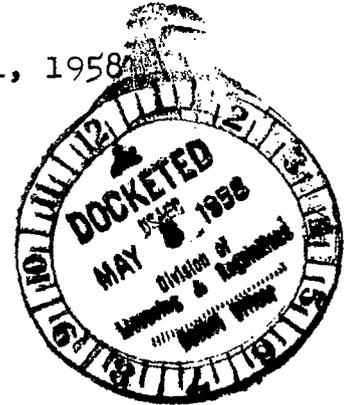


S.F. APPLIANCES LIMITED

105 STATE STREET, • PATERSON, NEW JERSEY, U.S.A.

Cables: SUFLACO
Telephone: ARmory 1-1658

May 1, 1958



United States
Atomic Energy Commission
Washington 25, D.C.

Attention: Mr. J. C. Delaney
Chief, Materials Section
Licensing Branch
Division of Licensing & Regulation

Gentlemen:

We refer to our former letter of March 25th about the renewal of our source material license to manufacture incandescent mantles.

Attached is the original copy of an inspection report on our Morris, Illinois plant, for compliance with "Standard for Protection Against Radiation," 10 CFR, Part 20. If the actual data, calculations, etc. are required these are available on request.

The required signs and labels will be obtained and posted in the necessary areas, in both the Morris, Illinois plant and in our warehouse in Paterson, N. J.

Personnel instructions will be given to present and future employees, and records of surveys made and of personnel monitoring will be kept.

Aside from the above mentioned minor changes we interpret this report to reveal that gamma and air-borne radioactivity levels are low in the Morris, Illinois plant.

We trust the receipt of this report will soon lead to an extension of the present expiration date of our source material license D-170.

Yours very truly,

S. F. APPLIANCES, Limited

C. G. Shears
Vice President

CTS/cum
Enc.

(12) A-12

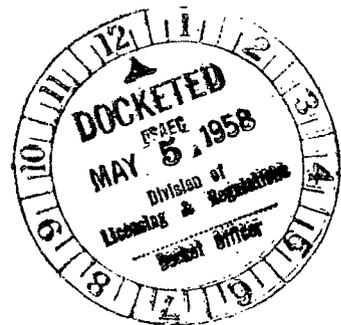
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INSPECTION OF S. F. APPLIANCES LTD. MANTLE PLANT AT
MORRIS, ILLINOIS, FOR COMPLIANCE WITH "STANDARD FOR PROTECTION
AGAINST RADIATION," 10 CFR PART 20

R. S. Landauer

H. E. Kremers

April 22, 1958



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INSPECTION OF S. F. APPLIANCES LTD. MANTLE PLANT AT MORRIS,
ILLINOIS FOR COMPLIANCE WITH "STANDARDS FOR PROTECTION
AGAINST RADIATION," 10 CFR PART 20

R. S. Landauer, Consultant on Radiation, Graemere Hotel, 3400 W. Washington
Blvd., Chicago 34, Illinois

H. E. Kremers, Lindsay Chemical Company, West Chicago, Illinois

April 22, 1958

(1) INTRODUCTION

An inspection of the Morris, Illinois, mantle plant was made on April 11, 1958. At the time of the inspection, the plant was operating normally. Fourteen people were employed at the time of the inspection.

The plant is housed in a three story brick building. Housekeeping was acceptable.

In this plant, the only radioactive material used is thorium nitrate. This is obtained in 200 lb. fiber drums from the Lindsay Chemical Company at West Chicago, Illinois. Recent usage has been on the order of 200 to 500 pounds of thorium nitrate monthly resulting in an average production of about 30,000 mantles weekly (1.5 million mantles yearly).

In determining compliance with 10 CFR Part 20, attention was, therefore, given only to those limits specified for thorium. Determination of compliance was made by measuring gamma radiation levels and air-borne alpha activity levels. Measurements of beta activity were not required since beta emission from natural thorium is small compared to gamma activity, and compliance with maximum permissible gamma radiation levels automatically indicates compliance with beta permissible levels.

Most of the actual measurements were made by Mr. Edward Maryniw, radiation technician for Lindsay Chemical Company.

