts	3.67E-04
St_Wall	3.57E-04
SI_Wall	3.56E-04
ULI_Wall	3.68E-04
LLI_Wall	3.94E-04
Kidneys	1.04E-03
Liver	1.34E-02
Muscle	3.63E-04
Ovaries	3.88E-03
Pancreas	3.53E-04
R_Marrow	6.96E-03
Skin	3.93E-04
Spleen	3.57E-04
Testes	3.86E-03
Thymus	3.58E-04
Thyroid	3.59E-04
GB_Wall	3.54E-04
Ht_Wall	3.55E-04
Uterus	3.53E-04
ET_Reg	9.54E-04
Lung_66	3.41E-03
Effectiv	4.89E-03

RADIONUCLIDE EMISSIONS DURING THE YEAR 2020

Nuclide	Type	Size	Source #1 Ci/y	TOTAL Ci/y
U-233	M	1.000	6.3E-11	6.3E-11
U-235	M	1.000	3.6E-12	3.6E-12
U-238	M	1.000	9.7E-13	9.7E-13
Pu-238	M	1.000	1.6E-08	1.6E-08
Pu-239	M	1.000	3.8E-06	3.8E-06
Pu-241	M	1.000	5.1E-06	5.1E-06

Am-241	M	1.000	1.1E-04	1.1E-04
Sr-90	M	1.000	3.5E-11	3.5E-11
Co-60	M	1.000	1.1E-10	1.1E-10
Cs-134	F	1.000	2.5E-10	2.5E-10
Cs-137	F	1.000	2.6E-10	2.6E-10
Th-228	S	1.000	2.2E-09	2.2E-09
Th-230	S	1.000	1.9E-11	1.9E-11
Th-232	S	1.000	1.7E-13	1.7E-13

SITE INFORMATION

```
  Temperature:   18.060 degrees C
Precipitation:   29.200 cm/y
Humidity:        8.000 g/cu m
Mixing Height:   1000.0 m

User specified location of max exposed individual.
(ILOC, JLOC): ESE,  335 meters
```

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Mon Jan 13 21:38:05 2020                                   SYNOPSIS
                                                         Page  2

               SOURCE INFORMATION


   Source Number:    1
                 ________

Stack Height (m):    9.69
    Diameter (m):   4.66

 Plume Rise
  Momentum (m/s):   4.90
  (Exit Velocity)



               AGRICULTURAL DATA

                                  Vegetable    Milk     Meat
                                  _________   ______   ______

            Fraction Home Produced:     1.0000   1.0000   1.0000
      Fraction From Assessment Area:     0.0000   0.0000   0.0000
                Fraction Imported:     0.0000   0.0000   0.0000


              Food Arrays were not generated for this run.
                       Default Values used.


 DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT


     268    290    308    335    378    506    600
     650    700    800    934   5100   5400   8850
   11520  15610  16670  47000  70000
```

General Data Report

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                 C A P 8 8 - P C

                  Version 4.0

        Clean Air Act Assessment Package - 1988


              G E N E R A L   D A T A

            Non-Radon Individual Assessment
                Mon Jan 13 21:38:05 2020


    Facility:  Waste Isolation Pilot Plant
     Address:  26 Miles (42 km) East of Carlsbad, NM 88220
              Lat. 32.372, Long. -103.792
        City:  Carlsbad
       State:  NM                   Zip:  88220


    Source Category:  Stack
        Source Type:  Stack
      Emission Year:  2020


    Comments:  700 Fan Restart
              SSCVS Office


       Dataset Name:  700F_Rev1.
       Dataset Date:  Jan 13, 2020 09:37 PM
          Wind File:  \\Mac\Home\Desktop\WIPP Rev 1\CAP88 bcb\5YR_WND.WND
```

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RADIONUCLIDE-DEPENDENT PARAMETERS FOR RELEASED ISOTOPES

Nuclide	Clearance Type	Particle Size (microns)	Scavenging Coefficient (per second)	Dry Deposition Velocity (m/s)
U-233	M	1.000	2.92E-06	1.80E-03
U-235	M	1.000	2.92E-06	1.80E-03
U-238	M	1.000	2.92E-06	1.80E-03
Pu-238	M	1.000	2.92E-06	1.80E-03
Pu-239	M	1.000	2.92E-06	1.80E-03
Pu-241	M	1.000	2.92E-06	1.80E-03
Am-241	M	1.000	2.92E-06	1.80E-03
Sr-90	M	1.000	2.92E-06	1.80E-03
Co-60	M	1.000	2.92E-06	1.80E-03
Cs-134	F	1.000	2.92E-06	1.80E-03
Cs-137	F	1.000	2.92E-06	1.80E-03
Th-228	S	1.000	2.92E-06	1.80E-03
Th-230	S	1.000	2.92E-06	1.80E-03
Th-232	S	1.000	2.92E-06	1.80E-03

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RADIONUCLIDE-DEPENDENT PARAMETERS FOR RELEASED ISOTOPES

	DECAY CONSTANT (PER DAY)		TRANSFER COEFFICIENT		
Nuclide	Radio-active	Surface	Water	Milk (1)	Meat (2)
U-233	1.19E-08	5.48E-05	0.00E+00	4.00E-04	8.00E-04
U-235	2.70E-12	5.48E-05	0.00E+00	4.00E-04	8.00E-04
U-238	4.25E-13	5.48E-05	0.00E+00	4.00E-04	8.00E-04
Pu-238	2.16E-05	5.48E-05	0.00E+00	1.00E-06	1.00E-04
Pu-239	7.87E-08	5.48E-05	0.00E+00	1.00E-06	1.00E-04
Pu-241	1.32E-04	5.48E-05	0.00E+00	1.00E-06	1.00E-04
Am-241	4.39E-06	5.48E-05	0.00E+00	2.00E-06	5.00E-05
Sr-90	6.59E-05	5.48E-05	0.00E+00	2.00E-03	1.00E-02
Co-60	3.60E-04	5.48E-05	0.00E+00	2.00E-03	3.00E-02
Cs-134	9.19E-04	5.48E-05	0.00E+00	1.00E-02	5.00E-02
Cs-137	6.29E-05	5.48E-05	0.00E+00	1.00E-02	5.00E-02
Th-228	9.93E-04	5.48E-05	0.00E+00	5.00E-06	1.00E-04
Th-230	2.52E-08	5.48E-05	0.00E+00	5.00E-06	1.00E-04
Th-232	1.35E-13	5.48E-05	0.00E+00	5.00E-06	1.00E-04

FOOTNOTES:

(1) Fraction of animal's daily intake of nuclide which appears in each L of milk (days/L)

(2) Fraction of animal's daily intake of nuclide which appears in each kg of meat (days/kg)

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RADIONUCLIDE-DEPENDENT PARAMETERS FOR RELEASED ISOTOPES

	CONCENTRATION UPTAKE FACTOR		GI UPTAKE FRACTION	
Nuclide	Forage (1)	Edible (2)	Inhalation	Ingestion
U-233	1.00E-01	2.00E-03	2.00E-02	2.00E-02
U-235	1.00E-01	2.00E-03	2.00E-02	2.00E-02
U-238	1.00E-01	2.00E-03	2.00E-02	2.00E-02
Pu-238	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Pu-239	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Pu-241	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Am-241	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Sr-90	4.00E+00	3.00E-01	3.00E-01	3.00E-01
Co-60	2.00E+00	8.00E-02	1.00E-01	1.00E-01
Cs-134	1.00E+00	2.00E-01	1.00E+00	1.00E+00
Cs-137	1.00E+00	2.00E-01	1.00E+00	1.00E+00
Th-228	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Th-230	1.00E-01	1.00E-03	5.00E-04	5.00E-04
Th-232	1.00E-01	1.00E-03	5.00E-04	5.00E-04

FOOTNOTES: (1) Concentration factor for uptake of nuclide from soil for pasture and forage (in pCi/kg dry weight per pCi/kg dry soil)

(2) Concentration factor for uptake of nuclide from soil by edible parts of crops (in pCi/kg wet weight per pCi/kg dry soil)

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      VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS
_________________________________________________________________________

  HUMAN INHALATION RATE
      Cubic meters/yr                                 5.26E+03

  SOIL PARAMETERS
      Effective surface density (kg/sq m, dry weight)
      (Assumes 15 cm plow layer)                        2.15E+02

  BUILDUP TIMES
      For activity in soil (years)                      1.00E+02
      For radionuclides deposited on ground/water (days) 3.65E+04

  DELAY TIMES
      Ingestion of pasture grass by animals (hr)       0.00E+00
      Ingestion of stored feed by animals (hr)         2.16E+03
      Ingestion of leafy vegetables by man (hr)        3.36E+02
      Ingestion of produce by man (hr)                3.36E+02
      Transport time from animal feed-milk-man (day)    2.00E+00
      Time from slaughter to consumption (day)         2.00E+01

  WEATHERING
      Removal rate constant for physical loss (per hr)  2.90E-03

  CROP EXPOSURE DURATION
      Pasture grass (hr)                               7.20E+02
      Crops/leafy vegetables (hr)                        1.44E+03

  AGRICULTURAL PRODUCTIVITY
      Grass-cow-milk-man pathway (kg/sq m)              2.80E-01
      Produce/leafy veg for human consumption (kg/sq m)  7.16E-01

  FALLOUT INTERCEPTION FRACTIONS
      Vegetables                                      2.00E-01
      Pasture                                        5.70E-01

  GRAZING PARAMETERS
      Fraction of year animals graze on pasture        4.00E-01
      Fraction of daily feed that is pasture grass
      when animal grazes on pasture                   4.30E-01
_________________________________________________________________________
```

VALUES FOR RADIONUCLIDE-INDEPENDENT PARAMETERS

ANIMAL FEED CONSUMPTION FACTORS	
Contaminated feed/forage (kg/day, dry weight)	1.56E+01
DAIRY PRODUCTIVITY	
Milk production of cow (L/day)	1.10E+01
MEAT ANIMAL SLAUGHTER PARAMETERS	
Muscle mass of animal at slaughter (kg)	2.00E+02
Fraction of herd slaughtered (per day)	3.81E-03
DECONTAMINATION	
Fraction of radioactivity retained after washing for leafy vegetables and produce	5.00E-01
FRACTIONS GROWN IN GARDEN OF INTEREST	
Produce ingested	1.00E+00
Leafy vegetables ingested	1.00E+00
INGESTION RATIOS:	
IMMEDIATE SURROUNDING AREA/TOTAL WITHIN AREA	
Vegetables	1.00E+00
Meat	1.00E+00
Milk	1.00E+00
MINIMUM INGESTION FRACTIONS FROM OUTSIDE AREA	
(Minimum fractions of food types from outside area listed below are actual fixed values.)	
Vegetables	0.00E+00
Meat	0.00E+00
Milk	0.00E+00
HUMAN FOOD UTILIZATION FACTORS	
Produce ingestion (kg/y)	7.62E+01
Milk ingestion (L/y)	5.30E+01
Meat ingestion (kg/y)	8.40E+01
Leafy vegetable ingestion (kg/y)	7.79E+00
SWIMMING PARAMETERS	
Fraction of time spent swimming	0.00E+00
Dilution factor for water (cm)	1.00E+00

Dose and Risk Summary Report

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          D O S E   A N D   R I S K   S U M M A R I E S

                  Non-Radon Individual Assessment
                      Mon Jan 13 21:38:05 2020


     Facility:  Waste Isolation Pilot Plant
      Address:  26 Miles (42 km) East of Carlsbad, NM 88220
                Lat. 32.372, Long. -103.792
         City:  Carlsbad
        State:  NM        Zip:  88220


Source Category:  Stack
    Source Type:  Stack
  Emission Year:  2020
DOSE Age Group:  Adult

       Comments:  700 Fan Restart
                  SSCVS Office


   Dataset Name:  700F_Rev1.
   Dataset Date:  Jan 13, 2020 09:37 PM
      Wind File:  \\Mac\Home\Desktop\WIPP Rev 1\CAP88 bcb\5YR_WND.WND
```

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ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem)
Adrenal	3.54E-04
UB_Wall	3.56E-04
Bone_Sur	2.02E-01
Brain	3.54E-04
Breasts	3.67E-04
St_Wall	3.57E-04
SI_Wall	3.56E-04
ULI_Wall	3.68E-04
LLI_Wall	3.94E-04
Kidneys	1.04E-03
Liver	1.34E-02
Muscle	3.63E-04
Ovaries	3.88E-03
Pancreas	3.53E-04
R_Marrow	6.96E-03
Skin	3.93E-04
Spleen	3.57E-04
Testes	3.86E-03
Thymus	3.58E-04
Thyroid	3.59E-04
GB_Wall	3.54E-04
Ht_Wall	3.55E-04
Uterus	3.53E-04
ET_Reg	9.54E-04
Lung_66	3.41E-03
Effectiv	4.89E-03

