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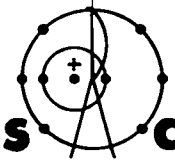
Los Alamos Environmental Monitoring Program

July through December 1970



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LOS ALAMOS ENVIRONMENTAL MONITORING PROGRAM

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ABSTRACT

The Los Alamos Scientific Laboratory complex includes accelerators, research reactors, radioactive materials separation facilities, and other experimental installations using radiation, chemicals and radioactive materials. In the operation of the Laboratory, certain wastes are generated and must be disposed of safely.

This report is a six month summary (July through December, 1970) of results of a surveillance program in the area to determine the effect of Laboratory operations upon the environment. Gamma radiation measurements are routinely made. Scheduled samples of air and water are taken and assayed for certain chemical and radioactive materials which may be present in some concentration. Soil samples may be taken when considered necessary.

I. INTRODUCTION

Los Alamos County, New Mexico, containing approximately 100 square miles, lies on the eastern slope of the Jemez Mountain range. The area is bordered on the southeast by the Rio Grande River (elevation 5400 ft. msl) and on the west by the peaks of the Jemez range (elevation approximately 11,000 ft. msl). The average annual rainfall is approximately 18 inches. Drainage is in general from west to east, and the land is cut into finger-shaped mesas by the drainage. Stream flow in the canyons is seasonal and dependent on snow runoff and thunderstorm activity. The Los Alamos townsite is centrally located in the county on a series of such mesas at an elevation of approximately 7000 ft. msl. Suburban residential areas of White Rock and Pajarito Acres are located in the southeastern part of the county, just west of the Rio Grande. The physical relationship of Los Alamos to the surrounding country is shown on Figure 1.

The Environmental Monitoring Program was initiated by the Los Alamos Scientific Laboratory during the early days of the project to determine how much, if any, increase in radiation exposure in the area might occur due to activities of the Laboratory. The program has grown in size and scope as the activities of the Laboratory have expanded and become more diversified. Measurements being made on a continuing basis include: gamma radiation background; air sampling for materials emitting alpha, beta and gamma radiation; and water sampling and assaying for certain radioactive materials.

The program is carried out by the Laboratory's Environmental Services Group. The U. S. Geological Survey, Ground Water Branch, Albuquerque, New Mexico assists

Fig. 1. U.S.G.S. LASL river sampling points.

and advises the Laboratory as necessary, for collection of water samples and location of radioactive waste burial pits.

During the processing of materials in the Laboratory, chemical and radioactive wastes are generated. The basic philosophy in the treatment of such wastes has been to concentrate and confine the waste products. Accordingly, solid waste materials are buried in special pits chosen to prevent migration of the materials once they are buried. Liquid wastes are processed in special waste treatment plants constructed for the purpose, and chemical and radioactive material concentrations are reduced to acceptable levels before these effluents are released. The air from processing areas is passed through filters to remove particulate materials and, in some cases, through adsorption beds to remove gaseous materials before being released to the atmosphere.

Treated effluents from the liquid waste treatment plants drain into normally dry stream beds and then flow down gradient towards the Rio Grande and vertically towards perched water zones well above the main ground water that lies 1000 ft. below the surface.

II. SURVEILLANCE PROGRAM

A. Gamma Radiation Measurements

There are 60 stations throughout the county where thermoluminescent dosimeters (TLD's) are located at air sampling stations or planted on stakes at approximately 3 ft. above ground. The stations are located both in the townsite and along various roads inside and outside Laboratory work sites. The TLD's are changed on a monthly basis, read, and readings recorded. The sensitivity of the method is such that natural background due to cosmic radiation and the presence of normal amounts of naturally occurring radioactive isotopes in the air, soil, and the dosimeter system itself will be detected. Man-made radiation or radiation resulting from environmental contamination will be detected and measured along with such dosimeter and natural background. Values reported have been corrected for dosimeter background. A summary of values found is reported in Table I.