(2) PROCESS RESUME

The process for making mantles consists essentially of the following steps:

1. Rayon thread is knitted into a continuous open mesh seamless hollow webbing by automatic knitting machines.
2. Lighting solution is prepared by dissolving thorium nitrate in water in the ratio 72 pounds thorium nitrate in 9 gallons water. This is done in a 30-gallon stainless steel tub equipped for mechanical agitation with

a stainless steel propeller type mixer. The tub is covered during mixing.

3. Webbing packed in knit open mesh nylon bags is soaked in the lighting solution in the tub, drained, and excess solution removed by centrifugation in a covered standard laundry type suspended basket centrifuge. The centrifuge liquor is returned to the tub. In handling the wet impregnated webbing, the operator wears rubber gloves and an apron.
4. The impregnated webbing is air dried overnight by draping it on a stainless steel rack.
5. The dried webbing, still on the drying rack, is placed in a closed chamber and partially denitrated by treating it with pyridine vapor in a steam atmosphere.
6. The partially denitrated webbing is then packed in open mesh nylon bags and denitration completed by soaking in dilute morpholine-water solution. The excess solution is removed by centrifugation in the laundry centrifuge, and the webbing is washed three times in distilled water. After each wash, the webbing is centrifuged.
7. The denitrated webbing is then dried on racks at room temperature, pressed, and if of a very loose knit, is sized with a weak cellulose nitrate lacquer solution.
8. The webbing is spooled, and is then sewed on a sewing machine which automatically gathers, sews, and cuts the webbing into short pieces with one end sewed shut. Rayon thread impregnated with thorium nitrate and denitrated is used for sewing.
9. The cut, sewed pieces are fastened together by the sewing thread, and these are cut apart.
10. The sewed mantles are turned inside out by hand and cardboard forms inserted. They are then pressed in a standard laundry steam heated clothes press.
- 11.1 "Head hardening" solution (a mixture of alkaline earth salts and red dye in water) is applied by hand stamping to the open end of "head" of the mantle.
12. The "head" end is turned by hand and an asbestos thread sewn into the hem.
13. The finished mantle is stamped with a trademark and packed in polyethylene bags for shipment.
14. Mantles are shipped in corrugated fiber board cartons containing 5,000 or 10,000 mantles each.

(3) METHOD FOR GAMMA RAY MEASUREMENT

Gamma ray activities were measured with a portable geiger survey meter. The instrument used was a Nuclear-Chicago Model 2612 meter having three ranges showing full scale readings of approximately 0.2, 2, and 20 mr/hr.*

*mr/hr - milliroentgens per hour. As used in this report, it refers to hard gamma radiation.

The meter had recently been calibrated against a known radium standard, and all readings reported here are corrected for this calibration and include normal background. The background at Morris, Illinois, was 0.03-0.06 mr/hr.

(4) METHOD FOR AIR-BORNE ALPHA RADIATION MEASUREMENT

The method used was patterned after that developed by the New York Operations Office of the Atomic Energy Commission.

Sampling was of two types: Breathing zone (BZ) samples of air were taken at the place of work occupied by the worker, and represent air breathed by the worker. General air samples (GA) represent air samples taken in the vicinity of work operations, for example in the center of the work area.

The sampling and test procedure was as follows: A known rate of air, measured with a calibrated rotometer, was pumped through a 1-1/4 inch diameter No. 41 Whatman filter paper circle for a known length of time. Standard rate and time conditions were 35 liters per minute for 15 minutes. The filter papers containing any airborne activity adhering to dust particles in the air were allowed to stand for one week to allow short-lived thorium daughter products and radon to decay, and were then counted for alpha activity.

Counting was done in a scintillation counter having approximately 2 pi geometry. The counter and scaler used were calibrated against a standard U-238 alpha source. The counter is sensitive only to alpha radiation. The alpha counts per minute obtained from the filter paper samples were converted to disintegrations per minute based on the counter calibration, and this data with the air sample time and rate was used to calculate the concentration of alpha activity in the original air sample.

The results are expressed as a factor of the maximum permissible dose for natural thorium (XML), and this is based on the maximum dose of 100 alpha disintegrations per cubic meter of air per minute for restricted areas.

