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SUBJECT: APPLIED HEALTH PHYSICS QUARTERLY REPORT - OCTOBER, NOVEMBER, AND DECEMBER OF 1962

TO: K. Z. Morgan - W. S. Snyder

FROM: D. M. Davis

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HEALTH PHYSICS DIVISION

APPLIED HEALTH PHYSICS QUARTERY REPORT - OCTOBER, NOVEMBER, and DECEMBER OF 1962

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1.0 MONITORING SUMMARY

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Nine unusual occurrences were recorded during the fourth quarter. (The number for the first, second, and third quarters of 1962 was 20, 14, and 16 respectively; the quarterly average for 1961 was 19.)

1.2 Personnel Exposures

Six exposures which equalled or exceeded 1/3 of a maximum permissible quarterly dose occurred during the fourth quarter. In all cases the whole body dose was involved. In no case did an exposure exceed 50 per cent of a maximum permissible quarterly dose.

1.3 Atmospheric Monitoring

Air-borne radioparticulate matter collected by the LAM network (Laboratory area) averaged 3.8×10^{-12} µc/cc during the quarter; the average value determined from the data generated by the PAM network (Oak Ridge controlled area) was 3.6×10^{-12} µc/cc; the value for the RAM network (remote stations) was 4.4×10^{-12} µc/cc. The above values (together with other data shown in this report) indicate that Laboratory operations did not contribute significantly to air contamination levels recorded in the East Tennessee area during the fourth quarter of 1962.

1.4 Water Monitoring

Clinch River water taken from the ORGDP water intake (CRM 14.5) during the quarter averaged 15.0% of the $(MPC)_w$ considered permissible for the neighborhood of an atomic energy installation. The average recorded during the four quarters of 1962 was 11.2 per cent of the $(MPC)_w$.

1.5 Background Measurements of Ionizing Radiation

The background radiation at ORNL averaged 0.12 mr/hr during the fourth quarter. The background level measured at individual stations ranged from a minimum of 0.03 mr/hr to a maximum of 2.2 mr/hr. The off-site fourth quarter average was 0.03 mr/hr. The quarterly average recorded during 1962 at ORNL was 0.11 mr/hr; the off-site average for the year was 0.02 mr/hr.

2.0 UNUSUAL OCCURRENCES

Nine unusual occurrences were recorded[1] during the last quarter of 1962. The total for the year was 59 with 20 events occurring during the first quarter, 14 events occurring during the second quarter, and 16 events occurring during the third quarter.

Five of the nine events (2.1, 2.2, 2.3, 2.4, and 2.6) involved the contamination of operating facilities and in three of these instances (2.1, 2.4, and 2.6) some contamination of personnel occurred. There

[1] The method for classifying unusual occurrences is described in ORNL-3073, pp. 4-5.

were two instances (2.7 and 2.9) involving cuts or abrasions where significant contamination of the wound did not materialize although the potential for contamination was present. Two events (2.5 and 2.8) presented a high external exposure potential to portions of the body when (a) an employee, in violation of departmental procedures, performed work over an open port associated with a hot cell operation, and (b) an employee received a neutron exposure to his left hand while performing an experiment in a Cockcroft-Walton accelerator facility.

The proximate cause of three events (2.1, 2.3, and 2.4) was due in the main to faulty or inadequate equipment. The remaining six events (2.2, 2.5, 2.6, 2.7, 2.8, and 2.9) may be attributed to failure to observe departmental procedures and/or failure by an operator to use adequate care in some part of the performance of the operation which led to the incident.

2.1 Extensive tritium contamination, thought to have originated from operations being conducted in a plastic hood in Bldg. 3033, necessitated clean-up measures which extended over a wide area including a section of street in Isotope Circle and several nearby buildings. Personnel contamination was limited to the shoes and no significant internal exposure was indicated as determined by bio-assay techniques.

Plans are underway to house all tritium facilities used in this area in a special facility located in Bldg. 3033 and to perform all future work involving tritiated compounds in glove boxes. In addition, it has been recommended that operations of this type be monitored routinely as the work progresses and at the conclusion of each operation.

2.2 Wall surfaces and laboratory equipment were contaminated in Bldg. 5500 following a release of tritium from the 5 Mev Van de Graaff accelerator vacuum system. The decontamination of the area was effected without difficulty and no significant internal exposure resulted as determined by bio-assay techniques.

The tritium release occurred during a routine leak test operation which was being performed for the purpose of determining the tightness of the vacuum system. This particular leak test method utilizes a helium detection unit placed in the exhaust stream which flows from the vacuum lines; then, with the vacuum pumps operating, helium gas is introduced at points along the vacuum line where a break is suspected. Ordinarily, the exhaust from the vacuum line leads to the outside of the building with the result that residual contamination which might be released from the system is controlled. However, on this particular occasion, the exhaust from the system was allowed to pass directly into the room atmosphere. Unfortunately, just prior to this leak testing operation, an experiment had been conducted which was of a nature that the vacuum system became contaminated with tritium gas. The operators who were performing the leak test were unaware that residual contamination remained and connections were not made with the outside vent when the helium detectors were placed in the vacuum exhaust. Fortunately, the operation had proceeded just a few minutes when a tritium monitor located in the immediate area sounded an alarm. This led to a halt in operations and a personnel evacuation of the area.

It has been recommended that the exhaust system be vented to the outside of the building in all cases where potential contamination may exist inside the system.

2.3 MSR fuel specimens were being removed from an experiment in the ORR reactor core when escaping fission product gases actuated alarms that prompted evacuation of personnel from the building which houses the reactor. The principal contaminant was determined to be Rb-88 with a half-life of approximately 18 minutes. Accordingly, residual contamination was of short term duration and no significant internal dose occurred.

The Operations Division has taken steps to provide secondary containment for future operations of the above type.

