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SINCLAIR RESEARCH LABORATORIES, INC.

400 EAST SIBLEY BOULEVARD
HARVEY, ILLINOIS

July 5, 1960

U. S. Atomic Energy Commission
Washington 25, D. C.

Attention: Division of Licensing and Regulation, Isotopes Branch

Gentlemen:

We are hereby applying for an amendment to our current AEC License No. 12-140-4 (G61) to enable us to use tritium tagged hydrocarbons in leak testing experiments in refinery catalytic units such as reforming and desulfurization units.

Locations where this technique is intended for use include refineries owned and operated by the Sinclair Refining Company at the following locations:

East Chicago, Indiana	Marcus Hook, Pennsylvania
Corpus Christi, Texas	Wood River, Illinois
Houston, Texas	Sinclair, Wyoming

Purpose of Test

The purpose of these tests is to determine whether heat exchangers in operating refining units such as catalytic reforming and desulfurization units leak during operation of the units. Specifically, we are interested in feed-product heat exchangers where there is a loss in quality of the product if some of the feed leaks into the product in the heat exchanger, thus contaminating the product with material which has not passed through the catalytic system involved.

Chemical and/or Physical Form and Maximum Number of Millicuries of Each Chemical and/or Physical Form that we Will Possess at any one Time

The tritium tagged compounds which are liquid hydrocarbons are to be added to the feed of a catalytic reforming or desulfurization unit. The feed consists of a mixture of paraffins and aromatics. It is desired to run these tests when operating data on the units involved indicate that a heat exchanger leak may exist. These tests are not run continuously but are individual tests to be run only when deemed necessary by analysis of unit operating data. The maximum number of tests per year which we are requesting is ten with a maximum number of six at any one refinery location. In practice, probably less testing than this will be required but since it cannot be predicted when leaks will occur it is difficult at this time to make accurate prediction of the number of tests required. The maximum activity of tritium contained in tritiated hydrocarbon requested for each test is one curie. Less activity than this will be used where feasible. The activity level to be used is dependent upon the sizes of the units to be tested.

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In order to calculate levels to be expected in the product, the catalytic reformer at the Sinclair East Chicago, Indiana refinery will be used as a typical example with the assumption that one curie of tritium activity is used in the test. The tagged compounds appear in the product as a mixture of tritium labeled paraffins and aromatics. The tracer compound will be injected as a single pulse. Product from this catalytic reformer varies between approximately 14,000 and 20,000 bbl. per day depending upon the season of the year with the lower rates in the winter time. On leaving the catalytic reformer approximately two-thirds of the product is sent to an intermediate storage tank containing at least 30,000 or 40,000 bbl. of hydrocarbon. One-third of the product is sent to a tank containing a minimum of 10,000 bbl. of hydrocarbon.

The products from both of these tanks are blended into gasoline in blending tanks. The products from the catalytic reformers are diluted in the blending tank with at least an equal volume of hydrocarbon which does not contain tritium. There is mixing in the intermediate storage tanks due to the pumps that transfer the products of these tanks and from these tanks to the blending tanks. In the blending tanks the various components are mixed with tetraethyl lead to manufacture gasoline. The blending tanks contain stirrers so that one is assured of uniform mixing of the tritium labeled hydrocarbons with the rest of the gasoline.

The calculation of activity level to be expected in the product follows:

$$1 \text{ barrel} = 1.59 \times 10^5 \text{ ml.}$$

One curie will be mixed with 40,000 bbl. at the intermediate storage tanks plus 40,000 bbl. in the blending tanks. Therefore one curie of tritium tagged hydrocarbon will be dissolved in 80,000 bbl. of gasoline.

$$\text{Activity in product} = \frac{10^6 \text{ microcuries}}{1.59 \times 10^5 \times 80{,}000} = \frac{10^6}{1.27 \times 10^{10}} = 7.9 \times 10^{-5}\ \mu c/\text{ml}$$

The maximum activity in the product is therefore $7.9 \times 10^{-5}\ \mu c/\text{ml}$. Appendix B, Table II of Title 10, part 20 of the Federal Register for tritiated water indicates a limit of 1.6×10^{-2} microcuries per ml. Therefore the maximum possible levels to be expected in gasoline are approximately 1/200th of this "unrestricted area" limit. The calculations apply to the maximum activity in the product. If one applies time averages then the concentration in the product will be below the concentration calculated.

The body burden limit for tritium in the newly proposed AEC regulations (Title 10, Chapter I, part 20) is 1000 microcuries. Therefore one would have to ingest and totally absorb inside the body $1000/7.9 \times 10^{-5} = 1.27 \times 10^7$ ml. of gasoline to reach this body burden. This volume is equal to 3360 gallons of gasoline which is obviously impossible to absorb within the human system.

Another way of looking at the safety aspects is to compare radiation doses with that received from natural radiocarbon. Since the human body contains about 18 wt. % of carbon then at the natural radiocarbon level of 15.3 dpm/gm. the permanent dose rate from this source (which is a minor one) can be calculated as follows:

$$0.18 \times 15.3 \frac{\text{dpm}}{\text{gm}} \times 50 \frac{\text{kev}}{\text{disintegration}} = 138 \text{ kev/minute/gm}$$

One gallon of gasoline at the maximum tritium concentration of 7.9×10^{-5} μc/ml will contain 0.299 microcuries. If one person were to totally ingest the tritium from one gallon of gasoline the dose from this source would be

$$\frac{0.299 \text{ mc} \times 2.22 \times 10^{6} \text{ dpm/mc} \times 6 \text{ kev/disintegration}}{7 \times 10^{4} \text{ gms (in standard man)}} = 57 \text{ kev/min/gm}$$

The instantaneous dose from tritium contained in one gallon of product totally dissolved in the body is therefore, less than the permanent dose due only to carbon-14 in the body. The body receives radiation from many other sources in addition to carbon-14.

The dose rate delivered to the body from tritium would of course be temporary due to the well-known rapid biological turnover of hydrogen in the body. A calculation using 12 days for the biological half life of tritium gives a total integrated dose of 0.025 milliroentgens to the body resulting from the ingestion of 0.299 microcuries of tritium in the body of the standard man.

It should be realized that petroleum products contain no radioactive carbon or hydrogen per se. On the basis of the various calculations presented including comparisons with current tritium concentration limits, proposed future body burden limits, comparisons with naturally occurring carbon-14 radiation doses, and calculation of expected maximum integrated dose to the standard man per gallon of product ingested, we feel that the use of tritium for the purpose outlined above can be conducted quite safely.

Preparation of the tracer containing compounds, injection at the refinery and obtaining of samples during the experiments will be supervised by Dr. A. I. Snow.

We would appreciate an early reply to this request for use of tritium containing compounds in leak detection at Sinclair refineries.

Yours very truly,

SINCLAIR RESEARCH LABORATORIES, INC.

A. I. Snow

A. I. Snow, Chairman
Radioisotope Committee

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