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Personnel Radiation Exposure Records at BNL

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Personnel Radiation Exposure Records at Brookhaven National Laboratory have been set up in such a way as to show both occupational and medical X-ray exposures. The necessary data is accumulated and the records are kept cooperatively by the Medical Department and the Health Physics Division in the manner outlined in the paragraphs that follow.

#### Personnel Monitoring Records of Occupational Exposure

The general features of the system of Personnel Monitoring in use at Brookhaven are explained in the sections of our Safety Manual which are attached to this report as Exhibit 1. The system is patterned after that in use at Oak Ridge National Laboratory with a number of modifications.

The day by day exposure records of individuals with regularly assigned Personnel Monitoring equipment is kept on the card attached as Exhibit 2. The technique of record keeping is illustrated by the hypothetical case of Paul T. Smith BNL Life No. 1516 who was assigned call number B 15 and issued a regular film badge on January 3, 1949. The square for each day is divided in two. The upper part is reserved for pocket chamber entries and the lower half for film densities, open window/shield (blue crayon) expressed in mrep, and neutron exposures (red crayon) expressed in the number of proton tracks/number of tracks constituting a tolerance value. Film badges for this group are read regularly on Mondays (other groups on other days to distribute the work load) and also whenever pocket chambers indicate an overexposure, as on January 12. Other events noted on the card are self-explanatory. A visitor badge may be used, as on January 26, when the regular badge has been left at another area.

All visitors, when issued a film badge, fill out a card (Exhibit 3) that is forwarded to the Personnel Monitoring Group. These are held until the badge is processed and the readings posted, after which the cards are filed by visitors' names. A cross check is made to remove ones who also have regularly assigned equipment as in the preceding paragraph and their exposures posted on Exhibit 2. A daily log of visitors who have been issued personnel monitoring equipment is prepared (Exhibit 4) before the cards for that day are put into the alphabetical file. These log sheets are available for use in investigating unusual situations and for analytical purposes.

Every 6 months, the Exhibit 2 cards will be totalized and the totals transferred to the composite exposure record (Exhibit 8) which will provide space for a 10 year accumulation of data. At this time, totals will be obtained for visitors and also transferred to composite exposure records. The Exhibit 2 cards, composite record cards and other pertinent data relating to exposures are kept in a folder for each BNL employee, this constituting the complete central exposure record for that person.

Exhibit 5 is a form used for recording calibration data. These sheets are filed chronologically by the serial number of the batch of film for which the set of calibration films are used. All films, including the calibration films, are filed according to batch number. Individual films are identified by a system of X-ray marking that shows call numbers and dates or calibration type and value.

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### Medical Records of X-Ray Exposures

The form used by the Medical Department to obtain a medical history at the time of employment (Exhibit 6) contains a question in regard to radiation exposure. If exposure is indicated, further information is solicited. The yearly recheck examination form calls for information in regard to X-ray treatment. The enclosed form (Exhibit 7) currently asks for the pre-employment X-ray history since this was not obtained from present employees during their first examination. This information is now being obtained at the time of the first examination and will be eliminated from the recheck exam in due course.

All X-ray examinations and treatments are logged by the Medical Department on a standard X-ray record form (Exhibit 9). Detailed tables are being prepared for estimating X-ray exposures. These will be looked up by the technician and entered in a column reserved for this purpose.

### Exchange of Records Between Medical and Health Physics

A weekly summary of X-ray exposures is prepared by the X-ray technician and sent to the Personnel Monitoring group of the Health Physics Division. This includes names, dates, parts of body X-rayed and estimated dosages in milli-roentgen. The data in regard to pre-employment radiation exposures and X-ray history obtained in Exhibits 6 & 7 are retained in the files of the Medical Department except where the exposures are out of the ordinary. In such cases, the data is sent to Personnel Monitoring for inclusion in the individual's exposure folder with a notation on his composite exposure record. Any data on current exposures obtained from Exhibit 7 and not already reported, for instance X-ray treatments by outside physicians, are sent to Health Physics.

The routine exposure records of the Personnel Monitoring group are not transmitted to the Medical Department, however, a report will be made in all cases where the exposure is more than the Laboratory tolerance of 250 mrem per week. No such exposures have occurred as yet and no regular form has been established.

