UCID- 79-1

Lawrence Livermore Laboratory

QUARTERLY PROGRESS REPORT: CHEMICAL EFFLUENTS IN SURFACE WATERS FROM NUCLEAR POWER PLANTS

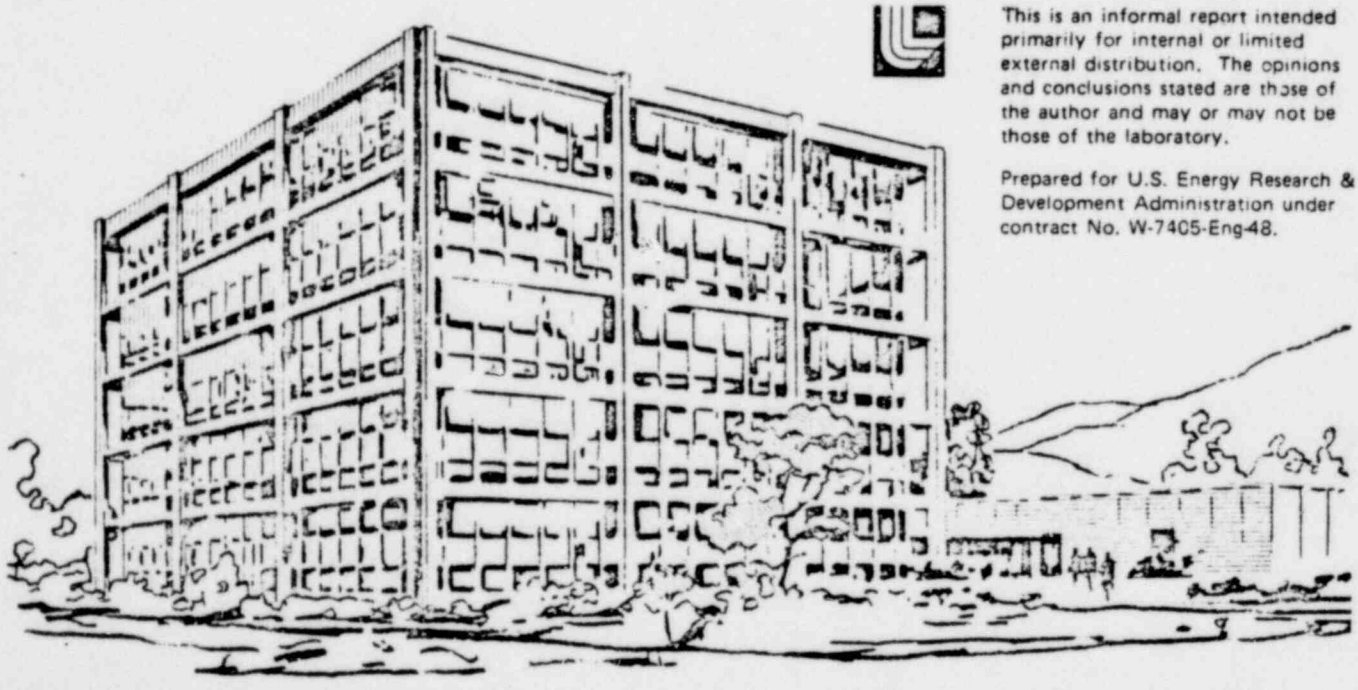
Research Order No. 60-79-022

Florence L. Harrison

January 31, 1979

OCT 1 - DEC 31, 1978

NRC Research and Technical Assistance Report



This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the laboratory.

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48.

POOR ORIGINAL

7906260620

QUARTERLY PROGRESS REPORT:

CHEMICAL EFFLUENTS IN SURFACE WATERS FROM NUCLEAR POWER PLANTS

Research Order No. 60-79-022

Florence L. Harrison, Biologist
Environmental Sciences Division
Lawrence Livermore Laboratory
Livermore, California 94550

January 31, 1978

2133 205

QUARTERLY PROGRESS REPORT:

CHEMICAL EFFLUENTS IN SURFACE WATERS FROM NUCLEAR POWER PLANTS

ABSTRACT

Field collections were initiated in October, 1978, at the Salem and Surry Power Stations. Copper concentrations in soluble and particulate fractions of the water and in bedload sediments were similar to those measured earlier in samples from several power stations at fresh water sites, but higher than those from marine stations. Polarographic analyses of filtered influent and effluent waters indicate that little or no copper was labile. According to ultrafiltration studies, a significant fraction of the copper in water from both sites was complexed to organic matter. Distribution coefficients determined with ^{64}Cu were higher for suspended particles in the water column than for bedload sediments from the intake and discharge areas.

