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To Dr. J. J. Burbage

Date December 14, 1953

At "A" Building

Subject Trip Report - J. E. Bradley and D. S. Anthony, Los Alamos, December 7 and 8, 1953

Introduction

The writers made a trip to Los Alamos on December 7 and 8 to obtain information concerning the biological effects and health physics problems associated with the hydriside program. We wish to express our gratitude and appreciation to the Los Alamos staff for their wholehearted cooperation and extra special efforts to assist us in accumulating information. Particularly helpful in making special arrangements, conducting tours, and answering our questions were:

Dr. Thomas Shipman
Dr. Wright Langham
Mr. Dean Meyer
Mr. L. G. Chelius
Mr. Harry Schulte
Mr. B. B. McInteer
Mr. M. C. Robbins
Mr. Morris Milligan
Mr. B. C. Eutsler

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Instrumentation

The two area monitoring instruments currently used at Los Alamos are the "Monster" and the "Sniffer". Both instruments were developed to continuously detect and measure the amount of tritium in the atmosphere, although both are also sensitive to other radiations. Neither instrument has been quantitatively calibrated as yet, but both provide valuable information qualitatively and serve as alarms in case of dangerously high concentrations. Los Alamos also reports excellent correlation between instrument readings and the urine counts of personnel working in the area. This correlation has, to date, been the most effective way of calibrating these instruments.

"Monster"

The "Monster" is an ionization chamber type of instrument whose principle of operation is as follows: an electric fan continuously sucks room air first through a filter element, then through an ionization chamber and then blows the air back into the room. Except for the particles removed by the filter element the air sample inside the ionization chamber is identical to the air in the room.

The filter element consists of two parts. First, there is a mechanical filter which is an E4R3 Army canister. This removes particulate matter from the air stream, but no gases are removed. Second, there is an electrical filter, whose purpose is to remove any residual charged particles from the air before it passes into the ionization chamber.

The ionization chamber is approximately one liter in volume and is of conventional design. The base of the chamber is designed to fit the Model 30 Vibrating Reed Electrometer, which measures the ion current and records continuously on an Esterline-Angus recorder.

More complete details on this instrument are available in report number LA-1270, written by J. B. Deal, Jr.

"Sniffer"

The "Sniffer" is a portable version of the "Monster". It has no filter element except a fine mesh screen placed over the air intake. The air mover is a constant speed fan which sucks air into a one-liter ionization chamber and exhausts it back into the room. The ionization current is measured by a Los Alamos constructed meter which operates off either batteries or AC power supply. If a battery-operated, DC fan is used the instrument can be made completely independent of plant power supply.

The instrument has four scales differing in sensitivity by a factor of ten. It, like the "Monster", has no absolute calibration as yet, but will measure concentrations ranging from a few microcuries per cubic meter to about one curie per cubic meter.

Mr. Dean Meyer of the Los Alamos health physics staff has agreed, upon request, to supply us with complete drawings and a prototype instrument. This is merely one example of the excellent cooperation given us by the Los Alamos personnel.

Estimated costs of these two instruments are:

"Monster" - $2500 each
"Sniffer" - $300 - $350 each

Geiger-Müller Tube Construction

The Geiger-Müller tubes employed in the urine monitoring are about 1 foot long and approximately 1 inch in diameter. The ends are soft glass through which passes a sealed platinum wire. The main body of the tube is pyrex glass which is silvered on the outside. A copper strip is taped to this silvered coat and serves as the other electrical connection. The platinum lead-in wire is connected inside the tube to the platinum electrode wire by means of a much heavier gauge stainless steel spring. This spring keeps the center wire taut at all times, even when the tube is "flashed" at high voltage during a decontamination procedure. One operating detail for these tubes is of interest. They are operated at 50 volts above threshold voltage since the plateau is variable and often short.

Operating Areas

The writers were given a tour of the various tritium processing areas conducted by Los Alamos health physics personnel. Potential hazards, air concentrations, personnel exposure, and area monitoring problems were discussed as the tour progressed. The areas visited were "DP" West, "D" Building, and Ten Site.

"DP" West

Mound Personnel - D. S. Anthony, J. E. Bradley
Los Alamos Personnel - B. B. McInteer, Dean, Meyer, L. H. Chelius, Harry Schulte.