PATHWAY COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem)
INGESTION	1.35E-04
INHALATION	4.74E-03
AIR IMMERSION	4.55E-10
GROUND SURFACE	1.87E-05
INTERNAL	4.87E-03
EXTERNAL	1.87E-05
TOTAL	4.89E-03

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NUCLIDE COMMITTED EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem)
U-233	2.11E-10
Th-229	1.35E-13
Ra-225	1.91E-14
Ac-225	2.29E-14
Fr-221	4.67E-14
At-217	3.94E-16
Bi-213	2.85E-13
Po-213	6.06E-17
Tl-209	7.33E-14
Pb-209	5.53E-15
U-235	1.55E-11
Th-231	4.91E-13
Pa-231	8.07E-16
Ac-227	2.70E-18
Th-227	1.29E-15
Fr-223	1.21E-17
Ra-223	1.44E-15
Rn-219	6.24E-16
At-219	0.00E+00
Bi-215	2.81E-21
Po-215	1.91E-18
Pb-211	1.22E-15
Bi-211	5.05E-16
Tl-207	6.35E-16
Po-211	2.43E-19
U-238	2.68E-12
Th-234	6.84E-14
Pa-234m	9.35E-13
Pa-234	1.84E-14
U-234	6.50E-15
Th-230	2.90E-10
Ra-226	1.58E-14
Rn-222	8.77E-16
Po-218	1.57E-20
Pb-214	5.73E-13
At-218	5.89E-20
Bi-214	3.35E-12
Rn-218	3.41E-22
Po-214	1.85E-16
Tl-210	1.31E-15
Pb-210	2.49E-15
Bi-210	4.02E-14
Hg-206	3.25E-21
Po-210	1.04E-17
Tl-206	9.40E-20
Pu-238	8.11E-07
Pu-239	2.04E-04
U-235m	0.00E+00
Pu-241	4.98E-06
Am-241	4.68E-03
U-237	4.44E-11

Np-237	2.34E-10
Pa-233	1.93E-09
Sr-90	1.28E-10
Y-90	1.74E-11
Co-60	3.47E-10
Cs-134	5.77E-10
Cs-137	6.96E-10
Ba-137m	6.57E-10
Th-228	7.92E-08
Ra-224	1.24E-11
Rn-220	6.81E-13
Po-216	1.64E-14
Pb-212	1.50E-10
Bi-212	1.74E-10
Po-212	0.00E+00
Tl-208	1.21E-09
Th-232	4.75E-12
Ra-228	9.02E-16
Ac-228	1.03E-12
TOTAL	4.89E-03

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CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	1.14E-11
INHALATION	3.50E-10
AIR IMMERSION	2.24E-16
GROUND SURFACE	9.16E-12
INTERNAL	3.62E-10
EXTERNAL	9.17E-12
TOTAL	3.71E-10

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NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
U-233	7.19E-17
Th-229	7.14E-20
Ra-225	8.65E-21
Ac-225	1.21E-20
Fr-221	2.53E-20
At-217	2.15E-22
Bi-213	1.23E-19
Po-213	3.31E-23
Tl-209	3.92E-20
Pb-209	7.29E-22
U-235	5.87E-18
Th-231	2.24E-19
Pa-231	4.21E-22
Ac-227	1.01E-24
Th-227	6.98E-22
Fr-223	4.53E-24
Ra-223	7.78E-22
Rn-219	3.41E-22
At-219	0.00E+00
Bi-215	1.25E-27
Po-215	1.04E-24
Pb-211	4.38E-22
Bi-211	2.76E-22
Tl-207	8.16E-23
Po-211	1.33E-25
U-238	8.17E-19
Th-234	3.54E-20
Pa-234m	1.64E-19
Pa-234	1.00E-20
U-234	2.24E-21
Th-230	6.22E-17
Ra-226	8.56E-21
Rn-222	4.79E-22
Po-218	7.00E-27
Pb-214	3.06E-19
At-218	7.26E-27
Bi-214	1.77E-18
Rn-218	1.87E-28
Po-214	1.02E-22
Tl-210	6.98E-22
Pb-210	1.12E-21
Bi-210	4.46E-21
Hg-206	1.44E-27
Po-210	5.70E-24
Tl-206	1.06E-26
Pu-238	6.94E-14
Pu-239	1.51E-11
U-235m	0.00E+00
Pu-241	2.17E-13
Am-241	3.55E-10
U-237	2.36E-17

Np-237	1.15E-16
Pa-233	1.04E-15
Sr-90	2.77E-18
Y-90	2.07E-18
Co-60	1.77E-16
Cs-134	1.32E-16
Cs-137	1.16E-17
Ba-137m	3.55E-16
Th-228	2.84E-14
Ra-224	6.51E-18
Rn-220	3.73E-19
Po-216	9.03E-21
Pb-212	8.13E-17
Bi-212	6.73E-17
Po-212	0.00E+00
Tl-208	6.55E-16
Th-232	1.00E-18
Ra-228	2.74E-22
Ac-228	5.48E-19
TOTAL	3.71E-10

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INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	268	290	308	335	378	506	600
N	1.2E-02	1.1E-02	1.1E-02	9.8E-03	8.6E-03	6.0E-03	4.8E-03
NNW	1.8E-02	1.7E-02	1.7E-02	1.6E-02	1.4E-02	1.0E-02	8.3E-03
NW	2.3E-02	2.2E-02	2.2E-02	2.1E-02	1.9E-02	1.5E-02	1.2E-02
WNW	1.4E-02	1.4E-02	1.4E-02	1.3E-02	1.3E-02	1.0E-02	8.4E-03
W	9.5E-03	9.1E-03	8.7E-03	8.3E-03	7.5E-03	5.6E-03	4.5E-03
WSW	7.1E-03	6.7E-03	6.4E-03	6.0E-03	5.3E-03	3.9E-03	3.1E-03
SW	7.2E-03	6.8E-03	6.5E-03	6.1E-03	5.4E-03	4.0E-03	3.2E-03
SSW	7.2E-03	6.8E-03	6.4E-03	5.9E-03	5.3E-03	3.8E-03	3.1E-03
S	6.5E-03	5.9E-03	5.5E-03	5.0E-03	4.2E-03	2.8E-03	2.1E-03
SSE	5.9E-03	5.4E-03	5.0E-03	4.5E-03	3.9E-03	2.6E-03	2.1E-03
SSE	5.6E-03	5.2E-03	4.9E-03	4.4E-03	3.9E-03	2.7E-03	2.1E-03
ESE	6.2E-03	5.7E-03	5.4E-03	4.9E-03	4.2E-03	2.9E-03	2.2E-03
E	7.7E-03	7.1E-03	6.6E-03	5.9E-03	5.1E-03	3.4E-03	2.6E-03
ENE	9.2E-03	8.4E-03	7.8E-03	7.0E-03	5.9E-03	3.8E-03	2.9E-03
NE	8.3E-03	7.5E-03	6.9E-03	6.2E-03	5.3E-03	3.4E-03	2.6E-03
NNE	9.3E-03	8.5E-03	7.9E-03	7.1E-03	6.1E-03	4.1E-03	3.2E-03

	Distance (m)						
Direction	650	700	800	934	5100	5400	8850
N	4.3E-03	3.8E-03	3.1E-03	2.5E-03	1.7E-04	1.5E-04	7.5E-05
NNW	7.4E-03	6.7E-03	5.5E-03	4.4E-03	3.2E-04	3.0E-04	1.4E-04
NW	1.1E-02	9.9E-03	8.2E-03	6.6E-03	5.2E-04	4.8E-04	2.3E-04
WNW	7.7E-03	7.0E-03	5.9E-03	4.8E-03	3.9E-04	3.6E-04	1.8E-04
W	4.1E-03	3.7E-03	3.0E-03	2.4E-03	1.8E-04	1.7E-04	8.2E-05
WSW	2.8E-03	2.5E-03	2.1E-03	1.7E-03	1.3E-04	1.2E-04	5.9E-05
SW	2.9E-03	2.6E-03	2.2E-03	1.8E-03	1.4E-04	1.3E-04	6.3E-05
SSW	2.8E-03	2.5E-03	2.1E-03	1.7E-03	1.3E-04	1.2E-04	5.9E-05
S	1.9E-03	1.7E-03	1.4E-03	1.0E-03	6.5E-05	5.9E-05	2.8E-05
SSE	1.8E-03	1.6E-03	1.3E-03	1.0E-03	6.7E-05	6.2E-05	3.0E-05
SSE	1.9E-03	1.7E-03	1.4E-03	1.1E-03	7.6E-05	7.0E-05	3.4E-05
ESE	2.0E-03	1.7E-03	1.4E-03	1.1E-03	6.9E-05	6.3E-05	3.1E-05
E	2.3E-03	2.0E-03	1.6E-03	1.3E-03	7.9E-05	7.2E-05	3.5E-05
ENE	2.6E-03	2.3E-03	1.8E-03	1.4E-03	8.2E-05	7.5E-05	3.6E-05
NE	2.3E-03	2.0E-03	1.6E-03	1.2E-03	7.4E-05	6.7E-05	3.3E-05
NNE	2.8E-03	2.5E-03	2.0E-03	1.6E-03	9.8E-05	9.0E-05	4.3E-05

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INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT (mrem)
(All Radionuclides and Pathways)

	Distance (m)				
Direction	11520	15610	16670	47000	70000
N	5.2E-05	3.4E-05	3.2E-05	7.9E-06	4.4E-06
NNW	9.9E-05	6.7E-05	6.1E-05	1.5E-05	8.5E-06
NW	1.6E-04	1.1E-04	1.0E-04	2.6E-05	1.4E-05
WNW	1.2E-04	8.6E-05	7.9E-05	2.1E-05	1.2E-05
W	5.7E-05	3.9E-05	3.6E-05	9.3E-06	5.2E-06
WSW	4.1E-05	2.8E-05	2.6E-05	6.7E-06	3.7E-06
SW	4.4E-05	3.0E-05	2.7E-05	6.9E-06	3.7E-06
SSW	4.1E-05	2.8E-05	2.5E-05	6.5E-06	3.5E-06
S	1.9E-05	1.3E-05	1.2E-05	3.0E-06	1.7E-06
SSE	2.1E-05	1.4E-05	1.3E-05	3.2E-06	1.8E-06
SSE	2.4E-05	1.6E-05	1.4E-05	3.6E-06	2.0E-06
ESE	2.1E-05	1.4E-05	1.3E-05	3.3E-06	1.9E-06
E	2.5E-05	1.6E-05	1.5E-05	3.9E-06	2.3E-06
ENE	2.5E-05	1.6E-05	1.5E-05	3.8E-06	2.2E-06
NE	2.3E-05	1.5E-05	1.4E-05	3.6E-06	2.1E-06
NNE	3.0E-05	2.0E-05	1.8E-05	4.7E-06	2.7E-06

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INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	268	290	308	335	378	506	600
N	9.3E-10	8.6E-10	8.1E-10	7.4E-10	6.5E-10	4.5E-10	3.6E-10
NNW	1.4E-09	1.3E-09	1.3E-09	1.2E-09	1.1E-09	7.8E-10	6.3E-10
NW	1.7E-09	1.7E-09	1.6E-09	1.6E-09	1.4E-09	1.1E-09	9.1E-10
WNW	1.1E-09	1.1E-09	1.0E-09	1.0E-09	9.5E-10	7.6E-10	6.4E-10
W	7.2E-10	6.9E-10	6.6E-10	6.3E-10	5.7E-10	4.2E-10	3.4E-10
WSW	5.4E-10	5.1E-10	4.9E-10	4.5E-10	4.0E-10	2.9E-10	2.4E-10
SW	5.5E-10	5.2E-10	4.9E-10	4.6E-10	4.1E-10	3.0E-10	2.4E-10
SSW	5.5E-10	5.1E-10	4.9E-10	4.5E-10	4.0E-10	2.9E-10	2.3E-10
S	5.0E-10	4.5E-10	4.2E-10	3.8E-10	3.2E-10	2.1E-10	1.6E-10
SSE	4.4E-10	4.1E-10	3.8E-10	3.4E-10	3.0E-10	2.0E-10	1.6E-10
SSE	4.2E-10	3.9E-10	3.7E-10	3.4E-10	2.9E-10	2.0E-10	1.6E-10
ESE	4.7E-10	4.4E-10	4.1E-10	3.7E-10	3.2E-10	2.2E-10	1.7E-10
E	5.9E-10	5.4E-10	5.0E-10	4.5E-10	3.9E-10	2.6E-10	2.0E-10
ENE	7.0E-10	6.4E-10	5.9E-10	5.3E-10	4.5E-10	2.9E-10	2.2E-10
NE	6.3E-10	5.7E-10	5.3E-10	4.7E-10	4.0E-10	2.6E-10	2.0E-10
NNE	7.0E-10	6.4E-10	6.0E-10	5.4E-10	4.6E-10	3.1E-10	2.4E-10

