PRNC - 6
(Health Physics)

PROCEDURES MANUAL FOR PERSONNEL MONITORING

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Operated by
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PUERTO RICO NUCLEAR CENTER
Operated by
UNIVERSITY OF PUERTO RICO
for
U. S. ATOMIC ENERGY COMMISSION

AUTHORIZATION

This Procedures Manual for Personnel Monitoring has been reviewed and approved by the Safety Committee. It is hereby approved and made operative as of April 30, 1964.

John C. Bugher

John C. Bugher, M.D.
Director

PROCEDURES MANUAL FOR PERSONNEL MONITORING

INTRODUCTION

In all installations where external or internal exposure to radiation may occur as a result of handling or using radioactive materials and sources of radiation a Radiation Safety or Health Physics group is organized. One of the functions of this group is the safeguard of personnel, the calculation of radiation exposures, record keeping of such exposures and counseling as to the best methods for protection from radiation.

In personnel monitoring several devices or instruments are used, of which the most practical ones are the pocket-type ionization chamber and the film badge dosimeter.

The procedures and techniques presented in the following pages have two purposes: To provide standard techniques on personnel monitoring resulting in reliable records of personal exposure and to provide instruction for new employees as well as training for participants in various programs offered by the Puerto Rico Nuclear Center.

SECTION I

I. 1 Personnel Monitoring Devices, Description and Use.

There are a number of personnel monitoring devices, all of which have a definite use for a particular type of work with radioactive material, with the purpose of gathering information in regard to exposure dose received by personnel. These devices shall be worn as indicated. Failure to do so will be detrimental mainly to the wearer.

A. Film badges - these badges, made of plastic about 1 1/4 x 1 3/4 inches in size, have a beta-gamma film only or a beta gamma film and a neutron one depending on the need.

1. Types - three types of badges will be assigned.

a. Permanent badges - these have a picture of the person to whom it is assigned in the front, with the badge number at the top of the picture. The serial number is preceeded by a set of capital letters indicating the area where the badge is used and its permanent status. The following set of letters has been assigned so far:

a) MP - Mayaguez permanent badge
b) RP - Rio Piedras permanent badge

b. Temporary badges - these are similar to permanent badges but they do not have a picture of the wearer. Instead, the name of the person is typed in a white cardboard front with the badge number at the top. The serial number is preceeded by a set of capital letters indicating the area where the badge is used an its temporary status. The following set of letters has been assigned so far:

a) MT - Mayaguez temporary badge
b) RT - Río Piedras temporary badge
c) CT - Cancer Hospital temporary badge

Note:
CT badges have been assigned to Cancer Hospital employees to differentiate them from the PRNC employees which are either RP or RT. Although the badge bears letters suggesting temporary status it is meant merely to provide identification regardless of their permanent or temporary status in the institution for which they work.

c. Short term badges - these badges have a yellow cardboard front with the serial number typed at the top. This number is preceded by a set of capital letters indicating the area where the badge is used an its short-term status. The following set of letters has been assigned so far:

a) MS - Mayaguez short - term badge
b) RS - Rio Piedras short-term badge

2. Due to the diversity of facilities in PRNC a color coding scheme is used for safety and operational purposes. Badges will have a red, yellow, or green stripe in the bottom front depending on the wearer's duties and needs.

3. Regardless of type of badge, this shall be worn with the serial number toward the front.

4. The badges shall be worn somewhere between the chest and waist level outside of all clothing.

5. Permanent and temporary badges shall be picked up from a badge rack located in the main lobby when entering the installation. The rack is numbered serially to correspond with the film badge. Badges shall be returned to their proper place in the rack on leaving the installation.

6. Short-term badges are supplied by the receptionist and in special cases, by the Health Physics Division directly. On leaving the installation the wearer shall return the badge to the receptionist or to the rack if he is staying more than one day.

7. Besides radiation, films are sensitive to a certain extent to humidity and changes in temperature, therefore, the badges shall never be tampered with, taken home, left in the drawers, near radiation sources or on top of cold or hot surfaces, etc. If this is done, an erroneous reading may be recorded for the person to whom the badge was assigned.

B. Pocket dosimeters - these are self-reading pen type electroscopes.

1. These will be used by personnel working in radiation areas where the possiblity exists of getting an exposure dose greater than 60 millirems of X or beta-gamma radiation in 8 hours (See Table I for Maximum Permissible Exposures to External Radiation).

2. Pocket dosimeters shall be placed in boxes clearly marked "Dosimeters". Such boxes shall be located in the:

   a) Lobby dosimeter rack (Mayaguez and San Juan)
   b) Reactor building main entrance door
   c) Annex building hall

3. Personnel using pocket dosimeters shall be instructed by their supervisors on how to read them and when to use them.

4. Whenever such a dosimeter is to be used the person interested should pick one from the box, write down in a slip of paper provided for, his full name, number of dosimeter, initial reading of dosimeter and date.

5. When leaving the area the wearer shall read the dosimeter record its final reading in the slip of paper, attach the slip to the dosimeter, clip, and return both to its appropriate place. If meter is reading off-scale notify Health Physics Division immediately.
   In case a dosimeter is to be used for more than one day, the wearer should return it to its corresponding place in the rack.

Table I. RECOMMENDED LIMITS OF OCCUPATIONAL EXPOSURE TO EXTERNAL SOURCE OF RADIATION

EXPOSURE TO	CONDITION	DOSE (REM)
Whole body, head and trunk, blood forming organs, gonads, lens of eyes	Accumulated dose	5 (N - 18)*
	13 weeks (quarterly)	3
Skin of whole body and thyroid	year	30
	13 weeks (quarterly)	10
Extremeties	year	75
	13 weeks (quarterly)	25

* N is the age and greater than 18.