The measured values include background. Since this background reading can vary from point to point depending upon the local terrain and make-up of the soils, it is difficult to assign responsibility for small differences in the reading.

The values found outside controlled areas vary from 6 to 18 mR/month, with an average of 10 mR/month, and are well within values given by others for natural background radiation.[1./a./] The AEC radiation protection standards allow an annual dose of up to 170 millirem above natural background based on an average dose to a suitable sample of the exposed population.

B. Air Measurements, Gross Alpha, Beta, Gamma Activities

Amounts of particulates emitting beta radiation found in the air and deposited along with precipitation are collected on a continuous basis using a high volume sampler for air and a rain gauge of 0.4 m^2 area for precipitation. Samples are normally collected on a work-day basis, five days per week. The first sample each week usually represents a 72-hour sampling period followed by four daily samples representing 24 hours each. The stations were established to measure fallout in the area due to the material in the atmosphere world-wide from weapon testing. Amounts found, and rates of deposit, are similar to the values reported by the U. S. Department of Health, Education and Welfare, Public Health Service, Radiation Alert Network (RAN), for other stations in the southwest. The average

TABLE I - ENVIRONMENTAL MONITORING DATA, JULY - DECEMBER 1970

Sample and Units	Number of Sampling Locations	Number of Samples	Type of Analyses	Maximum Single Sample Activity	Average Activity	Minimum Detectable Activity
External Radiation						
Including Natural Background mR/month						
On Site	24	144	Gamma	15.	11.	2.5
Community	13	78	Gamma	15.	9.	2.5
Perimeter	22	132	Gamma	18.	11.	2.5
Fallout Collector						
Rain Gauge $\mu Ci/m^2$	1	126	Beta (unidentified)	$643. \times 10^{-6}$	$120. \times 10^{-6}$	$1. \times 10^{-6}$
Air $\mu Ci/ml$						
On Site	5	130	Alpha (unidentified)	$150. \times 10^{-16}$	$6. \times 10^{-16}$	0.3×10^{-16}
	2	260	Beta (Unidentified)	$120. \times 10^{-14}$	$17. \times 10^{-14}$	$1. \times 10^{-14}$
	3 (Low Volume)	30	Iodine 131	5. "	2.3 "	0.01 "
	2 (High Volume)	228	Iodine 131	5. "	0.5 "	0.01 "
	5	30	Plutonium 239	$4. \times 10^{-16}$	0.7×10^{-16}	0.04×10^{-16}
	5	30	Plutonium 238	28. "	2. "	0.04 "
	5	24	Americium 241	2. "	0.2 "	0.04 "
	4	108	Tritium	$140. \times 10^{-12}$	$18. \times 10^{-12}$	0.7×10^{-12}
Community	13	338	Alpha (unidentified)	$28. \times 10^{-16}$	$4. \times 10^{-16}$	0.3×10^{-16}
	13	78	Plutonium 239	1. "	0.1 "	0.04 "
	13	78	Plutonium 238	8. "	0.4 "	0.04 "
	13	60	Americium 241	3. "	0.2 "	0.04 "
	2	20	Iodine 131	$4. \times 10^{-14}$	$1. \times 10^{-14}$	0.01×10^{-14}
	1	22	Tritium	$18. \times 10^{-12}$	3.5×10^{-12}	0.7×10^{-12}
Off Site	5	130	Alpha (unidentified)	$65. \times 10^{-16}$	$6. \times 10^{-16}$	0.3×10^{-16}
	2	20	Iodine 131	$4. \times 10^{-14}$	1.4×10^{-14}	0.01×10^{-14}
	5	30	Plutonium 239	$1. \times 10^{-16}$	0.4×10^{-16}	0.04×10^{-16}
	5	30	Plutonium 238	2. "	0.8 "	0.04 "
	5	20	Americium 241	1. "	0.2 "	0.04 "

