EMISSION CHAMBERS

Bulk and Surface Emission Detection for the RAD7

User Manual

DURRIDGE
Radon Capture & Analytics

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INTRODUCTION

With its internal pump, sealed sample path, and inlet and outlet connectors, the RAD7 is well suited to the measurement of radon emissions from a variety of objects and surfaces. Furthermore, the option to count only polonium-218 decays means that dynamic measurements can be clean, and not complicated by long-half-life events.

DURRIDGE offers a series of Emission Chamber accessories to facilitate these measurements. The Bulk Emission Chamber is a solid aluminum box with an airtight seal, and it is intended for the measurement of radon from dirt samples and objects. In addition, two Surface Emission Chambers are offered: the Soil Surface Emission Chamber is a plate-like device with a metal rim which forms a tight seal when placed upon soft ground surfaces. A similar device for hard surfaces uses rope caulk to form a seal against flat smooth surfaces such as concrete.

Each DURRIDGE Emission Chamber creates an enclosed space from which the RAD7 may draw air. The air sample passes through the a tube of desiccant and an inlet filter, and into the RAD7's measurement chamber. The air may then be returned to the enclosure from the RAD7 outlet, to form a closed loop. Alternatively, an open loop configuration will allow the air being drawn from the enclosure to be replaced with 'zero' air from a cylinder, or with ambient air, which should have a low but known radon concentration.

1 SYSTEM CONFIGURATION

1.1 Closed Loop Configuration

A closed loop configuration allows radon to build up within an airtight system involving an Emission Chamber, RAD7, and Laboratory Drying unit. First, the system is thoroughly purged. Once the purge is complete, the loop is sealed as shown in Figure 1. The radon concentration within the loop is monitored in SNIFF mode, with a short (e.g. 15 min.) cycle time, for a few hours. It is necessary to know the total volume of the closed-loop system. For this purpose, the volume inside the RAD7 may be taken as 800mL. The initial rate of increase in radon concentration (neglecting the first 15-min cycle), multiplied by the internal air volume, gives the rate of emission of radon. A reduction in the slope, as the radon level builds up, may be due to leaks in the system, or to a reduction in the net emission.

DURRIDGE's CAPTURE software can be used to position a slope line on the radon graph and inspect the change in radon concentration over time. The line should be set to begin after the initial response delay and before any observable drop from either leakage or decay. CAPTURE will express the slope of the line in the units of your choice.

Very low emission rates can be measured by placing the sample in an airtight container with sealable inlet and outlet valves, and allowing the ingrowth of radon to occur over at least a week (after which the ingrowth must be calculated) and preferably a month or more (after which the ingrowth may be assumed to have reached equilibrium). The container is then connected to the RAD7 in a closed loop, as shown in Figure 2 on the next page. The valves are then opened and the RAD7 measures the radon concentration. The concentration will rise as the radon is distributed around the loop. Eventually the concentration will settle to a slowly decreasing value.