Distance (m)

Direction	650	700	800	934	5100	5400	8850
N	3.2E-10	2.9E-10	2.4E-10	1.9E-10	1.3E-11	1.2E-11	5.7E-12
NNW	5.6E-10	5.1E-10	4.2E-10	3.3E-10	2.4E-11	2.2E-11	1.1E-11
NW	8.2E-10	7.5E-10	6.2E-10	5.0E-10	4.0E-11	3.7E-11	1.8E-11
WNW	5.8E-10	5.3E-10	4.5E-10	3.6E-10	3.0E-11	2.7E-11	1.4E-11
W	3.1E-10	2.8E-10	2.3E-10	1.8E-10	1.4E-11	1.3E-11	6.2E-12
WSW	2.1E-10	1.9E-10	1.6E-10	1.3E-10	9.9E-12	9.1E-12	4.5E-12
SW	2.2E-10	2.0E-10	1.7E-10	1.3E-10	1.1E-11	9.7E-12	4.8E-12
SSW	2.1E-10	1.9E-10	1.6E-10	1.3E-10	1.0E-11	9.2E-12	4.5E-12
S	1.4E-10	1.3E-10	1.0E-10	8.0E-11	4.9E-12	4.5E-12	2.2E-12
SSE	1.4E-10	1.2E-10	1.0E-10	7.8E-11	5.1E-12	4.7E-12	2.3E-12
SSE	1.4E-10	1.3E-10	1.1E-10	8.4E-11	5.8E-12	5.3E-12	2.6E-12
ESE	1.5E-10	1.3E-10	1.1E-10	8.2E-11	5.3E-12	4.8E-12	2.4E-12
E	1.7E-10	1.5E-10	1.2E-10	9.5E-11	6.0E-12	5.5E-12	2.7E-12
ENE	1.9E-10	1.7E-10	1.4E-10	1.0E-10	6.3E-12	5.7E-12	2.8E-12
NE	1.7E-10	1.5E-10	1.2E-10	9.5E-11	5.6E-12	5.2E-12	2.5E-12
NNE	2.1E-10	1.9E-10	1.5E-10	1.2E-10	7.5E-12	6.9E-12	3.3E-12

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INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

	Distance (m)				
Direction	11520	15610	16670	47000	70000
N	3.9E-12	2.6E-12	2.4E-12	6.1E-13	3.4E-13
NNW	7.6E-12	5.1E-12	4.7E-12	1.2E-12	6.5E-13
NW	1.2E-11	8.4E-12	7.8E-12	2.0E-12	1.1E-12
WNW	9.5E-12	6.5E-12	6.0E-12	1.6E-12	8.8E-13
W	4.4E-12	3.0E-12	2.7E-12	7.1E-13	3.9E-13
WSW	3.1E-12	2.1E-12	2.0E-12	5.1E-13	2.8E-13
SW	3.3E-12	2.3E-12	2.1E-12	5.3E-13	2.9E-13
SSW	3.1E-12	2.1E-12	1.9E-12	4.9E-13	2.7E-13
S	1.5E-12	9.9E-13	9.1E-13	2.3E-13	1.3E-13
SSE	1.6E-12	1.1E-12	9.7E-13	2.5E-13	1.4E-13
SSE	1.8E-12	1.2E-12	1.1E-12	2.8E-13	1.5E-13
ESE	1.6E-12	1.1E-12	1.0E-12	2.6E-13	1.5E-13
E	1.9E-12	1.3E-12	1.2E-12	3.0E-13	1.8E-13
ENE	1.9E-12	1.3E-12	1.2E-12	2.9E-13	1.7E-13
NE	1.7E-12	1.2E-12	1.1E-12	2.7E-13	1.6E-13
NNE	2.3E-12	1.5E-12	1.4E-12	3.6E-13	2.1E-13

Attachment 4

02RC-001,
700C Fan Startup &Testing: Air Emissions and Ambient Environmental Air Surveillance Sampling Plan

700C Fan Startup &Testing: Air Emissions and Ambient Environmental Air Surveillance Sampling Plan

Nuclear Waste Partnership

An AMENTUM-led partnership with BWXT and ORANO

02RC-001, Rev. 0

December 2, 2020

Approved by: [redacted] 12-2-2020

S.B. Jones, Manager – Site Environmental Compliance   Date

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INTRODUCTION

The WIPP Project mission is to safely dispose of transuranic (TRU) waste (radionuclides with an atomic number greater than 92, uranium) generated by the production of nuclear weapons and other activities related to the national defense of the United States. The DOE collects data needed to detect and quantify potential impacts that WIPP facility operations may have on public health and the surrounding environment. WIPP facility employees have prepared this two-part emissions and ambient surveillance plan which includes both effluent monitoring (i.e., point-source monitoring at release points such as the Exhaust Shaft) to detect radionuclides and quantify doses, and traditional pathway and receptor monitoring in the broader environment

Due to radiological contamination in the exhaust ductwork downstream of Station "A", which is the emissions air particulate compliance sampling point for the underground (contaminants in the mine ventilation and exhaust shaft) during unfiltered operation, additional radiological monitoring will be implemented to account for potential releases from the above-ground duct during startup testing of the 700C fan. The purpose of this two-part sampling plan is to delineate the actions necessary to primarily detect and quantify any release of radionuclides from the 700C exhaust fan, satisfying the requirement to account for rad air emissions from contamination sources by sampling emissions at their source, and to conduct environmental surveillance by monitoring ambient air in the vicinity to corroborate the emission sampling activity.

These two activities support the 40 CFR 191 Subpart A requirements (the EPA implementation guidance also invokes 40 CFR 61 regulations, per a 1995 MOU between DOE and EPA) to sample the radiological air emissions, and confirm the sample results by ambient air monitoring around the WIPP facility. The activities prescribed by this two-part sampling plan are a part of the Radiological Controls (RadCon) actions to closely monitor the sequence of test activities in order to control personnel exposure, and impact to property, public health, and the environment.

1 700C FAN STARTUP & TESTING: AIR EMISSIONS SAMPLING PLAN

Methodology

The 700C fan duct downstream of the primary sample probes (Station "A") is known to have removable alpha contamination inside the duct. As a result, any fan operations which exhaust air will need to have sampling conducted at the fan shroud outlet screen to account for this contaminated stretch of duct.

The fan outlet is a rectangle approximately 12 feet by 16 feet, with the top at about 35 feet above grade. Fan airflow is directed at a 45 degree up angle, with a calculated average exhaust velocity of about 6.9 meters/second (1,356 feet /minute) at the fan shroud screen. (See Figure 1.)

In that there is no opening or access upstream of the contaminated duct that would allow introduction of a qualified sampling device, emissions sampling will be conducted on the outside of the fan screen with the sampling device immersed in the exhaust air stream. Two stainless steel shrouded probes, each attached to a stainless steel transport line, will be placed directly in front of the screen at the location shown in Figure 2. The shrouded probes will be placed within two areas free of obstructions, a few inches to several feet away from the fan screen, about two feet down from the screen top and a second area two feet up from the bottom, within four feet of the center. The positioning of an upper and a lower sampler is intended to account for potential gravitational effects, although the fan exhaust is expected to be well-mixed. The shrouded probes transport lines will be connected to scaffolding erected below the fan screen. Each shrouded probe will be connected to up to three air sampling units on the ground via a sample flow splitter. For the 700C fan restart and testing, a three way split is planned. A description of this system can be found in BC-RP-0134, 700 Fan External Sampling System Design, August 2020.

The original installed shrouded probes at Station "A" will also be in operation, with two filters (FASs A-2- 3 and A-3-3) designated as air emissions samplers-of-record. During initial testing those filters (reinforced membrane type) will be exchanged and/or screened for radioactivity changes on a schedule synchronized to the RadCon portable air sampler (PAS) array deployed downwind of the fan outlet. Station "A" filter changes will be coordinated with the RadCon PAS on-ground array filter exchanges for the first four-hour initial test, with daily filter exchanges during longer-term test periods afterwards.

The estimated maximum dose to a member of the public for the initial four-hour test run and a subsequent test period of up to 34 days totals less than 0.1 mrem/year. The fan screen samplers will be in operation for the duration of the test period, with exchange frequencies (after the initial four-hour test period) synchronized to the Station "A" filter changes, in order to account for any unexpected particulate emissions during the test period. The filter media will be analyzed, per the WIPP facility rad air emissions quality program plan controls, for the primary radionuclides (Am-241, Pu-238, Pu-239/240, Sr-90, Cs-137, U-233/234, and U-238) that constitute over 95% of the dose to the public from radiological air emissions. The calculated total emitted radioactivity will be added to the radiological air emissions from the other two exhaust points at the WIPP facility for modeling the combined dose to a member of the public for that calendar year by the WIPP NESHAP team (RES).

Basis Documents:

- 40 CFR 61 Subpart H
- 40 CFR 191 Subpart A
- DOE Order 458.1 ANSI N13.1-1969

Implementing Documents:

- DOE/WIPP-97-2238
- WP 12-HP1305 WP 12-HP3500 WP 12-ER4924 WP 12-RE3004
- WP 12-RC.01
- WIPP Labs SOW, 2017

Safety

The deployment of sample equipment overhead will require attention to both exclusion "don't walk here" zones, and proper PPE for those in the vicinity of the samplers. There will also be hazards associated with line voltage from power generators and fuel flammability precautions. Overlaying these precautions will be protection against personnel contamination from particulate emissions. These hazards will be addressed by radiological work permits, as needed, job hazard analyses and pre-job briefings, and adherence to proper use of PPE and administrative controls.

Process Flow

Pre-Test Preparation

Station "A" preparation will be performed by RadCon staff to set up, verify calibration of Station "A" samplers-of-record at FAS A-2-3 and FAS A-3-3, and upon notification, to exchange filters just before the test initiation. This process will be performed per existing standard procedures.

The shrouded probe sampling system was fabricated by a subcontractor who has been involved in the design, installation and testing of numerous sampling systems across the DOE complex. The subcontractor delivered the sampling system withdrawal and transport components to the WIPP site and they were setup at the fan screen by NWP.

RadCon will verify that the operability status of the sampling systems, including dry run deployment and retrieval is satisfactory. RadCon will verify that the sampler systems are each calibrated. RadCon will ensure the sampler is set to the 2 SCFM. Dry runs to verify system operability and hazard mitigation will be conducted on the final sampler system.

RadCon and Regulatory Environmental Services (RES) staff will ensure that the sample systems and sample handling chain (including Chain-of-Custody participants) are in place, and will notify the FWS that those systems are ready for test initiation.

Test Period Actions

RadCon will install new filter media in each of the six legs, Attachment A, of the sampling system prior to fan-start. The designation of the legs are; High-1, High-2, High-3, Low-1, Low-2, and Low-3. The installed media on each leg of the sampling system will be marked to identify the leg it was taken from and to identify the filters as sample-of-record NESHAP filters.

The FWS will start the initial fan startup test, which will run for four hours. If the test does not run the allotted time, it will be continued until such time as the required elapsed sampling time is complete. Any test initiated afterward will be treated as if it were an initial startup, with full deployment of all sampling and monitoring processes.

If water/salt discharge is visibly observed during initial startup, RadCon will exchange the filter media when discharge is no longer observed. The initial and the replaced filters will be analyzed separately for the initial test filter data set to differentiate between potentially wetted and dry media.

In the event there is an indication of an unexpected release (e.g., CAM alarm) the fan will be shut down and RadCon has the option to expose the sample filters (without removal from the filter holder) for non-destructive probe counting to determine notable elevation in radioactivity.

Post-Test Actions

RadCon will, at the four-hour initial test run conclusion, remove/replace all filters and segregate for initial gross activity counting. These filters will be considered samples-of-record, and will be placed in the queue for transferal to WIPP Labs for radiochemical analyses as NESHAP samples.