TABLE II - ENVIRONMENTAL WATER MONITORING DATA, JULY - DECEMBER 1970

Water						
Off Site Radiochemical $\mu Ci/ml$	31	40	Alpha	20.3×10^{-9}	1.4×10^{-9}	0.6×10^{-9}
	31	40	Beta	11.3 "	3.1 "	1.0 "
	31	40	Plutonium 238	0.03 "	0.01 "	0.01 "
	31	40	Plutonium 239	0.05 "	0.01 "	0.01 "
	31	40	Tritium	$<0.005 \times 10^{-3}$	$<0.005 \times 10^{-3}$	0.005×10^{-3}
	1	1	Radium 226	$<0.15 \times 10^{-9}$	$<0.15 \times 10^{-9}$	0.15×10^{-9}
Chemical mg/l	31	37	Chloride	17.	7.	1.
	31	37	Fluoride	2.4	0.6	0.1
	31	37	Nitrate	7.0	0.4	0.1
	31	35	Dissolved Solids	479.	215.	86.
	31	40	Uranium (Natural)	29.4×10^{-3}	1.8×10^{-3}	0.4×10^{-3}
On Site Radiochemical $\mu Ci/ml$	34	67	Alpha	74.2×10^{-9}	3.4×10^{-9}	0.6×10^{-9}
	34	67	Beta	19280. "	541.0 "	1.0 "
	34	67	Plutonium 238	50.7 "	1.57 "	0.01 "
	34	67	Plutonium 239	18.48 "	0.79 "	0.01 "
	34	65	Tritium	1.124×10^{-3}	0.164×10^{-3}	0.005×10^{-3}
	5	19	Uranium 234	166.7×10^{-9}	16.30×10^{-9}	0.23×10^{-9}
	5	19	Americium 241	17.60 "	1.75 "	0.01 "
	5	18	Cesium 137	323.3×10^{-7}	30.32×10^{-7}	2.2×10^{-7}
	6	7	Radium 226	$<0.15 \times 10^{-9}$	$<0.15 \times 10^{-9}$	0.15×10^{-9}
	7	20	Strontium 90	1260. "	369. x "	6.0 "
Chemical mg/l	34	66	Chloride	310.	43.	3.
	34	66	Fluoride	10.	2.8	0.1
	34	66	Nitrate	187.	18.9	0.1
	34	66	Dissolved Solids	1735.	522.	101.
	2	7	Chromate Cr^{+6}	9.8	6.1	0.01
	29	52	Uranium (Natural)	2.3×10^{-3}	0.8×10^{-3}	0.4×10^{-3}

concentration for beta emitters is 17×10^{-14} μCi/ml.

There are 23 air particulate sampling stations running continuously located throughout the townsite, at various work sites, and on the perimeter of the Los Alamos area. For station locations see Fig. 2. Samples are collected on a weekly basis and counted for long-lived alpha activity.

An activated charcoal canister is used behind the particulate filters for gamma-emitting ^{131}I if present. The maximum concentration is less than 1% of the applicable Concentration Guide* for uncontrolled areas.

Many of the individual samples are below the listed limit of detection. However, the limit of detection, rather than zero, has been used as the value when computing the average. Thus the average value is weighted on the high side. All values were below the applicable Concentration Guide* values for uncontrolled areas.

A summary of results of the air sampling program is reported in Table I.

C. Tritium in Air

During the second half of 1970, five stations were in continuous operation sampling for tritiated water vapor in air. A desiccant is used for sampling. These stations were located at TA-33, TA-49, Administration Building, TA-50, and White Rock Area.

Results from these five stations are shown in Table I. Additional planned stations are also shown in Fig. 2.

D. Plutonium and Americium in Air

The filters from the 23 air particulate sampling stations described above were combined into monthly samples and analyzed for plutonium and americium. The stations were divided into three groups representing off site locations, on site locations and samples from the Los Alamos community.

The results of these analyses are tabulated in Table I.