Revised: January 2, 1963

6. Pocket dosimeters shall never be handled roughly or left near a source of radiation.

C. Pocket chambers - these devices are similar to pocket dosimeters, except they are not self-reading and have to be read with a special instrument.

1. These will be used by personnel working in radiation areas where the possibility exists of receiving a dose greater than 20 millirems of X or beta-gamma radiation in 8 hours.

2. Pocket chambers shall be used and handled in the same manner as pocket dosimeters.

D. Others

1. The HPD keeps a number of high range pocket dosimeters for emergency cases.

2. Use of audible alarms is required for the operation of certain irradiation facilities such as the gamma room, and reactor facilities. Specific instructions on their use are given in the operating procedure of the facility.

SECTION II

Procedures and Criteria for the Assignment of Personal Monitoring Devices

II.1 Procedure on Arrival to PRNC

A. New Personnel

1. The receptionist will instruct new employees reporting to work for the first time to contact HPD before they are admitted to work.

2. Health Physics will proceed as follows:

a. Request two photographs (2 X 2 inches) from the Administration of new employees if hired for a period of no less than one calendar year.

b. Fill Form PRNC HPD (PM) 602. The division hiring the person will supply the information called for in this form.

c. Fill in a reference blue card (Figure 1) for every person for whom Form PRNC-HPD (PM) 602 is completed. If the person's stay is for more than six months, two cards, a white and a pink one, will be issued, in addition to the blue one. The blue card will be kept in alphabetical order in a file in the HPD Director's office, the pink and white ones in a file in the Record Keeper's office. The white card will be filed by name, while the pink one will be filed by badge number. When a person terminates the pink card can be discarded. The white and blue ones are clipped together and placed in a file drawer headed "terminate" in the HPD Director's Office.

1. Instructions for writing up reference cards

a. Type badge number
b. Type name of person
c. Type division (Reactor, Health Physics, Radioisotopes Application, etc.)
d. Type FMI, FMO, and termination date. FMI is the date when the person shall start wearing the film badge.
FMO is the date when the person stops wearing the film badge or meter.
Termination date is when the person terminates.

d. Issue a provisional badge or pocket chamber until the final badge is assigned, if one is needed. In case a film badge is assigned, its purpose shall be explained to the person.

PUERTO RICO NUCLEAR CENTER
Notice of Arrival and Departure

TO BE FILLED BY SUPERVISOR

	Name	Expected Date of Arrival and Departure	Position	Division
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Supervisor _____ Date _____

	Name	FMI	No.	MI	No.	Remarks
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Note: If no FMI or MI is needed write under FMI and MI no. Explain under remarks. If MI is needed put a check mark under FMI and MI and write film badge number assigned next to FMI. Do the same for pocket meters.

FORM PRNC-HPD (PM)602

MP-001 FMO
John Doe
Health Physics

FMI MO

MI Termination date

Fig. 1

B. Students

1. The receptionist will refer students to the HPD where Form 662 will be filled and the type of badge to be worn determined.

2. Health Physics will proceed with steps c and d of II.1, A, 2 above.

C. Visitors

All visitors shall be interviewed by the receptionist who will decide which type of monitoring device is necessary. In case of doubt, the receptionist will contact HPD.

II. 2 Criteria for Issuance of Personal Monitoring Devices

A. Film Badges

1. All persons associated with PRNC shall wear a film badge. The following badges will be issued depending on their association with PRNC.

a. Permanent badges - are assigned to permanent employees or persons associated with PRNC for a relatively long period of time (one year or more). A permanent badge number shall be assigned to a person for life. It shall never be reassigned to any other person.

b. Temporary badges - are assigned to employees or persons associated with PRNC for a period less than one year, but more than six months. Part-time employees and full time PRNC students are also assigned temporary badges. This badge can be reassigned.

c. Short-term badges - are assigned to employees or persons associated for a short-time (six months or less) with PRNC. They are also assigned to PRNC San Juan Area personnel visiting or temporarily engaged at the Mayaguez Area and vice versa. Students attending classes at PRNC (other than full time PRNC students) also fall in this category. This badge can be reassigned.

2. Criteria for Color Coding

1. Red - persons wearing a badge with a red stripe have access to all facilities within PRNC. Assignment of red badges will be done after consulting with the Reactor Division Head.

2. Yellow - persons wearing a badge with a yellow stripe have access to any facility within PRNC except the Reactor Building, which they can visit provided they are escorted by a person wearing a red striped badge or by previously notifying the reactor supervisor and getting his approval.

3. Green - persons wearing a badge with a green stripe have access to all facilities of PRNC except Reactor Building, laboratories and radiation areas in general which they can visit, provided they are escorted by a person wearing a red or yellow striped badge according to the area visited, or receiving approval from the person working in the area.

B. Pocket Chambers

The receptionist will give pocket chambers to:

1. Individual visitors to offices within a laboratory or visiting an area where they may be exposed.
Prior approval must be had from person to be visited.

2. Employees of service companies (typewriter, telephone, electricity, etc.) after due identification. However, the Division Head shall request a film badge or pocket dosimeter from HPD if this work is to be performed in an area where the serviceman may be exposed to ionizing radiation.

3. One out of every 5 persons of touring groups.

C. Pocket Dosimeters

Will be used by personnel as described in Section 1.1 B.

D. Others

1. The HPD keeps a number of high range pocket dosimeters for emergency cases.

2. Use of audible alarms is required for the operation of certain irradiation facilities such as the gamma room and reactor facilities. Specific instructions on their use is given in the operating procedure of the facility.

II.3 Notification to Interested Person

Upon completion of reference cards and assignment of proper personnel monitoring device the HPD technician in charge of personnel monitoring will notify the interested person using Form PRNC-HPD (PM) 602a.