### Miscellaneous

All cases where there is an indication of an overexposure for a day or a longer time are reported to the Survey Group using Exhibit 10. The Survey Group makes an investigation and the form is filed in the individual's exposure folder. Space is provided on the back of the Composite Exposure Record cards for explanatory notes. Personnel Monitoring record forms and film have not yet accumulated to the point where storage is a problem.

2/11/49

F. P. Cowan  
O. H. Perry

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PERSONNEL MONITORING

## A. GENERAL PROCEDURES FOR PERSONNEL MONITORING

1. A film badge shall be worn by all persons entering a "radiation area". Two pocket ionization chambers shall be worn in addition to the film badge by all persons to whom a film badge is assigned for more than one day. Radiation areas shall include the Nuclear Reactor - Hot Laboratory Complex the chemistry and physics "warm" laboratories, the "hot" shops, Bldgs. T-5 and T-527 and any other areas where a daily whole body exposure of more than 10 millirem is likely. A film badge containing film sensitive to a neutron flux as well as to beta and gamma radiation shall be worn by all persons in the nuclear reactor - hot laboratory complex and by individuals in other areas when significant neutron exposures are possible.

The establishment of radiation areas in accordance with the definition just given shall be worked out by the Health Physics Officer and the department or other laboratory unit involved. This shall be done in such a manner as to avoid, in so far as possible, having numerous small areas or too frequent changes in location. The confines of all such radiation areas should be clearly delineated and suitable warning signs posted at the entrances. At the discretion of the unit involved, laboratories operating below the level mentioned above may be established as radiation areas for purposes of training or convenience.

It is recommended that a film badge be worn by individuals working with radioactive materials in areas where daily exposures of less than 10 millirem are possible as a precautionary measure. It is also recommended that all doubtful situations be resolved in the direction of using the personnel monitoring equipment. Such equipment will be made readily available with this end in view.

2. A film badge and two pocket ionization chambers shall be worn by all operators of x-ray equipment unless the installations and procedures are known to be such that no appreciable exposure is possible.
3. Personnel outside the Nuclear Reactor - Hot Laboratory complex wearing film badges in accordance with the conditions laid down above and expecting to be subjected to appreciable neutron fluxes should inform the Health Physics Personnel Monitoring Group (Ext. 552) of this fact, so that special arrangements can be made to include neutron recording film in the film badge or to issue boron lined pocket chambers.
4. Pocket chambers and film badges are not to be tampered with in anyway and are intended primarily for monitoring the person to whom they are issued. If personnel monitoring equipment is needed for special experimental purposes, arrangements should be made with the Health Physics Personnel Monitoring Group (Ext. 552).

## B. PERSONNEL EXPOSURE RECORDS - EXPOSURES

1. The Personnel Monitoring records will be maintained under the direction of the Health Physics Officer. These records may be reviewed by responsible scientific or administrative members of the laboratory staff.
2. All cases where film and pocket chamber readings of more than 50 millirem per day are obtained, must be investigated by a member of the Health Physics Staff, and written records of the investigations added to the ex-

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posure files of the individuals concerned. Indicated exposures of less than 50 millirem per day may be investigated at the discretion of the Health Physics Officer.

3. The Health Physics Officer shall inform the individuals concerned and their supervisors of indicated exposures greater than the 50 millirem per day limit. It shall be the responsibility of individuals receiving such reports and of their supervisors, to take such steps as are necessary to prevent recurrences.

### C. RESPONSIBILITY FOR THE ENFORCEMENT OF PERSONNEL MONITORING PROCEDURES

1. It shall be the responsibility of all individuals and supervisors to wear personnel monitoring instruments in radiation areas as defined above and to make certain that radiation conditions outside of such areas do not exceed the specified maximum limit. It shall be the further responsibility of supervisors to ensure compliance in these matters by the people for whom they are responsible.
2. It shall be the responsibility of all persons and supervisors to make available to the Health Physics representative information concerning the type of material to be handled and to see that the Health Physics representative has complete information concerning the name and life number of the individual to whom the personnel monitoring instruments are assigned.

