Indoor Air Quality Investigation
Second Sampling and Analysis Plan Addendum
Bozeman Landfill

Bozeman, Montana

Prepared for:

Dustin Johnson, P.E.

City of Bozeman
P.O. Box 1230
Bozeman, MT 59715

Prepared by:

Tetra Tech

851 Bridger Drive, Suite 6 (59715)
P.O. Box 1413 (59771)
Bozeman, MT
(406) 582-8790

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Signatures and Distribution List:

_____
Mark F. Pearson, Tetra Tech
Project Manager

_____
Kirk A. Miller, Tetra Tech
Senior Project Manager

_____
Dustin Johnson, P.E., City of Bozeman
City Engineer

LIST OF ACRONYMS

APH	Air Phase Hydrocarbon
DEQ	Montana Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
ft/min	Feet per minute
inHg	Inches of Mercury
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This document includes the Second Sampling and Analysis Plan (SAP) Addendum for the continued indoor air quality investigation in residences in the vicinity of the Bozeman Landfill. This project is funded by the City of Bozeman.

This Second SAP Addendum was prepared to guide continued work for the Bozeman Landfill indoor air quality investigation and is intended to be used in conjunction with the June 27, 2013 SAP (Tetra Tech, 2013a) and the August 6, 2013 SAP Addendum (Tetra Tech, 2013b). The indoor air quality investigation is being conducted in response to the discovery of elevated concentrations of volatile organic compounds (VOCs) in soil gas near the southern border of the Bozeman Landfill and the neighboring community (Tetra Tech, 2013c). Additional sampling methods are being employed to determine whether VOCs found in residences along the southern boundary of the Landfill originate from beneath the structures or if they are background concentrations from typical consumer products and attached garages found throughout the neighborhood. This Second SAP Addendum specifically addresses direct sampling methods such as indoor air, sub-slab, and depressurization system air sampling. Other methods that are included in this document are the use of semi-permanent Vapor Pins™, post-mitigation sampling, sub-slab vacuum monitoring, depressurization system air velocity measurements, radon testing, and additional quality assurance/quality control (QA/QC) measures that reduce decision error.

This Second SAP Addendum is organized as follows: *Section 1* presents the Introduction; *Section 2* presents a Site Summary Update; *Section 3* the Methodology, and; *Section 4* presents Quality Assurance/Quality Control measures. **Figure** 1 presents the Site Map, **Appendix A** presents the Vapor Pin™ standard operating procedures, and **Appendix B** presents the Radon in Air Test Data Sheet.

1.1 Objectives

The primary objective for additional sampling in neighborhoods adjacent to the Bozeman Landfill are to determine whether mitigation efforts are reducing or eliminating VOC's from beneath the homes adjacent to the landfill (Phase I), to sample a representative number of homes in a second neighborhood further from the landfill (Phase II), and to ensure QA/QC objectives are being obtained.

2.0 SITE SUMMARY UPDATE

Since June 2013 Tetra Tech has conducted indoor air sampling and sub-slab or depressurization system air sampling in all but one residence along Saint Andrews Drive, Turnberry Court, and Caddie Court. This neighborhood is identified as Phase III (**Figure 1**). Laboratory analytical results for both indoor air and sub-slab soil gas have shown concentrations of carbon tetrachloride, 1,4-dioxane, 1,2,4-trimethylbenzene, vinyl chloride, benzene, 1,2-dichloroethane, trichloroethane, tetrachloroethene, ethyl benzene, m,p-xylenes, and chloroform above 2013 Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) for residential indoor air. Soil gas identified in soil probes, sub-slab samples, and depressurization systems (also known as radon mitigation systems) is likely originating from the unlined cell at the landfill and is migrating into homes through basement slabs. This exposure pathway is defined as vapor intrusion. It is difficult to determine what amount of VOCs in the homes are due to landfill gases, and what amount is from common household products used in building materials, fuels, solvents, furniture, etc.

Tetra Tech, on behalf of the City of Bozeman has been actively installing sub-slab depressurization systems in residences since September 2013. Implementing mitigation has triggered the need for additional sampling. Additional sampling has included the use of vacuum monitoring points, radon testing, and post-mitigation indoor air and sub-slab soil gas sampling.

Tetra Tech selected four homes in the neighborhood along Augusta Drive, identified as Phase II, for indoor air and sub-slab air sampling (**Figure 1**). Analytical results for VOCs and air phase hydrocarbons (APH) will be used to determine whether additional sampling is necessary in Phase II and ultimately whether mitigation will be necessary.

3.0 METHODOLOGY

This section presents the methodology being employed to continually assess the effects or potential effects of vapor intrusion in neighborhoods in the vicinity of the Bozeman Landfill. Additional methods addressed in this section includes the installation of sub-slab specific Vapor Pins for extracting soil gas samples, sub-slab vacuum monitoring, air speed monitoring from within the depressurization systems, the use of radon test kits, post-mitigation sampling schedules and techniques, and the use of 10^{-5} risk calculations.

3.1 Vapor Pin Installation

Tetra Tech is implementing the use of Cox-Colvin and Associates, Inc. (Cox-Colvin) Vapor Pins to collect sub-slab soil gas samples in homes where there is either no existing radon mitigation system or to check the vacuum in homes with radon or VOC mitigation systems (see **Section 3.2.1**). Each Vapor Pin consists of a stainless steel or brass tube, a silicone seal, a plastic cap, and a stainless steel secure flush-mount cover. Each Vapor Pin is installed according to Cox-Colvin standard operating procedures (**Appendix A**).