RadCon will perform counting of filters upon removal on a Tennelec gas flow proportional alpha beta detection instrument for 10 minutes and provide results to RES to determine if radioactivity levels are above or below the action level in DOE/WIPP-97-2238, Attachment II – Action Level Calculations, Table1 – Station "A" Action Levels Based on 2009 NESHAP. If action levels are reached RES will perform a dose estimate in conjunction with follow-up RadCon actions for contamination mitigation. If no action levels are reached based on DOE/WIPP-97-2238, Attachment II and TBD 20-003 Sampling Plan for 700C Fan, RadCon, with the concurrence of RES and receipt of CBFO concurrence to hold point, will determine if follow-up fan flow and ventilation testing may proceed before completion of the 72 hour decay period and final Tennelec count. Restarting of the fan for follow up testing can be initiated with the issuance of a written notice of intent from NWP.

RadCon will, after a 72-hour decay, re-count the air sample filters and relinquish them, per RES direction, by Chain-of-Custody to WIPP Labs for NESHAP-track radiochemical analyses. It is expected that, were there to be no screening radioactivity value above action levels, the fan screen filters would be composited, per sample location, for the entire test period. These radiochemical analysis results would be combined with the Station "A" sample filter data to provide a conservative value for NESHAP dose calculations.

Follow-up Testing

Repeat the above sequence for each test run up to 24 hours in duration. Exchange filters daily if test duration exceeds 24 hours.

RES will evaluate and track gross radioactivity data for dose estimate iterations after each test sequence/filter exchange.

RES will track and report air emission test data from the 700C fan test period in the annual Periodic Confirmatory Measurement Compliance report for the year in which the testing occurred.

2 700C FAN STARTUP & TESTING: AMBIENT ENVIRONMENTAL AIR SURVEILLANCE SAMPLING PLAN

Methodology

The WIPP Environmental Monitoring Plan (DOE/WIPP-99-2194) describes the deployment of low- volume (2 standard cubic feet per minute [SCFM]) ambient air samplers in the immediate vicinity of the WIPP facility, as well as samplers further-out in nearby communities and historical baseline sample locations. The close-in sampler locations have (with the exception of the East [WEE] sampler) duplicate samplers, designated "event evaluation" (EE). The filters from these EE samplers are routinely collected weekly but are not analyzed unless there is an upset event that would indicate an air release. Analysis of the EE filters can be performed on an "as needed" schedule without disturbing the routine quarterly composite analysis of the co-located routine ambient particulate air network samples. For the 700C fan test, the EE samplers, plus one specially located "maximum receptor" sampler, will be used to corroborate the emission sampler data (See ANSI N13.1-1969, Section 6, last paragraph).

The EE samplers use a glass fiber filter, which is good for sample particle retention but does cause self-absorption bias for direct alpha counting. Were there to be a release indicated by the emissions and/or downwind array testing, radiochemical analyses of EE filters would be conducted to determine the extent and direction of any contaminating event.

Basis Documents:

- 40 CFR 191 Subpart A
- DOE Order 458.1

Implementing Documents:

- DOE/WIPP-99-2194
- WP 02-EM1012
- WP 12-HP3500
- WP 12-ER4924
- WIPP Labs SOW

Safety

Safety concerns during the collection of ambient air samples have been captured under Job Hazard Analysis documents specific to that type of field work. The same concerns are addressed for any of the ambient air sampling installations, including the test-specific sampler at the maximum receptor.

In case there is a radiological concern, RadCon would provide qualified individuals with appropriate PPE to retrieve and re-deploy EE sample media.

Process Flow

Pre-test Preparation

Environmental Monitoring (EM) staff will verify current calibration/operation of EE ambient air samplers at locations within a 6-mile radius is acceptable. (See Figures 3 and 4. Note that all relevant samplers within a six mile radius are shown in Figure 4.)

EM/RadCon staff verify that the current calibration/operation of the Safety Significant Confinement Ventilation System (SSCVS) maximum receptor ambient air sampler is acceptable. (See Figure 3.)

EM/RadCon staff will coordinate filter changes to replace media within a day before test initiation.

Test Actions

EM/RadCon staff will coordinate startup sequence with the Field Work Supervisor (FWS).

Conduct test startup, RadCon communicating emissions result levels that would trigger a RadCon EE sample exchange.

Post-Test Actions

EM staff will, at the four-hour initial test run conclusion, remove/replace all EE filters within 6-mile radius, RadCon will remove and demobilize SSCVS air filter and sampler, and segregate for initial gross activity counting. If there is indication of a release, RadCon will coordinate and conduct the remainder of the EE sampler filter changes to assure personnel radiological protection is maintained.

RadCon will, after a 72-hour decay, count the EE and maximum receptor air filters for gross radioactivity.

EM staff, if indicated by RadCon communications, will relinquish the EE air filters to WIPP Labs, per RES request, for Environmental-track radiochemical analyses.

Follow-up Testing

EM and RadCon staff will repeat the above sequence for each follow-up test run up to 168 hours in duration.

Data obtained from EE and maximum receptor sampling will be provided as needed to RadCon and will be incorporated by RES into the WIPP Annual Site Environmental Report for the calendar year in which the testing occurred.

