INDEPENDENT MEASUREMENTS

PROGRAM

ENVIRONMENTAL RADIOLOGICAL SURVEY

FOR THE

HUMBOLDT BAY POWER REACTOR

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I. INTRODUCTION

The general objective of the Independent Measurements Program is to provide the AEC with an independent source of information about radiation conditions in unrestricted areas near certain AEC-licensed operations.

The design of the Independent Measurements Program for the Humboldt Bay Power reactor results from four factors:

(1) a preliminary program designed by regional persons cognizant of the Humboldt Bay Power reactor operations and problems;

(2) a review of licensee and state research and environmental monitoring results;

(3) a review of pertinent operating technical specifications in the license; and

(4) a tour of the plant environs.

Information gained from these four sources was then applied to achieving the above-stated general objective through what is believed to be the simplest and most economical program. To be more specific, the operating history of the plant has shown that the most obvious facet of operation requiring surveillance is the airborne radioactivity releases from the plant stack. Consequently, it is this facet which is most emphasized in the subject program. The radioactive materials themselves and the direct radiation doses from the material are of equal importance from the surveillance standpoint.

In addition to the airborne releases, the amounts and types of released liquid radio-contaminants will be checked by the current program with emphasis on water used directly for human consumption.

Finally, only minor surveillance efforts will be directed toward foodstuffs and food chain examinations unless evidence is forthcoming which indicates that more intensive surveillance is necessary.

Sampling locations are shown in Figure 1, attached, and the overall sampling program is shown in Table I, attached.

II. AIR MONITORING

A. Locations and Equipment

The licensee currently maintains only one continuous air sampler which is located on Humboldt Hill. Continuous air samplers will be furnished and installed by ID Health Services Laboratory/at the following locations:

	Location	Identification
1.	School at South Bay	3
2.	Humboldt Hill	4
3.	U. S. Coast Guard Station	7
4.	King Salmon community	2
5.	Arcata (Background information)	10

The choice of locations of these samplers was primarily based on information presented in Meteorology and Atmospheric Diffusion in the Vicinity of the Humboldt Bay Power Plant, L. H. Robinson, et al, November, 1965, Meteorological Office, Pacific Gas and Electric Company, particularly the wind rose and observed trajectory information.

The air samples will be collected continuously by means of Gelman Nuclear Air Samplers (Model 26001) at a flow rate of 1 cfm. The samplers will be equipped with a two-stage in-line filter head which contains a membrane pre-filter (Gelman Model VM-4, or equivalent), capable of collecting particles down to 0.05 micron with an efficiency of greater than 95%, followed by a charcoal-impregnated glass fiber filter (Gelman Model AC-1, or equivalent), for removal of iodine from the air stream. The samplers will be enclosed in housings to reduce tampering and are provided with necessary weather protection.

Filters will be changed and collected samples will be sent to ID Health Services Laboratory weekly.

B. Analysis

1. Air Sample Preparation and Counting: No chemical preparation of air sample filters is required to assess the gross alpha, beta, and gamma activity in the samples. Gross activity measurements are made before specific isotope evaluations which require destruction of filters.

a. Gross Alpha: In measuring the gross alpha activity in an air sample, the technique employed is essentially that reported by Hallden and Harley ("An Improved Alpha-Counting Technique", Analytical Chemistry 32, 1861 (1960). In this technique, an alpha-sensitive phosphor disc is placed in direct contact with the filter sample disc both of which are held in place on a nylon locking ring. Thus assembled, the sample is placed in a rotating sample holder and rotated into a light tight counting compartment. Within the compartment, the sample is pressed firmly against the face of a spring loaded, low-noise photomultiplier tube and counted with an appropriate scaler system. Air sample loading does not require a correction for absorption. When heavily loaded samples are encountered, a correction will be needed as described below for water samples. If the gross alpha activity in the sample exceeds the 10 CFR 20, Table II, limit for unknown mixtures of alpha emitters, an isotopic analysis for transuranium elements and uranium will be made.

b. Gross Beta: For gross beta activity measurements, the filter disc is mounted on a ringed planchet and counted in a low-background beta counter which is calibrated with a standard thallium-204 source.

Air sample loading does not require a correction for absorption. If heavily loaded samples are encountered they will be corrected as described below for water samples. Because the distribution of energies resulting from beta emission is continuous from the characteristic E_{max} down to zero, the actual disintegration rate is highly dependent on the composition of the sample and the quantity of absorber present. Consequently, absolute beta counting of unknown mixtures is virtually impossible and the results can be interpreted only as being thallium-204 equivalent, and nothing else. The results are not particularly meaningful in themselves. If $Sr^{90}Y^{90}$ betas are present, they will be absorbed less and detected more efficiently than Tl^{204} so that Sr^{90} analyses will be made prior to reaching MPC.