M_____

Effective_____you have

been assigned FM No._____PM No._____

which is located in the rack in the lobby.

FORM PRNC-HPD (PM) 602a

SECTION III

Procedures for the Distribution, Reading and Collection of Monitoring Devices

III.1 Pocket Meters

A. Distribution - pocket chambers and dosimeters are distributed as follows:

1. Dosimeters used by personnel are routinely charged and distributed weekly, according to section I.B. The slips of paper referred to in Section I.1, B.4-5 with the readings will be collected daily. This will determine if a dosimeter needs to be charged more frequently.

2. Pocket chambers assigned to visitors are read, charged and returned daily to their assigned place in the receptionist's desk.

B. Reading of meters

1. Meter number is recorded in DCWS. (Form 600)

2. For pocket chambers, the reading is recorded in the DCWS before removing meter from charger reader. When dealing with pocket dosimeters, the reading is transferred daily from the slip of paper to the DCWS.

PUERTO RICO NUCLEAR CENTER

PERSONNEL MONITORING

DAILY DOSIMETER AND CHAMBER WORK SHEET

Distributed by:_____

Collected by:_____ Date_____

Recorded by_____

Meter No.	Name	X-Gamma (mr-mrem)	N_t (mrem)	Test	Remarks

FORM PRNC-HPD (PM) 600

3. Rejects

a. Meters reading more than 30 mrems in one 8 hr. day shall be placed in a box marked "Examine".

b. The meter number is entered in the DCWS. Under the corresponding column, record the exposure dose followed by the letter (E) or write (OS) if the meter reads off-scale.

c. Mechanical and leak tests are carried out on the meters and the results are recorded under the column "TEST" of DCWS; M, L - OK shows satisfactory results on both test, M. referring to mechanical damage test and L to leak test. If one of the tests, fails, then an X is written after the identifying letter (M or L), for example, L - OK, M - X means leak test satisfactory, and mechanical damage of the meter.

d. If both tests are satisfactory the meter reading previously recorded will be accepted. In the case of a meter reading off-scale an investigation is started to determine the reason for such a high reading (e.g. the meter was left inadvertently near a radiation source). Use Form 601.

e. If one of both tests show the meter is beyond repair discard it.

C. Procedures for Off-Scale Readings

1. Whenever an investigation for the off-scale reading indicates that a person received more than 200 mr or mrems, the film in the badge shall be removed and processed immediately. The film exposure reading will be entered in column 3 or 4 of DCWS making a note under remarks that such exposure is due to film dosimeter.

D. Miscellaneous

Keep the form DCWS until final results have been obtained and recorded in "Kardex" cards or Short-Term records (see next section).

III.2 Film Badges

A. Collection and Processing

1. Permanent and temporary badges issued, are assigned a place in the rack at the lobby of the building, where they will be kept when not in use. The film shall be collected and processed routinely as follows:

a. Neutron films

(1) twice a month- for personnel that can be exposed to neutrons routinely.

PUERTO RICO NUCLEAR CENTER

Personnel Exposure Questionnaire Information

This report shall be made only after a pocket chamber or pocket dosimeter reading OS has been tested for leakage and mechanical damage and found in good working condition.

Meter No._____ Identification No._____

Date when meter read OS_____

Name_____ Division_____
(Last, First, Middle)

Mechanical damage test satisfactory_____(Yes or no)

Leakage test satisfactory_____(Yes or no)

Film density_____ equivalent to_____rems of

_____radiation.

Neutron tracks/cm^2 equivalent to_____rems of

_____neutrons.

TCD to date when meter read OS (TCD dose obtained from Kardex Records or Short-Term Records).

Estimated exposure dose_____.

Person (s) working in the same area where possible overexposure occurred and meter readings.

Name	FM No.	Reading	Date	Remarks

Description of work performed by person during the day when meter was found OS.

Description of work performed by another person or persons in the same area or nearby area where possible overexposure occurred.

Action taken upon disclosure of possible overexposure.

Is an Investigation Report of Radiation Exposure in process?_____
(yes or no)

Reason: _____

_____

_____.

Investigated by_____Date_____

Approved by_____
Head, Health Physics Division

FORM PRNC-HPD(PM)601

(2) once every three months (quarterly) - for personnel whose duties routinely do not imply exposure to neutrons.

b. Beta-gamma film

(1) once a month - for personnel that can be exposed to these radiations routinely.

(2) once every three months (quarterly) - for personnel whose duties routinely do not imply exposure to these radiation.

2. Short term badges - shall be assigned a place in the rack only when the wearer visits PRNC for more than one day, otherwise, they will be returned to the receptionist. The films shall be collected the same day the person leaves PRNC and are processed together with films of permanent and temporary badges.

NOTE: In special cases films can be processed at an interval other than indicated above.

B. Schedule of Film Processing

The procedure outlined below is to be followed:

1- All films will be processed within 2 days after change date except when this comes on a Friday. In this case wait until first working day in the next week.

2- All films not processed at this time will be designated "not received".

3- If film appears later it will be developed with the next batch.

4- If at the end of this second period the film has not been found record in appropriate form as film lost.

SECTION IV

Records

IV.1 Two types of records will be kept: "Kardex" and Short-Term Personnel Exposure records.
"Kardex" records will be kept only for persons employed, associated or visiting for a period of not less than 6 months. For other persons, exposure records are kept in a different system called Short-Term Personnel Exposure Records.

IV.2 "Kardex" Record Cards - Description

A. The "Kardex" record consists of two "Kardex" cards designated Card A (see figure 2) and Card B (see figure 3). Cards A and B are printed on both sides and provide record space up to 26 weeks or two quarters each.