### D. DETAILED PROCEDURES FOR PERSONNEL MONITORING

1. Radiation areas at Brookhaven shall be divided into the following three classes:  
  
Class I - Areas where the issuance and collection of personnel monitoring equipment are closely controlled, such as the Nuclear Reactor - Hot Laboratory complex.  
  
Class II - Areas where there is a check-in to guarantee that all who enter are wearing personnel monitoring equipment, but where such equipment is not restricted to a single area as in Class I above.  
  
Class III - Areas where personnel monitoring equipment is required to be worn but is provided on a self-service basis.
2. Personnel Monitoring equipment for any area in Classes II and III can be worn in and out of all areas in these classes at will. Separate equipment will be required for each area under Class I.
3. It is the intent of the procedures below to afford individuals required to wear personnel monitoring equipment the minimum of inconvenience consistent with the maintenance of adequate control. It therefore follows that these procedures require the cooperation of all individuals required to wear personnel monitoring equipment.
4. Personnel monitoring equipment will be made available for use at the following installations:

- a) Nuclear Reactor - Hot Laboratory Complex

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## PERSONNEL MONITORING

- b) Hot Shops
- c) Chemistry Complex
- d) Biology Buildings as required.
- e) T-197
- f) Physics laboratories as required.
- g) Fire Houses
- h) Police Headquarters
- i) Other sites as required.

### 5. Definitions

- a) Radiation Area - Any area where a daily whole body exposure of more than ten (10) millirem is likely. The Nuclear Reactor - Hot Laboratory complex, the Chemistry and Physics "Warm" laboratories "Hot" shops, Bldgs. T-526 and T-527 are designated radiation area as well as such other areas as may be established under GENERAL PROCEDURES FOR PERSONNEL MONITORING, paragraph A, 1, above.
- b) Film badge - A badge containing film sensitive to Beta and Gamma radiation.
- c) Neutron film badge - a badge containing film sensitive to a neutron flux in addition to the Beta - Gamma sensitive film.
- d) Pocket chambers - pocket ionization chambers
- e) Racks - Boards or similar devices on which either type of film badge and pocket chambers can be placed.
- f) Call number - that number preceded by a letter or letters to designate location and identification of film badge.
- g) Visitors - those individuals not regularly assigned personnel monitoring equipment.

6. Racks are available in the locations listed above. Each film badge is identified by a call number assigned to an individual. This call number also appears on the rack to facilitate replacing the film badge and pocket chambers at the correct location. The individual's name and life number is also shown on the film badge to facilitate identification.

Pocket chambers that have been worn during the day are read that night and pocket chambers ready for use are issued prior to the beginning of the next day's work.

For the majority of film badges the films are exchanged once a week, fresh film installed, the old film developed and radiation dosage determined. Film badges for the Police and Fire Departments will be processed every two weeks unless a known exposure occurs in which case the film will be changed and processed as soon as possible thereafter. Visitors film badges are processed as soon as possible after turn in.

## PERSONNEL MONITORING

### 7. Visitors

The term "Visitors" includes persons in the following categories.

- a) Off-site personnel
- b) On-site personnel not regularly assigned personnel monitoring equipment.
- c) Consultants

Visitors will ordinarily be issued personnel monitoring equipment for only one day and therefore will be required to wear only a film badge. This badge must be obtained at a designated location for each radiation area before entering.

The wearing of badges from area to area is governed by the same procedures as given above in section D-2 for regularly assigned badges. The visitors badge should be turned in at the last radiation area visited but if this is not convenient may be left at the guard gate before leaving the site. Film badges for visitors may be obtained at the following locations:

Nuclear Reactor - Hot Laboratory Complex - from guard on duty

Hot Shops - from guard on duty

T-197 - from guard on duty

Chemistry - As indicated by signs at such radiation areas as may be established.

Biology - From Dr. Nims' secretary for T-127 and T-128. As indicated by signs at other areas when established.

Physics - a) Calibration Building, T-121 - from supervisor or designated technician

b) Nuclear Moments Lab, T-472 - from Dr. Cohen or one of his assistants for the present. From clerk at area entrance when provided.