2.4 An operator in the isotope shipping area became generally contaminated while removing the lid from a shipping container which had contained compounds of Sr-90. Although the operator became highly contaminated and nasal smears gave positive results, no significant internal exposure occurred as determined by bio-assay techniques.

The cause of the release was attributed to a build-up in pressure within the shipping container following its storage in a relatively high temperature zone. Steps have been taken to install a hood in the area where containers of this type will be opened in the future.

2.5 An operator received a radiation dose of approximately 5 rem to his left hand and a dose of approximately 400 mrem to the upper portion of his body while working over an open port in the top of the south hot cell at Bldg. 3042.

The operation required the removal of a six-inch diameter plug from the top of the cell. When the plug was removed, the operator observed two fuel specimens located directly below the open port and asked a fellow employee to move the specimens to one side of the cell on the assumption that this would reduce significantly the radiation intensity above the open port. He then proceeded with the assignment which required his left hand to remain in position over the open hole for a short time. Although manipulator equipment was available inside the cell, it was not used during this particular operation as it was not adaptable to this particular job. A radiation survey was not performed prior to the operation, and the operator did not take radiation measurements on his own. However, measurements made following the incident indicated that the radiation intensity at the port hole was between 200 and 270 R/hr.

The above exposure resulted from failure to observe operating procedures. A departmental regulation prohibits the removal of shielding plugs from hot cells, carriers, etc., without benefit of simultaneous radiation monitoring during removal. In addition, the Health Physics Manual requires that a radiation work permit be obtained in advance of work involving the exposure of an individual to a dose rate in excess of 5 rem/hr. Neither the departmental regulation nor the requirements set forth in the Health Physics Manual were followed in the above operation.

2.6 The removal of several sealed buckets containing fission product waste material from Cell 19 in Bldg. 3517 resulted in the general contamination of the make-up room and surrounding area when insufficient care was exercised by operators who were performing the work on an off-shift. Although the contamination of the area was relatively extensive and some contamination of personnel resulted, personnel exposures were kept well below the maximum permissible levels and no significant internal dose was recorded.

It is customary in this area, when fission product waste material is generated in the cell operation, to deposit the waste material in one-gallon buckets which are fitted subsequently with a tight-sealing lid. When a sufficient number of buckets have been filled, they are removed from the cell, placed in plastic bags, and transferred in a shielded carrier to the disposal area. The placement of the bucket within the plastic bag is an operation that is performed outside the cell; thus, it is important that extreme care be used in order that loose contamination does not become dispersed. Experience has shown that best results are obtained when the loading of the plastic bag is performed in a secondary enclosure apart from the cell itself but immediately adjacent thereto. The operation noted above which led to the contamination of the facility was performed without the use of a secondary enclosure on the theory that since operations in the building during the off-shifts were minimal there would be little chance of contamination moving from the immediate cell area. This reasoning proved to be wrong; strong air currents were being generated by building ventilation fans and this was sufficient to carry contamination from the immediate working area to other parts of the building.

It has been recommended that when contaminated equipment is removed from the cell areas that the packaging of such equipment be done in a secondary enclosure. Plastic sheeting has been used successfully in the past. If the use of a secondary enclosure is not practical, then extreme care should be used during the packaging process.

2.7 An employee was performing routine repairs on a manipulator in Bldg. 3517 when his hand slipped from a tape clamp striking one of the counterweight steel tapes. The steel tape cut through two pairs of rubber gloves and caused a laceration on the employee's left thumb. The wound was allowed to bleed freely and a blood smear test indicated the presence of a small amount of $Sr\text{-}Y^{90}$ at the site of the wound. Bio-assay techniques indicated that no significant internal exposure resulted from the incident.

The recommendation was made that in future work of this nature the steel tape be held with vise-grip pliers.

2.8 An employee received a neutron exposure of approximately 3 rem to the left hand while working in Bldg. 5500.

The operation which resulted in the exposure involved the positioning of some items of equipment used in connection with a neutron beam generated by a Cockcroft-Walton accelerator. The employee inadvertently by-passed a step in the operating procedure and failed to position a crystal shutter provided in the system for the purpose of blocking out the radiation beam. At the time that the adjustments were being made, the target was emitting 14 Mev neutrons at a rate of approximately 4×10^8 n/sec.

The best procedure for preventing exposures of the above type would require that the accelerator be turned off when personnel are performing work in the target area. Where experimenters reject this approach as impractical, operating procedures should be formulated in such a manner as to guarantee that there can be no personnel access to the direct beam of radiation.

2.9 While changing a swage lock fitting on a line in the N9 cubicle located in the west penthouse of Bldg. 3019, an employee suffered a slight abrasion on his forehead. Although traces of contamination were found near the wound, techniques employed at the dispensary indicated that the wound itself was free of contamination.

3.0 PERSONNEL MONITORING

3.1 External Dose Measurements

The highest total body exposure recorded during the fourth quarter (see Table 5.1) was 1.3 rem and the second highest exposure was 1.1 rem. The Laboratory operating limit is 3 rem to the total body during a calendar quarter. The highest total body skin dose recorded during the quarter was 2.0 rem and the second highest was 1.8 rem. The Laboratory operating limit is 10 rem to the skin of the total body during a calendar quarter. The highest cumulative total body exposure recorded during 1962 was 4.6 rem. The maximum permissible total body exposure should not exceed 5 rem per year when averaged over a lifetime.

3.2 Internal Dose Measurements

Bio-Assays - Three employees continued to have an estimated bone burden of Pu-239 which approximates 1/3 of the maximum permissible body burden.[2] During the third quarter one employee submitted several urine specimens which indicated that a significant fraction of a permissible body burden involving transuranic alpha emitters had been sustained. Continued surveillance during the fourth quarter led to an assessment of the magnitude of the exposure as being less than 50% of the maximum permissible body burden.

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[2]Action is taken to curtail an employee's exposure to internal emitters when measurements approach 30% of a body burden.