B. Card A is used to record exposure as obtained from the reading of pocket meters only, while Card B is used to record exposure as obtained from the reading of badge film as well as pocket meter. In the lower left hand corner of Card B on both sides shall be written the name of the person whose record is to be kept. Next, the division to which the person belongs. Then, the film badge number.

C. Transfer of Exposure Reading to "Kardex" Cards

All exposure entries shall be made in pencil. Other entries in ink. No erasures are allowed. If a mistake is made in an entry, cross out such entry, enter the correct one and initial the correction. Since "Kardex" cards are filed in numerical order and pocket meters and film badges are read also in numerical order:

1. Find card number corresponding to first meter number listed in the Daily Dosimeter and Chamber Work Sheet (DCWS).

2. Now make the appropriate transfer from DCWS to card and cross out meter number in DCWS. Complete ALL necessary entries in one card before proceeding to the next one.

3. Repeat step 2 until all meter numbers in DCWS have been crossed out.

4. Always pull out drawers in order and work with one drawer at a time only.

D. Specific Procedure

1. Card A

RADIATION EXPOSURE RECORD

MF- meter found; **MI**-date meter issued; **ML**-meter lost; **MO**-date meter out of service; **MR**-date meter reissued
CODE: 1- meter contaminated; 2- meter damaged; **QT**- quarter total; **TSRA**- total significant reading to date; **TSRW**- total significant reading for the week; **WK**- Health Physics week; **IRR**- irregularity; **OS**- meter off scale.

WK	DAYS M	T	W	T	F	S	S	$\frac{TSR_W}{TSR_A}$	IRR	WK	DAYS M	T	W	T	F	S	S	$\frac{TSR_W}{TSR_A}$	IRR	QT
1										8										
2										9										
3										10										
4										11										
5										12										
6										13										
7																				

FRNC - HPS(PM)C0003A

Fig. 2

FMF-film meter found; FMI-date film meter issued, FML-film meter lost, FMO-date film meter out of service, FMN-film meter not processed; FMR-date film meter reissued, CODE: 1- film fogged, 2- film contaminated, 3- film damaged, 4- film missing, 5- film damaged in process; 6- film lost in process; 7- evidence of X-ray exposure, 8- evidence of light exposure, FN- fast neutron dose; OW- open window, OWD- open window dose; PM- pocket meter; SW- shielded window; SWD- shielded window dose; TCD- total cumulated dose to date.

WK	FILM BADGE OW	OWD	SW	SWD	OWD / SWD	FN	PM TSR_A	TCD	IRR	WK	FILM BADGE OW	OWD	SW	SWD	OWD / SWD	FN	PM TSR_A	TCD	IRR	QT
1										8										
2										9										
3										10										
4										11										
5										12										
6										13										
7																				

FRNC - HPS(PM)C0003B

-Litho Peña-Mayagüez

JOHN DOE
HEALTH PHYSICS
MP-001

Fig. 3

a. First column WK in Kardex card refers to Health Physics week. HP week No. 1 always starts on January 1st of each year.

b. Write MI (meter issued) and date on side of card A corresponding to date of issuance as illustrated in Figure 4. The subscript denotes type of radiation meter issued, thus MI_{γ} means meter for X or γ radiation.

c. The second column "Days" is subdivided into seven sub-columns, one for each day of the week.

d. Each week is divided into two sections, by a horizontal line. Each day in any week is divided into four sections by two diagonal lines since 2 types of meters may be used in certain cases, one for X and/or gamma radiation and another for thermal neutron radiation. The following Figure 4 illustrates how the sections, which are numbered 1 to 8, are filled.

1) Enter daily exposure due to X and/or gamma radiation in this space.

2) Enter daily exposure due to thermal neutrons in this space.

3) Enter the sum of 1 for the day plus 3 of previous day.

4) Enter 2 for the day plus 4 of previous day.

5) Enter sum total of 1 for the whole week.

6) Enter sum total of 2 for the whole week.

7) Enter total of 7 of previous week plus 5 of present week except as noted below.

8) Enter total of 8 of previous week plus 6 of present week except as noted below.

Note: 7 and 8 will be equal to 5 and 6 respectively only for the first week an entry is made.

Figure 5 illustrates an exposure record with entries for the first 13 weeks.

e. Whenever an irregularity occurs it shall be indicated in the last column "IRR" and dated. The following shall be considered irregularities:

RADIATION EXPOSURE RECORD

MF- meter found; MI-date meter issued; ML-meter lost; MO-date meter out of service; MR-date meter reissued
CODE: 1- meter contaminated; 2- meter damaged; QT- quarter total; TSRA- total significant reading to date; TSRW- total significant reading for the week; WK- Health Physics week; IRR- irregularity; OS- meter off scale.

WK	DAYS M	T	W	T	F	S	S	TSR_W / TSR_A	IRR	WK	DAYS M	T	W	T	F	S	S	TSR_W / TSR_A	IRR	QT
1	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4	1 / 2 / 3 / 4	5 / 6 / 7 / 8		8										
2										9										
3										10										
4										11										
5										12										
6										13										
7											MI$_Y$ - DATE MI$_n$ - DATE									

FIG. 4

RADIATION EXPOSURE RECORD

MF- meter found; MI-date meter issued; ML-meter lost; MO-date meter out of service; MR-date meter reissued
CODE: 1- meter contaminated; 2- meter damaged; QT- quarter total; TSRA- total significant reading to date; TSRW- total significant reading for the week; WK- Health Physics week; IRR- irregularity; OS- meter off scale.