When an off-site visitor receives personnel monitoring equipment, the visitor pass (Form ENL 133A) will be stamped to the effect that personnel monitoring equipment was issued. A space will be provided so that when such equipment is turned in, the space will be initialled by the receiver. Upon leaving the lab site, the visitor clearance form is surrendered at the gate as is now normal procedure. If the pass indicates that personnel monitoring equipment was issued and not turned in, the guard will ask for the equipment. Personnel monitoring equipment is not to be taken off site without the written permission of the Personnel Monitoring Group Leader.

If a visitor expects to be in one radiation area from time to time over a

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period of three consecutive days or more, the Personnel Monitoring Group (Ext. 552) should be notified by the Department or Division concerned so that regularly assigned personnel monitoring equipment (film badge and two pocket chambers) can be provided. This service will be furnished for a definite period only if specified, or for an indefinite period. In the latter case, the Department or Division concerned should notify the Personnel Monitoring Group of the departure date when determined.

### 8. Operations at each of the establishments.

#### a) Nuclear Reactor - Hot Laboratory complex

Since this area is both a "Radiation Area" and "Classified Area", the neutron film badge will be used as a security check at the three entries through which normal entry and egress are made. Security has specified that in order to have an accurate check of each individual permitted regular access to this area, the individual will be assigned to check in either at the entry to the Nuclear Reactor Building or at the entry to the Hot Laboratory. For similar reasons, exit from the area must be made through the same assigned portal.

Upon arriving at the assigned entry, the individual who is regularly assigned to work in this area, will inform the guard of his call number and present the Brookhaven Identification Card. After proper clearance has been determined, the guard will then issue two (2) pocket chambers and a neutron film badge from the rack - first checking to be sure that the security card number is the same as the number shown on the badge. Upon leaving the area, the individual will leave his personnel monitoring equipment with the guard who will then place it in the proper location on the rack.

Visitors desiring to enter this area can obtain personnel monitoring equipment at either the Nuclear Reactor entry or the Hot Laboratory entry after having received the proper security clearance from the guard on duty. Security has stipulated that visitors leave via the entry by which they entered the area. Upon leaving, they will surrender their personnel monitoring equipment to the guard on duty.

Truck drivers, their helpers, etc., delivering supplies and equipment by truck will first obtain permission to enter the area and obtain personnel monitoring equipment from the guard on duty at the Nuclear Reactor entry and will then proceed to the truck gate.

Upon leaving the area personnel monitoring equipment will be surrendered to the guard at the truck gate. At the truck gate, a rack is provided upon which the guard will place the personnel monitoring equipment.

Until such a time as the facilities of the Pile Maintenance Building are in operation, Laboratory maintenance crews, etc., who are not permanently assigned to this area will obtain personnel monitoring equipment from the guard on duty at the Nuclear Reactor entry. Upon leaving the area with the intent to return to the area the same day, personnel monitoring equipment will be surrendered to the guard at

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## PERSONNEL MONITORING

the Nuclear Reactor entry. Upon leaving the area without the intent to return the same day, personnel monitoring equipment will be surrendered either to the guard at the Nuclear Reactor entry or to the guard at the truck gate. In the event an employee returns to this area the same day, the same badge and pocket chambers will be reissued by the guard at the Nuclear Reactor entry.

A neutron film badge and two (2) pocket chambers will be worn by everyone entering this area. A film badge obtained in another area will be left with the guard at the Nuclear Reactor or Hot Laboratory entrance and picked up upon departure. Pocket chambers brought from another area may be worn, in which case, additional pocket chambers will not be issued unless desired.

### b) Hot Shops

Personnel monitoring equipment will be made available on a self-service basis. The guard on duty will insure that all regularly assigned personnel to this building take their personnel monitoring equipment from the rack upon entering and also that the personnel replace the equipment upon final departure for the night. The guard will also insure that all visitors are equipped with a film badge before entering and that personnel from other radiation areas are equipped with film badge and pocket chambers.

Visitors to this area are required to wear a film badge and can obtain it from the guard on duty. The film badge need not be turned in to the guard upon leaving this area if the visitor intends to visit other radiation areas the same day.

