



UNITED STATES  
ATOMIC ENERGY COMMISSION  
DIVISION OF COMPLIANCE  
REGION I  
970 BROAD STREET  
NEWARK, NEW JERSEY 07102

201 645-3960

August 9, 1968

Jack R. Roeder, Chief, Materials Inspection &  
Enforcement Branch, Division of Compliance, HQ

COMPLIANCE INSPECTION REPORT  
UNITED STATES RADIUM CORPORATION  
BLOOMSBURG, PENNSYLVANIA  
LICENSE NOS. 37-30-2 AND -7

Transmitted herewith for appropriate enforcement action is the subject inspection report involving uncorrected and recurrent items of noncompliance.

The inspector noted significant improvements had been made in the licensee's program in areas of managerial control, capabilities of the health physics staff, employee supervision, process equipment, and radiation detection and measuring instruments. Bioassay data indicates good control over the use of americium and tritium, with the one exception noted in paragraph 40 of the report details, indicating that one employee had urinalyses results showing for one week a level of about 20uCi/1 H-3 in the urine.

The uncorrected noncompliance is the failure to make an adequate evaluation of concentrations of tritium released to unrestricted areas. The licensee had conducted a comprehensive stack sampling program and determined tritium concentrations at the point of discharge. Using these results, U. S. Radium, through the application of Sutton's dispersion formula and fencing in a portion of the facility property, had made an effort to achieve compliance with the requirements of 10 CFR 20.106(a); however, as the inspector discusses in the report, an inappropriate application of Sutton's equation resulted in failure to comply with 20.106(a). Furthermore, U. S. Radium has failed to control access to various plant roofs, resulting in non-compliance relating to excessive releases to unrestricted areas. The inspector shows in the report that, by restricting access to roofs and correct application of Sutton's equation at roof edges, U. S. Radium should be able to comply with the above mentioned regulations.

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The recurrent items of noncompliance relate to failure to evaluate the potential exposure to Rn-222 for janitors decontaminating the old radium facility and to exceeding removable contamination limits.

↖  
With regard to exceeding contamination limits, it is noted that the licensee has tied himself, by license condition, to such strict control limits and inflexible action to be taken with respect thereto that noncompliance is almost unavoidable. The inspector notes that licensee personnel recognize the deficiencies and plan on immediate correction for both items.

In summary, we note an improvement at U. S. Radium, and do not believe the items of noncompliance create a health and safety problem. Future reinspections will be conducted on a normal priority I frequency.

*Richard G. Eckert, for*

Paul R. Nelson  
Senior Radiation Specialist

CO:I:RGG

Enclosure:  
Inspection Report - Orig and 2 cys

Use of Sutton's Equations by CO-1 Inspector

Premise #1 - That the licensee's six exhaust stacks which emit tritium continuously, do so as one continuous combined cloud as if emerging from one central stack located 131 meters from end of east fence.

Premise #2 - That parameters "n" and "u" used by the licensee are valid.

Premise #3 - Concentrations of stack discharges are those determined by the licensee for the first 6 months of 1968 without a +30% correction.

Data in Table Obtained from USRC Records

Stack	h = height In Meters	Aver. 6 month Concentration H-3 Reported by Licensee	Average Conc. in Ci/m <sup>3</sup>	Stack Exhaust Rate		Q in Ci/s Aver Com Ci/m <sup>3</sup> x Exhaust Rate m <sup>3</sup> /s
				cfm	m <sup>3</sup> /sec	
Gas Fill	6.1	15.9 x MPC	31.8 x 10 <sup>-7</sup>	3800	1.8	57.24 x 10 <sup>-7</sup>
H-3 Build.	4.0	8.74 x MPC	17.5 x 10 <sup>-7</sup>	1500	0.707	12.37 x 10 <sup>-7</sup>
Hand Applic.	6.1	18.66 x MPC	37.32 x 10 <sup>-7</sup>	1600	0.755	28.17 x 10 <sup>-7</sup>
Watch Dial	9.2	0.87 x MPC	1.73 x 10 <sup>-7</sup>	9000	4.25	7.35 x 10 <sup>-7</sup>
H-3 Resin	6.1	5.18 x MPC	10.36 x 10 <sup>-7</sup>	6000	2.84	29.30 x 10 <sup>-7</sup>
Exit Sign	6.1	0.3 x MPC	0.6 x 10 <sup>-7</sup>	2000	0.945	0.57 x 10 <sup>-7</sup>

Total Q in Ci/sec = 135.0 x 10<sup>-7</sup>

f = wind frequency factor = 1 for wind east as used by licensee.

u = wind velocity given by licensee as 2.2

x = distance - 91.5 m to east fence

n = 0.25 as given by licensee.

C<sub>z</sub> = 0.2

h<sub>z</sub> = 6.26 m.

from all 6 H-3 stacks

Using Equation 4.76 Meteorology and Atomic Energy, July, 1955 - Average concentration over a long period of time, from a continuous elevated source

$$X_{av} = \frac{0.02 Q f}{\pi^{1/2} C_z \bar{u} x^{(2-n)/2}} \times e^{\left( \frac{-x^2}{C_z^2 x^{2-n}} \right)}$$

X<sub>A</sub> = X<sub>A</sub> 0.046 x 10<sup>-7</sup> uc/ml air H-3

at east fence line assuming wind was directly east.

If a person were standing in the center of the unrestricted main paved road at the start of the fence, he would be on the north side 12.5 meters away from the center of the effluent cloud, and using the above formula he would be exposed to

X<sub>z</sub> = 0.37 x 10<sup>-7</sup> uc/ml air H-3

for all other situations the concentrations would be less.