WK	DAYS M	T	W	T	F	S	S	TSR_W / TSR_A	IRR	WK	DAYS M	T	W	T	F	S	S	TSR_W / TSR_A	IRR	QT
1	0 / 0 / 0 / 0	5 / 0 / 5 / 0	10 / 5 / 15 / 5	0 / 0 / 15 / 15	0 / 5 / 15 / 10	0 / 0 / 15 / 10	0 / 0 / 15 / 10	15 / 10 / 15 / 10		8	0 / 0 / 0 / 0	0 / HO / 0 / –	0 / – / 0 / –	5 / – / 5 / –	5 / – / 10 / –	0 / – / 10 / –	0 / – / 10 / –	10 / 0 / 70 / 55		
2	5 / 0 / 5 / 0	0 / 0 / 5 / 0	5 / 0 / 15 / 5	0 / 10 / 15 / 10	0 / 0 / 15 / 10	0 / 0 / 15 / 10	0 / 0 / 15 / 10	10 / 10 / 25 / 20		9	0 / – / 0 / –	5 / – / 5 / –	0 / – / 5 / –	5 / – / 10 / –	0 / – / 10 / –	0 / – / 10 / –	0 / – / 10 / –	10 / – / 80 / 55		
3	0 / 0 / 0 / 0	– / 0 / – / 0	– / 0 / 0 / 0	0 / 0 / 0 / 0	5 / 5 / 5 / 5	5 / 0 / 10 / 5	0 / 0 / 10 / 5	10 / 5 / 35 / 25		10	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	3 / 0 / 2 / 0	5 / 2 / 7 / 2	0 / 0 / 7 / 2	0 / 0 / 7 / 2	7 / 2 / 87 / 57		
4	10 / 0 / 10 / 0	0 / 0 / 0 / 0	0 / 10 / 10 / 10	0 / 0 / 10 / 10	0 / 0 / 10 / 10	5 / 0 / 15 / 10	0 / 0 / 15 / 10	15 / 10 / 50 / 35		11	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 87 / 57		
5	HO / 0 / – / 0	– / 0 / – / 0	– / 5 / – / 5	– / 0 / – / 5	– / 5 / – / 10	– / 0 / – / 10	– / 0 / – / 10	– / 10 / 50 / 45		12	0 / 0 / 5 / 0	5 / 0 / 0 / 0	0 / 0 / 0 / 0	0 / 0 / 0 / 0	5 / 0 / 10 / 0	8 / 0 / 18 / 0	0 / 0 / 18 / 0	18 / 0 / 105 / 57		
6	– / 0 / – / 0	– / 0 / – / 0	– / 0 / – / 5	– / 5 / – / 5	– / 0 / – / 5	– / 0 / – / 5	– / 0 / – / 5	– / 5 / 50 / 50		13	5 / 0 / 5 / 0	0 / 0 / 5 / 0	0 / 0 / 5 / 0	0 / 5 / 10 / 0	0 / 0 / 10 / 0	0 / 0 / 10 / 0	0 / 0 / 10 / 0	10 / 0 / 115 / 57		1-13
7	0 / 0 / 0 / 0	5 / 0 / 5 / 0	0 / 0 / 5 / 0	0 / 0 / 5 / 0	5 / 5 / 10 / 5	0 / 0 / 10 / 5	0 / 0 / 10 / 5	10 / 5 / 60 / 55												

MI$_Y$ - DATE (1st. W'K) MI$_n$ - DATE (1st. W'K)
MO$_Y$ - DATE (5th. W'K) MO$_n$ - DATE (8th. W'K)
MR$_Y$ - DATE (7th. W'K) MR$_n$ - DATE (10th. W'K)

Fig. 5

Code: 1- Meter contaminated
2- Meter damaged
ML- Meter lost

f. Whenever a meter is taken out of service, type below MI, MO and date. The same procedures will be used when a meter is reissued. (See Figure 5)

g. The last column QT to the right of the card will be used to accumulate any thirteen consecutive weeks. The weeks covered will be written on top of the accumulutated exposure dose as shown in Fig. 5 for the first consecutive thirteen weeks.

2. Card B

a. Write FMI (film meter issued) and date at bottom of Card B as illustrated in Figure 6.

b. First column "WK" in Kardex cards refers to Health Physics week.

c. The second column (Film Badge) subidivided into six subcolumns, and the three columns following, are all numbered in Figure 6. An explanation of each one follows.

1. Enter open window density.

2. Enter open window dose (mrem equivalent of density).

3. Enter shielded window density.

4. Enter shielded window dose (mrem equivalent of density).

5. Enter total of 5 of previous entry plus 2 of current entry except as noted below.

6. Enter total of 6 of previous entry plus 4 of current entry except as noted below.

7. Enter current fast neutron dose (mrems).

8. Enter total of 8 of previous entry plus 7 of current entry except as noted below.

Note: 2 and 5, 4 and 6, and 7 and 8 will be equal in the first entry made.

9. Enter in this space the value for TSR_A from card A for the corresponding week. See part E of this section.

10. Enter sum of 6 plus 8 for the corresponding week.

FMF-film meter found; FMI-date film meter issued, FML-film meter lost, FMO-date film meter out of service, FMN-film meter not processed; FMR-date film meter reissued, CODE: 1- film fogged; 2- film contaminated; 3- film damaged; 4- film missing; 5- film damaged in process; 6- film lost in process; 7- evidence of X-ray exposure; 8- evidence of light exposure; FN- fast neutron dose; OW- open window; OWD- open window dose; PM- pocket meter; SW- shielded window; SWD- shielded window dose; TCD- total cumulated dose to date.