2133 206

CONTENTS

I. Copper Partitioning in Estuarine Ecosystems

A. Water Samples

1. Copper concentrations

2. Copper speciation

3. Ultrafiltration

4. Apparent complexing capacity

B. Suspended Particles

1. Distribution coefficients

2. Copper concentrations

3. Chlorophyll

C. Bedload Sediments

1. Distribution coefficients

2. Copper concentrations

II. Review

III. Publications

PERSONNEL

Florence L. Harrison, Principal Investigator
Dorothy J. Bishop, Chemist
John M. Dawson, Technician
John P. Knezovich, Graduate Student in Biology
David Lester, Graduate Student in Biology
David W. Rice, Jr., Biologist

2133 207

I. Copper Partitioning in Estuarine Ecosystems

Samples from the Salem and Surry Nuclear Power Plants were first collected in mid October. At Surry samples were collected at different sites on station property; at Salem they were made from a boat because access to the Salem station was not granted in time for the fall collection.

A. Water Samples

The temperature of the influent water, t both Salem and Surry was 17°C, that of effluent waters at Salem was 17 a.d at Surry 26.5°C. The temperature of the discharge water at the Salem station indicated that power was not being generated during the sampling period. The salinity of the water at both stations was 10.8°/$_{oo}$.

Copper Concentration. The total concentration of copper was lower in samples of intake water than in those of discharge water at Surry (Table 1). The percentage of copper in the soluble fraction was low in both the intake and discharge waters. At Salem, the copper concentrations were similar in all fractions of both intake and discharge waters because water was not circulated through the condensers. Copper concentrations in soluble and particulate fractions were similar to those measured in samples from several power stations at fresh water sites (Harrison, UCID-17744-78-4), but higher than those from marine stations (Harrison, UCID-17744-78-1).

Copper Speciation. The concentration of labile copper in water samples was measured by an ion exchange (Chelex-100 resin) and an electrochemical method (anodic stripping Voltammetry--ASV). Labile species include ions,

ion pairs, readily dissociable (labile) inorganic and organic complexes, and easily exchangeable copper absorbed on either colloidal inorganic or organic matter; bound species include stable copper-organic complexes, copper bound to high molecular weight organic material, some inorganic complexes, and copper occluded in, or sorbed tightly on, highly dispersed colloids.

The concentrations of labile copper determined by ion exchange were much greater than those by ASV; in fact, no labile copper was detected by ASV (Table 2).

Ultrafiltration. Samples of discharge water from both power stations were subjected to ultrafiltration before and after photooxidation with UV light to destroy organic matter (Table 3). As in our seawater and fresh water samples collected previously, destruction of organic matter increases the copper associated with lowest and highest molecular weight fractions. In the discharge water collected at the Salem station, approximately 50% of the copper was associated with the >10,000 <100,000 molecular weight fraction.

Dissolved organic carbon (DOC) was analyzed in filtrates and retentates from ultrafiltration of discharge water. From these analyses the percentages of the DOC in the different molecular weight fractions were calculated. Only a small percentage of the DOC was found in the molecular weight fractions that bound ^{64}Cu (Table 3).

Apparent Complexing Capacity. The apparent complexing capacity of the intake and discharge waters from both power stations was measured by quantifying the ASV-labile copper after copper additions. The apparent complexing capacities of both intake and discharge waters from each site

were similar (Table 4). Concentrations of DOC were also measured in water samples. Little difference were found between DOC concentrations in intake and discharge waters, but DOC concentrations were higher in water collected at Salem than that at the Surry power station.

B. Suspended Particles

Distribution coefficients. The ^{64}Cu distribution coefficients of particles suspended in the water were similar to those previously determined in water collected at fresh water power-plant sites (Table 5). At this time we do not know why the value for the intake waters at Salem was higher than that for the discharge waters.

Copper Concentrations. Concentrations of copper in µg/g dry weight were higher in particles suspended in the water column at Surry than at Salem power station. Variation among the samples collected at each power station was large and may have resulted from changes in the composition of the water during the collection period. Each sample required about 15 to 20 minutes to filter.

Chlorophyll. The quantity of chlorophyll and particulate organic carbon in the suspended particles was determined. Samples did not differ significantly in either parameter.

C. Bedload Sediments

Distribution Coefficients. The ^{64}Cu distribution coefficients (K_d) of intact bedload sediments collected at the three collection sites at the Surry intake area differed markedly (Table 6). The heterogeneity among samples from Salem was less. At all collection sites, K_ds of the <62µ

fraction were greater than that of the intact fraction.

Copper Concentrations. Concentrations of copper in the bedload sediments were higher at Salem than at Surry power stations (Table 7). However, the concentrations of copper in the sediment collected from the three collection sites at Salem varied less than those from Surry. At both sites copper concentrations in sediments from the discharge area were higher than those from the intake area.

II. Review on Copper

Data compilation for the review on copper is progressing satisfactorily. Information on toxic responses in mussels, oysters, and fishes has been reviewed; review of data on other aquatic organisms is underway. Copper concentrations in seawater from coastal and open ocean sites have also been compiled.

III. Publications

F.L. Harrison, D.J. Bishop, R.R. Emerson, and D.W. Rice, Jr. "Concentration and Speciation of Copper in the Receiving Waters of the San Onofre and Diablo Canyon Nuclear Power Stations." NUREG_____(in press).