E. Water Sampling

Water samples are collected from surface and ground water stations in cooperation with the U. S. Geological Survey. The samples collected periodically are analyzed for radiochemical and chemical constituents. Radiochemical analyses of samples collected on site below the outfall from industrial waste treatment plants were in some cases above the Atomic Energy Commission Concentration Guide* values for uncontrolled areas; however, the concentrations decreased downgradient to below the Concentration Guide* values before leaving AEC controlled lands. Chemical analyses of some of the water samples collected on site indicated chemical constituents above Drinking Water Standards as outlined by U. S. Public Health Services** in areas below the outfall from the power plant and industrial waste treatment plants.

Off-site water samples analyzed for radiochemical and chemical constituents were below AEC Concentration Guide values and Drinking Water Standards of the PHS.

A summary of the results of the water sampling program is reported in Table II.

F. Soil Sampling

An intensive soil sampling program was conducted in the area during this time period. Samples were analyzed particularly for the plutonium isotopes

* "Concentration Guides" as used in this report are values recommended by the U.S. Atomic Energy Commission Manual, Chapter 0524, with Appendix and Annex A, for individuals and population groups in uncontrolled areas.

** Drinking Water Standards as used in this report are values recommended by the U.S. Public Health Service Drinking Water Standards, 1962, Public Health Service Publication No. 956.