*MPC for unrestricted area = 2.0 x 10<sup>-7</sup> !!*

83. Wallhausen agreed to the statement that three sides of the licensee's facility were totally unrestricted but that he had no knowledge of Sutton's equations and wanted to confer with Dr. J. Krohmer, the licensee's consultant before he committed himself. O.L. Olsen, the R.S.O., stated he has used Sutton's equations and believed the inspector was correct in stating that a proper meteorological determination should be made of wind speed and direction before equations are used and that the total release should be treated rather than each individual stack.
84. It was pointed out that in two subsequent inspections in June 1967 and in November 1967 we had discussed that [redacted] who uses 1000 Ci H-3 at one time once monthly has never had his 40 hour occupation exposure to concentrations of tritium gas and water determined. Wallhausen agreed that this should be done and would be done at his next use of materials. *Walter Olsen's name and position, date of inspection, and name of licensee should be stated. (see 87)*
85. It was pointed out by the inspector that as a result of tests made of the analytical procedures used to determine the quantity of tritium in urine and the concentration of tritium in impinger water samples, a part of air sampling was inadequate. Tests made by the inspector indicated that results were being reported as only 70% of true value. Wallhausen and Olsen agreed that the analytical procedure should be reviewed and properly calibrated. He stated the situation should be corrected within two months as they have received notification that a Packard liquid low level scintillation analytical unit has been shipped and will be used by the H.P. group to analyze urine for tritium as well as impinger water concentrations from air sampling. *7 per 9/50*
86. It was pointed out that contamination existed fairly continuously in unrestricted and restricted areas even in excess of the new higher limits. Wallhausen stated they are now discovering this contamination because of improved detection instrumentation and attempt to clean up after contamination in excess of the new limit is noted.
87. It was pointed out that the Radium Screening Facility now closed down is highly contaminated and, although as is claimed by the licensee that contamination is fixed, high concentrations of Rn-222 may be involved and that the licensee has not determined the concentrations to which janitors are exposed. Wallhausen agreed that the facility was highly contaminated and that no discussion had been made yet as to what to do with the facility. He stated that proper surveys would be made.

3 new Eberline portable PAC SN-1 alpha scintillation survey meters  
one Eberline alpha floor survey meter  
one Eberline alpha constant air monitor Model AIM-3  
one remote high level gamma probe. (teletector) 0-1000 R/hr  
one 400 channel pulse height analyzer with integrated memory circuitry

76. Wallhausen stated a total of \$80,000 has been spent on new instrument action and that a Packard liquid scintillation counter has been shipped and will be used to analyze tritium in urine and tritium trapped in impinger liquid.

Improvements in the Americium Facility

77. The inspector noted that the americium compounding glove box and press hood were equipped with ne filter plenums of a Caisson type, supplied by Nuclear Safety Systems Inc., for easy replacement. It was also noted that one projection from the glove box to which gauntlet gloves are attached was extended from a former width of 1" to approximately 3" to allow easy replacement of gloves.

Six visible magnehelic pressure gauges have been installed and all show pressure differentials greater than 0.5" water in the exhaust system. Close supervision is provided by the constant attendance of a Health Physics monitor who enforces provisions as to the overseeing of protective clothing and face mask film badges and safety procedures. Mr. E. Taylor, a new supervisor also enforces strict safety rules.

78. A review of the records of breathing zone sampling revealed no overexposures in the americium facility during 1968 and stack releases were all below MPC.

Current Possession and Scope of Acting

79. Licensee currently possesses 22,486 Ci H-3 as gas and product. Wallhausen related that they are currently producing gas filled tubes at the rate of 350,000 tubes per year whereas during previous year 1966-1967 produced 600,000 gas filled bottles.
80. Licensee possesses currently 4.840 Ci of Am-241 and Wallhausen stated they are currently producing foil at the rate of 1.5 Ci monthly whereas during the year 1966-1967 production was at the rate of 5 Ci monthly. Other materials on hand were 95.28 mCi C-14, 1.1 Ci Ni-63 30.5 Ci Kr-85 license limits according to inventory records were never exceeded.

Management Discussion and Review

81. A discussion concerning the items of noncompliance and conditions noted was held immediately following the inspection on July 12, 1968 attended by the following:

R. Mac Donald - Pennsylvania Department of Health  
C.W. Wallhausen - Vice President in charge Nuclear Products  
O.L. Olsen - R.S.O.  
E.M. Burtsavage - Ass't R.S.O.

82. It was pointed out by the inspector that the licensees submittal of a use of Sutton's equations to prove that concentrations of tritium in air was inadequate because meteorological conditions had not been determined and three sides of the licensee's facility was totally unrestricted; moreover, the use of the equations considered each stack separately, used instantaneous release equations whereas the licensee has a duster of six stacks, and no particular array all omitting tritium on a continuous basis.

- 3.794 nCi
- 4.839 "
- 9.219 "
- 0.884 "
- 0.593 "
- 0.305 "
- None detectable
- 12.670 nc

15 nci is evidence of a lung burden according to the Holyosen report.

#### Tritium Urinalysis

70. As previously discussed in ¶ 25 and 26 of this report, analyses as performed by the licensee for tritium gave analytical results 30% too low and Burtsavage stated he arbitrarily applied a + 10% correction factor to the analytical results giving results 80% of true activity. The urinalysis performed weekly on 20 persons in all tritium operations shows with one exception (see #40), on the average of no more than 6-8 uc H-3/liter urine with no urines reported in excess of 28 uc H-3/liter urine.

#### Breathing Zone Air Sampling

71. Breathing zone air sampling is performed for all americium operations. Mighty-mite battery operated air samples were used and results indicate no overexposure based upon 40 hour exposures. Average breathing zone concentration run approximately  $0.8 \times 10^{-12}$  uCi Am-241/ml air.

Breathing zone samplings were performed over 5 consecutive days in the tritium gas fill facility for [redacted] during normal tube filling operations and maximum concentrations did not exceed  $2 \times 10^{-6}$  uCi/ml air. Breathing zone sampling were also performed on [redacted] during tritiated phosphor processing and maximum breathing zone concentrations did not exceed  $1.8 \times 10^{-6}$  uCi H-3/ml air.

72. No breathing zone sampling has ever been performed on [redacted], who prepares 1000 Ci tritiated tritide once yearly and who once monthly incorporates at one run 1000 Ci of tritium gas on to metallic foil. The licensee was cited for this lack of survey for this particular operation during our inspection of May 15-19, 1967 and June 10, 1967 and was informed of the item of noncompliance in CO:Hq. letter dated July 20, 1967 in citation No. 2(b). CO:I also listed this item of n/c in the report of the inspection of November 13-17, 1967 (item #3 of our Form 417 report dated Feb. 5, 1968). CO:Hq. letter to the licensee dated April 1, 1968; however, did not include this citation. Burtsavage stated that they have never sampled the environment to which [redacted] is exposed over a 40 work week when he works with 1000 Ci tritium gas in the tritium building because he is a difficult person to schedule. Burtsavage stated that although [redacted] notifies him in advance of his intended work the Health Physics staff has already been committed to other duties.