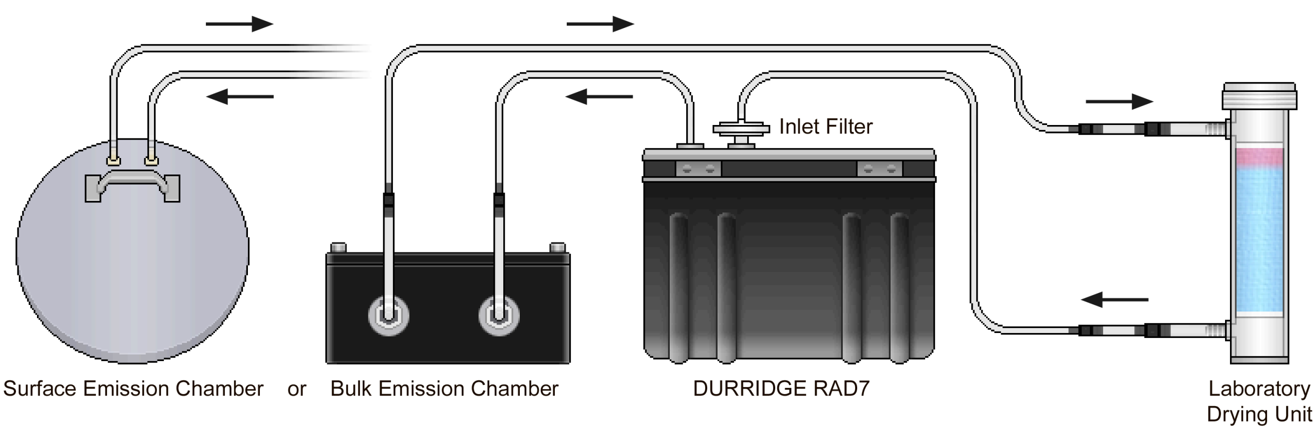

Fig. 1 Emission Chamber Closed Loop Configuration

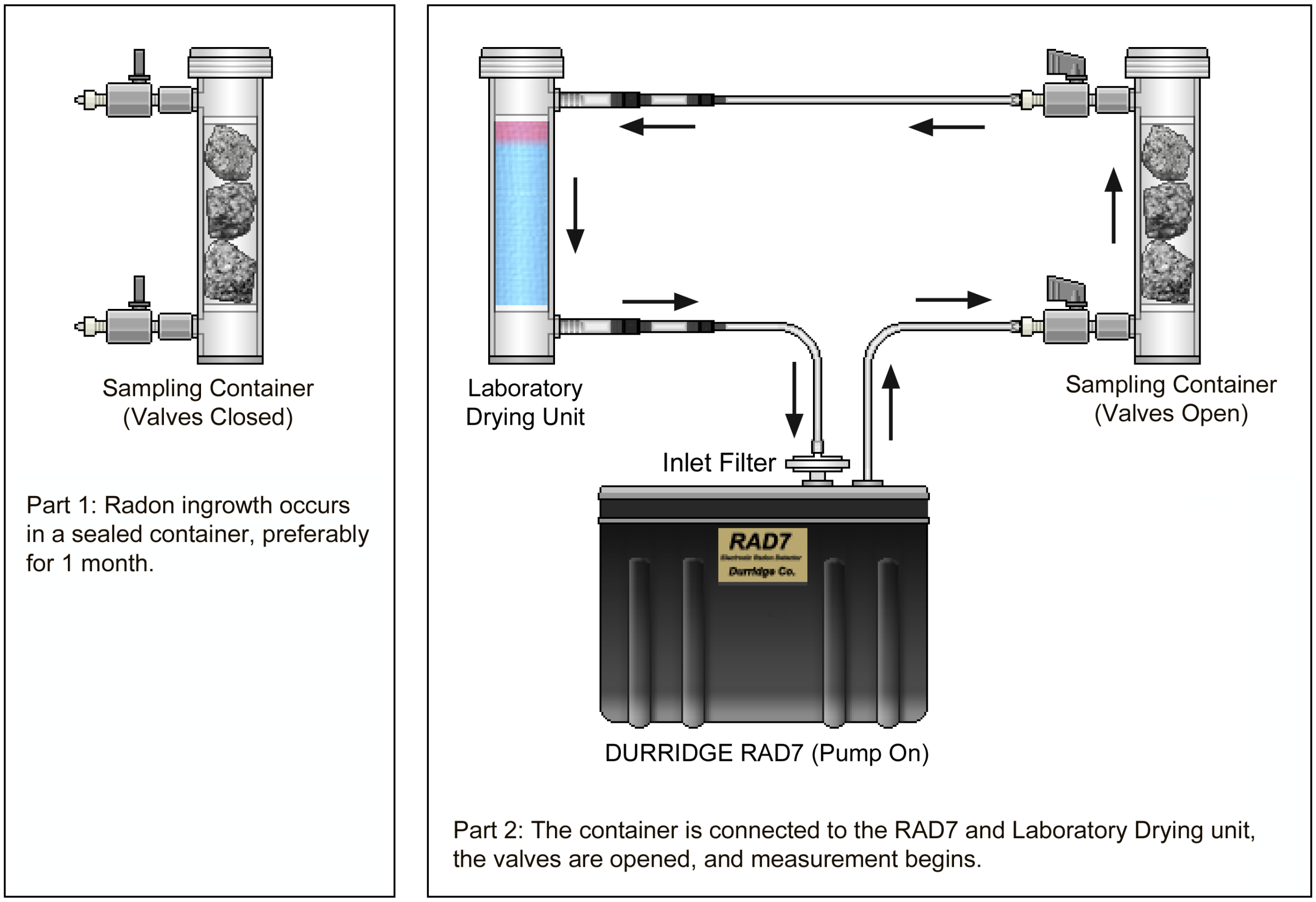

Fig. 2 Closed Loop Configuration For Very Low Emission Rates

1.2 Open Loop Configuration

In an open loop configuration, fresh air passes through the Emission Chamber and picks up radon on its way to the RAD7. Here it is necessary to first establish a low but known rate of air flow. This can be achieved using a DRYSTIK, as shown in Figure 3 on the next page. The DRYSTIK's Low Airflow port should be used, and its duty cycle should be set to a low value, such as 10%.