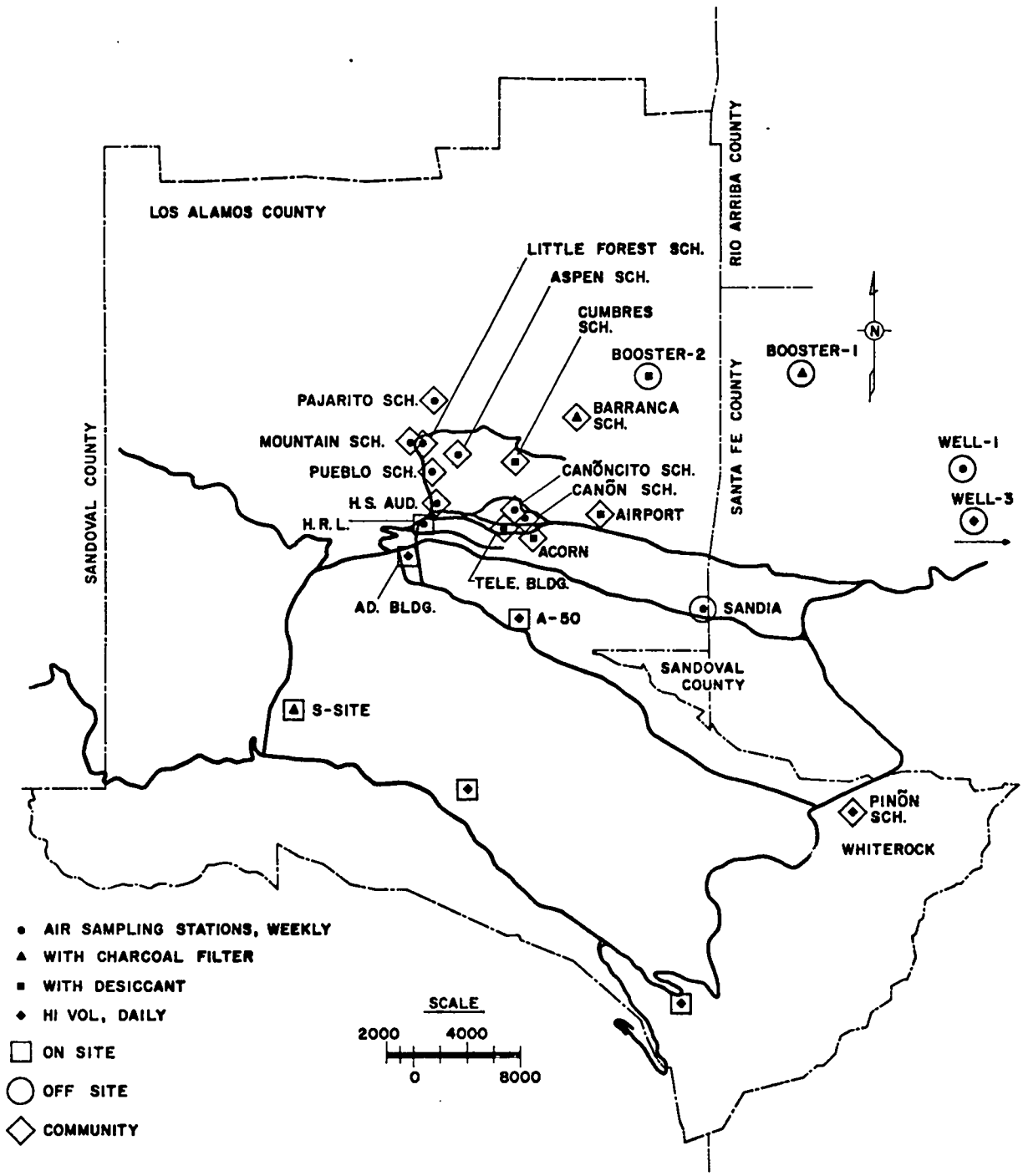

Fig. 2. Air sampling stations.

and in some cases for strontium to see if this would aid in detecting plutonium of local origin in comparison to that found worldwide. In areas where treated liquid effluents are or were released to the environment, assay values were above those considered normal due to atmospheric test bomb debris. At other places in the county and in the nearby region values were similar to those reported by others as normal.

For ^{239}Pu in the top 2 in. of soil in areas where material was expected to be deposited from gaseous effluents, the values ranged from a high of 3 dpm/gm of dry soil to 0.02 dpm/g. Values of 0.051 to 0.001 are considered to be due to world wide fallout. For ^{239}Pu in alluvium in canyons where we have put treatment plant effluents, we have observed concentrations as high as 103 dpm/g. The ion exchange materials in the alluvium act as concentration media.

The results of these studies were reported separately [3], [4], [5].

G. Air Pollution Measurements at Los Alamos - Non Radioactive Materials

A continuing program of air sampling of materials other than radioactive has been carried out in the Los Alamos area by the Industrial Hygiene Group, H-5.

For the past four years we have maintained an air sampling station on the roof of the Occupational Health Laboratory identical, as nearly as possible, to that of the National Air Surveillance Network (NASN). For the past year, filter papers for this station have been furnished by NASN. On these samples we run total particulates and benzene-soluble particulates. For the past year we also have been running beryllium on these samples. In conformity with the practice of NASN, the sampler is run one day each week, rotating the day of the week.

Two years ago, we also began running two additional samplers to collect samples for lead. These are operated in the air intake of the Occupational Health Laboratory (OHL) and in the air intake at the Health Research Laboratory (HRL). Occasional samples also have been taken on the roof of a building in the Community Center shopping area. Dust fall collectors were added to the OHL station six months ago. Two soiling index samplers have been operated for the past two years, one at OHL and the other in Espanola. Three months ago, an integrating nephelometer for measuring visibility was installed, drawing air from a point just below the roof of OHL. Results of these measurements are given in the following table and discussion.

TABLE III

Particulate Atmospheric Pollution at Los Alamos

	Concentration ($\mu g/m^3$)					
	July-Sept. 1970			Oct-Dec. 1970		
Substances	High	Low	Mean	High	Low	Mean
Suspended Particulate Matter	62.0	8.0	19.7	20.0	5.0	9.1
Benzene Soluble Particulates	1.8	0.1	1.1	1.6	0.4	0.9
Beryllium	All less than 2×10^{-4}					
Lead (OHL Bldg.)	0.20	0.04	0.08	0.14	0.006	0.06
Lead HRL Bldg.)	0.44	0.03	0.18	0.30	0.01	---

1. Total Suspended Particulates

These results are typical of a rural non-industrial area. Current data for the NASN are not available, but the last published report (1967) showed a maximum for 1967 to be 144 with an average value of 30 for a station in rural Rio Arriba County New Mexico. In contrast,Albuquerque had a maximum of 282 and a mean of 120 for the same year. There are seasonal variations with the winter tending to be low because of snow cover and the spring being high as a result of frequent high winds. The recently adopted national standard for total particulates is 60 $\mu g/m^3$ annual average, ***which corresponds to 46 $\mu g/m^3$ at this altitude.