Soil gas samples are collected from each monitoring point using a combination of silicone, Teflon, or Tygon tubing and a 6 Liter Summa canister assembly supplied by Air Toxics Eurofins laboratory of Folsom, California, or ALS Environmental laboratory of Simi Valley, California. Samples are collected according to April 2011 Montana Department of Environmental Quality (DEQ) Vapor Intrusion Guidance (DEQ, 2011) protocols.

3.2 Post-Mitigation Sampling Events

Tetra Tech will collect vacuum measurements beneath the concrete slab of each home 2 weeks after a mitigation system is installed, and will collect a second round of sub-slab soil gas samples and indoor air samples including a radon test 4 weeks after the system is installed.

3.2.1 Vacuum Monitoring

Collecting a vacuum measurement from a residence consists of installing a Vapor Pin most distal from the mitigation system as is practical. The purpose of a vacuum monitoring point is to determine whether the mitigation system is drawing enough negative pressure beneath the entire slab of a home to sufficiently reduce VOC concentrations below 2013 EPA RSLs (see **Section 3.2.3**). Vacuum is measured using a Fieldpiece SDMN5 Dual Port Manometer and the following steps: (1) connect hose to port P1, (2) zero the unit before measurement, (3) place the other end of hose on the Vapor Pin barb fitting, (4) wait approximately 5 minutes and collect a reading in inches Water Column (inWC). Target vacuum pressure is -0.01 inWC beneath the entire slab to ensure a mitigation system is operating properly.

3.2.2 Air Speed Monitoring

Air speed inside the depressurization system 4 inch PVC pipe will be checked 2 weeks after home installation is completed. In order to measure air speed in the exhaust pipe Tetra Tech will drill a small 1/8 inch threaded hole between where the pipe exits the concrete slab and before entering the mitigation system fan. Preferably, there should be 3 feet of straight pipe on either side of the measuring location in order to obtain the most accurate reading, however this may not be possible in every home. Air speed is measured using a TSI Air Speed Meter. Once the hole is drilled the following steps should be followed: (1) turn on the meter and allow to calibrate

for at least 30 seconds, (2) insert meter probe in the 1/8 inch hole until the tip reaches the center of the 4 inch pipe (approximately 2 inches), (3) record the measurement in cubic feet per minute (cfm) five times where measurements are 10 seconds apart, (4) remove the meter and cover opening with threaded brass cap.

Home mitigation systems were installed with either a Fantech FR-150 or an HP-220 exhaust fan. The recommended air flow for a smaller size home with an FR-150 with 0.1 inWC of static pressure is a minimum of 250 cfm. In larger homes or homes with more than one extraction point, the HP-220 fan was used to achieve a flow rate of at least 330 cfm with 0.1 inWC pressure. A performance chart from the manufacturer is presented in **Appendix B**.

3.2.3 VOC Sampling in the Sub-Slab and Indoor Air

VOCs are sampled for in the sub-slab soil gas and indoor air 4 weeks after the installation of the mitigation system is complete. This process consists of replicating the initial sub-slab and indoor air sampling events with regards to sample locations. Sample nomenclature will remain consistent with the initial sample. For example, if the basement sample was labeled SAI-1-A during pre-mitigation sampling, then that label would be used again during the post-mitigation event; the same is true for sub-slab samples with a suffix such as -SS1. If samples are drawn from a vacuum monitoring point the the label may change to -SS2 showing a change in location.

Samples will be collected using the same procedures outlined in the SAP (Tetra Tech, 2013a) and SAP Addendum (2013b) and are submitted for TO-15, air phase hydrocarbon (APH), and helium (for sub-slab samples only) analysis.

3.2.4 Radon Sampling

Quantitative monitoring for radon is conducted before and after mitigation system installation in the residence. The purpose of radon monitoring is to assess effectiveness of the mitigation system in breaking a potential vapor intrusion pathway between the subsurface soil material and the indoor living space of the residence. Radon has been selected because it is unlikely to be produced from products typically used in the residence. Charcoal Liquid Scintillation samples are submitted to AccuStar Labs of Medway, Massachusetts and submitted for radon analysis by EPA method #402-R-92-004. Radon in Air Test Data Sheet is presented in **Appendix C**, and the Project Short Term Charcoal Radon Test is presented in **Appendix C**.

The field procedures for the placement and pickup of radon samplers are the following:

- Review the completed occupied dwelling questionnaire basement or lowest level floor plan to determine the optimal placement of the radon samplers.
- Insure that field personnel have the signed access agreement to enter the residence and arrange with residence owner, a convenient time to place and pick up the samplers.
- Place two radon samplers per residence for a minimum of 48 hours to a maximum of 96 hours.
- The samplers should be placed away from open/or to be opened windows and doors to the outside, preferably in a living space such as a bedroom, family room, office, etc.

- The placement of samplers in a space such as a closet or bathroom with the door closed is not advisable but may be necessary to avoid outside air drafts and tampering (for the duration of the test).
- Each radon sample location will have its own particular designation written under the Unit # of the Radon in Air Test Data Sheet. Also, briefly describe the location under Name of Room.
- Sample labeling should be in accordance with the following example: at residence AI-1, two radon samplers are placed and have designations of AI-1-R1 and AI-1-R2. The duplicate placed at the location of AI-1-R1 would have the designation of AI-1-R1D and the blank placed at the location of AI-1-R2 would have the designation of AI-1-R2B.
- For QA/QC purposes, 10% of the total tests should consist of duplicate tests and 5% of the total tests should consist of blank tests. See the QC measurements section of the attached Instructions for the Project Short Term Charcoal Radon Test (**Appendix C**).