Whole Body Counter (data supplied by Health Physics Technology Section) - Measurable activity, above normal background, found in 18 exposure subjects for the fourth quarter was as follows:

Isotope	No. Persons	Highest Quantity Measured (μc)	Maximum Permissible Body Burden (μc)
I^{131}	5	2.0 (whole body)	50
Cs^{137}	10	0.27	30
Sb^{125}	1	0.14	60
Co^{60}	2	0.0016	10
Zr^{95}-Nb^{95}	2	0.005	20
Zn^{65}	1	0.003	60

4.0 ENVIRONMENTAL MONITORING

4.1 Atmospheric Monitoring

The average weekly concentration of radioactive materials in air sampled by the three ORNL air monitoring networks[3] is shown in Table 5.2. The quarterly average for the LAM network was 3.8×10^{-12} μc/cc; averages for the PAM and RAM networks were 3.6×10^{-12} μc/cc and 4.4×10^{-12} μc/cc respectively. Concentrations recorded during the month of November (Fig. 6.1) were about as high as the levels recorded during the second quarter, but a downward trend was evident during the month of December when the December average fell to about one-half of the November level. The fourth quarter average exceeded the third quarter average by a factor of 1.4.

4.2 Fall-Out Measurements

Fall-out measurements by the gummed paper technique[4] indicated that radioparticulate fall-out during the fourth quarter months of November and December was greater than at any other time during the year (1962). In fact, the level reached during November was about four times the average recorded for the year. However, the levels began to drop during December (Fig. 6.2), and the fourth quarter average was only about twice the yearly average. Fall-out is known to be highly influenced by meteorological conditions and there will be noticeable variations from week to week. Such variations are demonstrated typically in Table 5.3 where

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[3] LAM - Local Air Monitor (located at or near the ORNL site); PAM - Perimeter Air Monitor (located on the outer boundary of the AEC controlled area); RAM - Remote Air Monitor (located from 12 to 75 miles from ORNL).

[4] The gummed paper collector presents a collection surface of 1 square foot. Radioparticulates per square foot are determined by autoradiography.

fall-out activity is shown to be highly accelerated during certain times (note weeks 45, 46, 49, and 51). The consistency between network averages shown in Table 5.3 tends to support the contention that fall-out in the East Tennessee area is largely not of local origin.

4.3 Water Analysis

Rain Water - The quarterly average concentration of radioactive material deposited in rain water collected over the LAM, PAM, and RAM network system was 0.7×10^{-6} μc/ml, 0.8×10^{-6} μc/ml, and 1.2×10^{-6} μc/ml respectively. The above LAM and PAM values are approximately the same as those recorded during the third quarter of 1962; however, the fourth quarter RAM value was about twice the third quarter value. (The average concentration recorded at each collection station is given in Table 5.4.) The concentration of radioactive materials in rain water remained at fairly consistent levels during the whole of 1962 (Fig. 6.3) and averaged about four times the level measured during 1961; the 1961 average was about five times the 1960 average. The data shown in Fig. 6.3 graphically illustrate the dramatic rise in the radioactive content of rain water following the resumption of world-wide weapons testing late in 1961. The effect of the weapons testing moratorium which began late in 1958 is illustrated by the low levels recorded during 1960.

Clinch River Water - Approximately 248 beta curies of various isotopic mixtures were discharged via White Oak Lake effluent into the Clinch River during the fourth quarter of 1962. (The isotopic distribution of radionuclides in the White Oak Lake effluent is given for the months of October, November, and December in Table 5.5.) About 95 per cent of the curie content of the White Oak Lake effluent was due to Ru^{106} and this isotope represented about 46 per cent of the calculated maximum permissible concentration, $(MPC)_w$, at the juncture (CRM 20.8) of the two streams. Assuming a uniform mixing of White Oak Lake effluent with Clinch River waters at CRM 20.8, the calculated monthly average gross beta concentration in the Clinch River resulting from ORNL liquid waste discharges was as follows:

Month	Concentration[5]	% $(MPC)_w$[6]
October	0.19×10^{-6} μc/ml	4
November	0.58×10^{-6} μc/ml	11
December	0.37×10^{-6} μc/ml	6

The above values (taken from Table 5.6) represent about 7 per cent of the $(MPC)_w$. The third quarter average was 4.5 per cent of the $(MPC)_w$.

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[5] Calculated values based upon the dilution afforded by the river; these values do not include radioactive materials (e.g., fall-out) that enter the river upstream from CRM 20.8.

[6] Weighted average $(MPC)_w$ for populations residing in the neighborhood of a controlled area calculated for the isotopic mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

The measured average concentration of radioactive materials in Clinch River water sampled at the ORGDP water filtration plant intake (CRM 14.5) was as follows:

Month	Concentration	% $(MPC)_w$
October	0.14×10^{-6} μc/ml	8
November	0.53×10^{-6} μc/ml	23
December	0.33×10^{-6} μc/ml	14

The above values (taken from Table 5.7) represent about 15 per cent of the quarterly $(MPC)_w$ for the specific mixture of radionuclides present. The average for the third quarter was 5.7 per cent of the $(MPC)_w$. The difference between the per cent $(MPC)_w$ from the calculated concentrations at CRM 20.8 and measured concentrations at CRM 14.5 (Fig. 6.4) may be attributed in part to the presence of strontium in Clinch River water before it reached CRM 20.8. The average Sr-90 concentration in the Clinch River upstream (CRM 41.5) from the outfall of White Oak Creek for the fourth quarter 1962 was 0.14×10^{-8} μc/ml which is approximately equal to the average concentration resulting from releases by the Laboratory, Table 5.6. Radioactivity found to be present in Clinch River water upstream from the entry of White Oak Creek is presumed to be due to natural radioactivity and/or fall-out resulting from world-wide weapons testing.