If the gross beta activity in the sample exceeds the 10 CFR 20, Table II, limit for soluble strontium-90 a specific analysis for strontium-90 will be made.

c. Gross Gamma: Gross gamma activity is measured with a calibrated well-type counter. Air samples are counted under the same geometry used to count the calibration standards. A counting efficiency of 33% is used. Results of the gross counting are interpreted as being equivalent to soluble iodine-131. If the gross counting results show a concentration greater than 10 CFR 20, Table II, limit for iodine-131, a gamma spectrum will be run with a multi-channel analyzer to identify specific isotopes in the sample. Appropriate analyses will be made for individual isotopes identified.

d. Transuranium Elements, Strontium and Uranium: The filter is wet-ashed with nitric and perchloric acids and diluted to volume in water. An aliquot is fused with potassium sulfate and sulfuric acid and a determination of transuranium elements is made. The sample is then either dried on a planchet for alpha counting in a scintillation counter or electro-deposited for alpha spectrometry. Radiochemical procedures specific for uranium and strontium are made on other aliquots of the prepared solution.

2. Direct Radiation

a. Locations and Equipment: The licensee's program measures significant gamma radiation in unrestricted areas. For the purposes of this program, measurements will be taken at the following locations:

Location	Identification
1. S. perimeter fence	1
2. N. perimeter fence	1
3. School - South Bay	3
4. Humboldt Hill	4
5. U. S. Coast Guard station	7
6. King Salmon community	2
7. Eureka	8
8. Arcata (background levels)	10

Two types of thermoluminscent materials will be utilized in the measurements program. The first type is the lithium fluoride TLD 700 high sensitivity crystal. The second type of dosimeter

is the calcium fluoride: dysprosium TLD 200 high sensitivity crystal. This dosimeter has a gamma response approximately 30 times that of lithium fluoride. Each type of dosimeter will be placed in the NRTS dosimetry badge. There will be eight groups of five badges each as listed above, which will be exchanged on a monthly basis. The dosimeters will be evaluated in the Health Services Laboratory, Dosimetry Branch TLD Laboratory. A model 2000 Harshaw Chemical Company Thermoluminescence Analyzer will be used to evaluate the dosimeters. The experience and technology developed at the Laboratory in evaluation, annealing and handling will yield high precision. Each of the eight groups of badges will be averaged and the digital value converted to milli-rad based on a radium-226 calibration.

3. Water Monitoring

a. Locations of Drinking Water Sample Stations: Because of the water table gradient system, it is very unlikely that radio-contaminated water from the plant can reach domestic wells. However, two samples will be taken each month. The locations of these samples are as follows:

Location	Identifiation
1. King Salmon community	2
2. As yet unspecified farm well	Not shown

b. Location of Surface Water Sample Stations: The point at which the water effluent from the plant enters the bay will be sampled. For all practical purposes, this point is also where the licensee loses control of the water. One additional

sample station will be located across the bay for purposes of comparison. The sampling locations are as follows:

Location	Identification
1. Power reactor	1
2. U. S. Coast Guard station	7

c. Water Sample Preparation and Counting

Gross Alpha: A 100-ml aliquot of the sample containing 10 ml of HNO_3 is evaporated on a stainless steel planchet, flamed, and counted in a scintillation counter which has been calibrated with a standard polonium-210 sample. The results are corrected for absorption using a pre-determined graph of the percent absorption of Ra^{226} alphas versus sample thickness in mg/cm^2. If the gross alpha concentration thus determined exceeds the 10 CFR 20, Table II, limit for soluble plutonium (5×10^{-6} uc/ml) specific measurements will be made for uranium and transuranium elements.

Gross Beta: A 100-ml aliquot of the sample is dried on a planchet and counted in a low-background beta counter which has been calibrated with a standard thallium-204 source. Self-absorption is corrected from a pre-determined graph showing the percent absorption of Tl^{204} betas versus sample thickness in mg/cm^2. If the activity in the sample exceeds the 10 CFR 20, Table II, limit for strontium-90 a specific analysis for this isotope will be made.

Gross Gamma: A 1-liter aliquot is counted in a sodium iodide well-counter which has been calibrated with an I^{131} standard under the same conditions.