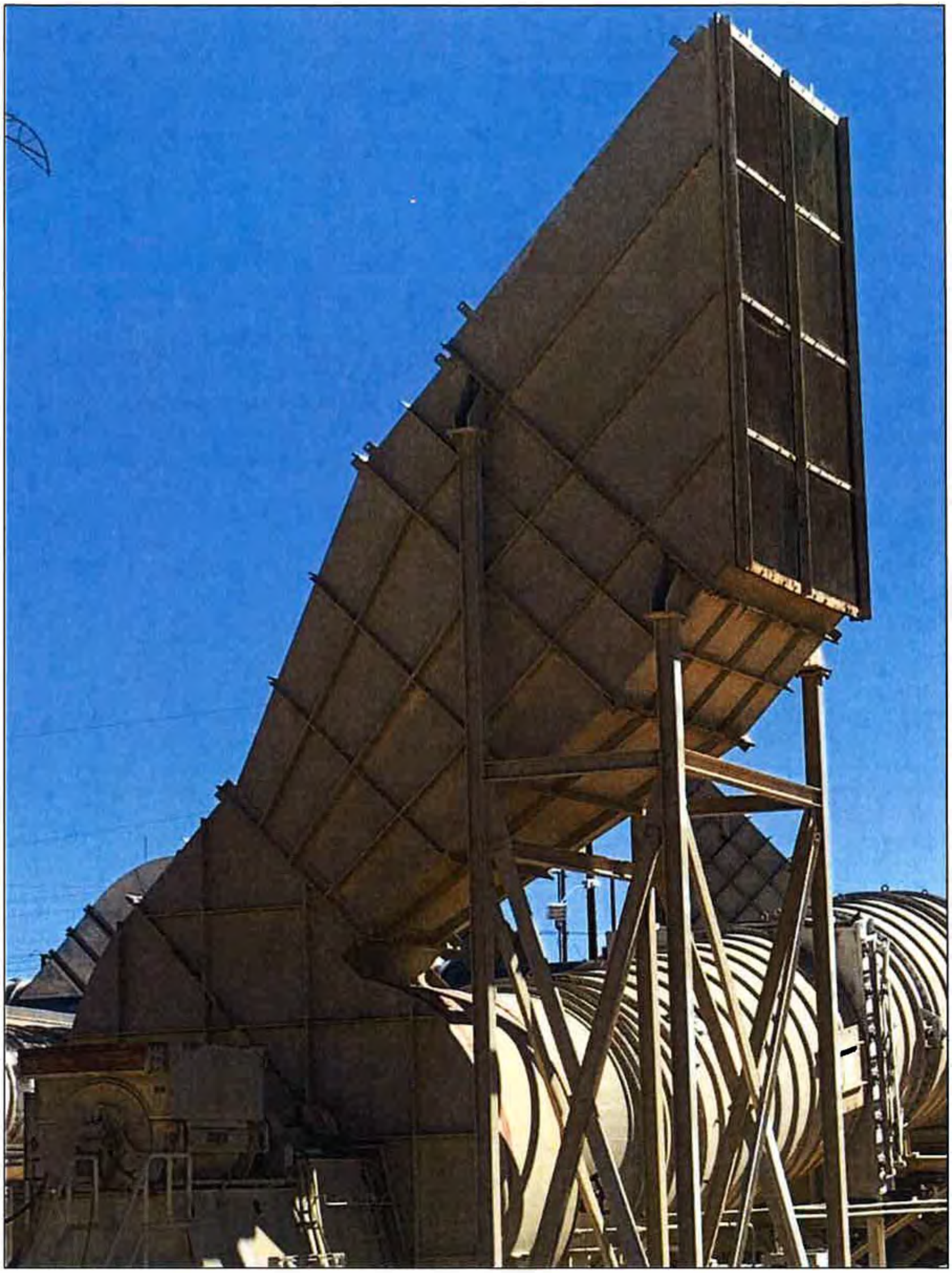


Figure 1 – Fan 700C Exhaust Shroud and Fan Screen

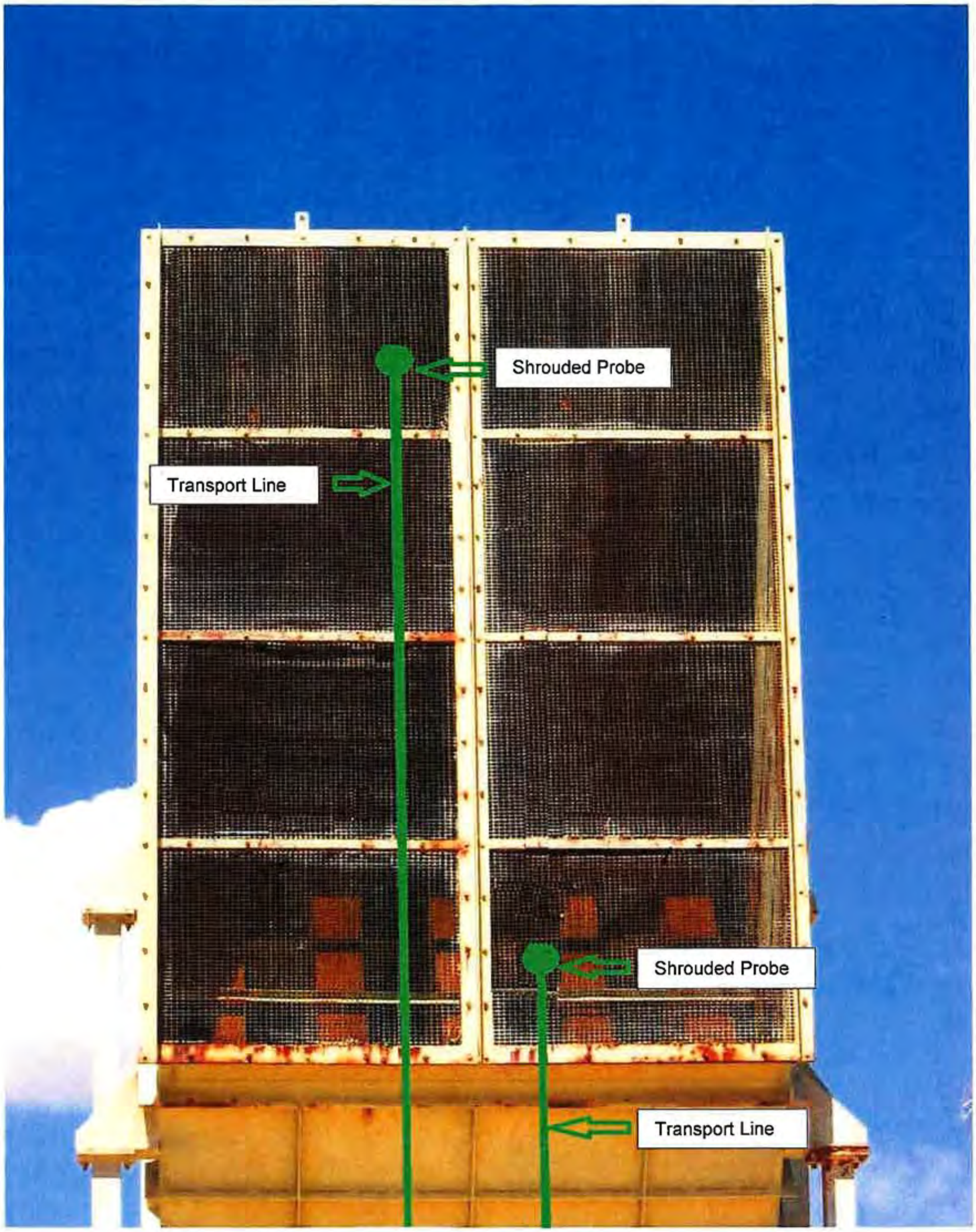


Figure 2 – Placement of Sampler Withdrawal Points on the 700C Fan Exhaust Screen

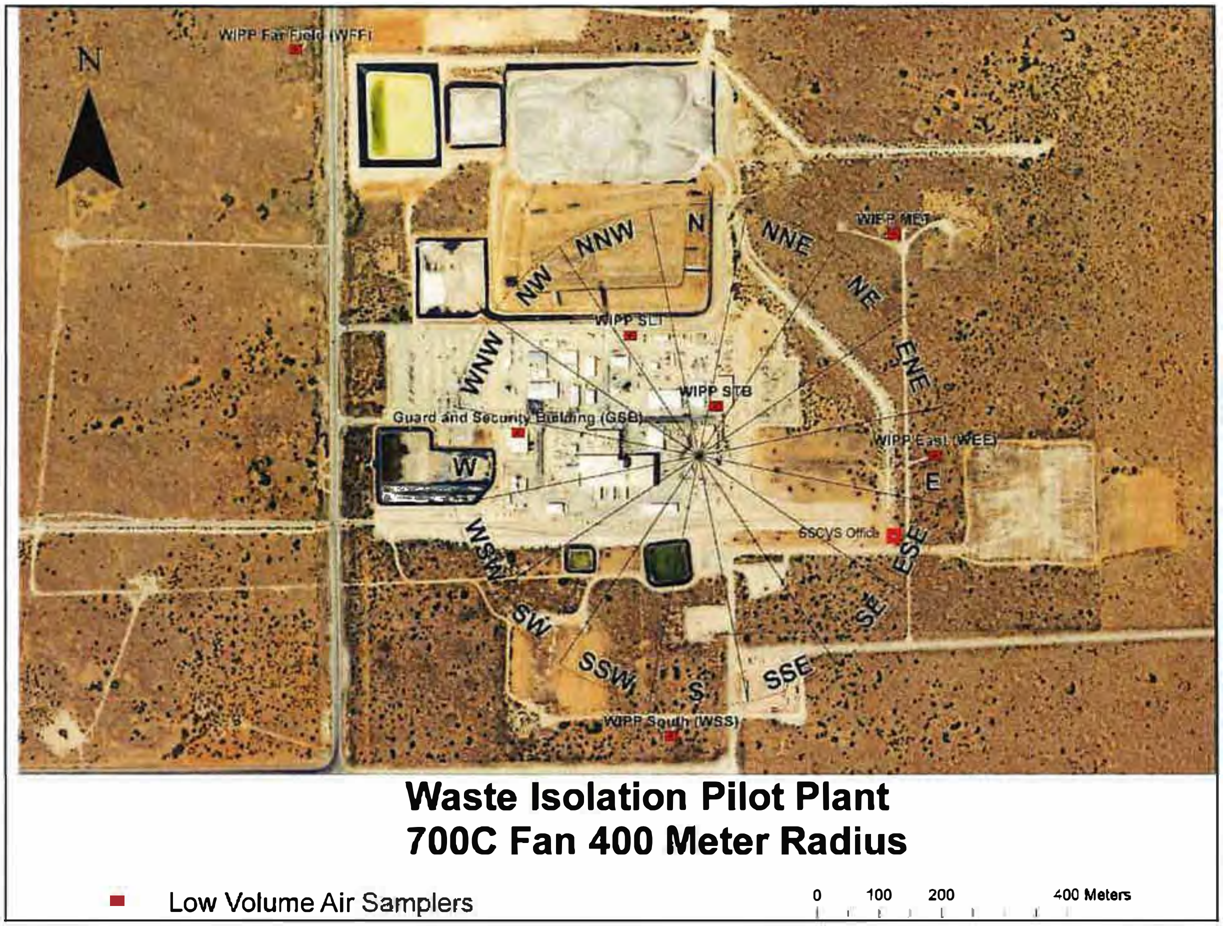


Figure 3 – Ambient Air Event Evaluation Sample Points near the WIPP Facility

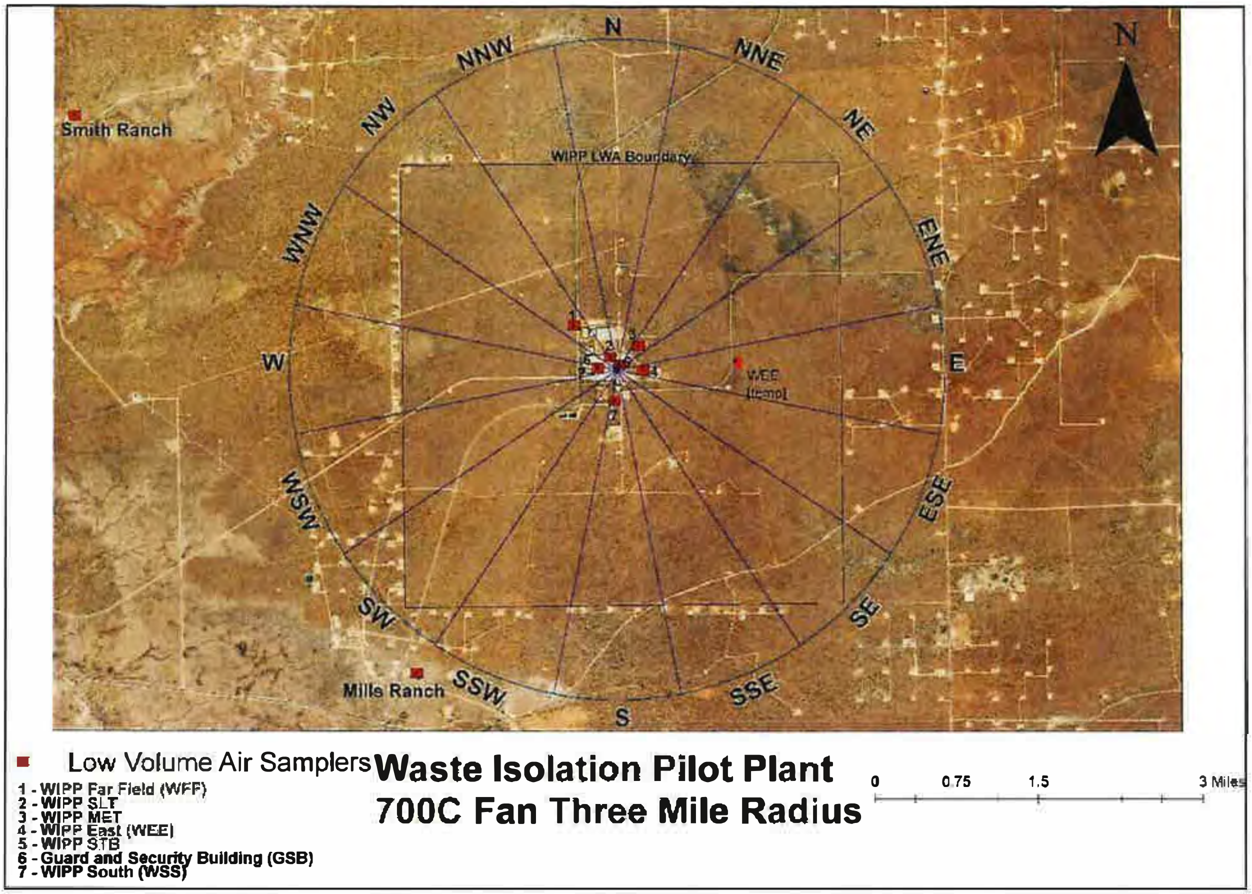


Figure 4 – Ambient Air Event Evaluation Sample Points in Vicinity of the WIPP Land Withdrawal Area

ATTACHMENT A, TRANSMISSION FACTORS FOR THE 700C FAN FACE SAMPLERS

The 700C fan face samplers collect exhaust emission air from two heights using one shrouded probe at each elevation above the ground level . Each probe sample line terminates in a splitter, which directs air two directions, one at 57 SLPM (2CFM), and the other at 114 SLPM (4CFM). The higher-flow leg then terminates in a second splitter, which results in an equal flow of 57 SLPM (2CFM) to each leg.

The Depo Cal model was used to determine the transmission factor for 10 micron particles through the sample transport line components to the sample filter. Parameters for as-built component lengths and elevation are incorporated. There are six samplers, three for the high sample point, and three for the low sample point. Since there are differences in the sample line length and path for four cases, the transmission factor is different for these cases. The transmission factor is to be divided into the value of the activity detected on the respective filter to provide a conservative value for that location.

Sample Location	Sample Line Description	Splitter Description	Transmission Factor
High -1	Upper splitter	From upper probe to splitter to sampler	0.7235
High -2	Lower splitter-1	From upper probe to splitter to splitter to sampler	0.6760
High-3	Lower splitter-2	From upper probe to splitter to splitter to sampler	0.6760
Low-1	Upper splitter	From lower probe to splitter to sampler	0.7518
Low-2	Lower splitter-1	From lower probe to splitter to splitter to sampler	0.7024
Low-3	Lower splitter-2	From lower probe to splitter to splitter to sampler	0.7024

Attachment 5

BC-RP-0134,
700 Fan External Sampling System Design

Doc. ID Number	BC-RP-0134
Revision Number	Rev. 1

700 Fan External Sampling System Design

Submitted by: Blunt Consulting LLC
283 Heritage Road
Williston, SC 29853

[redacted] 09/07/2020

Scope

In the effort to restart the 700C fan the Waste Isolation Pilot Plant (WIPP) plans to conduct a test program to determine the impacts of the increased air flow on any legacy radioactive contamination in the exhaust ducts and shafts. Station A, located in the exhaust shaft is the normal compliance sampler, however during the February 2014 event, some contamination was deposited in the exhaust ducts downstream of Station A. During the initial phase of the 700C fan startup, sampling at the 700C fan shroud outlet screen will be conducted to account for the potential release of contamination from the unmonitored section of duct.

With the exception of sampling in a qualified location, the sampling system described in the document meets the criteria contained in ANSI/HPS N13.1-1999[1], which is entitled "*Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stack and Ducts of Nuclear Facilities*."
The design is based on the general criteria contained in June 16, 2020 Statement of Work, SOW-20-36, Revision 1, "NESHAP Sampling for 700 Fan Restart" included with PO 515268. The general criteria are:

- Shrouded Probe system
- Sample at 700C Fan exhaust screen
- Shrouded probes placed in two area; one at the top and the other at the bottom of the exhaust screen
- Each probe assembly to connect to 2 or 3 WIPP supplied samplers
- Complete a depositional loss calculation
- System to be mounted on scaffolding provided by WIPP
- System assembly by WIPP personnel

Basic Design

The basic design dictates the placement of two separate sampling systems, each including a shrouded probe, transport line and a splitter system to allow either 2 or 3 independent samples to be used with each transport system. The supplied sampling system is depicted in Figures 1 and 2.