4.4 Background Measurements of Ionizing Radiation

The average background level determined from 53 stations located on the Laboratory site was 0.12 mr/hr. The background level measured at individual stations ranged from a minimum of 0.03 mr/hr to a maximum of 2.2 mr/hr. The average level recorded at five stations located off-site around the perimeter of the controlled area was 0.03 mr/hr. Tower Shielding Facility (TSF) operations during the fourth quarter resulted in a measured average dose rate of 0.048 mr/hr at the point nearest the TSF (Melton Hill Dam site) where the general public may have unrestricted access.[7] The above value (0.048 mr/hr) is well below the maximum permissible non-occupational exposure permitted in the neighborhood of an atomic energy installation.[8] From Table 5.8 it is observed that background levels at ORNL were about ten times those recorded in 1943 prior to the startup of the graphite reactor; the fourth quarter background in the Oak Ridge controlled area off-site was about 2.5 times the 1943 value; the average background level during 1962 differed only slightly from averages recorded during 1959, 1960, and 1961 (see Fig. 6.5).

4.5 Milk, Grass, and Tap Water Samples

During 1962, raw milk, pasture grass, and tap water were sampled routinely every six weeks from six stations located in the East Tennessee

[7] The accumulated total radiation dose at 3400 feet from the TSR-II as calculated from monitor data is 107 mrem. Calculations of dose from kw-hrs (generated) gave 157 mrem. (Data taken from TSF operating reports—L. B. Holland to file.)

[8] Federal Radiation Council, Staff Report No. 1, "Background Material for the Development of Radiation Protection Standards", May 13, 1960, p. 38.

area. Milk samples were analyzed for I-131 and Sr-90 content; grass samples were analyzed for I-131, radio-strontium, and other fission product material detectable by gamma spectrometry; tap water samples were analyzed for Sr-90 content. Levels that were higher than the FRC Range II values were noted on several occasions during the later part of 1962. This was particularly true in the case of I-131 found in raw milk where the concentration ranged from the lower limit of detection (10 μμc/l) to a maximum of 668 μμc/l. Although it is probable that some of the I-131 found in milk can be traced to local operations, the bulk of the I-131 concentration continues to result from world-wide weapons testing.

5.0 TABLES

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Table 5.1 Personnel Meters Exposure Resume—4th Quarter, 1962

Employee	Laboratory Division	Fourth Quarter Dose: Skin of Total Body (rem)	Fourth Quarter Dose: Total Body (rem)	Cumulative Dose for 1962: Skin of Total Body (rem)	Cumulative Dose for 1962: Total Body (rem)
A	Chem. Tech.	2.0	1.3	8.5	4.1
B	Chem. Tech.	1.6	1.1	2.6	1.7
C	Isotopes	1.8	1.1	5.6	3.8
D	Health Physics	1.4	1.1	2.9	1.9
E	E and M	1.5	1.1	2.1	1.5
F	Health Physics	1.8	1.0	9.2	4.1
G	Chem. Tech.	1.2	0.8	8.5	4.3
H	Isotopes	1.0	0.7	5.5	4.4
I	Isotopes	1.0	0.7	6.0	4.4
J	Isotopes	1.0	0.7	5.9	4.4
K	Isotopes	0.7	0.5	5.9	4.6

Note: Table 5.1 includes a breakdown of exposures for employees whose recorded dose equals or exceeds approximately 1/3 of the Laboratory operating limits.

Table 5.2 Concentration of Radioactive Materials in Air Averaged Weekly from Filter Paper Data—4th Quarter, 1962

Week No.	LAM Network[a]	PAM Network[b]	RAM Network[c]
40	2.0×10^{-12} μc/cc	1.7×10^{-12} μc/cc	2.3×10^{-12} μc/cc
41	2.9	2.7	3.0
42	3.8	3.7	4.4
43	5.7	4.4	7.4
44	2.8	2.6	3.6
45	4.1	4.0	4.9
46	6.7	5.9	6.6
47	3.8	3.9	5.1
48	7.0	6.8	8.0
49	3.3	3.5	3.8
50	3.3	2.9	3.5
51	1.8	2.1	2.4
52	2.7	2.7	2.3
Average for Quarter	3.8×10^{-12} μc/cc	3.6×10^{-12} μc/cc	4.4×10^{-12} μc/cc
Average for Year (1962)	3.7×10^{-12} μc/cc	3.6×10^{-12} μc/cc	4.3×10^{-12} μc/cc
Average Last Year (1961)	1.6×10^{-12} μc/cc	1.4×10^{-12} μc/cc	1.7×10^{-12} μc/cc

[a]LAM - Local Air Monitor located at or near the ORNL site.

[b]PAM - Perimeter Air Monitor located on the outer boundary of the AEC-controlled area.

[c]RAM - Remote Air Monitor located from 12 to 75 miles from ORNL.

Table 5.3 Radioparticulate Fall-Out Measurements Averaged Weekly From Gummed Paper Data—4th Quarter, 1962

Week No.	LAM Network	PAM Network	RAM Network
40	35 particles/ft^2	36 particles/ft^2	30 particles/ft^2
41	11	8	12
42	18	15	14
43	20	17	18
44	76	68	54
45	614	700	369
46	67	75	44
47	186	190	125
48	10	8	9
49	184	155	138
50	23	23	20
51	110	122	26
52	48	46	92
Average for Quarter	108 particles/ft^2/wk	113 particles/ft^2/wk	73 particles/ft^2/wk
Average for Year (1962)	48 particles/ft^2/wk	48 particles/ft^2/wk	35 particles/ft^2/wk
Average Last Year (1961)	29 particles/ft^2/wk	22 particles/ft^2/wk	13 particles/ft^2/wk

Table 5.4 Concentration of Radioactive Materials in Rain Water Averaged for the Quarter by Stations—4th Quarter, 1962