73. Breathing Zone sampling on several hand dial painters who performed, according to records, and the maximum 40 hour concentration level was  $0.94 \times \text{MPC}$  of  $5 \times 10^{-6}$  uCi-H<sup>3</sup> sol/ml air. However, it should be noted that if there is a 30% error in evaluation of liquid impinger samples MPC could have been exceeded.

74. During the inspection of the tritium building on 7/1/68, the inspector and Olsen both noted that a Johnson Laboratories tritium air monitor measuring room air was reading between  $4-6 \times 10^{-6}$  uCi/ml air or approximately at MPC while no work was in progress. A recording strip chart attached to the monitor indicated that the level existed for the previous 24 hours.

#### Improved Instrumentation

75. The inspector noted that the licensee has already procured the following new radiation detection and measuring instruments:

Organization and Management

65. All work involving radionuclides is now under the Nuclear Products Division. C.W. Wallhausen, Vice-President, of the above division stated he now spends more than 50% of his time at Bloomsburg to ensure safe use of materials. The Health Physics Group now has 12 persons including six janitors who are directly responsible to Wallhausen and not the local plant manager. O.L. Olsen, who joined the H.P. group June 1, 1968 as Principle Health Physicist has had 14 years experience at Hanford, Washington and three years with CON-RAD with principle experience in operational health physics. Organization and direct supervision appears to have improved. Olson reported that a member of the Health Physics Group is now on full time duty in the americium facility and the tritium hand paint facility to ensure safe practices. As of 7/11/68 Wallhausen issued written orders stating no new procedure can be initiated by production without prior approval of the Health Physics Group.

Personnel Monitoring  
Film Badges

66. Film badges processed weekly by Radiation Detection Co. are still used for personnel monitoring. Finger ring badges are used by all personnel in the americium facility. Records indicate that maximum exposure was received by [redacted] who processes most Am-241 under Baker's supervision. [redacted] received the following exposure:

	entire year 1967	
		Beta Gamma
right finger		14.150 mrad
left finger		22.633 " <i>rad?</i>
whole body		2640 mrem

67. All other exposures were less the above and average one half that of [redacted]. Records for the first 5½ months of 1968 were also examined and show that [redacted] who mixed radium paint received a maximum finger exposure of 12,430 mrad and 820 mrem whole body dose. [redacted] who processes <sup>226</sup>Ra Room 241, has a finger exposure for this period of 7370 mrad and a whole body exposure of 400 mrem. Calendar quarter year exposures did not exceed the limits expressed in 10 CFR 20-101.

Urinalysis

68. Weekly urine analysis for americium in urine is still performed by Eberline, New Mexico for 5 persons. The records were examined and do not indicate any overexposures. The maximum urinary output was noted for [redacted] who has a previously determined body burden of 0.03 uCi Am-241 and showed 3.38 dpm and 3.34 dpm in 24 hour voids on 12/30/67 and 1/14/68. Urines for [redacted] usually show no more than 1 dpm/24 hour void.

Helgesen Body Counting

69. Burtsavage reported that a Helgesen portable body counter was used on March 21 and 22, 1968 to evaluate body burdens for Ra-226 and chest burdens for Am-241. The records of Helgesen's results are as follows:

a. Whole body counting for radium

[redacted]	-	12.105	nCi
[redacted]	-	46.289	"
[redacted]	-	3.063	"
[redacted]	-	6.906	"
[redacted]	-	17.584	"
[redacted]	-	21.644	"

100 nCi is evidence of a Ra-226 body burden according to the Helgesen report.

b. Chest counting for Am-241

[redacted]	-	6.226	nCi
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58. "Item No. 9. Contrary to 10 CFR 20.201(b), "Surveys," except for the week of July 17, 1967, surveys were inadequate to determine compliance with 10 CFR 20.103 with respect to the airborne concentrations of radon 222 to which employees were exposed while working in the radium screening room. During the week noted above, several individuals working in the radium screening room were exposed to airborne concentrations of radon 222 in excess of AEC limits when averaged over a period of seven consecutive days."

Licensee's Reported Corrective Action

59. Licensee's reply dated April 30, 1968 stated that all radium operations have ceased.

Current Status

60. Burtsavage reported that the Ra dial paint facility was closed as of January 11, 1968. He stated use of the facility since the last previous inspection was for repairs on returns and work was performed as follows:

1/3/68	██████████ inspecting dials	Room air Rn-220	$3.3 + 10^{-9}$ uCi/ml air
		Rn-226 particulate	$3.8 + 10^{-13}$ uCi/ml air
1/9/68	██████████ screening watch		
	dials	90 minutes Rn-220	$5 + 10^{-9}$ uCi/ml air
1/10/68	██████████ " "		" "

61. Radon Breath Analysis performed by Dr. A. Weber, Fordham University, was performed on 1/8 and 4/23/68. The results are as follows:

	1/8/67	4/23/68	
██████████	0.36	0.27	Pci Rn-226 per liter expired breath
██████████	0.33	-	
██████████	0.33	0.48	
██████████	0.17	0.57	
██████████	0.13	0.13	
██████████	0.30	0.33	

62. One pci Rn-222 is evidence of 0.1 ugm Ra<sup>226</sup> considered to be a body burden as stated by Weber in his reports. The above personnel are all tritium dial painters who also worked in the radium screening facilities.

63. Burtsavage stated the radium screening facilities are highly contaminated with fixed radium contamination averaging from 100,000 - 200,000 cpm/60 cm<sup>2</sup> when measured with a Eberline PAC SN-1 alpha scintillation detector. He stated this is equivalent to 550,000-1,100,000 alpha dpm/100 cm<sup>2</sup>. He also stated that janitors have centered once or twice weekly to wash the entire area to remove any possible removable contamination. He stated that these persons also clean laboratories and rooms containing by-product material. He stated no room air sampling, breathing zone, or breath analysis was done on these persons. He also stated they wore overalls, gloves, workshoes but not face masks or respiratory protection.

64. This item of noncompliance is recurrent with respect to cleaning personnel who enter a dosed contaminated area without any determination of their working environment.