WK	FILM BADGE OW	OWD	SW	SWD	OWD/SWD	FN	PM TSR_A	TCD	IRR	WK	FILM BADGE OW	OWD	SW	SWD	OWD/SWD	FN	PM TSR_A	TCD	IRR	QT
1	1	2	3	4	5/6	7/8	9	10	11	8										
2										9										
3										10										
4										11										
5										12										
6										13										
7										FMI - DATE FMR - DATE FMO - DATE										

FRNC - HEALTH PHYSICS

-Litho Peña-Mayagüez

JOHN DOE
HEALTH PHYSICS
MP-001

Fig. 6

FMF-film meter found; FMI-date film meter issued, FML-film meter lost, FMO-date film meter out of service, FMN-film meter not processed; FMR-date film meter reissued; CODE: 1- film fogged; 2- film contaminated; 3- film damaged; 4- film missing; 5- film damaged in process; 6- film lost in process; 7- evidence of X-ray exposure; 8- evidence of light exposure; FN- fast neutron dose; OW- open window; OWD- open window dose; PM- pocket meter; SW- shielded window; SWD- shielded window dose; TCD- total cumulated dose to date.

WK	FILM BADGE OW	OWD	SW	SWD	OWD/SWD	FN	PM TSR_A	TCD	IRR	WK	FILM BADGE OW	OWD	SW	SWD	OWD/SWD	FN	PM TSR_A	TCD	IRR	QT
1										8	0.5	50	0.4	40	120/90	0/45		135		
2						15/15		15		9					120/90	/45		135		
3						/15		15		10					120/90	10/55		145		
4	0.7	70	0.5	50	70/50	5/120		70		11					120/90	/55		145		
5					70/50	/20		70		12	0.4	40	0.3	30	160/120	0/55		175		
6					70/50	25/45		95		13										
7					70/50	/45		95		FMI - DATE										

FRNC - HEALTH PHYSICS

-Litho Peña Mayagüez

Fig. 7

11. Enter irregularities if any.
The following will be considered as so.

Code
1. film fogged

2. film contaminated

3. film damaged

4. film missing

5. film damaged in process

6. film lost in process

7. evidence of X-ray exposure

8. evidence of light exposure

FML - film meter lost

FMN - film meter not processed

d. Whenever a film badge is taken out of service, write at bottom of card B, under FMI, FMO and date. If badge is reissued follow the same procedure (see figure 6).

e. Notice from figure 7:

1. That in this example in weeks 1, 2 and 3 no entries were made under OW, OWD, SW, SWD and OWD assuming film for beta, X and/or gamma radiation was processed normally every four weeks.

2. Similarly every two weeks an entry was made for FN (fast neutron dose) since this film was processed every two weeks.

3. SWD represents the dose due to penetrating radiation. This is the one of most interest.

4. Beta dose is not recorded directly in the exposure record. However, this can be calculated at any time from the OW and SW densities.

E. Exposure records are based on personnel monitoring film except as provided below.

1. If film is lost or damaged such that it is not usable for determining the exposure, then readings from meters will be used provided these readings cover the same period of time as the film. This implies that the person was using a meter plus a badge simultaneously.

2. If film is lost or damaged such that it is not usable for determining the exposure and no meter reading is available as provided in 1 above, then the exposure from the previous monitoring period will be used to prorate the exposure for the current period up to the time a new film was issued.

IV. 3 Short-term records - are kept for persons associated with PRNC for periods of less than 6 months other than one time visitors. Records will be kept in Form 603.

Film from ST badges are processed in accordance with Section III.2, however the exposure dose is not measured and recorded unless there is reason to suspect that the exposure may be significant, which is determined by the type of work performed by the individual.

PUERTO RICO NUCLEAR CENTER

SHORT TERM PERSONNEL EXPOSURE RECORD

NAME	PD, PC or ND No.	DATE	LOCATION	DOSE	REMARKS

If no PD, ND or PC was used indicate none. Under location enter: visiting reactor, or person, etc.

FORM PRNC-HPD(PM)603

SECTION V

Exposure Reports

V.1 A report of whole body exposure to external penetrating radiation shall be submitted by the HPD to PRNC's Director, Associate Directors and Heads of Divisions, using Form 603a in accordance with III.2, A, 1.a-b

V.2 An exposure report will be sent to institutions to which service is given whenever films are developed.

V.3 An annual summary report of whole body radiation exposure to external penetrating radiation accumulated during the year shall be submitted in duplicate to the Area Manager using Form AEC 190.

Similar reports are submitted to PRNC Director, and Associate Directors in Form PRNC 604.

V.4 An annual summary report of internal body exposure from deposition of radioactive material during the year, shall be submitted to the Area Manager using Form AEC 191.

Similar reports to PRNC Director and Associate Directors are submitted in Form PRNC 604a.

V.5 Whenever an external exposure greater than 25* rems occurs the Director should be informed immediately by telephone.

A. If the incident occurs outside of working hours, San Juan area personnel are to telephone the Director and Associate Director (San Juan area) and Mayaguez area personnel are to telephone the Deputy Director and Associate Director (Mayaguez area).

B. Start and investigation of incident and submit an Investigation Report of Radiation Exposure. Send four copies to AEC Area Manager, one copy to PRNC Director and Associate Directors and one to HPD Head.

Use Form PRNC-HPD (PM) 604b for this report.

V.6 Whenever an external exposure as determined from badge film exceeds 3 rems in any 13 consecutive weeks, start an investigation using Form 604b in quintuplicate. Send three copies to PRNC Director and two copies to HPD Head. The director will send one copy each to the associate director and division head concerned.

*See AEC Manual Appendix 502, April 4, 1962 and Chapter OR-0502 and OR Appendix 0502, November 9, 1962 for calssification of accidents and reporting instructions in detail.