3.3 10^{-5} Risk Calculation

Tetra Tech will review analytical results that have been applied to 2013 EPA Regional Screening Levels (RSLs) for Residential Air (EPA, 2013). Sample results for both sub-slab soil gas and indoor air that exceed RSLs will be adjusted from 1 x 10^{-6} (or one in one million) cancer risk to 1 x 10^{-5} (or one in one hundred thousand) excess lifetime cancer risk for up to 10 cancer-causing compounds. The table below is an example of a risk calculation:

Compound	Result	EPA RSL	Multiplied
Carbon Tetrachloride	0.52	0.406	1.28 x 10^{-6}
Benzene	1.3	0.31	4.19 x 10^{-6}
1,2-Dichloroethane	0.66	0.094	7.02 x 10^{-6}
Ethylbenzene	1.5	0.97	1.55 x 10^{-6}
Chloroform	1.3	0.11	11.82 x 10^{-6}
		Sum	25.9 x 10^{-6}

25.9 x 10^{-6} = 2.59 x 10^{-5} which is greater than 1 x 10^{-5} cancer risk[1]

[1]Calculations were drawn from the April 2011 DEQ Vapor Intrusion Guidance Document (DEQ, 2011)

This information may be used as an additional line of evidence to make project decisions regarding additional sampling and/or mitigation.

4.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

4.1.1 Split Sampling

Two sampling events for the Phase II homes occurred during fall 2013. The initial event is occurring in four homes in October, and the second event will occur in October and November 2013. During the second sampling event, ALS Environmental laboratories was contracted to provide a second set of canisters in conjunction with Air Toxics. Sampling occurred at four homes in Phase II, AI-1, AI-6, AI-7, and AI-11. Subslab and indoor air samples were collected simultaneously using a laboratory supplied 'T' connection where intake tubing could be split and collected in two separate Summa canisters.

The labeling convention for indoor air samples consisted of the suffix –S for split samples. For example, a natural sample label for location AI-1 is AI-1-F, and the split sample labeled AI-1-FS. Subslab split samples will be named in numeric order. For example, the natural sample label for location AI-1 is AI-1-SS1, and split sample is AI-1-SS2.

Samples will be shipped Federal Express Standard Overnight under standard chain-of-custody procedures the same day with rush 2-day turnaround requested for analysis. Sample results will be compared for accuracy.

4.1.2 Data Validation

Tetra Tech validates the analytical data for all environmental and field QC samples collected at the Site in general accordance with the EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA, 2008) data validation guidance document.

The analytical data are evaluated based on the following criteria:

- Data completeness
- Sample preservation, receipt, and holding times
- Field and laboratory blanks
- Field and laboratory duplicates
- Surrogate compound recoveries
- Laboratory control samples and laboratory control sample duplicates
- Sample dilution
- Re-extraction and reanalysis
- Analyte quantitation and reported detection limits

All qualifications resulting from the data validation process are hand written on the hard copy laboratory results pages and are subsequently entered into the project database.

5.0 REFERENCES

Montana Department of Environmental Quality (DEQ), 2011. Montana Vapor Intrusion Guide. MDEQ Remediation Division. April 22, 2011.

United States Environmental Protection Agency (EPA), 2008. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. EPA-540-R-08-01, dated June 2008.

Tetra Tech, 2013a. Indoor Air Quality Investigation Sampling and Analysis Plan, Bozeman Landfill. June 27, 2013.

Tetra Tech, 2013b. Indoor Air Quality Investigation Sampling and Analysis Plan Addendum, Bozeman Landfill. August 2013.

Tetra Tech, 2013c. Progress Report on Soil Gas Probe Installation, Sampling and Analysis of Soil Gas Samples; Soil Gas Probes BSV-1 through BSV-8. May 14, 2013.

FIGURE 1
SITE MAP

N:\PROJECTS\CITY OF BOZEMAN\Bozeman Landfill\114-710303 - Bozeman Landfill\GIS\ArcMap\Fig1_SoilGas_SubSlab.mxd

N

SCALE IN FEET

0 400

- Sub-Slab Sample
- Groundwater Monitoring Well
- Methane Monitoring Well
- Soil Gas Probe
- New Residential Construction

Figure 1
Location of Soil Gas Probes and Sub-Slab Samples
Bozeman Landfill
Bozeman, Montana

APPENDIX A
VAPOR PIN STANDARD OPERATING PROCEDURES

Standard Operating Procedure Installation and Extraction of the Vapor Pin™

May 20, 2011

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™[1] for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub-slab soil-gas samples.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve (Figure 1)];
- Hammer drill;
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00206514 or equivalent);
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch diameter bottle brush;
- Wet/dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, as necessary;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel.

[1]Cox-Colvin & Associates, Inc., designed and developed the Vapor Pin™; a patent is pending.

Figure 1. Assembled Vapor Pin™.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch diameter hole at least 1¾-inches into the slab.

4) Drill a 5/8-inch diameter hole through the slab and approximately 1-inch into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the Vapor Pin™ to protect the barb fitting and cap, and tap the Vapor Pin™ into place using a

dead blow hammer (Figure 2). Make sure the extraction/installation tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

For flush mount installations, unscrew the threaded coupling from the installation/extraction handle and use the hole in the end of the tool to assist with the installation (Figure 3).

Figure 3. Flush-mount installation.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 4).

Figure 4. Installed Vapor Pin™.

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover.

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™ (Figure 5).