Licensee's Reported Corrective Action

- 52. Licensee in his letter dated April 30, 1968 reported releases from the Hand Paint stack during December 1967 as all being below MPC, but those in January and February 1968 are approximately 28 times MPC. The letter states errors were made in sampling or in counting. During the inspection it was learned that sampling in December 1967 was done by inexperienced personnel and that too great an air flow was drawn through the water impinger sampler causing a loss of sample.

Current Status

- 53. As previously stated in paragraphs 25-32 of this report, average concentrations are determined by 27 samplings each for 24 hours between January 1, 1968 and June 28, 1968 show average releases of 18.66 x MPC or  $37.32 \times 10^{-7}$  uCi (sol)H<sup>3</sup>/ml air via stack No. 14 Hand Paint exhaust stack. Wallhausen stated the only corrective action taken was to indoctrinate watch dial painters in safe work habits and papering all floor and work table surfaces with work table paper changed twice daily. He also stated no other attempts were made to trap or reduce concentrations because they intend to build a new watch dial facility. The location at the time is undetermined according to Wallhausen.
- 54. This item of noncompliance remains uncorrected for the reason stated in Paragraph No. 33 of this report which constitute an improper evaluation. Because of an -30% counting error, the licensee could also exceed MPC by 23.84xMPC.
- 55. "Item #8. Survey data indicated that the surfaces throughout your plant exceeded the contamination limits specified in your letter dated April 28, 1961, and your revised Standard Operating Procedure 27, contrary to License Condition No. 17 which incorporates the referenced documents."

Licensee's Reported Corrective Action

- 56. Licensee in his letter dated April 30, 1968 reported that the reason for the citation was that the limits formerly imposed by the licensee were too low and that liberalized limits would mean compliance.

Current Status

- 57. Surveys performed by Burtsavage indicated that the licensee exceeds the limit of 50,000 dpm/100 cm<sup>2</sup> for removable tritium in accessible surfaces in restricted areas.

7/8/68	- Table surfaces where women do hand paint	- 60,000 dpm/100 cm <sup>2</sup>
6/20/68	South wall shelves hand paint room	95,000 dpm/100 cm <sup>2</sup>
6/11/68	Baseboard in hallway	195,000 " "
	Pencil sharpener	80,000 " "
6/7/68	Green cabinet surfaces	115,000 " "
	Surface of dolly	300,000 " "
	Electric wall circuit boxes	57,500 " "
	Wall shelf under clock	200,000 " "

Contamination continues to be released for the hand paint operations, and this item of noncompliance is recurrent. The third floor cafeteria (unrestricted) used by watch dial painters under License-7 is discussed in latter part of Paragraph 49 and frequently shows limits of SOP 27, page 14, Item D.I.C. 5000 dpm/100 cm<sup>2</sup> have been exceeded.

46. Burtsavage stated the Health Physics Group now has six janitors who clean up all restricted and unrestricted areas on a daily basis. Surveys for Alpha contamination are now made using an Eberline alpha floor monitor.

47. On 6/27/68 Baker in his daily surveys of the restricted americium laboratory using an Eberline PAC-3 scintillation alpha survey meter noted the following:

Aluminum Catch Tray	-	12000 cpm/60 cm <sup>2</sup> alpha removable
rolls base		80000 "
outside surface roller hood		125000 "
5/28/68	outside press lever handle	16,000 dpm/100 cm <sup>2</sup>
6/19/68	controls diacro cutters	10,000 cpm/60 cm <sup>2</sup>
	outside walls of hood	8,000 "
	foil inspection area	6,000
	tongs	2,000

On 6/3/68 and 6/14/68 similar contamination was noted. On 8/11/68 the inspector using an Eberline PAC-3 scintillation alpha noted 6000 cpm/60 cm<sup>2</sup> alpha at the base of the large rollers and 6000 cpm/60 cm<sup>2</sup> at an opening to a storage cell. The surveys for removable contamination noted here exceed the values specified in Item B.2.a. P 13 of sop 27, for restricted area surface.

48. Records of results of surveys for removable tritium contamination in restricted areas showed instances whereby the levels of Items B.1.c and B.2.c, page 13, sop 27 were exceeded. Examples are:

6/25/68 Survey of interior of hood in tritium gas fill area - several smears exceeded 500,000 dpm/100 cm<sup>2</sup>, the highest about 2,000,000 dpm/100 cm<sup>2</sup>

3/19/68, 4/5, 5/29, 6/4, and 7/5/68 surveys of equipment, floor, table surfaces in tritium gas fill area indicated about eight instances whereby 50,000 dpm/100 cm<sup>2</sup> was exceeded, levels ranging from 65,000 to 495,000 dpm/100 cm<sup>2</sup>.

49. A review of records of smear survey results for unrestricted areas showed numerous instances whereby removable alpha contamination exceeded levels of 200 dpm/100 cm<sup>2</sup> given in item D.1.a 1 page 14, SOP27. Surveys of 5/11 and 18/68 noted levels for floors in passageways and offices ranging up to 13600 dpm/100 cm<sup>2</sup>. Records showed that following the 5/18/68 survey, some decontamination was performed and limited surveys of 5/21 and 5/23 indicated appreciable reduction of removable contamination in several areas. Several instances of removable tritium contamination exceeding the limits of 5000 dpm/100 cm<sup>2</sup> were noted. These are:

3rd floor cafeteria	unrestricted area	H <sup>3</sup> contamination
removable contamination on	several occasions	exceeded 5000 dpm/100 cm <sup>2</sup>
6/6/68	26,000 dpm/100 cm <sup>2</sup>	top of waste can
5/18/68	6,000 dpm/100 cm <sup>2</sup>	Window sill North Wall
4/9/68	11,000 "	Kitchen cabinet shelf
3/12/68	8,000 "	Green chair surface

50. This item of noncompliance is continuously recurrent and although the licensee has obtained authority to have higher contamination limits he on occasion exceeds these limits.

License-7

51. "Item #7. Contrary to 10 CFR 20.201(b), "Surveys," surveys were inadequate to determine compliance with 10 CFR 20.106 with respect to the airborne concentrations of tritium released to unrestricted areas from the Tritium Hand Paint Facility. Based on the evaluations that have been made prior to May, 1967 of the concentrations of tritium released from the Tritium Hand Paint Facility, it appears that you may have exceeded the limits specified in 10 CFR 20.106 when averaged over a one-year period.

