Form AEC-417 (Tentative)
(8-56)

UNITED STATES ATOMIC ENERGY COMMISSION

Compliance Inspection Report

1. Name and address of Licensee
Brown and Caldwell
c/o Tumor Institute of Swedish Hospital
1211 Marion Street
Seattle 4, Washington - Attn: William M. Roman

2. Date of Inspection
April 11, 1957

3. Type of Inspection
Routine Scheduled

4. 10 CFR Part(s) Applicable
Parts 20 and 30

5. License (or Permit) No(s). and Expiration date(s)

Number	Exp. Date	Number	Exp. Date
46-1892-1	January 31, 1959		

6. Scope of License(s) and Permit

Use of Cesium-134 in the sewers of the City of Seattle, Washington, serves in determining flow rates and quantities. The Licensee may not possess more than 100 millicuries of Cesium-134 at any one time.

7. Special Conditions and Limitations of License(s) or Permit
(a) Byproduct material may also be used at Sewerage System, City of Seattle, Washington.
(b) Byproduct material to be used by, or under the supervision of, William M. Roman.
(c) Except as hereinafter provided the Licensee shall comply with provisions of the Atomic Energy Commission's Proposed Standards for Protection Against Radiation as published in the Federal Register, July 16, 1955 (10-CFR-20), until such time as said proposed regulations or revisions thereof become effective regulations of the Commission. Notwithstanding Section 20.24 (f) of said standards, (continued on reverse side of page)

8. Inspection Findings
Isotope material on hand was properly stored and handled at Swedish Hospital, Seattle (see License No. 46-922-1). Cesium-134 was suitably transported to the field and there added to the sewer flow. Adequate monitoring instruments were used in the field. Records maintained meet the requirements of 10-CFR-20. The quantity of Cesium-134 introduced into the sewer produces concentrations below that acceptable in drinking water. William M. Roman is the best employee in the Licensee's organization to contact on matters pertaining to the license.

9. Items of Non-compliance

None - "Clear Case"

10. Give date of last previous inspection: No previous inspections
11. Is "Company Confidential" information contained in this report? No
(Specify page(s) and paragraph(s).)

Distribution:

→ 1-2 Division of Inspection, Wash., D. C.
3 Division of Inspection, HOO

Carl N. Zangar
(Inspector)

Approved by: Carl N. Zangar
Hanford Operations Office
(Operations Office)

April 17, 1957
(Date report prepared)

If additional space is required for any numbered item above, the continuation may be extended to the reverse of this form using head to foot format, leaving sufficient margin at top for binding, identifying each item by number and noting "Continued" on the face of form under appropriate item.

SHOULD BE SET FORTH IN A SEPARATE COVERING MEMORANDUM

7. Special Conditions and Limitations of License(s) or Permit (con't)

(c) (con't)

labeling is not required for laboratory containers such as beakers, flasks and test tubes, used transiently in laboratory procedures during presence of the user.

(d) Total amount of Cesium-134 procured under this license shall not exceed 500 millicuries.

DETAILS

12. **General**

On April 11, 1957, Carl M. Zangar visited the office of Brown and Caldwell located in room 415 of the Jones Building. He was met there by Mr. Hal Miller, Project Engineer, Mr. William M. Roman and Mr. Dave Caldwell. After looking over their office, a room approximately 25' x 30' containing five desks and a drafting table, Mr. Roman and Mr. Zangar proceeded to the Swedish Hospital where their isotope, Cesium-134, is stored. Mr. Peter Wootton, Radiological Safety Officer, was present at the Swedish Hospital. At the Swedish Hospital we looked at the storage and handling facilities and records of receipts and uses of isotopes. Two plastic bottles of about eight-ounce capacity had been previously filled with a sodium chloride solution of Cesium-134. One bottle contained 1.2 millicuries and the other 0.5 millicurie of Cesium-134. These were placed in a wooden box having the yellow and magenta radiation symbol for transfer by car to the field test site. The party next proceeded to the test site at 11th Northwest and 45th Street where the samples were to be poured into the sewer, counts to be taken and flow determined. At the field test site, Emil Jensen and Robert Stockman of the Washington State Board of Health joined the group. Later in the afternoon the group at the field site was joined by the following:

Dr. Wallace Lane - Seattle, King County Board of Health
John Van Amburgh - Assistant Director of Sanitation, Seattle
John Bright - Director of Sanitation, Seattle
Roy Morris - City Engineer, Seattle
Jim Robertson - Assistant City Engineer, Seattle
Clarence Mossart - Councilman, Seattle
Bob Jones - Councilman, Seattle
Mike Mitchell - Councilman, Seattle
Mr. Alexander, Councilman, Seattle
Mr. Braman, Councilman, Seattle

The above were escorted by Mr. Hal Miller and Mr. Dave Caldwell of Brown and Caldwell, and were present at the field site for only a few minutes to observe the field test.