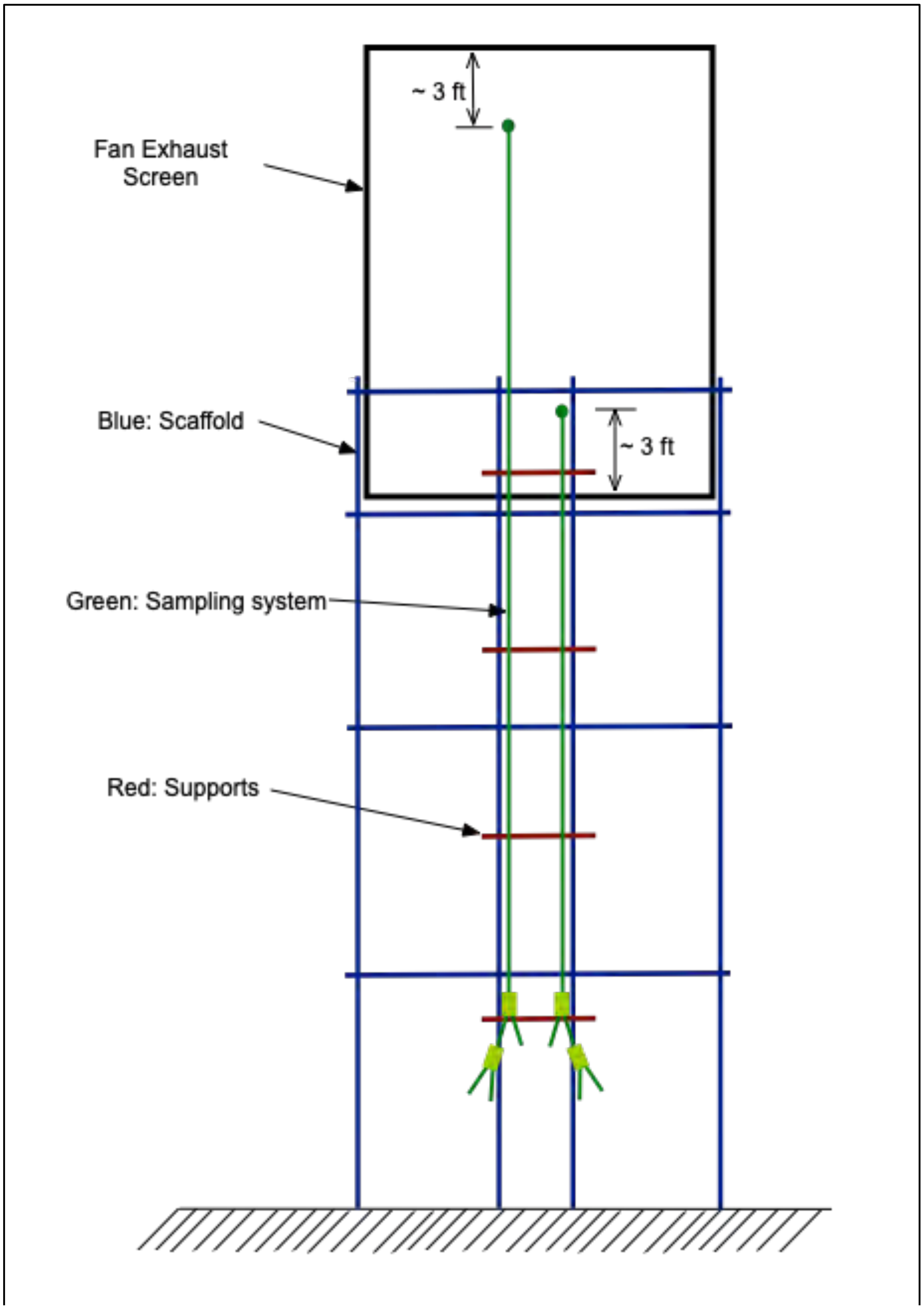


Figure 1: Sampling System View 1

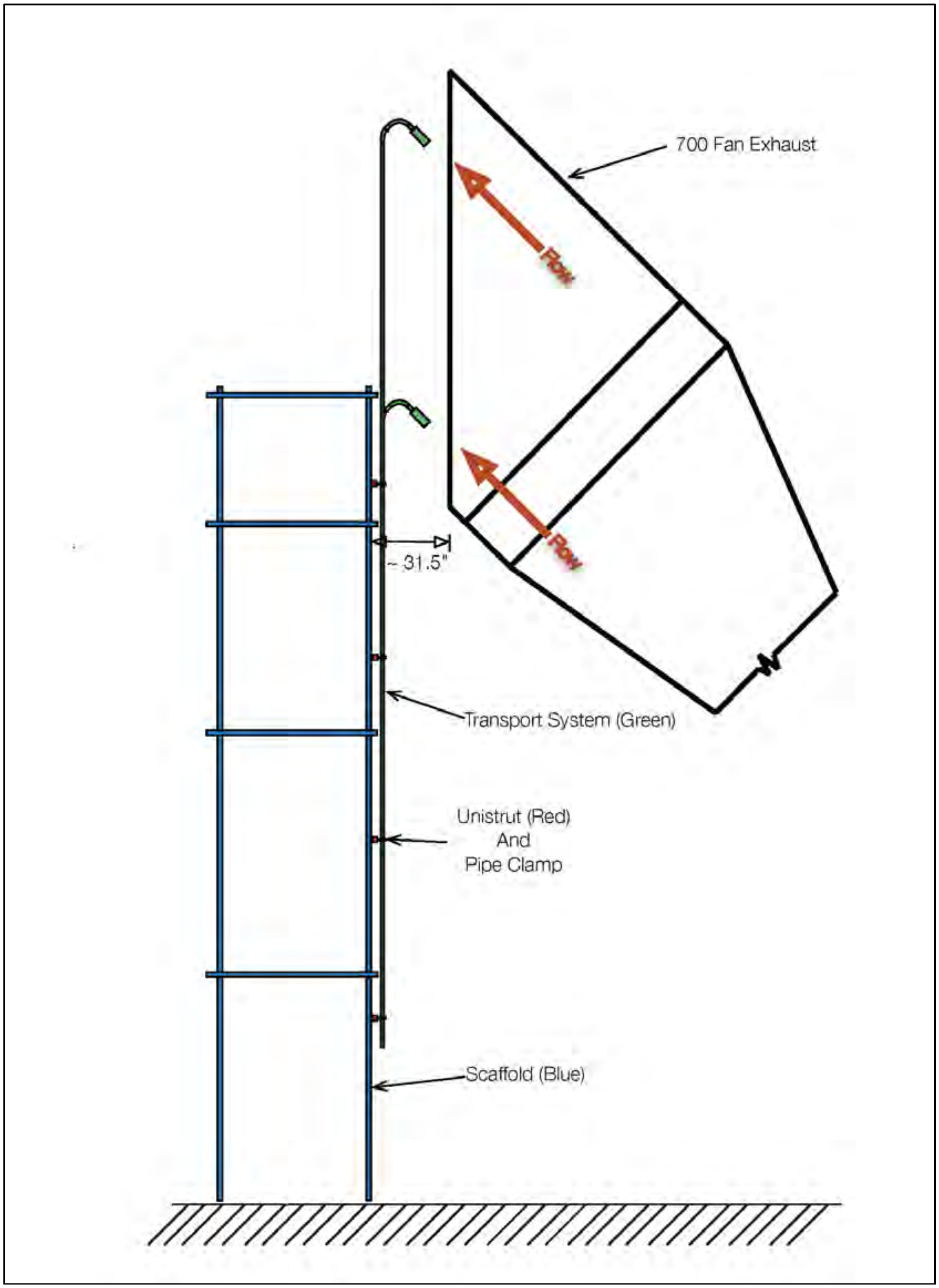


Figure 2: Sampling System View 1

Shrouded Probe

The Statement of Work states that the 700C fan has an exit velocity of 6.9 meters/second. ANSI N13.1-1999 states that a sampling nozzle shall have an aspiration ratio between 0.80 and 1.50 and that the transmission ratio shall be between 0.80 and 1.30. Based on these criteria, an RF2-112 commercially available shrouded probe was selected as the inlet to the sample transport system. The potential sample flow rates range from 2 cfm (57 lpm) for a single sampler to 6 cfm (170 lpm) for 3 samplers. As shown in Figures[1] 3, 4, and 5 the aspiration ratio and transmission ratio for the RF2-112 probe at the 700C fan exhaust velocity are all within the ANSI N13.1 limits.

- 2 cfm
    - Aspiration ratio = 1.13
    - Transmission ratio = 1.02
- 4 cfm
    - Aspiration ratio = 1.06
    - Transmission ratio = 0.98
- 6 cfm
    - Aspiration ratio = 1.03
    - Transmission ratio = 0.95

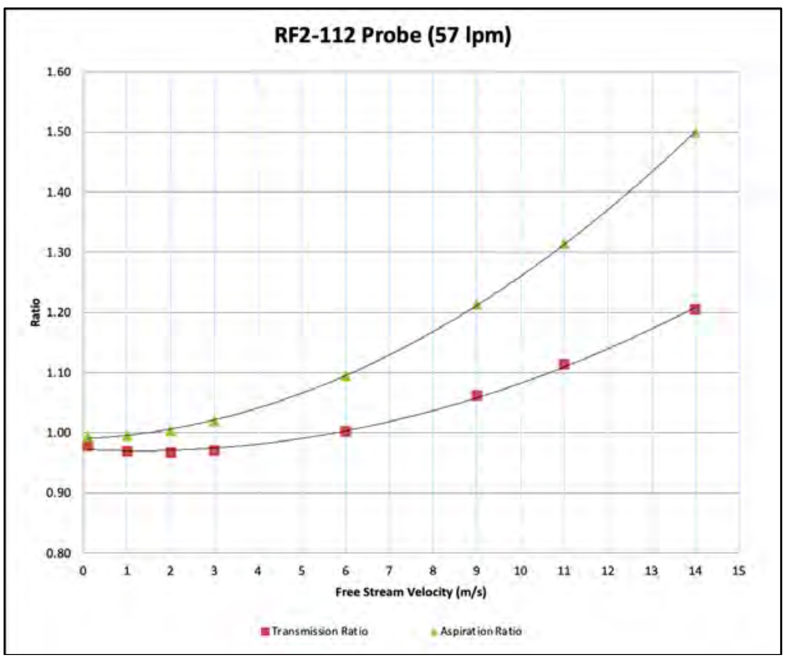


Figure 3: RF2-112 Aspiration and Transmission ratios at 2 cfm

[1] Figures are based on H Gong, AR McFarland, et al. *A Predictive Model for Aerosol Transmission through a Shrouded Probe*, Environmental Science and Technology, 30:3192-3198

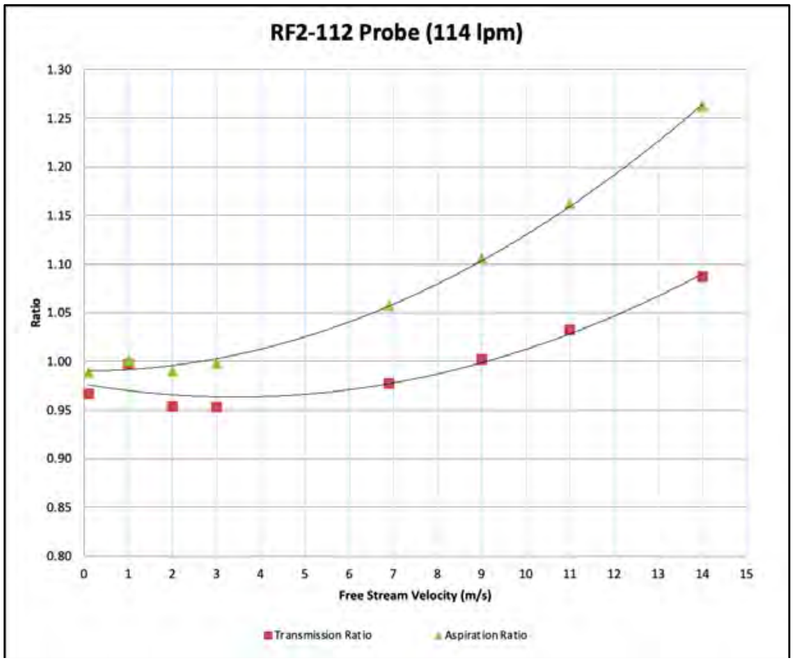


Figure 4: RF2-112 Aspiration and Transmission ratios at 4 cfm

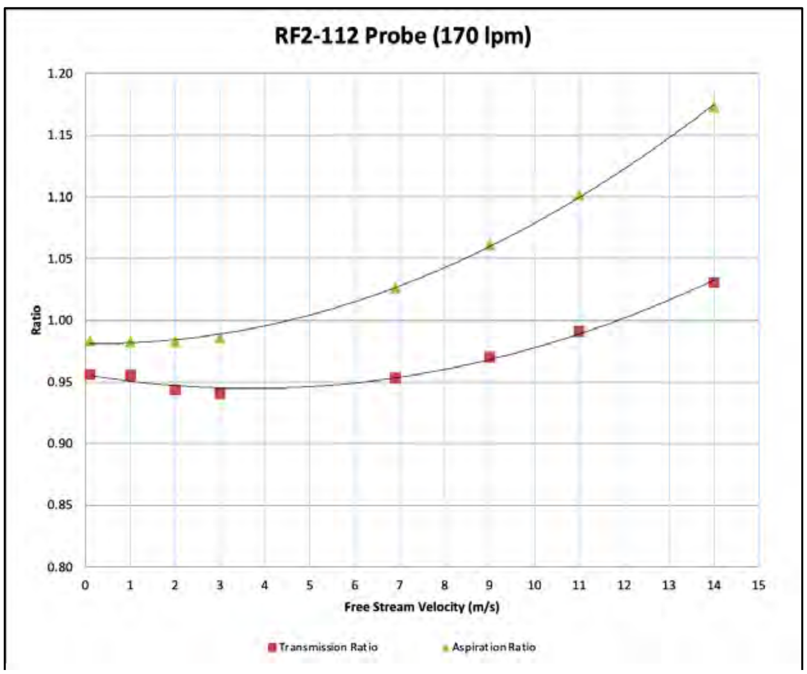


Figure 5: RF2-112 Aspiration and Transmission ratios at 6 cfm

Splitter Design

The SOW required that a splitter system be designed to allow for either a 2-way or 3-way split. To achieve this criterion two 2-way splitters were designed and fabricated per the design criteria contained in Gupta 2001[2]. Each splitter is based on “Splitter C” from Gupta 2001 with a 30-degree bifurcation angle. The splitters are fabricated from a block of 6061 aluminum as shown in Figure 6. The dimensions of each splitter are presented in Table 1. The splitters are constructed using bore through fittings. A bore through fitting allows for the tube to be pushed completely through the fitting. This design ensures a continuous diameter between the tubing and the holes in the aluminum body. The overall dimensions of each leg of the splitter is that given by Gupta 2001.