Current Status

40. Current inspection reveals only one instance which revealed possible exposure to excessive concentrations of  $H^3$  in air. [REDACTED], working filling glass tubes with  $4C H^3$  each and blending  $300 Ci H^3$  phosphor with organic material during the week of December 18-22, 1967 showed  $3.02 uCi H^3$  per liter urine on December 18, 1967 prior to starting work and  $20.70 uCi H^3/l$  on December 22, 1967. Burtsavage stated that these urines have a +10% correction factor added to the analytical data. He stated he added 10% because he felt that the urines's sampling results were low but did not quite know if 10% was valid. He stated he has added 10% to all urine analyses results since shortening analytical time but did not add any correction factor to analysis of stack impinger samples as there were for the most part high readings. According to Burtsavage, [REDACTED] results represented a gain of  $19.24 uCi$  in five days assuming 50% biological decay of the December 18, 1967 sample. He stated [REDACTED] elimination exhibits a five or six day half life for tritium. This represents a body burden of  $827.3 uCi H^3$  and indicates an exposure of  $1.65 x MPC$  of  $5x10^{-6} uCi H^3/ml$  air for a 40 hour consecutive work week as expressed in Table I, Column 1.
41. No report was transmitted to any office of the Commission concerning the exposure according to Burtsavage. His request for written explanation by [REDACTED] contained the wording that this exposure may required notification to the AEC. [REDACTED] in his reply reported no incident except a mixture of work involving handling of  $300-C H^3$  tritiated phosphor and filling 60 glass tubes with  $4 C$  each.
42. "Item #5. Individuals working in the restricted Americium Laboratory and engaged in various operations involving the decontamination of the laboratory, and the replacement of air filters were not adequately instructed in the safety problems associated with exposures to radioactive materials, and in the precautions or procedures to minimize their exposure during such operations, contrary to 10 CFR 20.206(a), "Instruction of personnel; posting of notices to employees."

Licensee's Reported Corrective Action

43. Licensee in his letter of April 30, 1968 reported that procedures have been drafted for all operations. The inspector noted that new SOP were drafted and were issued to all personnel who may be involved in operations. These SOP include procedure for changing filters on glove boxes, gauntlet gloves on glove boxes and roof filters. The inspector noted these pre written procedures were detailed with step by step drawings. Olsen stated all personnel were instructed in the proper procedures as well.

This item of noncompliance has been corrected.

44. "Item #6. Survey data indicated that the surfaces throughout your plant contaminated with radioactive material exceed the contamination limits specified in your letter dated April 28, 1961, and your revised Standard Operating Procedure 27, contrary to License Condition No. 10 which incorporates the referenced documents."

Licensee's Reported Corrective Action

45. Licensee in his letter of April 30, 1968 stated that the license limits were too low but that contaminated areas have been located and cleaned. The licensee amended his SOP No. 27 Health Physics Procedures to include higher limits for fixed and removable contamination, see pages 13-15. SOP 27, as amended, was included as License Condition No. 18 in License Amendment No. 35 dated June 27, 1968.

33. The licensee has made sufficient samples to evaluate stack concentrations; however, the licensee is still in noncompliance with 10 CFR 20.201 failing to properly evaluate the releases of  $H^3$  (sol) to unrestricted areas via stack discharge because:
- (a) Use of Sutton's equations was made without proper meteorological data.
  - (b) Use of Sutton's equations was made without evaluating the effect of the total effluent released by the licensee via stack discharge.
  - (c) Restriction exists on only one side of the licensee's facility and other three sides are unrestricted indicating that the licensee's facility is essentially unrestricted and the licensee is required to still use concentrations released at point of discharge.
  - (d) The licensee by shortening analytical time introduced an error of -30% in his estimation of concentrations of  $H^3$ (sol) stack effluent.
34. "Item #3. Contrary to 10 CFR 20.201(b), "Surveys," surveys were inadequate to determine compliance with 10 CFR 20.103 with respect to the airborne concentrations of nickel 63 and krypton 85 to which employees were exposed while working in laboratories where the plating of nickel 63 is performed and where tubes are filled with krypton 85 gas."

Licensee's Reported Corrective Action

35. Letter of April 30, 1968 reports that these operations occur infrequently and that Ni-63 plating involves no volatiles and subsequent surveys showed no exposures.

Current Status

36. Burtsavage stated that no external E.M.F. has been applied to Ni-63 plating. He reported that this is done using electromotive force on metals using an enclosed cell. All plating is done in an enclosed exhaust hood with air flow across the face of 100 lfm. Urine was checked of Gingrich who performed Ni-63 plating and analyzed specifically for Ni-63 on three occasions by Isotopes Inc. who reported activity as less than 6 dpm/24 hour void for each sampling.
37. Records indicate that 5 mCi of Kr-85 gas is used once monthly to create a gas filled light source and that filling occurs in a special hood with air flow greater than 100 lfm. Stack air from Stack No. 8 showed no detectable activity of Kr-85 in gas samples collected. Burtsavage stated use of small quantities for 1½ hours monthly could not create an overexposure.

This item of noncompliance appears to have been corrected by the licensee's evaluation.

38. "Item 4. Contrary to 10 CFR 20.405(a), "Reports of overexposures and excessive levels and concentrations," U. S. Radium Corporation failed to file with the Commission a report of the exposures of airborne concentrations of radioactive material, referred to in Item 1 above, received by its employees in excess of AEC limits. The reports which were filed with the Commission by U. S. Radium Corporation of the exposures were not timely."

Licensee's Reported Corrective Action

39. Licensee reported in letter dated April 30, 1968, the acquisition of new equipment to better identify reportable incidents and stated prompt reports would be submitted.