Operations performed in this area include gas blending and hydriside production. The material is then moved to "D" Building for further processing. Pertinent features discussed are:

1. The tritium is obtained from Hanford in 10-liter tanks. There have been no failures or leaks from these tanks since the O-ring type of seal was replaced with bellows welded to the tank valve. The tanks are changed manually, which requires opening the front of the hood and reaching into it. A man's arms, head, and shoulders are in the hood during this changing. The Los Alamos procedure is to require that supplied air masks and rubber gloves be worn for the job. Their health physics personnel recommend, however, that in a new design, better changing facilities be provided such as enclosing the tank in a small box or other container.

2. Another source of contamination in this area is the reaction chamber. After equilibrium has been reached, there may be as much as 20 cc of gas per hour diffusing through the wall of the chamber. The reaction operation has been carried out in a fume hood setup but most of those present agreed that for production operations a glove-port hood would be a better arrangement.

3. This area is equipped with one "Monster" and several "Sniffers". Six of the "Sniffers" are connected to a 6-point recorder where air concentrations at any of the six places may be checked immediately. In addition, a duplicate recorder is stationed in a clean emergency room, which is isolated from the operating area. This allows an individual to observe air concentrations from a safe spot if it becomes necessary to evacuate the area.

4. In general, when operations are proceeding smoothly and no accidents have occurred, the following average levels are maintained:

Air concentrations - 8 $\mu C/m^3$ (50 $\mu C/m^3$)
Personnel urine samples - 14 $\mu C/l$. (250 $\mu C/l$)

The values in parentheses are the Los Alamos maximum permissible exposure levels.

5. These relatively low levels are maintained by careful operating techniques; by stopping operations if a "Sniffer" alarm goes off; and by rapid air flows across the faces of the hoods. These flows ranged from 100 to 600 linear feet per minute although they prefer a minimum of 200 lfm.

6. The new line being installed in this area will incorporate several changes, such as:

a. Valves extending outside the hood with a knurled cap to turn any leakage back into the hood.

b. Foot-operated hydraulic lifts for the liquid nitrogen traps.

c. Only two access doors are provided - one in each hood.

"D" Building and Ten Site

Mound Personnel - D. S. Anthony, J. E. Bradley, L. G. Fauble

Los Alamos Personnel - Dean Meyer, T. Shipman, L. H. Chelius, Harry Schulte

Since these areas are concerned with the same operations, they will be discussed together. Ten Site is not operating yet but is to replace the "D" Building operations when it is ready.

The operations carried out in this area include grinding, weighing, pressing, machining and inspection and finishing. All operations are carried out in glove-port hoods with an enclosed ventilating system which maintains a dew point of -50° to -80°F.

Specific features which were discussed and are considered worth mention are:

1. Concentration of tritium inside the hoods ranges from 3 to 6 curies per cubic meter during normal operations.

2. Neoprene gloves, 25 gauge, are used in glove ports. Because tritium will penetrate these in time, personnel are required to wear obstetrical gloves also.

3. The gloves are changed using a procedure which pushes the contaminated glove into the hood and never opens the hood directly to the operating area.

4. Gloves are checked for contamination with a vacuum hose connected to a portable "Sniffer".

5. Los Alamos personnel agreed that round glove ports are preferable to the elliptical ones in use there.

6. All hood exhausts are equipped with an E4R3 Army canister.

7. Provisions must be made to enable operators to reach equipment in the rear of the boxes. (Extension handles, etc.)

8. Dry nitrogen is circulated through the glove boxes at a rate sufficient to change the atmosphere every minute. Discharge from the boxes is through an Army canister as noted above. The nitrogen is circulated through a "Deoxo" unit and the water formed collected in an "Lectrodryer" and is then recirculated to the boxes. The pump providing this circulation is put in a completely enclosed box, located in a room with the "Deoxo" unit and the "Lectrodryer". This room is equipped with an air lock, air supply for fresh air masks, and special ventilation. Any maintenance work in this area is well monitored by health physics, much the same as our high risk area work.

9. The average urine count of personnel working in these areas is about 50 μC/l. Occasional accidents or maintenance work have caused higher counts at times.

10. Penetrating, external radiation is a relatively minor problem until the finishing operations which require handling the completed item. Victoreen r meter measurements have indicated surface measurements of 160 mr/hr from a standard hemisphere. These intensities were measured through a 25-gauge glove and represent low energy X-rays produced by Bremsstrahlung.

11. All pass boxes open into a fume hood and not into the working area itself.

12. A feature, not incorporated in the Los Alamos design, but strongly recommended by them, is to have separate boxes. Their glove boxes have common side walls making it impossible to remove one box without opening or affecting the adjacent boxes. This has already given them some serious problems in attempting to move equipment from "D" Building to Ten Site.

