

## PASSIVE CRYOGENIC WHOLE AIR FIELD SAMPLER

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The portable, passive cryogenic sampler has been designed by the Idaho National Engineering Laboratory (INEL) for the collection of whole air samples without the loss or concentration of any atmospheric constituents. The principle of operation is the collection by bulk gas flow and condensation of a whole air sample into a previously evacuated cylinder held at liquid nitrogen temperature using a reservoir. The ability of the sampler to collect a highly compressed gas sample without concentration of condensable gases permits a large number of gas constituents to be analyzed from a single sample, even when analytes vary widely in their boiling points.

Design criteria for the portable, passive whole air sampler are listed in Table 1. The sampler, constructed in-house of readily commercially available components, is shown in Figure 1.

The sampler evaluation was performed in three phases. The first phase determined sample flowrate, sample size, resultant sample pressure, and sample collection lifetime as a function of the liquid nitrogen additions. The second phase analyzed simulated whole air samples for bulk composition, noble gases, selected chlorofluorocarbons, and tritium before and after collection in the cryogenic air sampler. In the third phase actual field samples were collected and analyzed for bulk composition and chlorofluorocarbon content. These samples were then concentrated, separated, and analyzed for noble gases. Also included in the third phase was the analysis of altered whole air samples,

blindly and randomly introduced into the sample analysis scheme as a means of detecting sample tampering.

Results of the evaluation of the design criteria for the sampler are listed in Table 2. A partial listing of past customers and their application of the sampler is found in Table 3. The need of a low cost passive cryogenic sampler that can collect many whole air samples at remote locations with minimal logistical support will become widespread in the future.

We have found the sampler to meet or exceed all of the characteristics intended for it. The sampler is capable of the collection of samples without concentration or loss of any sample constituents regardless of boiling point.

The required sample volume of 100 L at STP has been successfully achieved, and samples as large as 131.2 L have been collected. Most samples are between 70 and 90 L. The volume of sample collected is dependent upon the sample duration and flowrate. By selection of the proper combination of sample duration and flowrate, samples of accurately known size from a few to 100 liters may be collected unattended within 30 minutes or over a period of time of 2 hours.

Laboratory tests on known standards demonstrate that no concentration or loss of atmospheric constituents occurs.

No electrical power is required for operation of the sampler, which would enable it to operate in hazardous environments such as where potentially explosive mixtures of hydrogen and oxygen are found.

The sampling lifetime can extend to 4 hours with refilling of the liquid nitrogen reservoir.