27. Wallhausen stated that all roofs are not restricted and that workmen may enter to perform needed maintenance without restriction. He also stated and the inspector noted that the East end only of the licensee's facility is enclosed by a six foot high chain link fence 200' x 330' as described in drawings submitted with the licensee's letter of April 16, 1968. Within the fenced area are the Tritium Building, several waste storage buildings and evaporator waste handling facility. The fence was noted to have signs reading "Keep Out. Only Authorized Persons and Vehicles May Enter." No other fences were noted. The West, North and Southern sides of the licensee's main building and Westclox facilities are completely unrestricted. The unrestricted area houses the gas fill hand paint, americium, krypton-85, nickel-63, old Cs-131, hot cell and the Westclox Building in which a screening machine is used to apply H-3 paint automatically to large dials.
28. Wallhausen stated the fence was erected on the recommendation of their consultant, Dr. Krohmer, who applied a modified Sutton's equation based on the premise that prevailing winds were from West to East.
29. Wallhausen and O.L. Olsen, the licensee's health physicist, both stated however, that they have no knowledge of the wind conditions in the Bloomsburg area and no study was made of wind velocities or directions and that Krohmer used assumptions in his use of Sutton's equation without any knowledge of required meteorological data.

30. The inspector notes that Krohmer in his use of Sutton's equation treated each stack individually, whereas, the licensee has a random array of stacks not in a straight line. Examination of the formula used by Krohmer revealed that he used equations 4.72, 4.73 and 4.74 appearing on page 50 of "Meteorology and Atomic Energy" apparently relying on the note under these formulae which states that "The integrated dosage from an instantaneous source is in other words identical in form with the concentration from a continuous source (cf. Eqs. 4.50, 4.65, and 4.66). Mr. Irwin Spickler, Reactor Licensing, Hq. who had reviewed the use of the equations used by Krohmer, stated via telephone on July 22, 1968 that the formulas were incorrect because integration with respect to (T) time uses a short time factor (no greater than 30 minutes) and that formula representing average concentrations over a long period of time, from a continuous elevated source should be used. He suggested Gifford's equations "appearing Nuclear Safety 1961" are appropriate. Equation No. 4.76 in Meteorology and Atomic Energy is similar to Gifford's equation. Spickler also stated that Krohmer erred in not using total integrated effluent from all stacks and also assumed that the wind blows directly East 100% of the time. Use of equation 4.76 "Average concentrations once a long period of time from a continuous elevated source,

$$X_{av} = \frac{0.02 Qf}{(T) \frac{1}{2} C_2 \bar{u} x \frac{2-n}{2}} e^{-\frac{h^2}{C_2^2 x^2 - n}}$$

was made by the inspector, see Exhibit "A". *and see p. 100!*

31. The inspector noted during the inspection that the end of the East end fence was 91.5 meters away from center line of all roof stacks. Using C-2 = 0.2, from figure 4.4 page 54 Meteorology and Atomic Energy for neutral conditions, and n=.25 and  $\bar{u} = 2.2$ , parameters used by Krohmer.

$X_{av} = 4.6 = 10^{-9}$  uCi H-3 air at the East fence line if the wind were continuously in East direction only.

32. Since the fence runs parallel to the main building all positions along the North side of the fence are totally unrestricted and persons may approach unrestricted areas to within 42.5 feet of the center of the exhaust cloud, or 12.9 meters. At this distance, average continuous concentrations would be, using the above quotation with  $\bar{u} = 0.1$ ,  $3.7 \times 10^{-8}$  uCi H-3/ml air and such persons would not be exposed to excessive concentrations in air. (See Exhibit "A" for calculations). It appears that restriction of the roof may be all that is needed and confirming surveys at the roof perimeter.

18. Burtsavage stated and records showed that stack sampling was performed on Stack No. 9, the Gas Fill Stack, Main Building, on 56 days and represented 24 hour samplings with an average concentration of  $31.8 \times 10^{-7}$  uCi H<sup>3</sup> (SOL)/ml air for 6 months between 1/1/68 - 6/28/68, or 15.9 x MPC of  $2 \times 10^{-7}$  uCi H<sup>3</sup> (SOL) /ml air as expressed in Appendix B, Table II, Column I.
19. Records indicated that stack sampling was performed on 52 days over 24 hours on Stack No. 10, the Tritium Building, and average concentrations between 1/15 and 6/28 were 8.7 x MPC or  $17.4 \times 10^{-7}$  uCi H<sup>3</sup> (SOL)/ml air.
20. Records indicate stack sampling was performed on the Hand Application Stack #14, Main Building (License-7) on 27 days over 24 hours between June 1 and June 28, 1968, and average concentrations were 18.66 x MPC or  $37.32 \times 10^{-7}$  uCi H<sup>3</sup>/ml air.
21. Records indicate stack sampling was performed on the Watch Dial Facility, Stack No. 15 on 49 days over 24 hours between March 1, and June 28, 1968, and average concentrations were 0.55 x MPC or  $1.10 \times 10^{-7}$  uCi H<sup>3</sup>/ml air (License-7).
22. Records indicate that 27 samplings over 24 hours were performed on the Tritium Resin Incorporation Stack (Annex Room 4), Main Building, and average concentrations between January 1, and June 28, 1968 were 5.16 x MPC or  $10.32 \times 10^{-7}$  uCi/H<sup>3</sup> ml/air.
23. Exit Sign Stack No. 6, Main Building, also exhausts H<sup>3</sup> and records indicate that 16, twenty four hour air samplings were made during March and April 1968 and concentrations of H<sup>3</sup> sol in air of  $0.6 \times 10^{-7}$  uCi H<sup>3</sup> (Sol)/ml air was noted. 3 x MPC
24. The average concentration of H<sup>3</sup> released from the six exhaust stacks of the licensee's facility under License-2 and License-7 according to licensee's survey records during the 1st 6 months 1968 was  $12 \times 10^{-7}$  uCi H<sup>3</sup>/ml air or 6.0 MPC. His total release during 1st six months of 1968 based upon air flow would be  $135 \times 10^{-7}$  Ci/sec. (see table in Exhibit A) or  $135 \times 10^{-7}$  Ci/sec x  $3.156 \times 10^7$  sec/year, equal to 213 Ci H<sup>3</sup> (sol) released during the first six months of 1968.
25. Burtsavage stated that stack air samples were taken by drawing air by means of a Staplex Air Sampler from stacks via isokinetic probes, filter paper, water impingers, and a Model 32 Carey vibrating reed electrometer. The water gathered in the impinger is analyzed by Wayne Beaver using the same method to analyze urines for H<sup>3</sup>, adding urine or impinger water to calcium metal and passing the gas evolved through a drier and then through a Carey Model 32 vibrating reed electrometer. On July 10, 1968, Epstein and MacDonald pooled urines to which was added 2 ml. of a N.B.S. tritiated water standard to give a concentration of 5.65 uCi H<sup>3</sup>/liter. This was analyzed by Wayne Beaver to be 3.86 mCi H<sup>3</sup>/liter or 69.5% of true concentration. A repeat was done with another sample of the inspector's urine using a sealed Packard Corp. H<sup>3</sup> liquid standard to give a concentration of 5.597 uCi/liter. This was also analyzed by Wayne Beaver using the above method who reported 3.98 uCi H<sup>3</sup>/liter or 71% of true value.
26. The inspector examined the calculations and method used by Wayne Beaver and found that prior to the last previous inspection in November 1967 they had timed the response of the Carey electrometer to 0.8. volts and that now they were only timing the response of the electrometer to 0.08 volts. Beaver and Burtsavage stated this accomplished a 9/10 reduction in analysis time. It took 340 seconds to obtain ionization sufficient to generate 0.08 volts. Beaver stated it would take well over 3600 seconds to go to the 0.8 volt level as before. He and Burtsavage stated however, all standardizations were made at the 0.8 volt value and that the printed instructions and procedures all prescribe determining the time interval it takes to reach 0.8 v. not 0.08 v. Since the licensee also uses this method to analyze stack liquid impinger samples, the licensee's average releases of H<sup>3</sup> could have been  $12 \times 10^{-7} + 30\%$  or  $17.2 \times 10^{-7}$  uCi H<sup>3</sup> sol/ml air equal to 8.6 x MPC with a total release of 213 Ci + 30% or 305 Ci during the first six months of 1968.