Alternatively, if a cylinder of 'zero' air, or nitrogen, is present, a pressure reduction valve may be used to control the flow rate of the air entering the apparatus, and a flow meter should be used to confirm the flow rate. If neither a DRYSTIK nor an air cylinder is available, the RAD7's internal pump may be turned On, for a continuous flow. (Otherwise the RAD7's internal pump should remain Off.) Any configuration not involving a DRYSTIK should use a flow meter downstream of the RAD7, to confirm the rate of air flow.

In all cases, a tube of activated charcoal should be placed just upstream of the Emission Chamber. This will remove any radon from the air entering the Emission Chamber, ensuring that all of the radon entering the RAD7 comes from the material inside the Emission Chamber itself. If activated charcoal is not available, another option is to conduct two tests, one with the Emission Chamber empty, so that the results may be compared.

Once a steady state has been achieved, a long-term measurement may be made. The rate of radon emission will equal the radon concentration reported by the RAD7, multiplied by the flow rate. The precision of the measurement will depend on the radon concentration and the duration of the process.

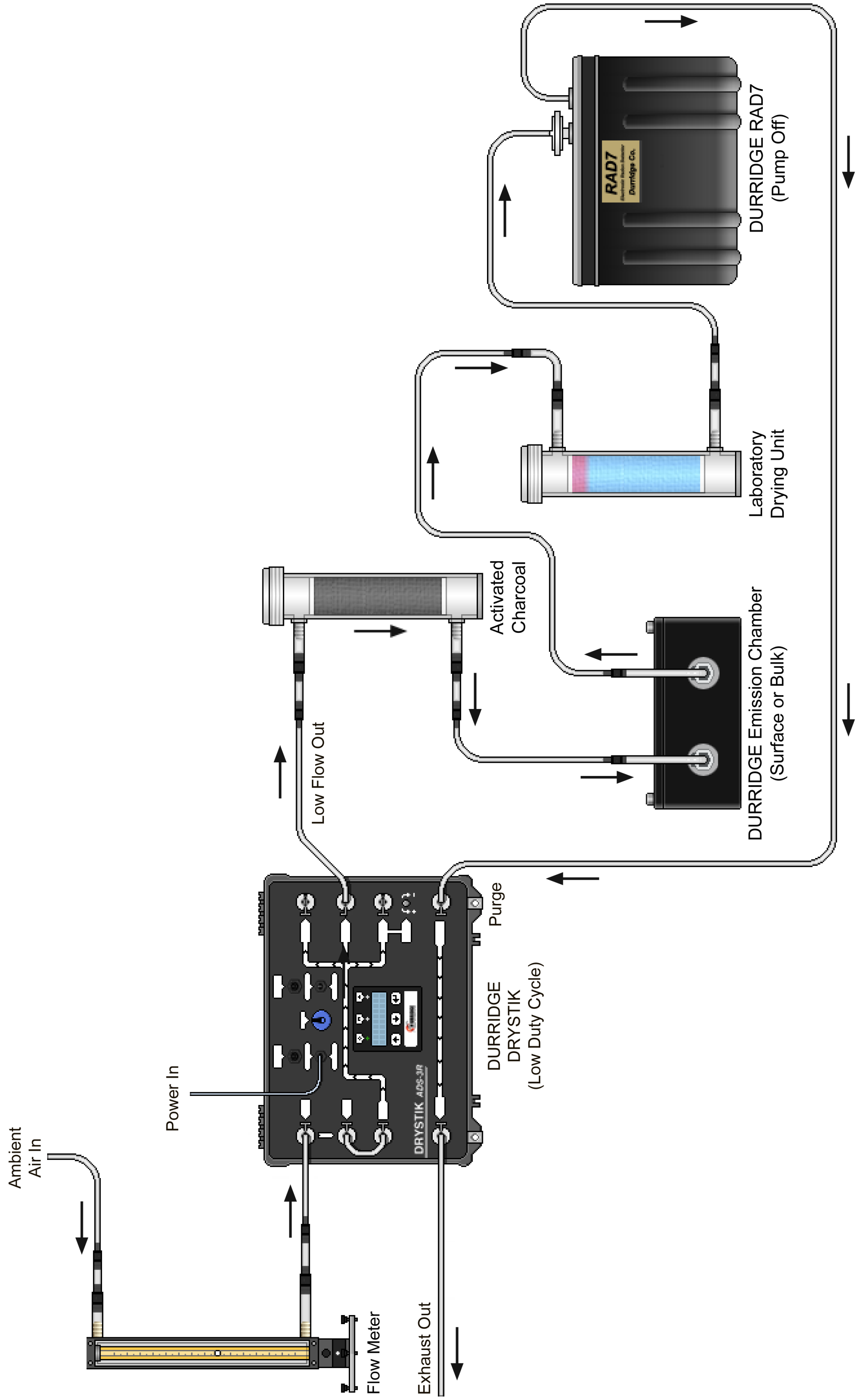

Fig. 3 Emission Chamber Open Loop Configuration with DRYSTIK

2 BULK EMISSIONS

The DURRIDGE Bulk Emission Chamber is an airtight box with two well separated hose connectors. The material to be tested is placed in the chamber, which is then connected to the laboratory drying unit, and thence to the inlet filter on the RAD7. The other box connector has tubing attached, which is either connected to the RAD7 outlet for closed-loop operation, or to a cylinder of zero gas or ambient air for open-loop operation.

Note that the emission of radon from bulk material may be affected by pressure fluctuations and by changes in temperature and humidity. All of these parameters can and should be controlled in both the closed-loop and open-loop configurations. Radon emission is also dependent on the grain size of loose materials, and the porosity of any bulk material.