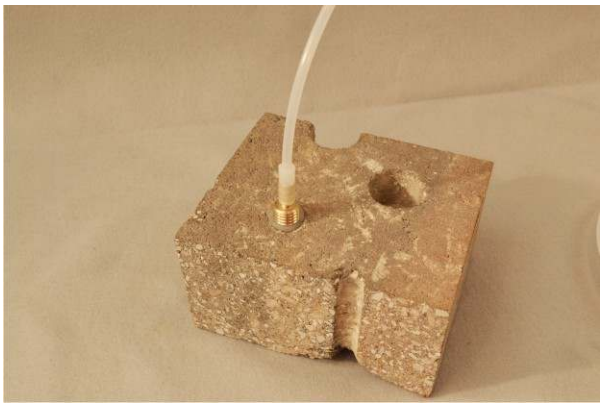


Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests [(e.g., real-time monitoring of oxygen levels on extracted sub-slab soil gas, or placement of a water

dam around the Vapor Pin™) Figure 6]. Consult your local guidance for possible tests.

Figure 6. Water dam used for leak detection.

11) Collect sub-slab soil gas sample. When finished sampling, replace the protective cap and flush mount cover until the next sampling event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue turning the tool to assist in extraction, then pull the Vapor Pin™ from the hole (Figure 8).

Figure 7. Removing the Vapor Pin™.

Figure 8. Extracted Vapor Pin™.

2) Fill the void with hydraulic cement and smooth with the trowel or putty knife.

3) Prior to reuse, remove the silicone sleeve and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 130° C.

The Vapor Pin™ to designed be used repeatedly; however, replacement parts and supplies will be required periodically. These parts are available on-line at www.CoxColvin.com.

Replacement Parts:

Vapor Pin™ Kit Case - VPC001
Vapor Pins™ - VPIN0522
Silicone Sleeves - VPTS077
Installation/Extraction Tool - VPIE023
Protective Caps - VPPC010
Flush Mount Covers - VPFM050
Water Dam - VPWD004
Brush - VPB026

Standard Operating Procedure Use of the Vapor Pin™ Drilling Guide and Secure Cover

July 16, 2012

Scope:

This standard operating procedure (SOP) describes the methodology to use the Vapor Pin™ Drilling Guide and Secure Cover to install and secure a Vapor Pin™ in a flush mount configuration.

Purpose:

The purpose of this SOP is to detail the methodology for installing a Vapor Pin™ and Secure Cover in a flush mount configuration. The flush mount configuration reduces the risk of damage to the Vapor Pin™ by foot and vehicular traffic, keeps dust and debris from falling into the flush mount hole, and reduces the opportunity for tampering. This SOP is an optional process performed in conjunction with the SOP entitled "Installation and Extraction of the Vapor Pin™". However, portions of this SOP should be performed prior to installing the Vapor Pin™.

Equipment Needed:

- Vapor Pin™ Secure Cover (Figure 1);
- Vapor Pin™ Drilling Guide (Figure 2);
- Hammer drill;
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent);
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00226514 or equivalent);
- assembled Vapor Pin™;
- #14 spanner wrench;
- Wet/Dry vacuum with HEPA filter (optional); and
- personal protective equipment (PPE).

Figure 1. Vapor Pin™ Secure Cover.

Figure 2. Vapor Pin™ Drilling Guide.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) While wearing PPE, drill a 1½-inch diameter hole into the concrete slab to a

depth of approximately 1 3/4 inches. Pre-marking the desired depth on the drill bit with tape will assist in this process.

4) Remove cuttings from the hole and place the Drilling Guide in the hole with the conical end down (Figure 3). The hole is sufficiently deep if the flange of the Drilling Guide lies flush with the surface of the slab. Deepen the hole as necessary, but avoid drilling more than 2 inches into the slab, as the threads on the Secure Cover may not engage properly with the threads on the Vapor Pin™.

Figure 3. Installing the Drilling Guide.

5) When the 1½-inch diameter hole is drilled to the proper depth, replace the drill bit with a $^{5}/_{8}$-inch diameter bit, insert the bit through the Drilling Guide (Figure 4), and drill through the slab. The Drilling Guide will help to center the hole for the Vapor Pin™, and keep the hole perpendicular to the slab.

6) Remove the bit and drilling guide, clean the hole, and install the Vapor Pin™ in accordance with the SOP "Installation and Extraction of the Vapor Pin™.

Figure 4. Using the Drilling Guide.

7) Screw the Secure Cover onto the Vapor Pin™ and tighten using a #14 spanner wrench by rotating it clockwise (Figure 5). Rotate the cover counter clockwise to remove it for subsequent access.

Figure 5. Tightening the Secured Cover.

Limitations:

On slabs less than 3 inches thick, it may be difficult to obtain a good seal in a flush mount configuration with the Vapor Pin™.

APPENDIX B
FAN PERFORMANCE CHART

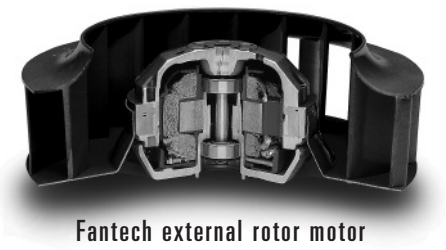
Fantech

HP SERIES

FANS FOR RADON APPLICATIONS
WITH IMPROVED UV RESISTANCE!

TRUST THE INDUSTRY STANDARD.
HERE'S WHY:

Don't put your reputation at stake by installing a fan you know won't perform like a Fantech! For nearly twenty years, Fantech has manufactured quality ventilation equipment for Radon applications. Fantech is the fan Radon contractors have turned to in over 1,000,000 successful Radon installations worldwide.