Current Status

14. The inspector noted that the licensee has acquired three additional Eberline low background gas flow scaler units to analyze smear and air activity from the Am-241 laboratory and now has a total of four such analytical units, two in the downtown Bloomsburg Laboratory used solely for air samples and two in the main plant to evaluate smear surveys. The inspector noted that air survey and smear survey results are now available within 2-3 days after sampling. A Wang Inc., desk top computer has been purchased and is assigned to the Health Physics Group to assist in rapid automatic calculation and the group has a full time secretary to assist in typing and issuing results. This item of noncompliance has been corrected.
  
15. "Item #2. Contrary to 10 CFR 20.201(b), "Surveys," surveys were inadequate to determine compliance with 10 CFR 20.106 with respect to:
  - a. the airborne concentrations of tritium gas released to unrestricted areas from the Tritium Building during tritium foil preparation and during various other operations involving curie quantities of tritium;
  - b. the airborne concentrations of tritium gas released to unrestricted areas from the Tritium Resin Preparation Laboratory during the incorporation of tritium gas into a plastic resin; and
  - c. the airborne concentrations of tritium gas released to unrestricted areas from the Tritium Gas Fill Facility from May 26 to September 28, 1967.

Based on the evaluations that have been made of the concentrations of tritium released from the Tritium Gas Fill Facility to unrestricted areas, it appears that you may have exceeded the limits specified in 10 CFR 20.106(a) when averaged over a one-year period."

Licensee's Reported Corrective Action

16. The licensee in his letter dated April 30, 1968 stated additional measuring equipment was obtained, a schedule of more frequent measurement has been scheduled and spot checking of intermittent areas. The licensee also pointed out a decreasing trend in releases from the stack exhausting effluent from the tritium gas fill facility. The letter further stated they intended to extend the restricted area and that a fence would be constructed. The letter also had an attachment entitled February, March and April 1968 representing stack discharges from the gas fill facility, stack discharges from Stack No. 10 the Tritium Building, Stack No. 2 Annex Room 4, and another set of data for the tritium gas fill Stack No. 9, some data from the Hand Painting Stack No. 14 was also included. Another attachment contained the use of modified "Sutton's" equations by the licensee's consultant, Dr. J.S. Krohmer.

Current Status

17. Wallhausen stated that two sets of data represented stack effluent from the gas fill system and the first set of data labeled February, March and April 1968, represented surveys made by R&D group. He further explained that these surveys were not valid stack concentrations and were not made at the stack and not under isokinetic conditions, whereas the detailed surveys were made by Burtsavage and were made at the point of exhaust on the roof and were under isokinetic conditions.

PARTS 20 - 30 INSPECTION

UNITED STATES RADIUM CORPORATION  
4150 Old Berwick Road  
Bloomburg, Pennsylvania 17815

Date of Inspection: July 8 - 12, 1968

Persons Accompanying Inspector

Mr. R. MacDonald, Pennsylvania Dept. of Health

Persons Contacted

Mr. C.W. Wallhausen, Vice President, Nuclear Products  
Mr. E.M. Burtsavage, Assistant Health Physicist  
Mr. O.L. Olsen, Health Physicist  
Others: As noted in details

DETAILS

Background Information

9. The last previous inspection was performed November 13-17, 1967 and results were reported using Form AEC-417 because of uncorrected items of noncompliance. CO:Hq by letter dated April 1, 1968 notified the licensee of six items of noncompliance for License-2 and three items of noncompliance for License-7
10. The licensee by letter dated April 30, 1968 replied to CO:Hq letter of April 1, 1968 setting forth corrective action.
11. The items of noncompliance set forth in CO:Hq letter of April 1, 1968 were reviewed during the current inspection. The licensee's reported corrective action was also reviewed and the current status will be discussed.

License-2

12. "LICENSE NO 37-30-2

Item #1. Contrary to 10 CFR 20.201(b), "Surveys," surveys conducted in the Americium Laboratory were not adequate to evaluate the concentrations of americium 241 to which employees were exposed during decontamination operations which were performed in that area from June to October, 1967. We note that while air samples were taken in the Americium Laboratory during this period, the results of such samples were not immediately reviewed and evaluated to determine the hazards incident to this operation. As a result, many individuals were exposed to airborne concentrations of americium 241 in the Americium Laboratory in excess of the limits specified in Table I, Column 1, Appendix B of 10 CFR 20 during the June-October 1967 period."

Licensee's Reported Corrective Action

13. The licensee explained the reasons for past noncompliance and stated additional measuring equipment was obtained and that prompt analysis and reporting of results is now in progress.