Urine Monitoring

Nearly everyone associated with the hydriside project at Los Alamos emphasized the importance of frequent urine monitoring for tritium. Daily sampling of all personnel actively working with tritium was the rule since such a procedure afforded a high degree of protection to the individuals and incidentally gave information on operating procedures. Samples can be easily, quickly, and accurately assayed and from them a quite precise knowledge of body burden can be inferred. Within less than an hour an excellent measure of the degree of hazard from an expected or unexpected source can be obtained. The urine monitoring shows the amount of dangerous absorbed and metabolized tritium water and ignores the relatively harmless tritium gas. The various area monitors such as the "Sniffer" and "Monster" do not differentiate between tritium gas and tritium water although they do give an almost instantaneous reading. Correlation of the area monitoring with urine sampling frequently indicated the kind and degree of operating difficulties being encountered.

The method of tritium assay is quite simple. A sample of urine is collected sometime after the beginning of the work day such as by mid- or late morning. The urine sample is introduced into an evacuated manifold system which has a generator at one end and a G-M tube at the other end. Upon entering the generator the 5 milliliter sample of urine comes in contact with a charge of metallic calcium. The calcium decomposes the water in the urine producing hydrogen (and deuterium and tritium if they are present). The evolved gas is run through one or more tubes immersed in liquid air in order to remove water vapor. The evacuated G-M tube at the end of the line is then filled to a pressure of 15 centimeters (of mercury) with the dried gas. An additional 5 centimeters of ethylene and 2 centimeters of argon are added to provide a proper quenching medium. The G-M tube is then connected to a scaler and the count is recorded simultaneously with that from a similar hydrogen-ethylene-argon filled blank tube connected to another scaler. The difference in counts from the two tubes is considered to be due to the tritium from the urine. The precision is ± about 5% in the activity range usually met. The accuracy is unknown but is being determined. The sensitivity is more than adequate since it will readily detect a few microcuries of tritium/liter of body fluid, whereas 250 microcuries/liter of body fluids represents the tolerance value. There have been a few instances of higher than tolerance values, the highest recorded to date being 2,000 microcuries/liter. Even such high values are comparatively harmless since the tolerance figure is on the basis of a burden which could be continuously maintained without trouble. Normally, the short half-time in the body (8-12 days) provides adequate relief. If dangerously high body burdens ever result, the hazard can be considerably reduced by greatly increasing fluid intake since the 1/2 time in the body can be dropped to perhaps two or three days. Large quantities of beer have been recommended for this purpose and after suitable experimentation we will work out the details of this method with Dr. Reagan.

General

1. Air monitoring - although, as stated previously, the "Sniffer" has not been calibrated absolutely as yet, certain correlations and rules of thumb have been established. These are:

a. If personnel work in an area where the air concentration measures full scale on the most sensitive (number 5) scale of "Sniffer", their urine counts average about 70 μC/l.

b. If "Sniffer" readings are full scale on the number 4 scale, 4 hours working time is allowed then supplied air masks are worn.

c. If "Sniffer" readings are full scale on the number 3 scale, normal operations are suspended, supplied air masks are donned immediately, and the source of difficulty is sought.

d. When readings are on the number 2 scale, the area is evacuated and emergency measures are taken.

2. Decontamination - It is possible to decontaminate glassware and other items by flushing and washing with appropriate acid solutions.

3. Liquid waste disposal - Los Alamos is at present storing all tritium water waste. They hope to dispose of it by evaporation. At Mound, we may be able to meet AEC requirements by treatment or by trickling the tritium water waste into our plant effluent to obtain a large dilution factor.

4. Stack effluent - Dilution (factor of about 60) is the only treatment given exhaust gases at Los Alamos. This has proved to be sufficient during normal operations but they are concerned over the possibility of an accident releasing large quantities of tritium in a short time. The same will probably be true at Mound. We should have sufficient dilution and stack height for normal operations, but calculations must be made to determine maximum concentrations in case of accidental release of large quantities.

5. Skin absorption - It must be stressed that any tritium water contamination on the skin can not be washed off. Almost all of the tritium is absorbed into the body in a relatively short period of time. Adequate protection must be afforded personnel for this type of exposure as well as protection against airborne contamination.

6. Tritium vs. tritium water - Escaped tritium gas must be considered as tritium water. Thus the apparent safety factor due to the minimal absorption of the gas is an illusion in actual operation. Los Alamos experience has shown rapid conversion of tritium to tritium water in normal room atmosphere.

David S. Anthony

John E. Bradley

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