Fantech external rotor motor

FANTECH HP SERIES FANS MEET THE CHALLENGES OF RADON APPLICATIONS:

HOUSING
- UV resistant, UL Listed durable plastic
- UL Listed for use in commercial applications
- Factory sealed to prevent leakage
- Watertight electrical terminal box
- Approved for mounting in wet locations - i.e. Outdoors

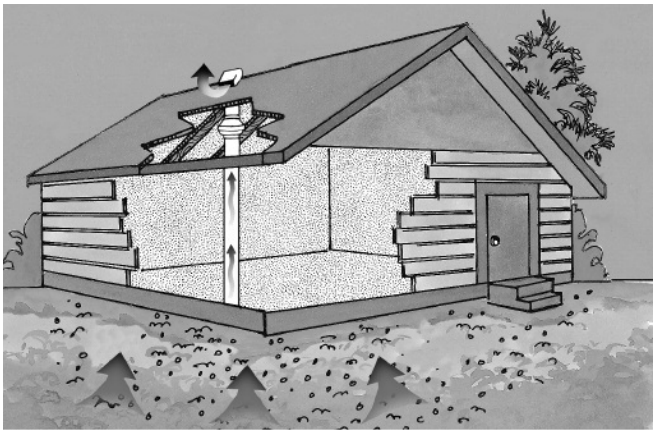
MOTOR
- Totally enclosed for protection
- High efficiency EBM motorized impeller
- Automatic reset thermal overload protection
- Average life expectancy of 7-10 years under continuous load conditions

RELIABILITY
- Five Year Full Factory Warranty
- Over 1,000,000 successful radon installations worldwide

Fantech

HP Series Fans are Specially Designed with Higher Pressure Capabilities for Radon Mitigation Applications

MOST RADON MITIGATORS WHO PREVIOUSLY USED THE FANTECH FR SERIES FANS HAVE SWITCHED TO THE NEW HP SERIES.



PERFORMANCE DATA

Fan Model	Volts	Wattage Range	Max. Amps	CFM vs. Static Pressure in Inches W.G.								Max. Ps
				0"	0.5"	0.75"	1.0"	1.25"	1.5"	1.75"	2.0"	
HP2133	115	14 - 20	0.17	134	68	19	-	-	-	-	-	0.84
HP2190	115	60 - 85	0.78	163	126	104	81	58	35	15	-	1.93
HP175	115	44 - 65	0.57	151	112	91	70	40	12	-	-	1.66
HP190	115	60 - 85	0.78	157	123	106	89	67	45	18	1	2.01
HP220	115	85 - 152	1.30	344	260	226	193	166	137	102	58	2.46

HVI MEMBER™

PERFORMANCE CURVES

Fantech provides you with independently tested performance specifications.

The performance curves shown in this brochure are representative of the actual test results recorded at Texas Engineering Experiment Station/Energy Systems Lab, a recognized testing authority for HVI. Testing was done in accordance with AMCA Standard 210-85 and HVI 916 Test Procedures. Performance graphs show air flow vs. static pressure.

Use of HP Series fans in low resistance applications such as bathroom venting will result in elevated sound levels. We suggest FR Series or other Fantech fans for such applications.

HP FEATURES INCLUDE

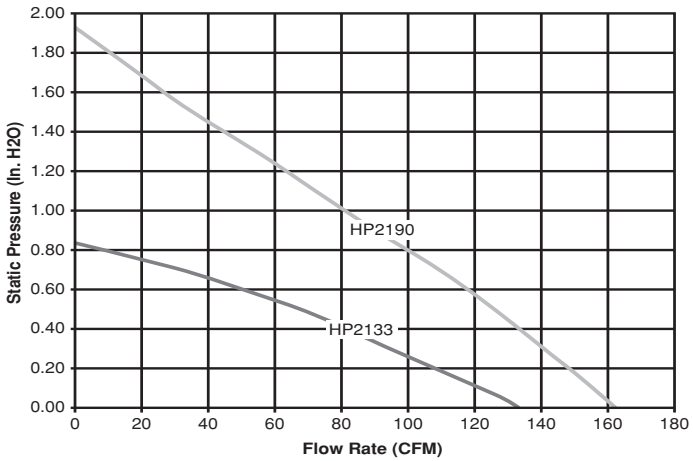
- Improved UV resistant housings approved for commercial applications.
- UL Approved for Wet Locations (Outdoors)
- Sealed housings and wiring boxes to prevent Radon leakage or water penetration
- Energy efficient permanent split capacitor motors
- External wiring box
- Full Five Year Factory Warranty

c UL us

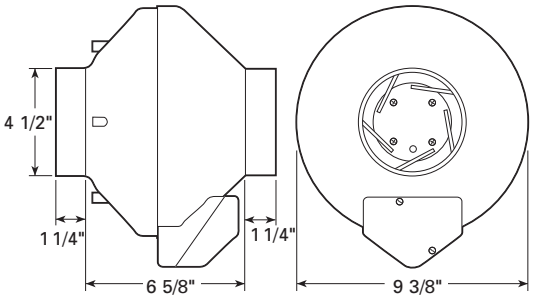
NOTE:

Installations that will result in condensate forming in the outlet ducting should have a condensate bypass installed to route the condensate outside of the fan housing. Conditions that are likely to produce condensate include but are not limited to: outdoor installations in cold climates, long lengths of outlet ducting, high moisture content in soil and thin wall or aluminum outlet ducting. Failure to install a proper condensate bypass may void any warranty claims.

HP2133 & HP2190 RADON MITIGATION FANS



Tested with 4" ID duct and standard couplings.