Station Number	Location	Concentration
	LAM Network	
HP-7	West of 7001	0.7×10^{-6} μc/ml
	PAM Network	
HP-31	Kerr Hollow Gate	1.0×10^{-6} μc/ml
HP-32	Midway Gate	1.0
HP-33	Gallaher Gate	0.7
HP-34	White Oak Dam	0.7
HP-35	Blair Gate	0.8
HP-36	Turnpike Gate	0.7
HP-37	Hickory Creek Bend	0.8
Network Average		0.8×10^{-6} μc/ml
	RAM Network	
HP-51	Norris Dam	1.1×10^{-6} μc/ml
HP-52	Loudoun Dam	0.8
HP-53	Douglas Dam	1.5
HP-54	Cherokee Dam	1.1
HP-55	Watts Bar Dam	1.3
HP-56	Great Falls Dam	1.4
HP-57	Dale Hollow Dam	1.3
Network Average		1.2×10^{-6} μc/ml

Table 5.5 Radioisotopic Distribution in White Oak Lake Effluent—4th Quarter, 1962

Isotope	% of Total Beta Radioactivity		
	October	November	December
Ru^{106}	93.87	94.27	96.75
Zr^{95}	0.02	0.04	0.03
Nb^{95}	0.0	0.0	0.05
TRE (less Ce^{144})*	1.27	1.86	0.43
Cs^{137}	0.78	0.34	0.30
I^{131}	0.04	0.04	0.08
Ce^{144}	0.12	0.04	0.12
Ba^{140}	0.26	0.04	0.02
Co^{60}	2.09	1.92	1.37
Sr^{89}	0.16	0.15	0.08
Sr^{90}	1.39	1.26	0.78
Total Ci			= 248

* TRE-Total rare earths

Table 5.6 Average Concentration of Major Radioactive Constituents in the Clinch River at Mile 20.8 Resulting from ORNL Waste Releases via White Oak Lake[a]—4th Quarter, 1962

Month	Radionuclides of Primary Concern (10^{-8} μc/ml)					Gross Beta	$(MPC)_w$ [b]	%
	Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	(10^{-6} μc/ml)	(10^{-6} μc/ml)	$(MPC)_w$ [b]
October	0.15	0.01	0.09	11	0.23	0.19	4.7	4.0
November	0.25	0.02	0.07	19	0.38	0.58	5.1	11
December	0.08	0.01	0.03	11	0.15	0.37	5.9	6.3

[a]Calculated values based upon the dilution afforded by the river; these values do not include radioactive materials (e.g., fall-out) that enter the river upstream from CRM 20.8.

[b]Weighted average $(MPC)_w$ for populations residing in the neighborhood of a controlled area calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

Table 5.7 Average Concentration[a] of Radioactive Materials in Clinch River Water at ORGDP Filtration Plant Intake—4th Quarter, 1962

Month	Radionuclides of Primary Concern (10^{-8} μc/ml)		Gross Beta	$(MPC)_w$[b]	%
	Sr^{89-90}	$Ru^{103-106}$	(10^{-6} μc/ml)	(10^{-6} μc/ml)	$(MPC)_w$[b]
October	0.72	14	0.14	1.7	8
November	1.85	47	0.53	2.3	23
December	1.04	33	0.33	2.5	14

[a]Observed values based on analyses of weekly composited samples.

[b]Weighted average $(MPC)_w$ for populations in the vicinity of a controlled area calculated for the mixture using $(MPC)_w$ values for specific radionuclides recommended in NBS Handbook 69.

Table 5.8 Background Measurements of Ionizing Radiation—4th Quarter, 1962

Area	Monthly Average for All Stations (mr/hr)			Quarterly Average for All Stations (mr/hr)	Year to Date Average All Stations (mr/hr)
	October	November	December		
Laboratory Site (53 stations)	0.123	0.123	0.120	0.122	0.106
Off-Site (Oak Ridge Controlled Area) (5 stations)	0.037	0.033	0.029	0.033	0.030

Note: The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mr/hr.

6.0 FIGURES

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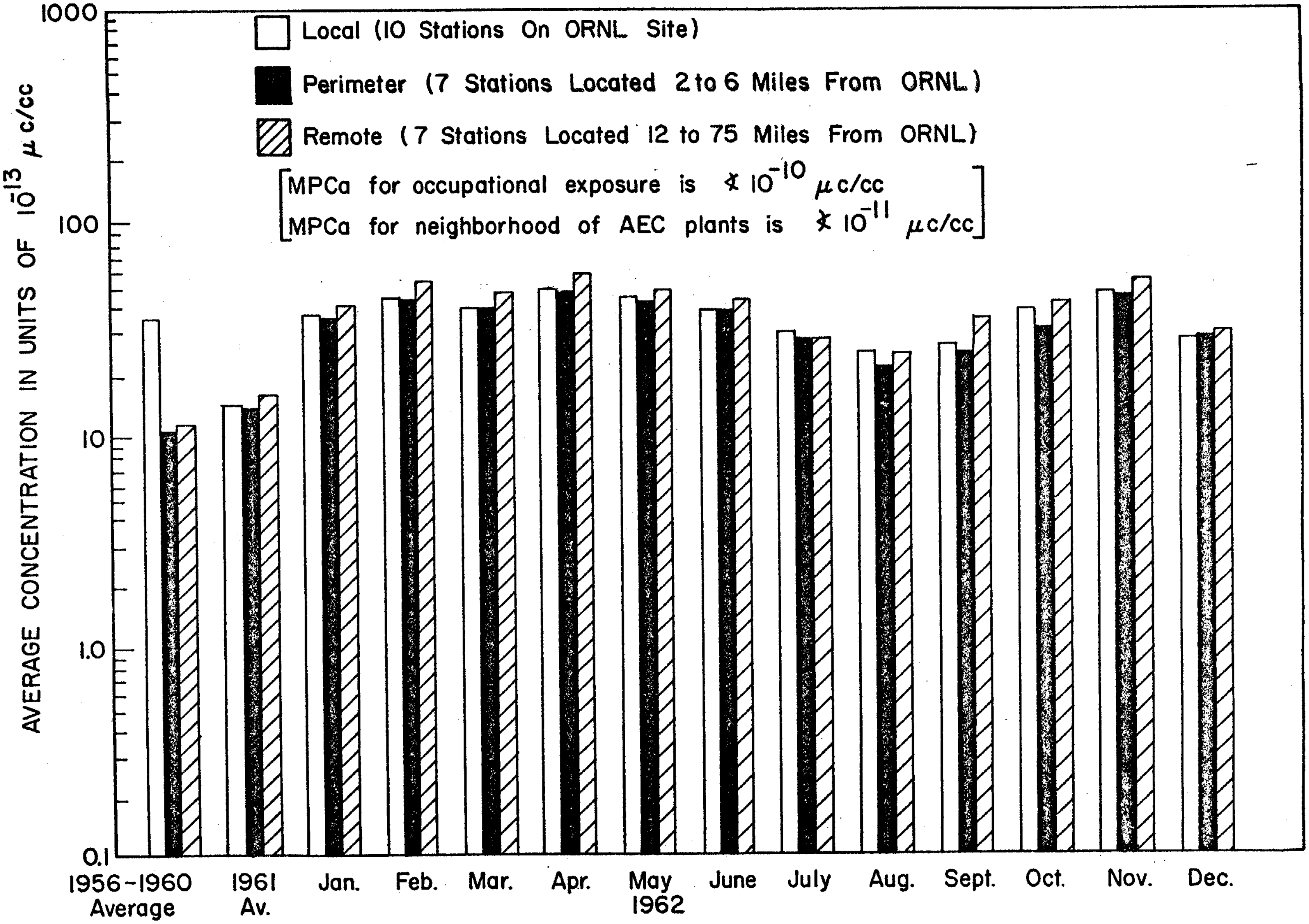

