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SUBJECT: Operational Tests Associated with Use of Freon in HRT
Secondary Refrigeration System

TO: W. R. Gall

FROM: R. C. Robertson

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Unless the radiation damage tests now being made by H. D. Silverman greatly alter the situation, it is presumed that the HRT will operate initially with Freon as the secondary refrigerant to be circulated through the cold traps and freeze jackets.

Periodic observation of the condition will be required to guard against corrosion and to indicate when the silica-gel driers need replacement. Also, there is an apparent lack of information on secondary refrigerants for this type of application so that this phase of the HRT will be of general interest. A running record of the condition of the Freon will, therefore, be desirable to properly evaluate the corrosion and decomposition effects.

The system should be initially charged with commercial grade F-11, essentially oil and moisture free, the system having been previously air-dried and cleaned and flushed with carbon tetrachloride or similar solvent.

The frequency of sampling of the F-11 will be a function of the radiation damage encountered, reactor power levels, whether frequent connections have been made to freeze jackets, whether cells have been flooded, etc., but possibly weekly tests will be adequate.

It is believed that regular pH measurements will be the best protection against corrosion difficulties. Since the release of free chlorine or fluorine by radiation-induced decomposition should be marked by an immediate increase in the acidity (assuming that some free water is always present), the pH values should detect the condition before free chlorine or fluorine gas accumulates to significant amounts above the liquid in the Freon tanks. The rate of change in the amounts of these gases found in the tanks after the experiments becomes critical, however, will be significant and it is recommended that the gases be sampled periodically.

Visual comparison of the Freon samples for turbidity and color will also be a useful indication of the refrigerant condition.

Some of the general effects of the presence of free water in the HRT refrigeration system have been discussed in a previous memorandum⁽¹⁾. The silica-gel drier cartridges are expected to maintain the free water content to less than 100 ppm. Periodic measurement of the water content should serve to indicate when replacement cartridges should be inserted. Several methods of testing for water are possible through existing ORNL facilities:

- a. Water determination using infra-red techniques appears practical⁽²⁾ and apparently can be accomplished with existing apparatus in the Isotope Physics group; although, according to Henry Morgan, there may be complications regarding the availability of, and the charges for, service work of this nature.
- b. Determination by ultra-violet techniques may also be practical, according to O. Menis, and C. M. Boyd of his group is looking into the literature in this respect. Ultra-violet apparatus is set-up and under the direction of Dr. Menis.
- c. Di-electric measurements might also be used, but it is believed development of techniques and calibration procedures would be required.
- d. Water determination by the Karl Fischer method is widely used for Freons⁽³⁾ and the Analytical Chemistry Division has at least two sets of apparatus. This method probably will prove the most practical to employ for routine testing.

(1) Memo., W. R. Gall from R. C. Robertson, 8-2-55, "Effect of Moisture in the HRT F-11 Circulating System for Cold Traps".

(2) Benning, et al, "Water Determination in F-12 by Infra-Red Spectrophotometry", Refrig. Engn., Feb., 1948, p. 166.

(3) Reed, F. T., "Moisture Determination in Refrigerant-Oil Solutions by the Karl Fischer Method", Refrig. Engn., July, 1954.