PUERTO RICO NUCLEAR CENTER
Monthly Report of Whole Body Radiation Exposure to External Penetrating Radiation

Division _____ Month _____

Send Report to: _____ Division Head

Name	Badge No.	Exposure Totals (mrems)		Comments
		Current Month	Yearly Cumulative	

Date _____ _____

FORM PRNC-PHD (PM) 603a HPD, Personnel Monitoring Supervisor

PUERTO RICO NUCLEAR CENTER
Annual Report Summary of Whole Body Radiation Exposure to
External Penetrating Radiation Accumulated During the Year

Date Prepared:
Prepared by

Year Covered:

Measured at or near the body surface by:
Film badge_____ pocketmeter_____

NAME	No. of estimated accumulated REM doses in each of the following ranges.													
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	>12	
Total														

Note: entries for rem doses are obtained from "Kardex" Records (Card B) and/or from Short Term Records

Remarks:

V-03

Form PRNC-HPD(PM)604

PUERTO RICO NUCLEAR CENTER
Annual Report Summary of Internal Body Exposures from
Deposition of Radioactive Material During the Year

Date Prepared:
Prepared by:

Year Covered:

Determination by: Chemical analysis
Gross counting
Air sampling

	No. of body depositions for isotope of interest												< 1/2 M.P.	>1/2 M.P.
	U-238	C-14	P-32	H-3	I-131	Th230	F.P.	Unk.						
Totals														

Notes: From second year on make a double entry for each isotope of interest - one entry in red ink for year reported and one entry in black ink total for previously reported depositions.

V-04

FORM-PRNC-HPD(PM)604a

PUERTO RICO NUCLEAR CENTER
Operated by
University Of Puerto Rico
For
U. S. ATOMIC ENERGY COMMISSION
College Station
Mayaguez, P. R.

INVESTIGATION REPORT
Of
RADIATION EXPOSURE

1. Date _____

2. Name _____
Last, First Middle

3. Home Address _____

4. Date of Birth _____ 5. Place _____

6. Sex _____ 7. S.S. No. _____ 8. Occupation _____

_____ (at time of exposure) _____

9. Employer's Name & Address _____

_____

10. Other individual exposed? _____ (if yes list under item 24 and use an additional form for each one).

11. Any animals exposed? _____(if yes report on a separate sheet and attach to this report).

12. External exposure _____ Internal exposure _____(check)

13. External estimated total exposure _____ (rems)

14. Procedure for converting units of measurement to rems:

a: survey meter reading in r times RBE of _____ for _____ radiation

b: density of film in terms of r times RBE of _____for_____radiation

c: neutron tracks/cm^2 equals _____ rems

15. Isotope (s) involved_____

16. Internal estimated total deposition_____(microcuries)

17. Estimated fraction of P.C. deposited in organ (s) of interest_____
(microcuries)

18. Biological assay or procedure used to estimate deposition including instrumentation.

a: air sampling_____Instrument

b: bioassay_____Instrument

c: other

19. Method of transportation and probable mode of entry into the body.

a: gaseous effluent_____ingestion or/and inhalation (underline).

b: aqueous effluent_____ingestion or/and inhalation (underline).

c: airbone particles_____ingestion or/and inhalation (underline).

d: other

20. Date (s) covering period in which exposure occured_____

21. Description of events leading up to and including occurrence of exposure.

22. Role played by person(s).

23. Suggestions for preventing similar incidents.

24. Name(s) of other person (s) exposed. (see item 10)

25. PRNC Insurance Company

---

a: Company has been notified_____.

Submitted by

_____
Health Physics Division

Approved by:

PRNC SAFETY COMMITTEE

FORM PRNC-HPD (PM)604b

V.7 Whenever an unplanned release of radioactive material in concentrations which, if averaged over a period of 24 hours would exceed 5000 times the limits for that material specified in appendix B, table II, 10 CFR 20 or if the release is offsite and may cause the general population to receive an exposure greater than the values set forth in the Radiation Protection Guide for Federal Agencies,* the Director shall be notified immediately by telephone.

A. Start an investigation of incident and submit an Investigation Report of Radiation Exposure. Distribution will be the same as for V.3 above.

V.8 The HPD will determine the action to be taken in case a person (s) exceeds the MPE in order to bring the cumulated exposure total within the established limits. These are discussed fully in Section 6.

A. The Radiation Safety Officer will notify in writing the supervisor concerned. One copy will be sent to PRNC's Director.

V.9 PRNC will notify any person receiving an overexposure (see Section VI.1) of the nature and extent of exposure. Such notice shall be in writing in accordance with CFR Section 20. 405 (b).

* See AEC Appendix 0302, Annex 2.

SECTION VI

Permissible Occupational Levels of Exposure to External Sources of Radiation

VI.1 Beginning with 1958* and thereafter, the maximum permissible accumulated exposure dose, MPE, in rems at any age, is equal to 5 times the number of years beyond age 18.

A. To calculate MPE to critical organs (whole body, gonads, blood forming organs, lens of the eye) the MPE = 5 (N-18)** rems.

For N = 30

$$MPE = 5(30-18) = 60 \text{ rems}$$

B. In any one year a maximum of 12 rems is allowed, provided the average of 5 rems/year is not violated.***

C. The MPE allowed to the skin of the whole body (non-penetrating radiation) is 30 rems per year.

D. The MPE to the extremities is 75 rems/year.

E. The MPE for one quarter (13 weeks) is 3 rems averaged over a period of 13 weeks.

F. The MPE for one week (40 hours) is 0.3 rems. This is an administrative value.

G. The MPE for 1 day (8 hours) is 0.06 rems. This is an administrative value. Likewise for administrative purposes the MPE per hour is 7.5 mrems.

*See Addendum of April 15, 1958 to NBS Handbook 59, Permissible Dose from External Sources of Ionizing Radiation.

**This is the basic equation in determining permissible exposure levels.

***See Addendum of April 15, 1958 to NBS Handbook 59, Permissible Dose from External Sources of Ionizing Radiation, Section 7, page (6). In this case 12 rems/yr may be allowed under certain circumstances. The age at which a person will reach his age prorated limit is obtained by $x = N + \frac{5(N-18)}{7}$.