13. **Facilities**

No radioactive material is kept at the office of Brown and Caldwell; materials are stored and handled at the Swedish Hospital. Here, the radiation hazard symbol was displayed on the door to the isotope laboratory, on four storage caves, and on hood and work areas. The Cesium-134 in its shipping container was kept in one of the caves. Tongs and hoods are employed when measuring samples. Cesium-134 is poured into eight-ounce plastic bottles using tongs behind a shielded area within a hood. The plastic bottles contain a one per cent salt solution. Amounts of radioactive material added to the bottles are in the order of one millicurie. The filled bottles are then inserted in a yellow wooden box, having the radiation symbol, which is transported to the field site by car. A count taken at approximately 12 inches above the uncovered box, containing approximately 1.7 millicuries of Cesium-134, was 0.8 mr/hr. At the time of pouring into a sewer the bottles are handled by hand.

14. **Badges and Dosimeters**

Mr. Roman is the only individual that wears a film badge since only he handles the radioactive material. Badges are processed by Radiation Detection Company, 576 College Avenue, Palo Alto, California. Records on badges showed the following: Ex6

3/21/57 - Worn 20 hours - Gamma, [redacted]
4/9/57 - Worn 6 hours - Gamma, [redacted]

Dosimeters are worn by Mr. Roman, Mr. Miller and others when they are engaged in work at the field test site. Dosimeters show from [redacted] when used for one day. Ex6

15. **Records**

In addition to the film badge record described above, records of receipt and use were examined. These records showed the following:

Receipt

3/1/57 50 millicuries Cesium-134

Use

3/27/57	1.26 millicuries	to Ballard sewer
4/4/57	1.22 millicuries	to sewer at 113 NE and E 135
4/8/57	0.65 millicurie	to Rainier Sewer
4/8/57	3.16 millicuries	to Ballard sewer
4/11/57	1.20 millicuries	to Ballard sewer, 11th NW and 45th

Other records examined, and considered significant, were Peter Wootton's computations showing the quantity of Cesium-134 that may safely be added to the sewer system at various flows. A copy of these computations is enclosed. The computations clearly show that the concentrations are below acceptable limits for drinking water.

16. **Surveys**

Due to the very small amount of radioactive material used on the site and the low reading of 0.8 mr/hr obtained at approximately 12 inches from the open field carrying case, Peter Wootton, the Radiological Safety Officer, did not deem complete surveys in the field necessary. However, the party does keep a model 107 C Professional Gieger Counter (by Precision Radiation Instruments, Inc., Los Angeles, California) in continuous operation on the field test site. This reads less than 100 counts per minute.

17. **Waste Disposal**

There is no waste disposal problem here for the isotope is poured into the sewers for hydraulic studies. This procedure automatically takes care of the disposal. The eight-ounce plastic bottles are reused. At the completion of the job, it is planned to dispose of plastic bottles and any other remaining material through the disposal service of Mr. Ralph Baltso of the University of Washington.

18. **Field Test**

The site selected for the test was at 11th Northwest and 45th in Ballard (a part of Seattle). Here the sewer is box shaped, being 69½ inches deep and 116 inches wide. The estimated flow was 4,000,000 gallons per day. Two manholes were opened approximately 500 feet apart. The isotope was poured into the upstream manhole and sewerage was pumped from the downstream manhole into a vertical cylinder or tank approximately 6 inches in diameter and 24 inches high. A counter was inserted into the sewerage-filled cylinder and the counter was attached to a Berkley Portable Scaler-Continuous Counter. The test was run for about 1,000 seconds prior to injection of the isotope in order to get an initial count. This initial or background count averaged 6 per second. After injection of 1.2 mc of Cesium-134, the count averaged 13.4 per second. The increase in count of 7.4 per second when considered with the volume of the test cylinder and the duration of the test permits a computation of the sewerage flow rate. Counting was continued until the background count was reached. Studies of this type will be made for various depths of flow in the sewers. Then a depth-flow curve may be plotted which will permit the city to determine the sewerage flow rate in the future (at the calibrated locations) merely by measuring the depth of flow.

A short description of the test method was handed out by Mr. Hal Miller to members of the City Council who were present at the test site. A copy is enclosed.