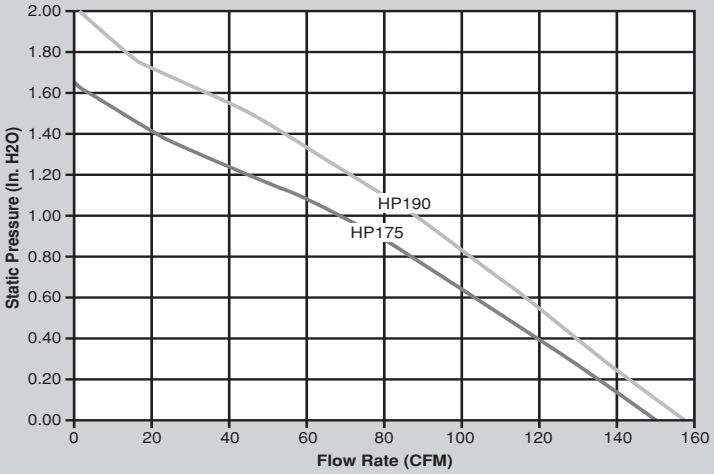


HP2133 – For applications where lower pressure and flow are needed. Record low power consumption of 14-20 watts! Often used where there is good sub slab communication and lower Radon levels.

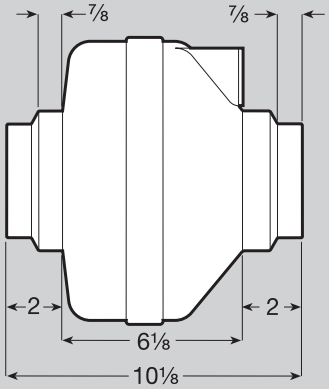
HP2190 – Performance like the HP190 but in a smaller housing. Performance suitable for the majority of installations.

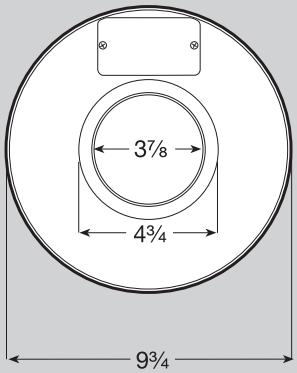
Fans are attached to PVC pipe using flexible couplings.
For 4" PVC pipe use Indiana Seals #156-44, Pipeconx PCX 56-44 or equivalent.
For 3" PVC pipe use Indiana Seals #156-43, Pipeconx PCX 56-43 or equivalent.

HP175 & HP190 RADON MITIGATION FANS



Tested with 4" ID duct and standard couplings.



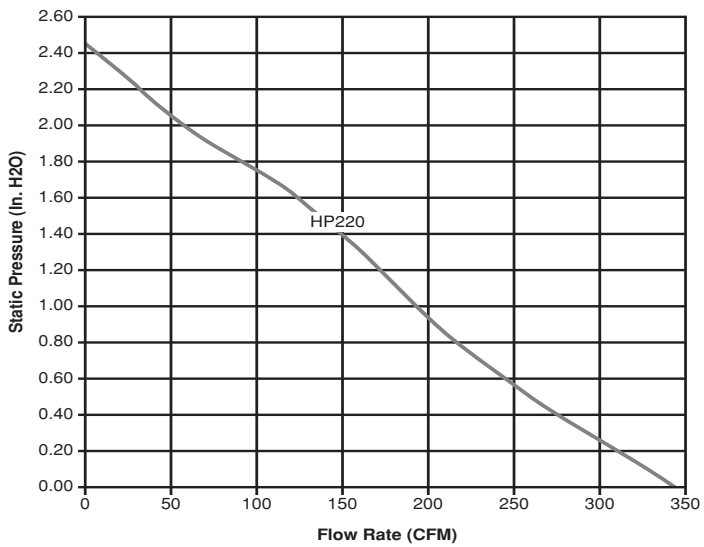


HP175 – The economical choice where slightly less air flow is needed. Often used where there is good sub slab communication and lower Radon levels.

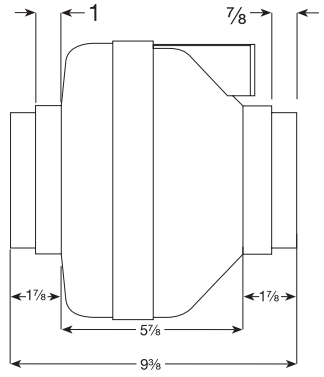
HP190 – The standard for Radon Mitigation. Ideally tailored performance curve for a vast majority of your mitigations.

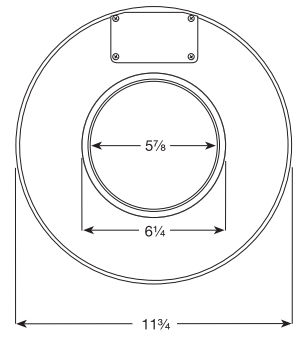
Fans are attached to PVC pipe using flexible couplings.
For 4" PVC pipe use Indiana Seals #151-44, Pipeconx PCX 51-44 or equivalent.
For 3" PVC pipe use Indiana Seals #156-43, Pipeconx PCX 56-43 or equivalent.

HP220 RADON MITIGATION FAN



Tested with 6" ID duct and standard couplings.





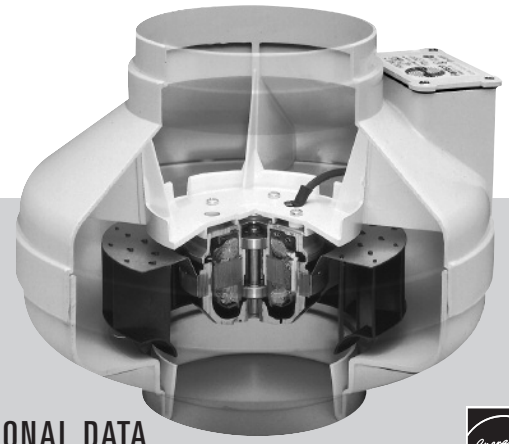
HP 220 – Excellent choice for systems with elevated radon levels, poor communication, multiple suction points and large subslab footprint. Replaces FR 175.