If activity in the sample exceeds the 10 CFR 20, Table II, limit for soluble iodine-131, a gamma spectrum will be run on the sample using a multi-channel analyzer. The activities of specific isotopes identified in the spectrum will be determined.

Transuranium and Uranium: A 100-ml aliquot of the sample is treated with sulphuric, nitric and perchloric acids and evaporated to fumes, then fused in a pyrosulfate flux. Dissolution is made in dilute H_2SO_4 containing peroxide, silica is removed, the oxidation states are adjusted and barium added to precipitate the transuranium elements. The supernate is analyzed for uranium and the precipitate, which contains neptunium, plutonium, americium, curium, and californium, is counted.

Strontium: Based on the beta count, either a 100-ml or a 400-ml sample is taken. Strontium is removed by a calcium phosphate precipitation. The precipitate is dissolved in nitric acid and re-precipitated as strontium nitrate. The sample is then stored for yttrium-90 in-growth followed by counting in a calibrated low-background counter.

Tritium: Tritium content is determined by liquid scintillation counting. In this method, a PPO, POPOP, napthalene, p-dioxane scintillator is used with a Beckman Scintillation System. The sample is first gamma counted to determine whether other radioactivity is present. If activity other than tritium is present, distillation of the sample is necessary. When distillation is not necessary, particulate matter is removed by filtering and color, if any, is removed to prevent quenching.

Five milliliters of aqueous sample are used in 18 ml of scintillator. A blank sample of identical size is used to determine background. A standard tritiated water sample is used to calibrate the counting system.

4. Foodstuffs Monitoring

a. Sampling Locations

Under the Humboldt Bay power reactor Independent Measurements Program, only milk and a few seasonal seafoods will be monitored. All evidence to date indicates that the probability of contaminating foodstuffs through normal operations is minimal. Results from outfall water monitoring or air monitoring may change this point of view in the future, but it is not deemed worthwhile to monitor vegetation, soils, etc., at this time.

Milk sample locations are as follows:

Location	Identification
1. Farm south of Fields Landing (to be selected)	5
2. Elk River Valley (to be selected)	6
3. North Spit farm (to be selected)	9

In addition to milk, seafoods will be selected from time to time as available. These will probably consist of oysters which are cultured for commercial use close to Eureka, and probably perch or jack smelt taken from close to the water effluent outfall from the plant.

Sampling locations and frequencies for these seafoods (and perhaps kelp or other seaweeds) have been intentionally left

open and will be worked out on an ad hoc basis as the program develops.

b. Milk Sample Preparation and Counting

Milk samples are first counted in a scintillation well-counter. If significant gamma activity is present, a gamma spectral analysis is made to identify and quantify the nuclides present. Gross alpha, beta and gamma radioactivity concentrations are determined in a similar manner as those in water samples.

The strontium-90 concentrations are determined by decomposing one liter of milk with nitric acid and removing the strontium by a calcium phosphate precipitation. The strontium is separated from the calcium phosphate by precipitation as strontium nitrate with fuming nitric acid. The sample is then stored for Y-90 ingrowth and counted in a low-background beta counter.