Table 1: Splitter Dimensions

Parameter		Upper Splitter		Lower Splitter	
	Gupta Ratio	Dimensions	Ratios	Dimensions	Ratios
D1	Inlet Diameter	1.26 “	Inlet Dia.	0.87”	Inlet Dia.
D2	0.7 D1	0.87”	0.7	0.62”	0.7
L1,2	7.5 D1 + 3.0 D1	13.23”	9.45” + 3.78”	9.14”	6.525” + 2.61”
L3,4	5.0 D1 + 8.0 D1	16.38”	6.3” + 10.08”	11.31”	4.35” + 6.96”

[2] Rajiv Gupta and Andrew McFarland, “Experimental Study of Aerosol Deposition in Flow Splitters with Turbulent Flow”, Aerosol Science and Technology, 34: 216-226 (2001)

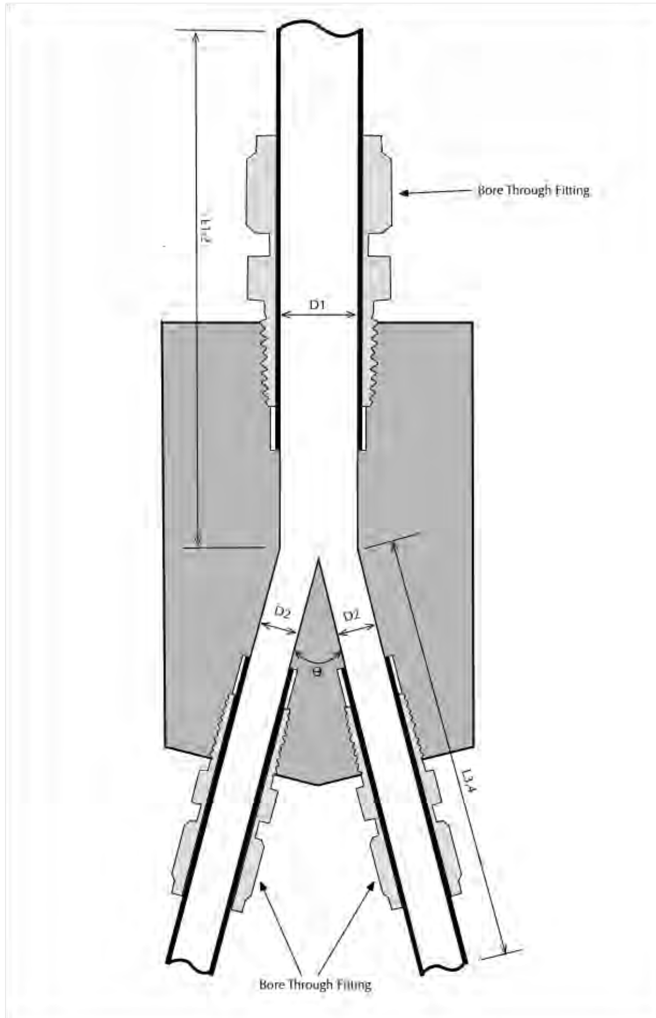


Figure 6: Splitter design

Depositional Loss Calculation

ANSI N13.1-1999 requires that the depositional losses in a sample transport system by less than 50%. Stated in terms of transmission, the particle transmission through the sample transport system should be greater than 50%. A depositional analysis has been conducted on the longer sampling system. The deposition in the shorter system will be slightly less than that of the longer system. The analysis is performed assuming both splitters are in use. The sample tubing has an internal diameter of 1.31 inches. A summary of the analysis is presented in Table 3. The general system data is presented as Table 2. For the case where the sample is split 3-ways at a flowrate of 2 cfm per sampler, the total penetration through the system to the most distant sample holder is 65.8%, which is within the ANSI N13.1 limit.

Table 2: General Analysis Data

General System Data	Input	Units		
Particle Size	10	microns AD	1.00E-05	meter AD
Sample Temperature	35	°C	3.08E+02	K
Absolute Pressure	101.325	kPa	1.01E+02	kPa
Actual Volumetric Flow	170	L/min	2.83E-03	m3/s
Free Stream Velocity	6.9	m/s	6.9	m/s

Table 3: Depositional Analysis

Component Data									
Component Number	Type	Tube Internal Diameter (inch)	Tube Length (inch)	Inclination from Horizontal (degree)	Bend or Bifurcation Angle (degree)		Tube Diameter (millimeter)	Tube Length (meter)	Component Penetration (%)
1	RF2-112						NA	NA	95.34%
2	Tube	1.31	2	45			33.3	0.051	99.80%
3	Bend	1.31			90		33.3	NA	92.85%
4	Tube	1.31	4	45			33.3	0.102	99.60%
5	Bend	1.31			45		33.3	NA	96.36%
6	Tube	1.31	384	90			33.3	9.754	86.57%
7	splitter 1	1.26			30		32.0	NA	96.98%
8	splitter 2	0.87			30		22.1	0.000	93.83%
9	Tube	0.62	6	30			15.7	0.152	98.46%
10	Sample Chamber						NA	NA	100.000%
Total Penetration									65.76%

Leak Check

After assembly at the WIPP site a leak test was conducted on each system using the vacuum decay method. In order to use a vacuum decay method, the volume of the system must be known. The volume of the probe sections and the splitters were determined by measuring the volume of water required to fill each component. The sample tubing volume was calculated as the area of the tube ID (1.31 inch) times the length of each section. Table 4 presents the volume data.

Table 4: System Volume Calculations

Component	**Upper Probe (longer)**	**Lower Probe (shorter)**
Probe	2.91E-02 ft^3 (835 ml)	2.91E-02 ft^3 (835 ml)
Transport Line (1.31" ID)	2.81E-01 ft^3 (30 ft of tubing)	1.88E-01 ft^3 (20 ft of tubing)
Upper Splitter	2.08E-02 ft^3 (590 ml)	2.08E-02 ft^3 (590 ml)
Lower Splitter	8.29E-03 ft^3 (250 ml)	8.29E-03 ft^3. (250 ml)
Total Volume	3.40E-01 ft^3	2.46E-01 ft^3

A vacuum was pulled on the system, which was then sealed and allowed to set for 5 minutes. The initial and final vacuums were recorded.

For the upper system (the longer system), the initial vacuum was 21.8 in Hg and the final vacuum was 20.5 in Hg. The leak rate for this system is

$$Leak\ Rate = \frac{\left(\frac{System\ Volume}{Initial\ Vacuum}\right)(Initial\ Vacuum - Final\ Vacuum)}{5\ min}$$

$$Upper\ System\ Leak\ Rate = \frac{\left(\frac{3.40E-01\ ft^3}{21.8\ in\ Hg}\right)(21.8\ in\ Hg - 20.5\ in\ Hg)}{5\ min}$$

$$Upper\ System\ Leak\ Rate = 0.004\ cfm$$

For the lower system (the shorter system), the initial vacuum was 22.0 in Hg and the final vacuum was 22.0 in Hg. The leak rate for this system is

$$lower\ System\ Leak\ Rate = \frac{\left(\frac{2.46E-01\ ft^3}{22.0\ in\ Hg}\right)(22.0\ in\ Hg - 22.0\ in\ Hg)}{5\ min}$$

$$lower\ System\ Leak\ Rate = 0.000\ cfm$$

Section 6.9 of ANSI N13.1-1999 states that a sampling system leakage rate of 5% of nominal flow at a vacuum of 15" water would be unacceptable. At a flow rate of 2 cfm the acceptable leakage rate would by 0.1 cfm at 15" water and at 6 cfm the acceptable leakage rate would be 0.3 cfm at 15" water vacuum. The systems were tested at much higher vacuums. The measured leakage rates are much less than the ANSI N13-1 limits.

Installation Pictures

Depo Cal Runs for 700C Fan Face Samplers - Worst Case Proof Run: Lower Splitter HIGH

edp 091020

Component No.	Type	Tube Internal Dia (mm)	Tube Internal Dia (inch)	Tube Length (ft)	Tube Length (m)	Incline from Horizontal (deg)	Bend Angle (deg)	Bend Radius (m)	Particle Size (micron)	Sample Temp. (deg. C)	Absolute Press. (kPa)	Actual Volum. Flow (L/min)	Exhaust Stream Vel. (m/s)		Component Transmission (fraction)	Component Penetration (%)	Cumulative Transmission (fraction)	Cumulative Penetration (%)	Required Penetration Min. (%)
0	RF2-112	38.1	1.5	NA	NA	-45	NA	NA	10	35	101.325	170	6.9		0.953	95.340	0.953	95.34	NA
1	T-1	33.33	1.31	0.17	0.051	-45	NA	NA	10	35	101.325	170	NA		0.998	99.800	0.951	95.15	NA
2	B-1	33.33	1.31	NA	NA	-135	90	0.167	10	35	101.325	170	NA		0.929	92.890	0.884	88.38	NA
3	T2	33.33	1.31	0.33	0.102	45	NA	NA	10	35	101.325	170	NA		0.996	99.610	0.880	88.04	NA
4	B-2	33.33	1.31	NA	NA	135	45	0.167	10	35	101.325	170	NA		0.964	96.380	0.849	84.85	NA
5	T-3	33.33	1.31	32	9.754	90	NA	NA	10	35	101.325	170	NA		0.867	86.730	0.736	73.59	NA
Splitter-upper	S-1	32	1.26	NA	NA	30	NA	NA	10	35	101.325	170	NA		0.972	97.190	0.715	71.52	NA
Splitter-lower	S-2	22.1	0.87	NA	NA	30	NA	NA	10	35	101.325	114	NA		0.934	93.445	0.668	66.84	NA
Splitter Stub	T-1	15.7	0.618	0.5	0.152	30	NA	NA	10	35	101.325	56.5	NA	*	0.985	98.460	0.658	**65.81**	50
*	Minor Depo Cal discrepancy on this component																As reported:	65.76	

[redacted] 10 Sep 2020

Enclosure 2

TBD 20-003, Sampling Plan for the 700C Fan Startup and Testing

ISSUED

RADIOLOGICAL CONTROL TECHNICAL BASIS DOCUMENT OR TECHNICAL EVALUATION

Title: Sampling Plan for the 700C Fan Startup and Testing	☒ **TBD** ☐ **TE**
	TBD/TE Number: TBD 20-003
	Revision Number: 3
	Effective Date: 12/2/20

Author/Reviewer(s)/Approver(s):

Jennifer Lemons [redacted]	12/2/20
Author: (Print/Sign)	Date
Jennifer Lemons for Marty Jamieson [redacted]	12/2/20
Peer Reviewer: (Print/Sign)	Date
Reviewer: (Print/Sign)	Date
Reviewer: (Print/Sign)	Date
Reviewer: (Print/Sign)	Date
Reviewer: (Print/Sign)	Date
Roger Groves [redacted]	12/2/2020
Approval: REDM/DRCDM (or designee): (Print/Sign)	Date
Sean Griffith [redacted]	12/2/2020
Approval: RCDM (or designee): (Print/Sign)	Date

Evaluation Summary:

This sampling plan encompasses onsite monitoring during the four hour duration period of the startup and testing of the 700C fan. The sampling plan includes specific coordinate locations for placement of sampling equipment and sample protocol.

Sampling Plan for the 700C Fan Startup and Testing

TBD 20-003 Rev. 3

Introduction

This sampling plan encompasses onsite monitoring during the four hour duration period of the startup and testing of the 700C fan. The plan consists of specific coordinate locations for placement of sampling equipment and sample protocol.

Methodology

Based on Radiological Engineering Paper TE 20-002 Radiological Assessment of the Startup and Testing of the 700C Fan, a source term of 5.92E-6 curies is estimated to be released during the startup and 4 hour testing period of the 700C Fan. Requirements are established to provide assurance that radiological impacts to site personnel are minimized and controlled, and compliance with 10 CFR 835 is maintained as outlined in WIPP's radiological procedures. Additional requirements beyond 10 CFR 835 are outlined in the sampling plan to account for the uncertainty of actual radioactivity contained in the salt to ensure worker protection.