Table 1.
Copper Concentrations (µg/liter) in Water Samples
Collected at Nuclear Power Stations Located on Estuaries

Power Station	Date (1978)	Collection Site	Soluble Fraction	Particulate Fraction	Total	Percent Soluble
Surry	10/26	Intake	1.72 ± 0.06	4.78 ± 3.36	6.5	26
		Discharge	3.10 ± 0.70	7.61 ± 5.03	10.7	29
Salem	10/28	Intake	2.33 ± 0.42	5.18 ± 1.1	7.5	31
		Discharge	2.47 ± 0.56	5.40 ± 1.8	7.9	31

Table 2.
Concentrations of Soluble Copper Species in Water
Collected at Nuclear Power Stations Located on Estuaries

Power Station	Date (1978)	Collection Site	Total Soluble	Chelex-100 Labile	Chelex-100 Bound	ASV[a] Labile	ASV[a] Bound
Surry	10/26	Intake	1.72 ± .06	1.37 ± .15	0.4	0	1.7
		Discharge	3.10 ± .70	2.94 ± .41	0.2	0	3.1
Salem	10/28	Intake	2.33 ± .42	2.41	0	0	2.3
		Discharge	2.47 ± .56	2.33	0	0	2.5

[a] ASV, differential pulse anodic stripping voltammetry

2133 213

Table 3.
Percent of ^{64}Cu Spike and Dissolved Organic Carbon in Molecular-Size Fractions in Water Collected at Power Plants Located on Estuaries

Power Station	Date (1978)	UV Treatment h	Molecular-size Fraction <1,000	>1,000 <10,000	>10,000 <100,000	>100,000
		A. ^{64}Cu				
Surry	10/26	0	13	19	52	16
		6	29	0	16	55
Salem	10/28	0	11	51	28	10
		6	47	0	0	53
		B. Dissolved Organic Carbon				
Surry	10/26	0	88	4	8	0
Salem	10/28	0	88	6	6	0

2133 214

Table 4.
Apparent Complexing Capacity and Dissolved Organic Carbon
in Soluble Fraction of Water Collected at Nuclear Power Stations
Located on Estuaries

Power Station	Date (1978)	Collection Site	Complexing Capacity µg Cu/liter	Dissolved Organic Carbon mg/liter
Surry	10/26	Intake	7	3.2
		Discharge	5	3.3
Salem	10/28	Intake	6	2.4
		Discharge	8	2.8

2133 215

Table 5.
Characteristics of Suspended Particles in Water
Collected at Nuclear Power Stations
Located on Estuaries

Power Stations	Date (1978)	Collection Site	K_d	Cu mg/g dry	Particle Load mg/liter	Particulate Organic Carbon mg/liter	Chlorophyl Peak ht/liter
Surry	10/26	Intake	-	320 ± 220	14.6 ± 1	0.22	0.25
		Discharge	15,800	470 ± 290	15.6 ± 2	0.25	0.21
Salem	10/28	Intake	31,500	204 ± 52	26.1 ± 2	0.31	0 29
		Discharge	16,900	158 ± 45	33.5 ± 1.4	0.31	0.26

Table 6.
Distribution Coefficients for Bedload Sediments
Collected at Nuclear Power Stations
Located on Estuaries

Power Station	Date (1978)	Collection Site	Intake		Discharge	
			Intact	<62μ	Intact	<62μ
Surry	10/26	1	1,200	4,800	-[a]	36,000
			1,400	5,200	-	20,000
		2	2,800	4,300	4,700	12,000
			3,900	4,700	6,000	-
		3	400	8,700	5,300	21,000
			600	9,700	9,000	19,000
Salem	10/28	1	2,900	4,800	1,400	8,500
			3,100	5,800	900	8,400
		2	2,100	7,300	2,400	11,000
			4,900	6,600	5,400	9,000
		3	2,100	7,400	2,600	11,000
			3,500	6,400	1,800	15,000

[a] Sample Lost

Table 7.
Copper Concentrations in Bottom Sediments (µg/g Dry Weight)
Collected at Nuclear Power Stations
Located on Estuaries

Power Station	Date (1978)	Collection Site	Intake		Discharge	
			Intact	<62µ	Intact	<62µ
Surry		1	8.93 ±0.26	33.31 ±4.64	-[a]	62.85 ±2.72
		2	16.08 ±0.17	53.41 ±6.24	23.15 ±3.04	55.79 ±2.20
		3	5.35 ±0.44	46.74 ±8.41	29.80 ±0.52	67.58 ±3.94
		$\bar{x}$	10.12 ±5.46	44.49 ±10.24	26.48 ±4.70	62.07 ±5.93
Salem		1	35.54 ±0.65	56.25 ±1.21	56.84 ±1.09	77.37 ±1.42
		2	50.01 ±2.46	59.23 ±0.23	67.31 2.84	92.03 ±1.31
		3	49.48 ±2.52	58.93 ±0.12	-	65.52 ±2.22
		$\bar{x}$	45.01 ±8.21	58.14 ±1.64	62.08 ±	78.31 ±13.28

[a]Sample lost