Background alpha activity was measured both at West Chicago and at Morris on the same day the samples were taken. The background at Morris showed no observable alpha activity, so no correction for background was necessary. Background at West Chicago for three samples averaged 0.007 XML for restricted areas.

4.5 X 10⁻¹
 4.5 X 10⁻¹
 4.5 X 10⁻¹

(5) RADIATION LEVELS

(a) GAMMA RADIATION. Measurements gave the data in the following table:

Gamma Radiation Levels

<u>Item</u>	<u>Description</u>	<u>mr/hr</u>
1	200 lb. drum of thorium nitrate, reading at drum surface	20
2	Thorium nitrate impregnating solution, reading at outside surface of tub	10
3	Washed impregnated webbing on drying rack	1
4	Sizing webbing with lacquer	0.06
5	Wet, washed impregnated webbing	0.04-0.05
6	Loose mantles in stock	2
7	Aisle in mantle storeroom	1
8	Mantles packed for shipment:	
	(a) Fiberboard carton approx. 1.5 x 1.5 x 2 Ft. cube containing 5,000 mantles	
	..... at surface	2
	..... at 1 meter from surface	0.1*
	(b) Fiberboard carton approx. 2 x 2 x 2 Ft. cube	
	..... at surface	2
	..... at 1 meter from surface	0.15*
	(c) Stack of 10 cartons of 5,000 mantles each, reading in center of cubical stack	4
9	Hand operations on mantles	
	..... at surface of mantles	2
	..... in working area	0.5
10	Hand of Mrs. Lois Nelson after 2 hours work sewing mantles	0.03**
11	Average in area where impregnation done	0.5

*Background at testing site was 0.06 mr/hr.
 **No observable increase in background with meter probe grasped in worker's hand.

The highest average gamma radiation level observed in the general area where sewing and the subsequent hand finishing steps were done in making the mantles was about 0.3 to 0.4 mr/hr. For a 40 hour week, this would indicate a dose of 12-16 mr, or 12 to 16 per cent of the acceptable limit of 100 mr per week for total body radiation.

Gamma activity in the area where impregnation is done was about 0.5 mr/hr, and the average occupation time in this area is about 2 hours daily.

The highest gamma activity was at the surface of drums containing thorium nitrate (20 mr/hr). Regardless of the quantity of thorium nitrate, self shielding limits the activity at the surface to about 20 mr/hr. Occupation time for the area in which thorium nitrate is stored is less than 5 hours per week, and this could contribute an additional 5 mr to the probable average exposure of 12 to 16 mr per week.

(b) AIR-BORNE ALPHA RADIATION. Measurements gave the data in the following table. The type of sample is indicated by BZ for breathing zone and GA for general air sample. Data is expressed as the fraction of the maximum permissible dose for natural thorium (XML); for example, XML = 0.02 means 2 per cent of the maximum dose.

AIR-BORNE RADIATION LEVELS

<u>Lindsay Sample Number</u>	<u>Type Sample</u>	<u>Description</u>	<u>XML</u>
2130	BZ	Impregnated webbing rack being taken out of pyridine denitration chamber	0
2131	BZ	Webbing being sewn and cut	0.02
2132	BZ	Hood used for sizing webbing with lacquer	0
2133	BZ	Cutting webbing after sewing	0
2134	BZ	Packing unsized mantles	0
2135	GA	Packing mantles	0
2136	BZ	Centrifuging excess thorium nitrate solution from impregnated mantles	0
2137	GA	Exhaust air from denitration chambers ..	0.02
2138	BZ	Centrifuge loading with wet impregnated mantles	0
2139	BZ	Turning and ironing mantles	0
2140	BZ	Centrifuge being loaded with impregnated webbing	0
2141	BZ	Applying head hardening to mantles	0
2142	GA	Knitting room	0

(6) COMPLIANCE WITH 10 CFR PART 20.

(a) Gamma radiation. The average indicated exposure to gamma radiation is probably less than 20 mr per week. The present maximum dose is 300 mr per week, and this will shortly be lowered to 100 mr per week. Therefore, the gamma ray exposures are well under the permissible dose as indicated by measurement with a geiger survey meter.

(b) Air-Borne Alpha radiation. The data taken show that the plant area is well below the maximum permissible levels. The highest level recorded was 2 per cent of the permissible maximum.