Fig. 6.1 Concentration Of Radioactive Materials in Air
(Filter Paper Data)

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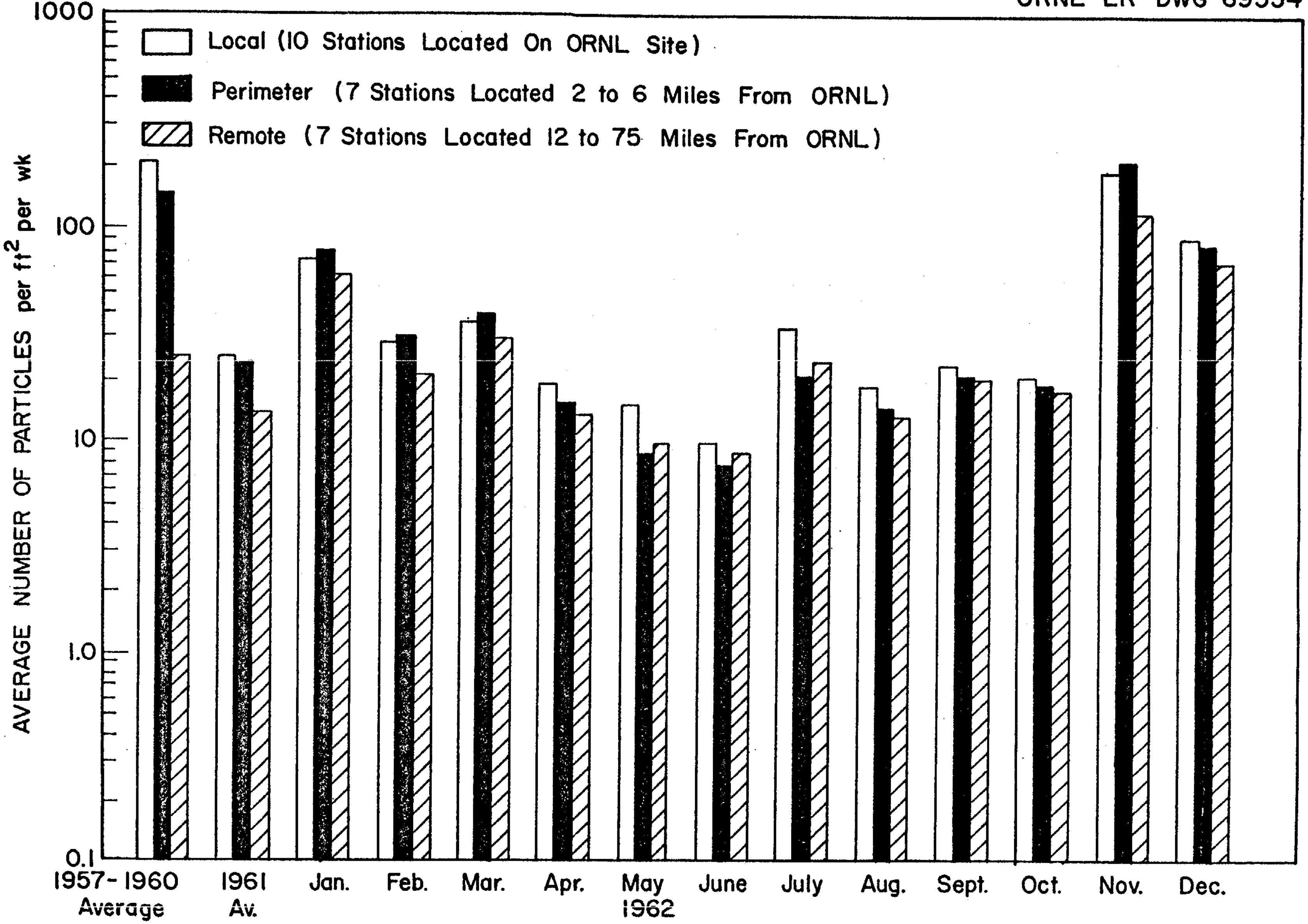

Fig. 6.2 Radioparticulate Fall-Out Measurements (Measured By Autoradiographic Techniques Using Gummed Paper Collectors)