In addition to radon, thoron can also be measured in the Bulk Emission Chamber. In the open loop mode, a correction is required for the decay of the thoron during the time between its emission and measurement in the RAD7. In closed loop mode, another correction must be made for the portion of thoron that gets fed back into the enclosure. Note that for thoron, both the closed loop and open loop modes are steady-state measurements.

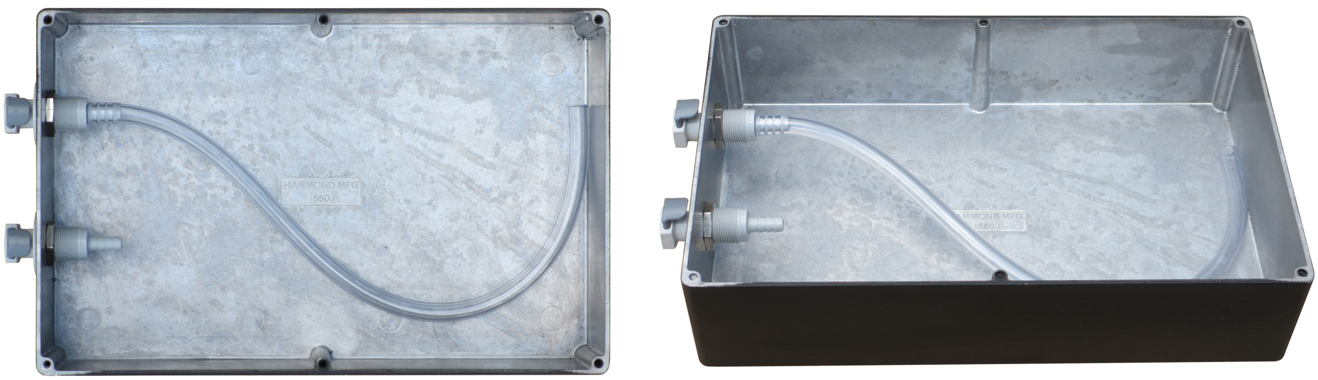

Fig. 4 Bulk Emission Chamber Uncovered

3 SURFACE EMISSIONS

DURRIDGE offers two surface emission chambers, one for solid hard surfaces, and another for soft soil surfaces. Each consists of a circular plate which is sealed against the surface under investigation. The Hard Surface Emission Chamber accomplishes this using a rope caulk seal, while the Soil Surface Emission Chamber uses a penetrating metal rim, as shown in Figures 5 and 6, below.

The measurement procedure for the Surface Emission Chambers is similar to that of the Bulk Emission Chamber described above. Once the total emission rate within the chamber enclosure has been calculated, it may be divided by the area of the surface within the sealed boundary, to determine the emission per unit area. These areas are listed in Section 3, Technical Specifications, on the next page.

Fig. 5 Hard Surface Emission Chamber

Fig. 6 Soil Surface Emission Chamber

4 TECHNICAL SPECIFICATIONS

4.1 Bulk Emission Chamber

Interior Dimensions	11” x 7” x 2.5” (28 x 18 x 6.4 cm)
Interior Volume	2.8L ± 0.05L depending on configuration
Material	Aluminum
Hose Connectors	Front Mounted

4.2 Surface Emission Chamber

Outer Dimensions	10” (25.4 cm) diameter by 1.25” (3.2 cm) deep
Interior Cavity Dimensions	8.5” (21.6 cm) diameter by 0.75” (2.0 cm) deep
Partition Dimensions	7.9” (20 cm) long by 0.5” (1.27 cm) wide
Interior Cavity Volume	Approx. 40 cubic in (660 mL)
Material	ABS Plastic
Hose Connectors	Top Mounted

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