(c) Personnel monitoring. Although the gamma and air-borne data show that radiation levels are below those required for personnel monitoring (one-quarter of the maximum permissible dose), it is recommended that a yearly film badge check be made of employees primarily to obtain a permanent record of gamma exposures. Such a film badge survey need only be run for a 13 week period once a year.

(d) Radiation area. "Radiation area" means any area accessible to personnel in which a dose of 5 mr/hr or more could be received by a major portion of the body of an individual in any one hour, or a dose of 150 mr in any 5 consecutive days. In the plant, it is extremely unlikely that such a dose could be obtained, so the plant does not need to be classed as a radiation area, and no posting of such is necessary.

(e) Air-Borne radioactivity area. Since the levels measured were below 25 per cent of the maximum permissible level, the plant is not classed as an airborne radioactivity area and need not be so posted.

(f) Signs, labels, etc. Paragraph 20.203(e)(2) requires that each area or room where more than 5000 microcuries of thorium is stored or used must be posted with a sign bearing the radiation caution symbol and the words

CAUTION

RADIOACTIVE MATERIAL

In terms of mantles, thorium oxide, and thorium nitrate, 5000 microcuries would be equivalent to 290 lbs. thorium nitrate, or 130 lbs. thorium oxide, or about 120,000 mantles (at 0.5 gram thorium oxide per mantle). Therefore, if any room contains more than 120,000 mantles, or more than 290 lbs. thorium nitrate, it must be posted with the radioactive material caution sign. In addition, if both mantles and thorium nitrate are stored in the same room or area, the total amount of radioactive material may not exceed 5000 microcuries without posting the radioactive material sign.

Paragraph 20.203(f)(2) requires that any container in which thorium is transported, stored, or used in quantities greater than 500 microcuries thorium must be labeled with the sign as above. This amount of radioactivity is equivalent to

12,000 mantles (at 0.5 gram thorium oxide per mantle) or 29 pounds thorium nitrate. Since the largest package of mantles in the plant contains 10,000 mantles, labeling is not required on containers of mantles. Impregnating solutions will contain more than 29 pounds thorium nitrate when made up, so they must be labeled with the radioactive material caution sign.

(g) Instruction of personnel. Paragraph 20.206 requires that personnel working with, or in an area containing radioactive material, be informed of the occurrence of radioactive material, and they must be instructed in the hazards of excessive exposure to such radioactivity and in precautions to minimize exposures. Such instruction is not done, and it is recommended that employees be informed that (1) they are working with materials containing radioactivity in very low amounts, (2) under normal conditions of operation and on the basis of currently accepted permissible doses of radiation, there is no occupational health hazard, (3) radioactive materials should not be ingested; ingestion may be avoided by refraining from putting in the mouth cigarettes, impregnated thread, or other materials containing thorium, and (4) good housekeeping be maintained, for example, in avoiding spillage of thorium nitrate impregnating solutions.

(h) Waste disposal. There is no direct disposal of thorium nitrate impregnation solution into the sewer. The only disposal of thorium materials into the sewer would be the result of clean up operations, and the quantity of thorium thus released to the sewer was unmeasurable, but would be expected to be considerably less than the maximum limits specified.

(i) Records. Permanent records should be kept of radiation surveys and of personnel monitoring data obtained by film badge surveys for each employee.

(7) SUMMARY

General conditions are good in the plant. Gamma and airborne radioactivity levels are low.

The following minor changes should be done to fully comply with with the regulations:

(a) Make yearly 13 week film badge surveys.

(b) Signs. If more than 290 lbs. thorium nitrate is stored or used in the webbing impregnation room, the room must be posted with the radioactive material sign.

(c) Labels. Tubs of thorium nitrate impregnating solution must be labeled with radioactivity caution signs. These may be self sticking labels. Labels and signs appropriate for your use may be obtained from Atomic Accessories, Inc., 244-02 Jamaica Avenue, Bellerose 26, New York.

(d) Personnel instruction should be given to present employees and to new employees at the time of hiring. The degree of hazard in working with mantles is small and does not warrant any increase in wage rates.

(e) Records should be kept of surveys made and of personnel monitoring.

H. S. Kramer
Robert S. Landauer Ph.D.