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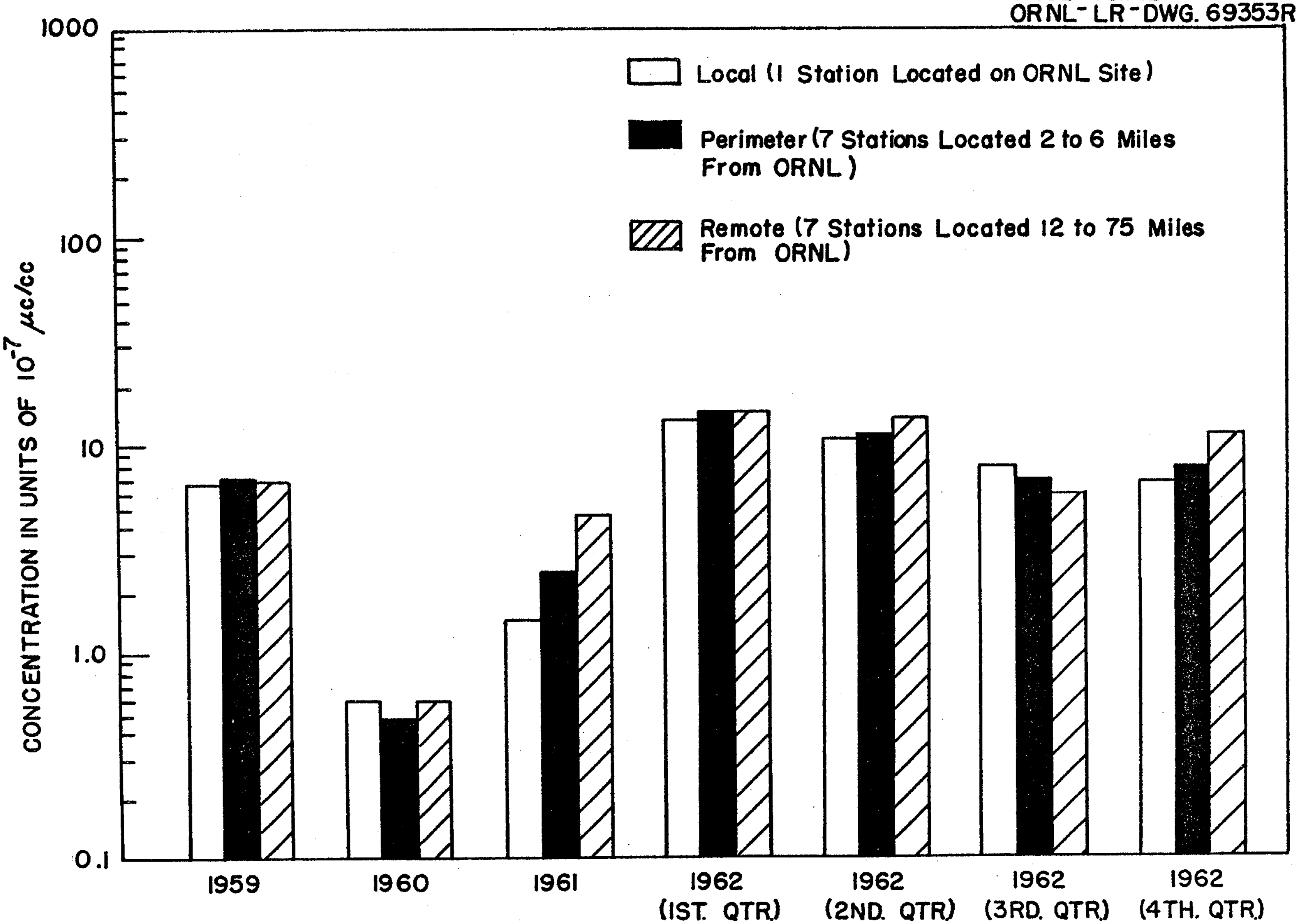

Fig 6.3 Concentration Of Radioactive Materials In Rain Water

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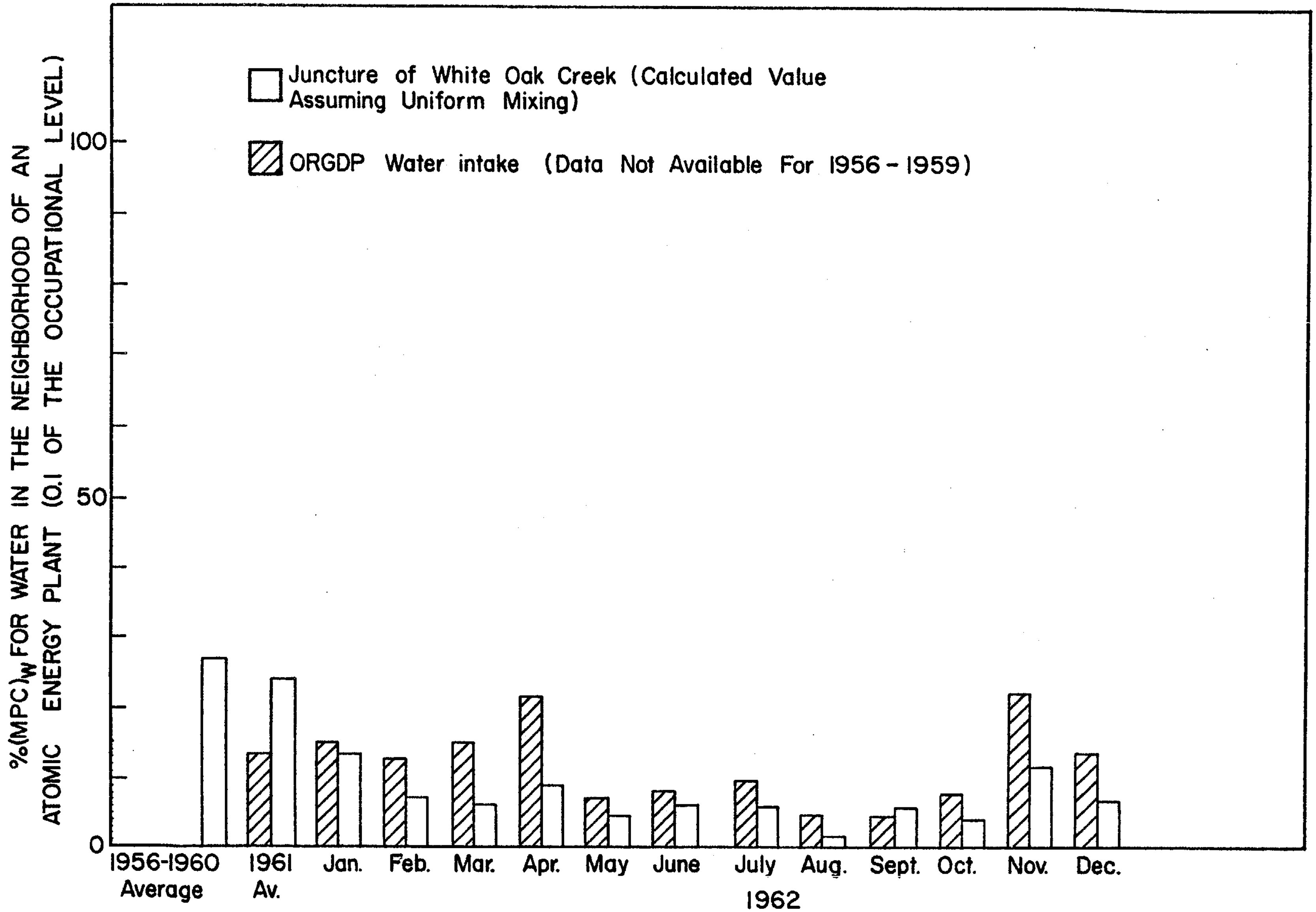