### c) Chemistry Complex

The personnel monitoring arrangements for Chemistry are incomplete and subject to revision as the facilities and personnel of the department are expanded. The Chemistry "warm" laboratory and nuclear moments laboratory, T-471 and T-472 respectively are currently the only radiation areas projected for this group of buildings but others may be set up under the terms of the above General Procedures, paragraph A1. Plans call for the establishment of T-471 and T-472 as a single area with a single personnel entrance and a clerk to issue personnel monitoring equipment to visitors. The clerk will also check to see that all who enter are properly equipped with personnel monitoring equipment. Suitable racks for regularly assigned personnel will be provided.

Until such time as the permanent arrangements just described are made, regular personnel of buildings T-471 and T-472 will obtain personnel monitoring equipment on a self service basis from racks in the individual buildings. Equipment must be worn by all and returned to the racks at night. It may be worn in and out without restriction during the day.

Visitors to these buildings are required to wear a film badge which may be obtained from a designated location in each building. Such visitors' equipment may be returned to the racks on leaving or worn to other parts of the Laboratory if desired.

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## PERSONNEL MONITORING

### d) Biology - Buildings

In order to maintain control of personnel monitoring equipment, buildings T-127 and T-128 consist of one area with one rack for film badges and pocket chambers. This rack is located in T-127. Building T-463, when it becomes a radiation area, will have a rack located there for those personnel normally assigned to work in that area. Each of these racks will operate on a self-service basis. Individuals will pick up their personnel monitoring equipment each morning before work and replace it upon final departure at night.

Visitors will obtain a film badge from Dr. Nims' secretary in Building T-127 or from someone to be designated later in Building T-463. Visitors leaving these areas need not turn in their equipment to these offices if there is intention to visit other radiation areas the same day.

### e) T-197

Personnel monitoring equipment is required only in certain designated parts of this building. The equipment is available on a self-service basis. Individuals required to wear personnel monitoring equipment will pick up their film badges and pocket chambers from the racks each morning and replace them upon the racks on final departure for the night.

Visitors desiring to enter a radiation area in this building are required to wear a film badge which may be obtained from the guard on duty. The equipment need not be turned in to the guard upon leaving this area if the visitor intends to visit other radiation areas the same day.

### f) Physics Laboratories

Although it is not contemplated that each of the laboratories of the Physics Department will be a "Radiation Area" in its entirety, it is possible that infrequently a portion of a certain laboratory will become a "Radiation Area" for a limited or longer length of time, in which case personnel monitoring equipment will be worn by individuals in the area.

Racks are currently provided in the calibration building, T-121, and in the Nuclear Moments Laboratory, T-472.

Racks and personnel monitoring equipment will be made available on a self-service basis in other locations when required. The Personnel Monitoring Group (Ext. 552) should be notified in advance insofar as possible so that film badges and pocket chambers will be supplied. Individuals required to wear personnel monitoring equipment will pick up their film badges and pocket chambers from the rack each morning and replace them upon final departure for the night. When the personnel monitoring equipment is no longer required, the equipment will be removed from the racks and stored in Building T-145.

Visitors' film badges will be available at the following installation:

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1. Calibration Building - T-121  
Contact supervisor or one of his assistants
2. Nuclear Moments Laboratory - T-472  
Contact Dr. Cohen or one of his assistants

Visitors need not turn in their equipment when leaving the area if the visitors intend to visit other radiation areas the same day.

### g) Buildings T-526 and T-527

Personnel monitoring equipment shall be worn by all persons entering either of these buildings. Pocket chambers in addition to the film badge will not be worn by everyone except the police, firemen and persons wearing visitors' film badges. A rack for personnel monitoring equipment is not provided at these buildings.

Visitors will obtain a film badge at one of the locations mentioned in paragraph D-7 above and may turn it in to any one of the areas mentioned therein.

### h) Fire Department

A rack with sufficient badges is available at each fire house. The shift chief will insure that each man reporting for duty picks up his film badge from the rack and returns the badge to the proper location on the rack when going off duty.

As soon as practical after a fire either in a radiation area or in an area where radioactive materials are stored, the shift chief will notify the Personnel Monitoring Group (Ext. 552) that the badges are available for changing the film.

Inasmuch as films are damaged by water, other liquids and excessive heat, etc., it is preferable that the film badge be worn in a protected area where possible.

### i) Police Headquarters

The Laboratory police are required to wear film badges while on duty. A rack with sufficient film badges is available at Police Headquarters. The duty sergeant will insure that the men on his shift not obtaining badges in a radiation area to which they are regularly assigned will pick them up before going on duty and will insure that the film badges are returned to the proper location upon going off duty.