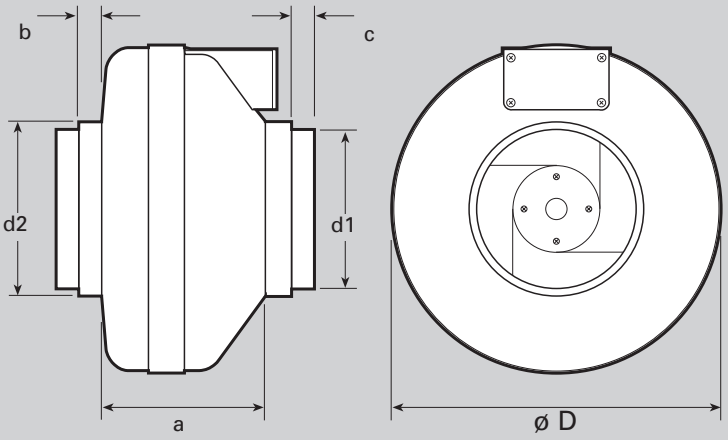
Fans are attached to PVC pipe using flexible couplings.
For 4" PVC pipe use Indiana Seals #156-64, Pipeconx PCX 56-64 or equivalent.
For 3" PVC pipe use Indiana Seals #156-63, Pipeconx PCX 56-63 or equivalent.

Fantech

FR SERIES

THE ORIGINAL MITIGATOR





DIMENSIONAL DATA

model	øD	d1	d2	a	b	c
FR100	9 1/2	3 7/8	4 7/8	6 1/8	7/8	7/8
FR110	9 1/2	3 7/8	4 7/8	6 1/8	7/8	7/8
FR125	9 1/2	–	4 7/8	6 1/8	7/8	–
FR140	11 3/4	5 7/8	6 1/4	5 7/8	1	7/8
FR150	11 3/4	5 7/8	6 1/4	5 7/8	1	7/8
FR160	11 3/4	5 7/8	6 1/4	6 3/8	1	7/8
FR200	13 1/4	7 7/8	9 7/8	6 1/4	1 1/2	1 1/2
FR225	13 1/4	7 7/8	9 7/8	6 1/4	1 1/2	1 1/2
FR250	13 1/4	–	9 7/8	6 1/4	–	1 1/2

All dimensions in inches

PERFORMANCE DATA

Fan Model	Energy Star	RPM	Volts	Rated Watts	Wattage Range	Max. Amps	CFM vs. Static Pressure in Inches W.G.							Max. Ps	Duct Dia.
							0"	.2"	.4"	.6"	.8"	1.0"	1.5"		
FR100	✓	2950	120	21.2	13 - 22	0.18	137	110	83	60	21	-	-	0.90"	4"
FR125	✓	2950	115	18	15 - 18	0.18	148	120	88	47	-	-	-	0.79"	5"
FR150	✓	2750	120	71	54 - 72	0.67	263	230	198	167	136	106	17	1.58"	6"
FR160	-	2750	115	129	103 - 130	1.14	289	260	233	206	179	154	89	2.32"	6"
FR200	✓	2750	115	122	106 - 128	1.11	408	360	308	259	213	173	72	2.14"	8"
FR225	✓	3100	115	137	111 - 152	1.35	429	400	366	332	297	260	168	2.48"	8"
FR250*	-	2850	115	241	146 - 248	2.40	649	600	553	506	454	403	294	2.58"	10"

FR Series performance is shown with ducted outlet. Per HVI's Certified Ratings Program, charted air flow performance has been derated by a factor based on actual test results and the certified rate at .2 inches WG.
** Also available with 8" duct connection. Model FR 250-8. Special Order.*

NOTE:

Installations that will result in condensate forming in the outlet ducting should have a condensate bypass installed to route the condensate outside of the fan housing. Conditions that are likely to produce condensate include but are not limited to: outdoor installations in cold climates, long lengths of outlet ducting, high moisture content in soil and thin wall or aluminum outlet ducting. Failure to install a proper condensate bypass may void any warranty claims.

FIVE YEAR WARRANTY

DURING ENTIRE WARRANTY PERIOD:

FANTECH will replace any fan which has a factory defect in workmanship or material. Product may need to be returned to the Fantech factory, together with a copy of the bill of sale and identified with RMA number.

FOR FACTORY RETURN YOU MUST:

- Have a Return Materials Authorization (RMA) number. This may be obtained by calling FANTECH either in the USA at 1.800.747.1762 or in CANADA at 1.800.565.3548. Please have bill of sale available.
- The RMA number must be clearly written on the outside of the carton, or the carton will be refused.
- All parts and/or product will be repaired/replaced and shipped back to buyer; no credit will be issued.

OR

The Distributor may place an order for the warranty fan and is invoiced.
The Distributor will receive a credit equal to the invoice only after product is returned prepaid and verified to be defective.

FANTECH WARRANTY TERMS DO NOT PROVIDE FOR REPLACEMENT WITHOUT CHARGE PRIOR TO INSPECTION FOR A DEFECT. REPLACEMENTS ISSUED IN ADVANCE OF DEFECT INSPECTION ARE INVOICED, AND CREDIT IS PENDING INSPECTION OF RETURNED MATERIAL. DEFECTIVE MATERIAL RETURNED BY END USERS SHOULD NOT BE REPLACED BY THE DISTRIBUTOR WITHOUT CHARGE TO THE END USER, AS CREDIT TO DISTRIBUTOR'S ACCOUNT WILL BE PENDING INSPECTION AND VERIFICATION OF ACTUAL DEFECT BY FANTECH.