2. Benzene-Soluble Particulates

Benzene-soluble particulates are assumed to relate most closely to pollution from automobile exhaust, although they could be a measure of almost any organic pollutant, including secretions from pine forests. The Los Alamos values are very low compared with the annual average of 7.3 for Albuquerque in 1967. In Rio Arriba County the reported average was 1.7. When total particulates are low, the benezene-soluble fraction is about 10% of the total. When the total particulates are high, the fraction decreases <5%.

3. Beryllium

The lower detectable limit for beryllium under these sampling conditions is 2×10^{-4} $\mu g/m^3$. This is about the amount of beryllium that would be found if the total particulate concentration were 100 $\mu g/m^3$ and if this material was all local tuff; 2×10^{-4} is 1/50 of the recognized off-site limit for beryllium concentration.

4. Lead

Lead concentrations at Los Alamos are quite low but measurable. No lead results were reported from New Mexico in 1967, but the 1966 report shows an average of 0.4 $\mu g/m^3$ for Albuquerque and 0.007 for Rio Arriba County. In large urban industrial areas, concentrations of lead are about four times as high as Albuquerque. Most airborne lead is due to automobile traffic and this is reflected even in Los Alamos where the lead concentration at HRL building is always higher than at OHL. Samples occasionally taken in the Community Center are slightly higher than at HRL. The present New Mexico State regulations set a maximum value of 10$\mu g/m^3$ for a 30-day average.

*** Geometric Mean

5. Dust Fall

Dust fall is measured by exposing an open jar for a period of 30 days and then weighing the collected material. Four such measurements over the past six months gave values of 26, 11, 2 and 10 tons/sq. mile. These can be compared with average values for 1968 of 7 in Farmington, N. M., 6 in Dulce, N. M. and 15 in El Paso, Texas. The Los Alamos results seem comparatively high and may reflect difficulties in keeping extraneous material out of the dust fall jar.

6. Visibility

Visibility measurements are made at OHL using the Integrating Nephelometer developed by Charlson. This instrument measures the total particle scattering coefficient (b_s), which is theoretically related to visible range ($L_v = \frac{2.4 \times 10^{-3}}{b_s}$ miles). Sampling also is being carried out to develop a relationship between b_s, mass concentration ($\mu g/m^3$) and mass size distribution. Preliminary data suggest the relationship $L_v = \frac{530}{\text{mass conc.}}$ miles may be locally applicable. Data obtained during the period 11/2/70 through 12/18/70 show the following:

	Scattering Coef. (b_s)	Visible Range (L_v)	Mass Concentration
Average	0.46×10^{-4} meters	52 miles	10.2$\mu g/m^3$
Max. L_v	0.2×10^{-4} meters	120 miles	---
Min. L_v	$>2.0 \times 10^{-4}$ meters	>12 miles	---

High scattering coefficient (b_s) conditions (minimum visibility range) were generally due to high moisture conditions, which precludes any correlation with particulate mass concentrations.

7. Soiling Index

The index is measured by the decrease in light transmission through a filter paper after drawing air through the paper. It is expressed in arbitrary units of cohs per 1000 linear feet. One sampler is run at OHL Building and the other at a residence near Espanola. Results generally show a cyclic tendency. In Los Alamos the average value of 1970 was 0.030 and the high for a single month was 0.170. In Espanola the average was 0.102 with a high of 0.610. Soiling index is strongly affected by the presence of dark colored pollutants, and the much higher values in Espanola may reflect the presence of wood smoke. High monthly average values in large cities run from 1.0 to 2.0.

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