C O P Y

NOTES ON THE USE OF Ca^{134} FOR MEASURING THE FLOW IN SEWERS BY THE INTEGRAL COUNT METHOD

It is proposed to inject batches of Ca^{134} into the sewer via one manhole over a period of 30 secs and extract a known quantity of the stream at a second manhole 400 yds. distant. The quantity of activity per batch will depend on the expected flow as in the following table:

Expected Flow	Activity/Batch
25 million gals/day	1 millicurie
100 million gals/day	5 millicurie
250 million gals/day	10 millicurie

Under Atomic Energy Commission 10CFR Part 20, Section 20.103. Concentration in Effluents to Unrestricted Areas. (Applies to effluent other than sanitary sewage. See paragraph d). The maximum permissible concentrations are specified in Appendix B, Table II. The quantities may be averaged over a year's dilution.

Section 20.303. Disposal by release into Sanitary Sewage Systems. The maximum permissible concentrations are specified in Appendix B. Table I and the quantities may be considered diluted in a day's flow.

The isotope Cs^{134} is not listed in this Appendix. Its chemical affinities may be expected to resemble those of Cs^{137} but has a much shorter half life (2.3 years opposed to 30 years for Cs^{137}). Adoption of the maximum concentrations listed for Cs^{137} would therefore appear to contain a liberal safety factor.

Maximum concentration of Cs^{137} Appendix B, Table II water 1.5×10^{-4} microcuries/millilitre

Maximum concentration of Cs^{137} Appendix B, Table II water 4.5×10^{-3} microcuries/millilitre

C O P Y

The highest specific concentration proposed 5 mc. of Ca^{134} in 100 million gals/day.

100 million gals/day 70,000 gallons per min.

Injection would take place over 30 secs.

5 millicuries would be added to 35,000 gallons $3.5 \times 10^4 \times 3.8$

1.33×10^5 litres

1.33×10^8 litres

Concentration $\frac{5 \times 10^3}{1.33 \times 10^8}$ microcuries/millilitres

3.76×10^{-5} microcuries/millilitres

This will be the maximum concentration at any time.

Suppose the entire shipment of 100 millicuries were used in a series of experiments in one sewer only during the course of several months, and that of the smallest expected daily flow of 25 millions gals. per day and suppose this sewer flowed only into its own effluent stored in a reservoir empty at the beginning of the year so that no further dilution could occur, then ignoring decay of the isotope, the concentration averaged over a year as allowed under Section 20.103 (the more stringent regulation) would be:

$$\frac{10^5}{25 \times 10^6 \times 3.65 \times 38 \times 10^3} \text{ microcuries/millilitres}$$

$$\frac{10^5}{3.46 \times 10^{13}} \text{ microcuries/millilitres } 2.9 \times 10^{-9} \text{ uc/millilitre}$$

This is far below the permissible concentration of even an unknown gamma emitter. (1×10^{-7} microcuries/millilitres) allowed under the same Section. It is suggested therefore that the procedure is in accordance with the requirements of the Atomic Energy Commission 10CFR, Part 20, Standards of Protection against Radiation.

/s/ P. Wootton 2/19/57

C O P Y

April 11, 1957

FLOW MEASUREMENT BY THE RADIOISOTOPE METHOD

An important prerequisite to good sewerage planning is a thorough knowledge of the quantity of sewage to be conveyed and treated. Measurement of sewage quantity is normally accomplished by means of a metering weir or flume installed in the sewer at a manhole or other suitable structure.

Because Seattle's sewers are large and flow velocities are high, conventional methods of flow measurement are not applicable. For these reasons and also to achieve a greater degree of accuracy, an entirely new method of flow measurement is being employed by the Metropolitan Seattle Sewerage Survey. This method was recently developed by D. E. Hull, of California Research Corporation, and is being utilized for sewage flow measurement for the first time.

In using this method, a known quantity of radioisotope is introduced into the sewer upstream from the metering point and a sensitive counter at the metering point totalizes the number of emissions from a representative portion of the activated sewage as it passes. The total flow is then calculated from the observed concentration of counts in the sample and the calculated flow is then related to the depth of flow.

This Survey is utilizing a pneumatic flow recording device which continuously records the depth of flow. The isotope method is used to calibrate this device. After a number of calibrations at various depths, a calibration curve is developed and thereafter the conversion of recorded depths to actual flow rates is automatic.

The isotope being utilized is Cesium 134, the use of which has been authorized under a license issued to Brown and Caldwell by the Atomic Energy Commission. The method has been reviewed with the appropriate officials of the State and local Health Departments and the safety features are being supervised by Mr. Peter Wootton of the Swedish Hospital's Tumor Institute.

It should be noted that the maximum concentration of radioisotope in the sewage is below the recommended maximum value considered safe for drinking water by the A. E. C.

C O P Y