TABLE 1  
Design Criteria for Whole Air Sampler

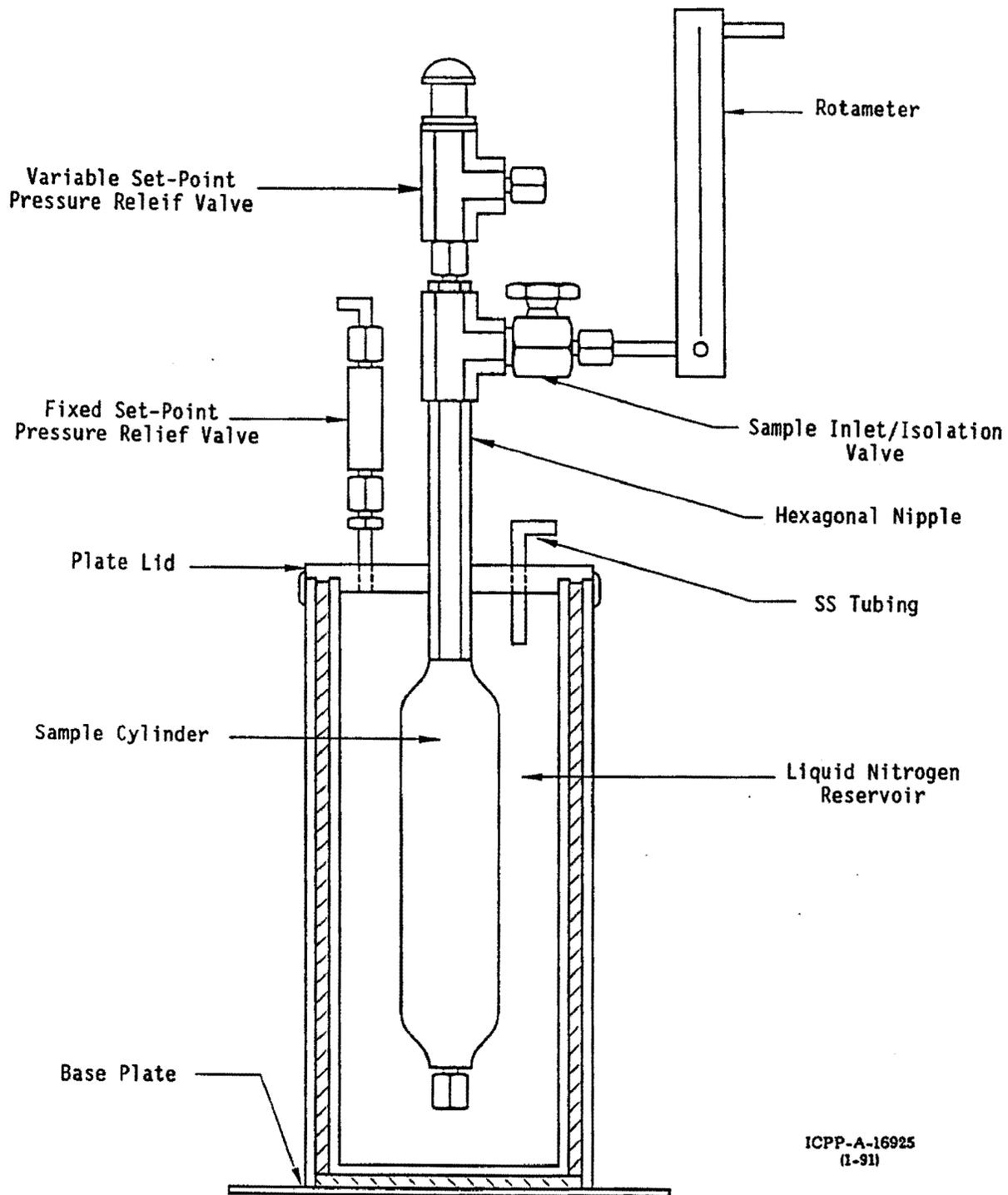
- 1) Sample Volume of 100 Liters
- 2) No Concentration or Loss of Constituents
- 3) Sampling Lifetime Greater Than 2 Hours
- 4) Small (50cm x 15cm) & Lightweight (20kg)
- 5) No Electrical Power
- 6) Operator Safety
- 7) Ease of Operation

TABLE 2  
Development of Cryogenic Whole Air Sampler

| Parameter            | Results  |
|----------------------|--|
| Sample Flowrate      | Controllable, 1 cc to 3 L/Min                                |
| Sample Volume        | Nominally 100 Liters, 130 L Maximum                          |
| Sample Pressure      | Nominal 2000 psi, 3650 psi Maximum                           |
| Sampling Lifetime    | 30 Min to 10 Hours   |
| Sample Concentration | Noble Gas Ratios, Unaltered                                  |
| Sample Loss Tests    | Chlorofluorocarbons, 100% Recovery<br>Tritium, 100% Recovery |

TABLE 3  
Past Applications of the Passive Cryogenic Whole Air Sampler

| Customer                 | Facility                                | Application                             | Analytes   |
|--------------------------|---|---|--|
| DOE- Office of Materials | ICPP                                    | Hydrogen-Rich Off-Gas Study             | Permanent Gases  |
| US Air Force             | Proposed for White Sands, KA-III Series | Fuel/Air Explosives                     | Combustion Products, Oxygen  |
| DOE- Office Waste Mgt    | ICPP                                    | Environmental Sampling                  | <sup>85</sup> Kr, N <sub>2</sub> , O <sub>2</sub> , Ar, CO <sub>2</sub>  |
| US Air Force             | TREAT Pulse Reactor INEL                | Environmental Sampling                  | Kr, Xe, Freon-11, Methyl-chloroform  |
| DOE- Defense Programs    | Advanced Test Reactor INEL              | Off-Gas Studies                         | <sup>41</sup> Ar, Kr, Xe, CFCl <sub>3</sub> , CH <sub>3</sub> CCl <sub>3</sub> , Freon-113                               |
| DOE-Office Arms Control  | INEL Research                           | Evaluation of Arms Control Verification | <sup>3</sup> H, Kr, Xe, He, N <sub>2</sub> , O <sub>2</sub> , Ar, H <sub>2</sub> , Freon-12, CO <sub>2</sub> , Freon-113 |
| US Air Force             | ICPP                                    | Fission Products in Ar Carrier Gas      | Fission Product Gases  |



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FIGURE 1  
PASSIVE CRYOGENIC WHOLE AIR FIELD SAMPLER

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