Fig. 6.4 Radioactive Content Of Clinch River Water

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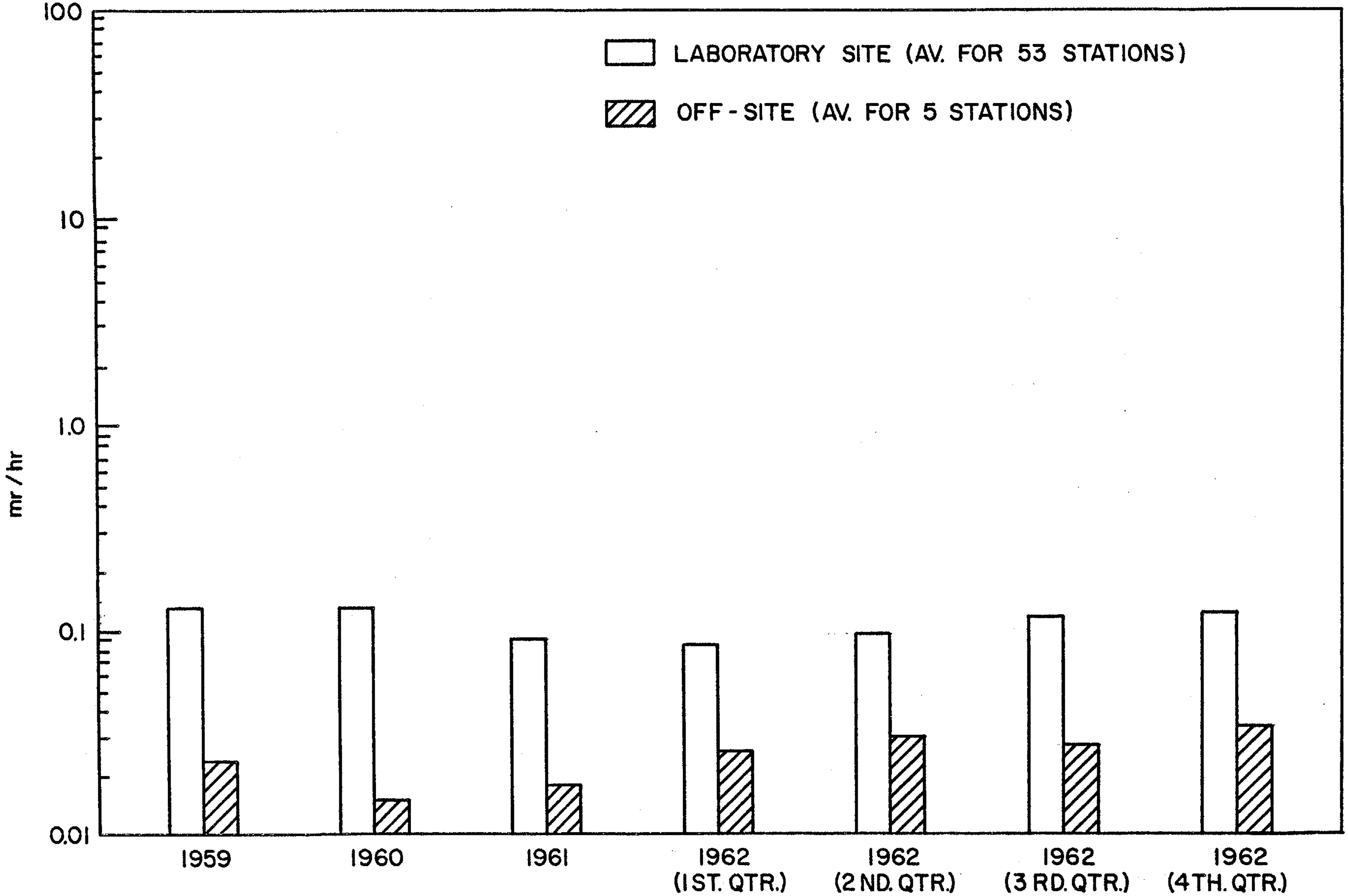

Fig. 6.5 Background Measurements Of Ionizing Radiation

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