Guards assigned to the Nuclear Reactor - Hot Laboratory complex for periods of three (3) consecutive days or more will have neutron film badges and pocket chambers assigned to them at the entry of the Nuclear Reactor Building. Guards assigned to this area for periods of less than three consecutive days will utilize visitors' equipment.

For guards assigned to any other radiation area for three (3) or more consecutive days, film badges and pocket chambers will be made available on the rack in that area.

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## PERSONNEL MONITORING

The duty sergeant will insure that the Personnel Monitoring Group (Ext 552) is notified in advance insofar as possible so that arrangements may be made to have personnel monitoring equipment available for policemen stationed three consecutive days or longer in a radiation area.

### 9. Maintenance Personnel

All maintenance personnel (except janitors) when required to enter a radiation area will follow the procedures for visitors as set forth in paragraph D-7 above. Personnel required to enter a radiation area such as buildings T-526 and T-527 where no facilities have been set-up to issue visitors badges, can in addition to the locations listed in paragraph D-7 obtain a visitors' film badge from the Personnel Monitoring Group, Bldg. T-145.

Janitors, on day or night shift, whose normally assigned work area is within a radiation area, will be issued film badges and two pocket chambers by their supervisor. Personnel monitoring equipment is to be returned to the supervisor at the end of the shift. A rack is provided in the supervisor's office.

Janitors, not normally assigned to work in a radiation area but required to enter one, will be issued a visitor's film badge by their supervisor. The visitor's film badge is to be returned to the supervisor upon completion of the job or at the end of the shift, whichever occurs first.

Janitors at Class I installations will follow the procedures as listed for maintenance personnel under the installation concerned.

EXHIBIT 3

NAME Smith, Paul T.

BNL No. 1516 DATE Jan. 26, '49 BADGE # V32

ADDRESS \_\_\_\_\_

BLDG. ISSUED FROM Chemistry BY D. K. G.

FILM BADGE:	SEN	INS
OW	<input type="radio"/>	
S	<input type="radio"/>	

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WEEK	This page begins Jan. 2, 1949 and ends Feb. 5, 1949							Weekly Totals				
	SUN.	MON.	TUE.	WED.	THUR.	FRI.	SAT.	PM	SEN	INS	NEUTRON	
								TSR	OW	S	OW	S
1	3	4	5	6	7	10/15	8	20/20	60			
2	9	10	11	12	13	14	15	220	210	170		
3	16	17	18	19	20	21	22	80	70	50	50	
4	23	24	25	26	27	28	29	80	150	100		
5	30	31										

This record is intended to show the complete record as indicated by the film badge and pocket chambers for the person named hereon during the time indicated. Symbols are explained below. Nomenclature, color codes, and systems for making entries are defined and maintained in Health Physics permanent records. Subsequent changes (if any) are recorded in permanent records and noted in the "square" of effective date. Supplementary exposure records are filed in the person's exposure folder maintained by Health Physics.

FILM BADGE SYMBOLS: FBI—film badge issued; FBP—film badge picked up; NBI—neutron film badge issued; NBP—neutron film badge picked up; NFB—neutron film added to film badge; BL—film badge lost; BF—badge found; SEN—sensitive film; INS—insensitive film; OW—open window; S—shield; POCKET CHAMBER SYMBOLS: OS—off scale; CM—cap missing; LC—lost chamber; DC—damaged chamber.

**BROOKHAVEN NATIONAL LABORATORY RADIATION EXPOSURE RECORD Exhibit #2**

WEEK	This page begins May 15, 1949 and ends July 2, 1949							Weekly Totals				
	SUN.	MON.	TUE.	WED.	THUR.	FRI.	SAT.	PM	SEN	INS	NEUTRON	
								TSR	OW	S	OW	S
20	15	16	17	18	19	20	21					
21	22	23	24	25	26	27	28					
22	29	30	31	1	2	3	4					
23	5	6	7	8	9	10	11					
24	12	13	14	15	16	17	18					
25	19	20	21	22	23	24	25					
26	26	27	28	29	30	1	2					

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Smith, Paul T.

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