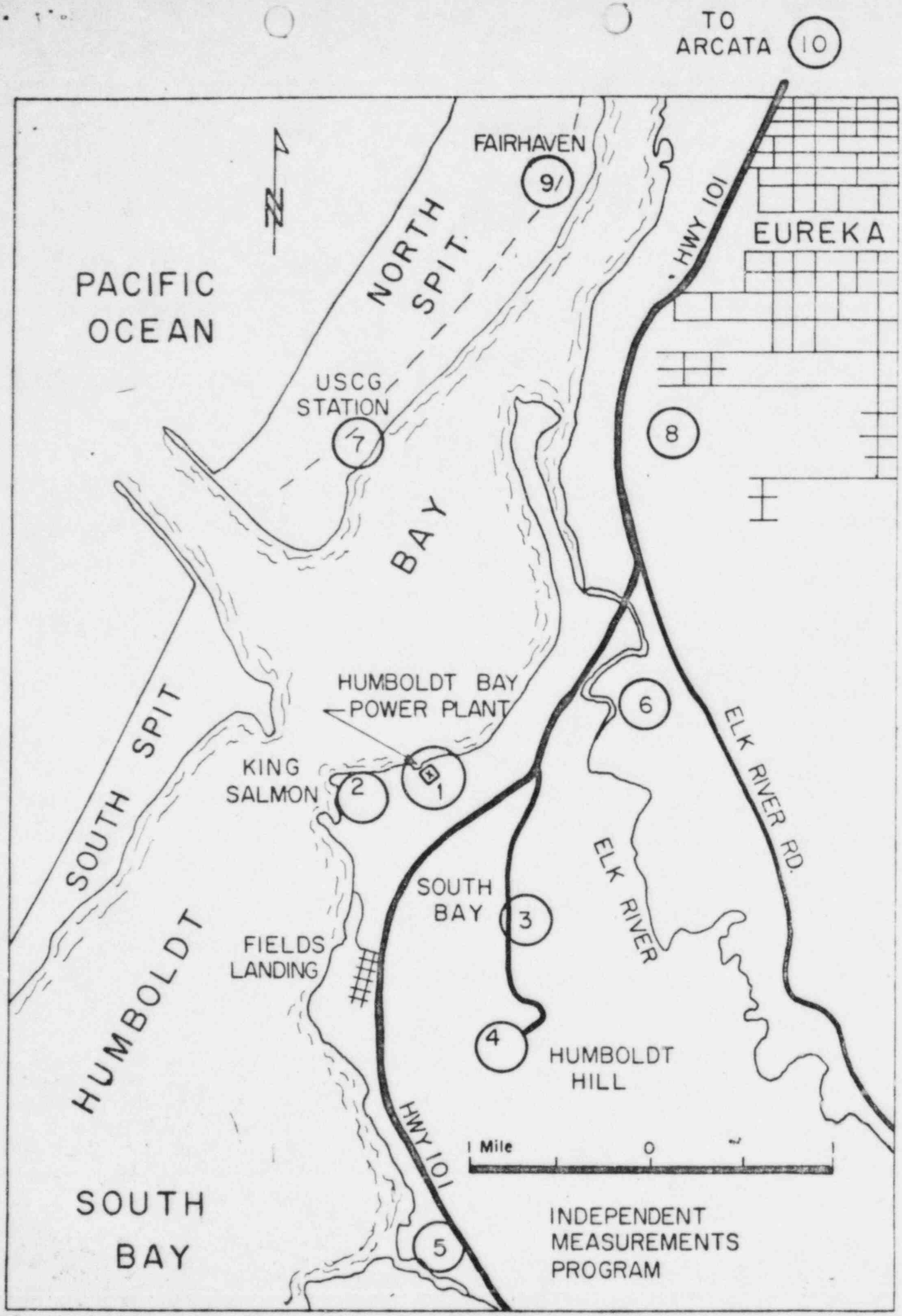
c. Fish and Seafood Sample Preparation and Counting

In preparing a fish sample for counting, the head, tail fins, and entrals are removed, the meat separated from the bones and each portion weighed, a quantitative gamma-ray spectrum analysis is made, the sample is dried under an I-R lamp and muffled at 700°C. The ash is dissolved in 10N HNO_3 and evaporated to dryness. The ash is again dissolved in 10N HNO_3 and the insoluble matter separated. Strontium-90 is then determined by the above procedure. Concentrations of both meat and bones are reported separately as microcuries per gram of original (wet) sample.

Special techniques will be developed for the analysis of molluscs and other types of sea foods.

TABLE I

Type of Sample	Location	Frequency
Continuous Air	South Bay school	Weekly
" "	Humboldt Hill	"
" "	U. S. Coast Guard station	"
" "	King Salmon community	"
" "	Arcata	"
Direct Radiation	S. Perimeter Plant Fence	Monthly
" "	N. Perimeter Plant Fence	"
" "	South Bay school	"
" "	Humboldt Hill	"
" "	U. S. Coast Guard Station	"
" "	King Salmon community	"
" "	Eureka	"
" "	Arcata	"
Drinking Water	King Salmon community	Weekly
" "	Nearby N. E. farm (to be selected)	"
Surface Water	Plant Effluent Outfall	"
" "	Bay near U. S. Coast Guard station	"
Milk	South of Fields Landing	"
"	Elk River Valley	"
"	North Spit farm	"
Sea Foods	Samples to be taken ~~on an ad hoc basis of types and frequencies~~ from selected location in Humboldt Bay	Weekly


TO ARCATA
10
FAIRHAVEN
9
NORTH SPIT
HWY 101
EUREKA
PACIFIC OCEAN
USCG STATION
7
8
BAY
HUMBOLDT BAY POWER PLANT
6
SOUTH SPIT
KING SALMON
2
1
ELK RIVER RD.
ELK RIVER
SOUTH BAY
3
FIELDS LANDING
HUMBOLDT
4
HUMBOLDT HILL
HWY 101
1 Mile
0
SOUTH BAY
5
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