ITEM 6 CONT'D

✓(a) no evaluation or surveys were made for one person in the restricted Tritium Building who used 1000 Ci tritium once monthly to prepare tritiated metal foil and once yearly to prepare tritiated tritide. (See paragraph 72 of report details.)

*Safety Item*  
(b) improper evaluation of the exposure of persons to concentrations of tritium in air in restricted tritium facilities because of urine analysis which gave results 30% too low and to which a + 10% "fudge factor" was applied without a proper evaluation. (See paragraphs 25, 26, 40 and 70 of report details.)

✓ 20.106(a), "Concentrations in effluents to unrestricted areas."

- Tritium stack released for the first six months of 1968, when averaged over a year, have exceeded concentrations as shown in Appendix B, Table II, Col I, for the Tritium Building, Gas Fill Facility and the Resin Incorporation Facility. (See paragraphs 18 - 20, 22 and 27 of report details.)

✓ License Condition 18

- Contamination limits set forth on pages 13 - 15 of the licensee's SOP 27, included as part of the above license condition, have been exceeded. (See paragraphs 45 - 50 of report details.)

License -7

20.201(b) "Surveys"

- Inadequate evaluations of releases of concentrations of tritium gas and water from exhaust stacks to unrestricted areas were made to determine compliance with 10 CFR 20.106(a); Deficiencies noted were use of "Sutton's Equations" to determine wind dispersal without a prior meteorological determination of wind velocity and direction, and analysis of tritium impinger water stack samples which appear to have given concentration results 30% too low. (See paragraphs 25 - 33, 53 and 54 of report details.)

20.201 "Surveys"

- Inadequate evaluations and surveys were made to determine compliance with 10 CFR 20.103(a), "Exposure of individuals to concentrations of radioactive materials in restricted areas," in that

✓(a) no evaluation was made to determine potential exposure to Rn-222 for janitors decontaminating the Radium Screening Facility. (See paragraphs 63 and 64 of report details.)

*Safety Item*  
(b) Urine analysis for tritium made to determine exposure of individuals to concentrations in air were inadequate in that urinalyses results were only 70% of true concentration and a 10% "fudge factor" was applied to analytical results without evaluation as to its proper use. (See paragraphs 25, 26, 40 and 70 of report details.)

? 20.106(a)

- in that the licensee, by his stack release during the first six months of 1968 from the Tritium Hand Paint Facility has exceeded the concentration he may release to unrestricted areas when averaged over a year. (See paragraphs 20 and 27 of report details.)

✓ License Condition 17

- in that the licensee at times exceeds the contamination limits set forth in pages 13 - 15 of his SOP-27 included as part of the license condition. (See paragraphs 55 - 57 of report details.)

**COMPLIANCE INSPECTION REPORT**

*B.I*

1. Name and address of licensee  UNITED STATES RADIUM CORPORATION 4150 Old Berwick Road Bloomsburg, Pennsylvania 17815	2. Date of inspection July 8 - 12, 1968
	3. Type of inspection Reinspection
	4. 10 CFR Part(s) applicable  20-30

5. License number(s), issue and expiration dates, scope and conditions (including amendments)

See previous reports.

6. Inspection findings (and items of noncompliance)

An announced inspection was made July 8 thru 12, 1968. Items of noncompliance noted at our last previous inspection were reviewed, as well as use of material, personnel monitoring, air surveys and contamination surveys. Managerial control was also examined. Items of noncompliance observed or noted as a result of the inspection are as listed below:

License -2

20.201(b), "Surveys"

- inadequate evaluations were made of releases of concentrations of tritium gas and water from exhaust stacks to unrestricted areas to determine compliance with 10 CFR 20.106(a). Deficiencies noted were use of "Sutton's Equations" to determine wind dispersal without a prior meteorological determination of wind velocity and direction, and analysis of tritium impinger water stack samples which appear to have given concentration results 30% too low. (See paragraphs 25 - 33 of report details.)

*Safety*

✓ 20.201(b), "Surveys"-inadequate evaluation to determine compliance with 20.103(a) in that:

(continued)

7. Date of last previous inspection  NOV 1967	8. Is "Company Confidential" information contained in this report? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> (Specify page(s) and paragraph(s))
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DISTRIBUTION:

*Richard G. Gelber*  
 Eugene Epstein  
 (Inspector)

Approved by: *Richard G. Gelber*

Paul R. Nelson, Senior Radiation Specialist  
 (Operations office)  
 Region I, Division of Compliance  
 AUG 7 1968  
 (Date report prepared)

If additional space is required for any numbered item above, the continuation may be extended to the reverse of this form using foot to head format, leaving sufficient margin at top for binding, identifying each item by number and noting "Continued" on the face of form under appropriate item.

RECOMMENDATIONS SHOULD BE SET FORTH IN A SEPARATE COVERING MEMORANDUM

*RJ*  
*HP*

37-30-2

37-30-7

DIVISION OF COMPLIANCE MONTHLY REPORT, JULY 1968

U. S. Radium Corporation, Bloomsburg, Pennsylvania - A reinspection revealed improvements in equipment, supervision, and instrumentation.

Specifically, alterations had been made in the americium facility to facilitate the safe changing of filters and glove box gloves. Breathing zone samples indicated no employee was being exposed to average concentrations in excess of the Part 20 limit. Improved contamination control in the tritium hand paint facility has been achieved by using protective paper, changing it twice daily, altering the facility such that only one door is available for entrance and egress, and providing a person for continuous health physics surveillance. Tritium urinalyses of employees show generally low results.

Although the licensee has conducted a comprehensive survey of tritium stack effluents, the previous item of noncompliance for failure to evaluate tritium effluent concentrations to unrestricted areas still remains uncorrected. This is the result of the use of diffusion equations without prior meteorological data, improper evaluation of restricted-unrestricted areas, and use of analytical results which appear to be 30 percent too low.

Additional uncorrected items of noncompliance noted during the inspection were the failure to properly evaluate exposure to air concentrations of Rn-222 to persons who enter a highly contaminated former radium screening area and exceeding the contamination limits set forth in the license.

Because of the improvements noted in management's attitude, administrative controls, and supervision of employees, no serious hazard is believed to exist. Region I (Newark) plans to transmit the case to Headquarters for enforcement action.