THE FOLLOWING WARRANTIES DO NOT APPLY:

- Damages from shipping, either concealed or visible. Claim must be filed with freight company.
- Damages resulting from improper wiring or installation.
- Damages or failure caused by acts of God, or resulting from improper consumer procedures, such as:

1. Improper maintenance
2. Misuse, abuse, abnormal use, or accident, and
3. Incorrect electrical voltage or current.

- Removal or any alteration made on the FANTECH label control number or date of manufacture.
- Any other warranty, expressed, implied or written, and to any consequential or incidental damages, loss or property, revenues, or profit, or costs of removal, installation or reinstallation, for any breach of warranty.

WARRANTY VALIDATION

- The user must keep a copy of the bill of sale to verify purchase date.
- These warranties give you specific legal rights, and are subject to an applicable consumer protection legislation. You may have additional rights which vary from state to state.

DISTRIBUTED BY:

Fantech

United States 10048 Industrial Blvd. • Lenexa, KS 66215 • 1.800.747.1762 • www.fantech.net
Canada 50 Kanalflakt Way • Bouctouche, NB E4S 3M5 • 1.800.565.3548 • www.fantech.net

Item #: 411741
Rev Date: 021010

APPENDIX C
ACCUSTAR LABS CHAIN OF CUSTODY AND SAMPLING INSTRUCTIONS

AccuStar Labs
11 Awl Street
Medway MA 02053
888-480-8812 fax 508-533-8831

Start test before expiration date on device or result will be invalid.

Radon in Air Test Data Sheet

Send Written Report To:

Tetra Tech
851 Bridger Cr., Ste 6
Bozeman, MT 59715

Contact: Mark Pearson Tel.: 406-582-8780
Email: mark.pearson@tetratech.com
nicholas.sovner@tetratech.com

Project Number: 114-710303 task 740

Site Name Address: Bozeman Landfill

City State Zip: Bozeman, Montana

Person Conducting Test: _____

Start Date: _____ **Stop Date:** _____

Start and Stop Times and Dates must be entered

Lab Use Only	Device Number	Building #	Unit #	Floor	Name of Room	**Start Time**	**Stop Time**	Lab Use

Please include this data sheet with your recapped test vials. Return test devices to **AccuStar immediately.** If the test devices are not returned promptly the test may be invalid.

rev 12_28_10

Instructions for the Project Short Term Charcoal Radon Test

The AccuStar Charcoal Liquid Scintillation (CLS) and Charcoal Canister (AC) devices are used to test radon in air for 48 – 96 hours (2 – 4 days). They include:

- Instructions and Datasheet
- CLS or Canister type devices

DO NOT OPEN THE DEVICES UNTIL YOU ARE READY TO TEST.

1. CHOOSE THE ROOMS TO TEST

The US EPA recommends you test the lowest level of the building, with ground contact, that is frequently used. Test in a room used for living space, or as a classroom, office, laboratory, cafeteria, library, gymnasium or auditorium. Do not test in a kitchen, laundry area, bathroom, crawl space, furnace room, hallway, elevator shaft, stairwell or closet.

QC Measurements You will need to place an additional 15% of the total number of devices for quality assurance measurements. 10% of the total tests are duplicate tests. To perform a duplicate test, open and place two devices side by side, 4" apart. 5% of the total tests are blank tests. To perform a blank test, place the device in testing area but do not open it.

Write all Device Numbers and matching building information, including the rooms you test, on the Datasheet.

Establish closed building conditions for 12 hours prior to starting the test, and maintain them for the test period.

2. START THE RADON TEST

a. **Start your test before the expiration date** shown on the device or test results will be invalid.

b. **When you are ready to start the test,** unscrew and remove the plastic cap, or untape and remove the metal canister lid. Save the plastic cap, or metal lid and tape. As soon as you open the device the test has begun. Reminder: for a blank test, do not open the device.

c. **Write the test Start Date** on the Datasheet.

3. PLACE THE RADON DEVICES

Hang or place each device *at least* three feet away from exterior doors or windows and at least two feet off the floor.

Leave all devices in place and undisturbed for at least 48 hours and no more than 96 hours. Exposures that are outside these times will cause invalid results and you will need to retest.

4. END THE RADON TEST

After 48 hours, replace the plastic cap, or the metal lid. Wrap the tape around the metal canister to seal the seam where the lid and base of the can meet. **Write the test Stop Date/Time** and other required information on the Datasheet.

5. RETURN THE DEVICES WITH DATASHEETS TO THE LABORATORY PROMPTLY

Make sure the Datasheet is complete and keep a copy. We must receive the devices within 8 days from the test Stop Date and Time or results will be invalid. Place up to 10 devices together with the matching Datasheet in a plastic "zip top" bag. Send the bagged devices and Datasheets to the lab. Please note that 1st Class Mail is not guaranteed. AccuStar will not replace lost devices.

INFORMATION ABOUT TEST REPORTS

AccuStar sends Reports via email the next business day after we receive your devices. You may access your test results on our website www.accustarlabs.com or by 24-hour, toll-free telephone 888-404-3144. You will need device numbers with corresponding test address zip code in order to access your test results.

If information is missing from the Datasheet or you need to make a change to your Report, you may request an Amended Report. You must request an Amended Report and provide new or changed information in writing. No verbal information will be accepted. AccuStar will issue the Amended Report within 5 business days after we receive your request.

AccuStar can issue a Same-Day Amended Report for a fee of $20.00 per report. To issue a Same-Day Amended Report we must receive, in writing, any changed or new test information, and payment by credit card before Noon, Eastern Time. We are open 8:30 am to 5 pm, Eastern Time, Monday-Friday.

11 Awl Street★P. O. Box 158★Medway, MA 02053★ 888-480-8812; 508-533-8812★Fax 508-533-8831★www.accustarlabs.com