The sample locations were determined using National Atmospheric Release Center (NARAC) plume models for ground deposition using the estimated source term. The sample locations were identified by overlaying the 3 plume models representing a 320 degree to 20 degree wind direction range from the point of release assuming a wind speed of 20 miles per hour. Refer to Attachment 1 for onsite sampling locations. It is imperative the following meteorological conditions be met prior to execution to ensure proper implementation of the sampling plan and worker protection:

- wind direction between 320-20 degrees
- average wind speed below 20 mph
- no precipitation

Airborne radioactivity sampling will consist of Continuous Air Monitors (CAMs) and Portable Air Samplers (PASs). For ground deposition, swipes will be taken for measurement of removable activity and portable contamination monitoring equipment known as friskers will be used for total activity. Round aluminum ground deposition pans will be placed prior to the fan startup at the sample locations to allow for more accurate removable/total contamination surveys. A control ground deposition pan will be located near Building 952. This control pan will be treated as background when surveying all of the other pans. All ground deposition pans will be divided into two halves labeled side A and side B. Generators will be used at all CAM/PAS locations that do not have permanent power.

Notification will be made to the Radiological Controls (Radcon) department and Radiological Engineering that the conditions are ideal for starting the 700C Fan in 24 hours. Once the notification is received, the Radcon department will deploy the pre-staged equipment. See Attachment 3 for equipment list.

The sampling team will deploy PASs, CAMs, and ground deposition pans prior to 700C Fan startup/operation. See Attachments 1-2 for map and sample locations. If a sample location could be deemed as hazardous, then Radcon Supervisor will adjust the sample location and notify Rad

Engineering. To ensure an appropriate volume is collected in order to meet the minimum sensitivity for the air samples, PASs will be set to run at approximately 2 CFM.

Safety

During the initial startup of the 700C Fan, contractors supporting the SSCVS will not be allowed on the worksite. Onsite staffing will be restricted to essential and test support personnel during testing. The Central Monitoring Room will announce to remain indoors to notify all site personnel prior to starting the 700C Fan. The Radiological Controls Manager will determine the termination of area controls after reviewing the initial data.

In compliance with 10 CFR 835, areas on the WIPP site are required to be posted as Airborne Radioactivity Areas (ARAs) when the levels reach ≥ 0.3 DAC. A Technical Evaluation, TE 20-002, shows that the predicted DAC levels outside the 700C fan will be more than 0.02 DAC. Respiratory protection will be required as a precautionary measure to compensate for the uncertainty of the activity released.

Four CAMs will be placed in the cardinal directions for worker protection purposes. The CAM alarm set point will be 8 DAC-Hr, which is the current set point for work areas outside of airborne radiological areas. If the CAM alarms as a result of transuranic activity, then notify Fac Ops/CMR and Radcon Supervisor to request immediate shutdown of the fan. A recovery plan will then be implemented. If the CAM alarms as result of a malfunction or low flow alarm, the CAM will be secured in accordance with procedure WP- 12HP1304 Canberra iCAM Alpha/Beta Continuous Air Monitor and/or WP 12-HP1321 Bladewerx SabreAlert Alpha Continious Air Monitor.

Personal Protective Equipment (PPE) requirements: Employees working in the posted radiological area during the startup and initial four hour test operation of 700 Fan will be required to wear a single set of PPE including a respirator. The sampling team will carry a portable CAM as a precaution during the retrieval of samples. The PPE requirement will be in effect until the Radiological Protection Project Manager releases the area from controls.

Sample Protocol

Attachment 1 shows the approximate locations of the deposition pans and portable air samplers (PAS). Radiological Control management may change the positioning, type, and quantity of the samples, as necessary.

The sampling team should consist of at least 5 RCTs to execute the plan efficiently. It may be necessary to divide the sampling team into smaller groups in order to retrieve all the samples in a timely manner. Each group would be responsible for retrieving samples from a specific section of the map. The Radcon supervisor will verify the conformance of sample collection after every sample collection evolution.

The minimum collection time is 4 hours to ensure the required 0.02 DAC sensitivity is met. This means the test window run time may increase. It will be necessary to record and subtract the volume from the filter for the time out of tolerance; either when the fan is off and/or when the wind shifts outside the window. A Stop Work consisting of stopping the fan and pausing the test will be required if the time out of tolerance is greater than 5 consecutive minutes.

The plan should be implemented in the following order:

1. 10 minutes after restart of 700C Fan- The sampling team will perform a removable (swipe) and total (1 minute frisk) contamination survey on side A of the control pan. The results will be considered as background.

2. The survey team will perform contamination surveys on side A of all ground deposition pans. The 1 minute direct results will immediately be reported to the Radcon supervisor. The swipes will then be counted and the results reported to the Radcon supervisor. The supervisor will compare results to the stop level set points of Attachment 4. If the net (total activity-control pan activity) result is greater than the listed stop level limit then request Fac Ops/CMR to secure 700C Fan. An offsite sampling plan will be implemented if elevated activity is detected onsite. The sampling team will also monitor the four CAMs in conjunction while performing the contaminations surveys. If the CAM alarms as a result of transuranic activity, then notify Fac Ops/CMR and Radcon Supervisor to request immediate shutdown of the fan. A recovery plan will then be implemented. If the CAM alarms as result of a malfunction or low flow alarm, the CAM will be secured in accordance with procedure WP- 12HP1304 Canberra iCAM Alpha/Beta Continuous Air Monitor and/or WP 12-HP1321 Bladewerx SabreAlert Alpha Continuous Air Monitor.

Steps 1 and 2 will be repeated every 60 minutes of fan operation.

3. After the fan has been secured, a final survey will be conducted on side B of all ground deposition locations. All PAS filters will then be collected.

Analysis

Swipes- During fan operation, all swipes performed on ground deposition pans and control pan will be counted using the normal one minute swipe count. After the fan has been secured and all swipes have been collected, then perform a 10 minute count on all swipes.

PASs- After fan is secured and all PAS filters have been collected, then perform a 10 minute air sample count on all PAS filters.

72 hour recount- After 72 hours, a 30 minute recount is to be performed on all PAS filters and swipes.

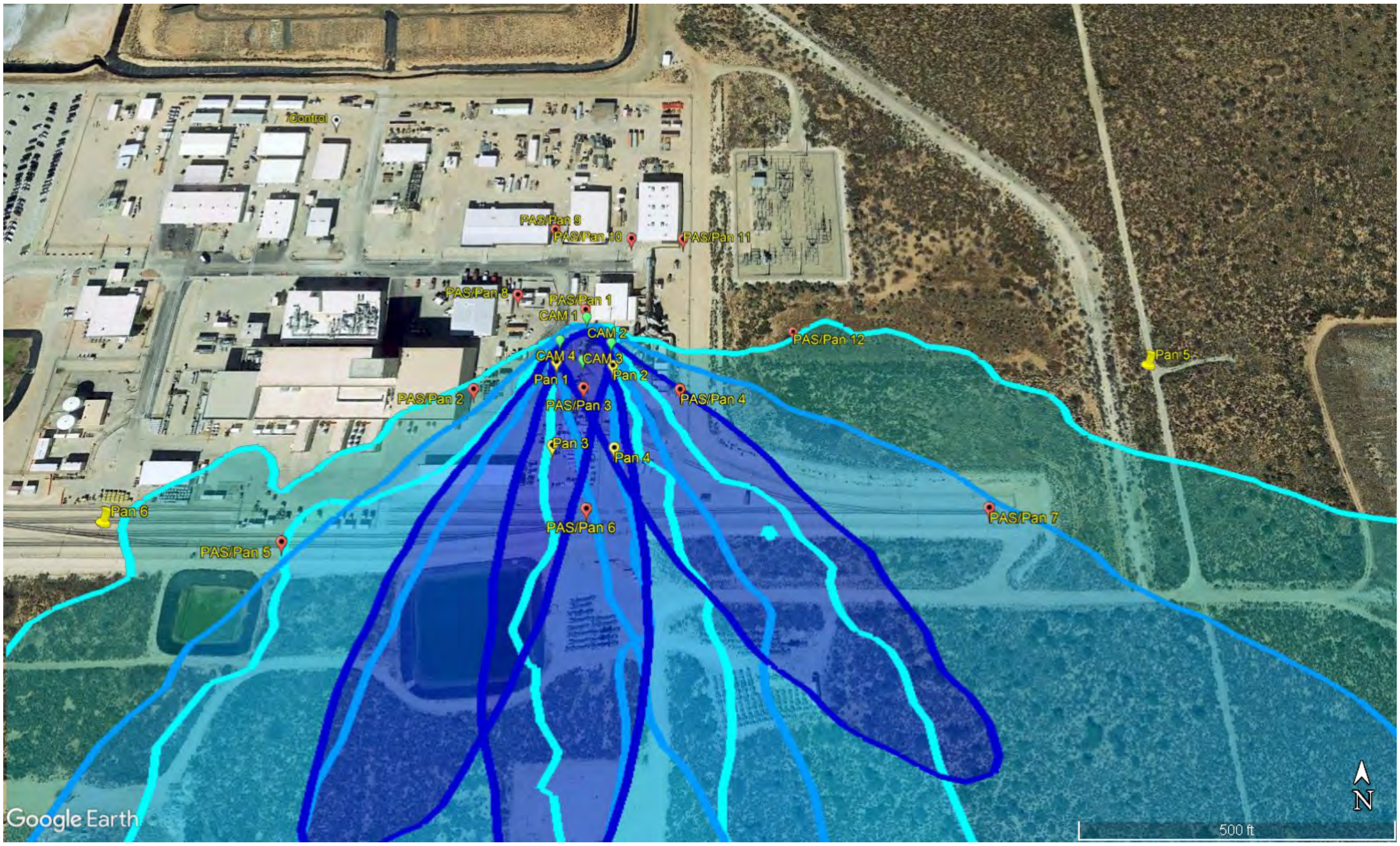
Upon completion of 72 hour recount, all PAS filters and swipes will be sent to WIPP Labs for gross alpha/beta analysis and gamma spectroscopy analysis. The need for isotopic analysis will be determined based on the gamma and gross alpha beta activity results.

Conclusion

All results from the initial restart and 4 hour testing period will be used to determine the future monitoring and operating requirements of the 700C fan. The continuous operation of the 700C fan will require further evaluation demonstrating acceptable results. The results and evaluation will be peer reviewed and shared with CBFO for concurrence.

Attachment 1

Sampling Locations



Attachment 2

Sampling Location Coordinates

	Latitude	Longitude
Control Pan	32.373261	-103.793856
PAS/Pan 1	32.371908	-103.792031
PAS/Pan 2	32.371411	-103.792694
PAS/Pan 3	32.371422	-103.792017
PAS/Pan 4	32.371411	-103.791422
PAS/Pan 5	32.370556	-103.793711
PAS/Pan 6	32.370733	-103.791964
PAS/Pan 7	32.370733	-103.789611
PAS/Pan 8	32.372006	-103.792472
PAS/Pan 9	32.372447	-103.792261
PAS/Pan 10	32.372383	-103.791753
PAS/Pan 11	32.372378	-103.791411
PAS/Pan 12	32.371769	-103.790711
Pan 1	32.371575	-103.792194
Pan 2	32.371556	-103.791842
Pan 3	32.371081	-103.792186
Pan 4	32.371072	-103.791814
Pan 5	32.371561	-103.788534
Pan 6	32.370668	-103.794789
CAM 1	32.371873	-103.792021
CAM 2	32.371711	-103.791858
CAM 3	32.371602	-103.792031
CAM 4	32.371725	-103.792182

Attachment 3

Equipment List

14 Portable Air Samplers (PAS)
20 Ground Deposition Pans
4 iCAMS
3 Portable CAMS
3 Tennelecs with 30 min count capability
15 Generators
15 Extension Cords
20 Cinder Blocks
10 Tubes of Adhesive (Liquid Nail)
2 Caulking Guns

Attachment 4

Stop Level Set Points

Instrument	Stop Level	10CFR835 Level
2360	>55 dpm/100 cm^2 alpha *	100 dpm/100 cm^2 alpha
2360	>325 dpm/100 cm^2 beta *	1000 dpm/100 cm^2 beta
Tennelec	>14 dpm/100 cm^2 alpha *	20 dpm/100 cm^2 alpha
Tennelec	>20 dpm/100 cm^2 beta *	200 dpm/100 cm^2 beta
iCAM	>8 DAC-HR	No Applicable Limit

All stop level readings are based on typical MDAs of instrument.

* The stop level is the value above what was determined to be background on the control pan