VI.2. In calculating MPE accumulated using MPE - 5(N-18) previous exposure shall be taken in consideration.

A. Whenever a previous radiation exposure record exists, this shall be used in calculating MPE accumulated at age N. This will allow a person to use his reserve exposure as explained under VI IB. (See footnote *** on previous page).

B. Whenever a previous radiation exposure record is not available, assume that the MPE beyond 18 years of age has been accumulated.

C. To the effect of making the calculations required under VI-2A or VI-2B, an Occupational Radiation Exposure History (Form PRNC-HPD (PM) 604d) shall be filed with the Health Physics Division not later than two weeks after employment, provided such person is expected to be employed, associated or visiting for a period not less than six months consecutively (See subsection IV.1)

VI.3 An individual folder will be used to keep all exposure records, reports, etc. for each person with a "Kardex" record.

A. The front and back covers are printed as shown in Figures 8 and 9.

B. On the front cover of the folder is printed an exposure record-graph. The recordgraph is prepared and read as follows (see figure 8):

1. Draw (using black ink) a line from a point in the abscissa - Age in Years (AA) - at which the person starts working to a point corresponding to the same age in the right ordinate - Age in Years (RA). Read in the left ordinate the accumulated dose to any age up to 65 assuming that the 5 rems per year exposure limit is not exceeded. In the example illustrated the person started to work at age 35, therefore at 65 years of age the MPE accumulated is 150 rems.

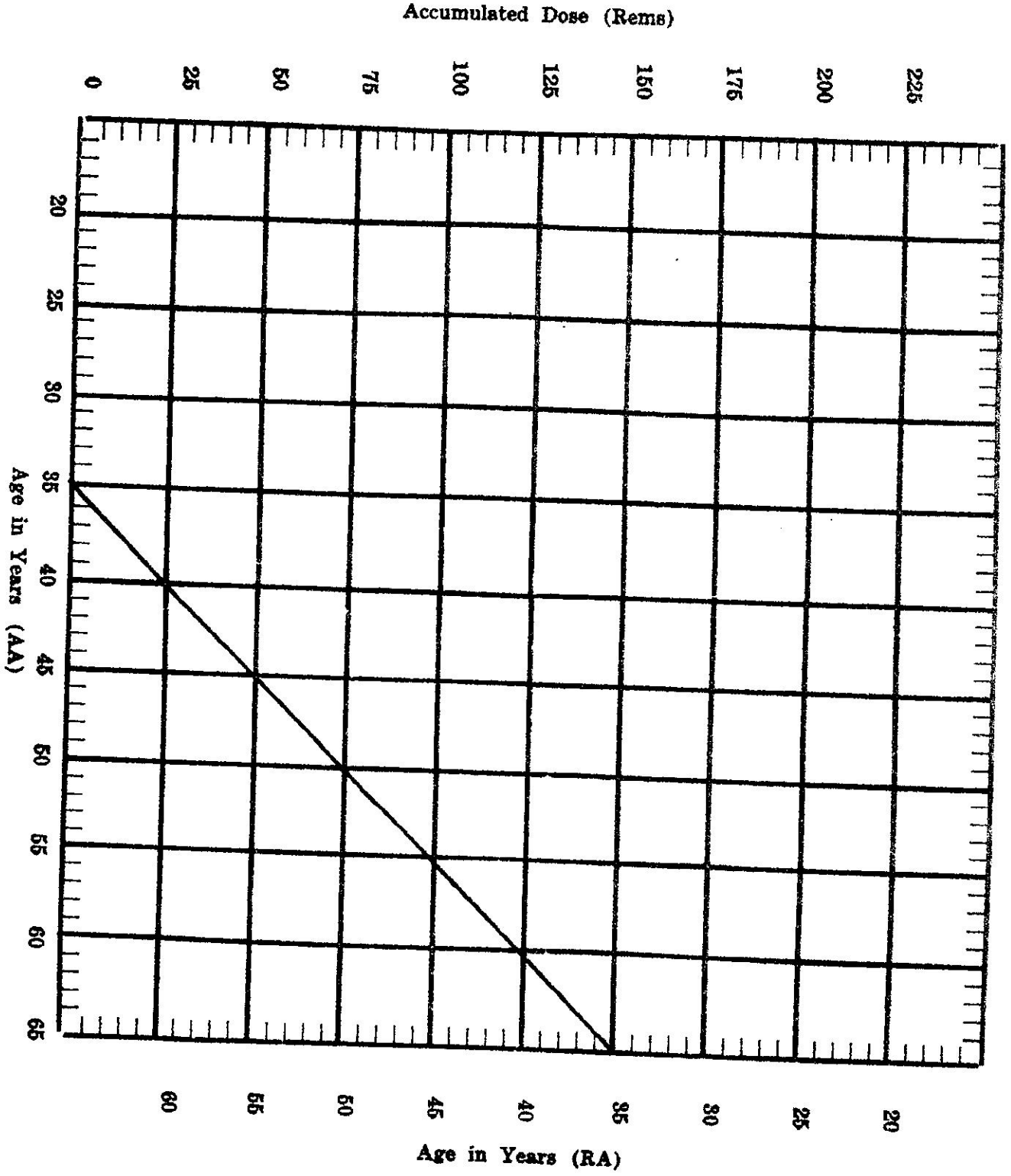
Accumulated Dose (Rems)
0
25
50
75
100
125
150
175
200
225
Age in Years (AA)
20
25
30
35
40
45
50
55
60
65
60
55
50
45
40
35
30
25
20
Age in Years (RA)

Figure 8

2. At the end of each year the cumulated dose is entered in the summary record, Form 605, and plotted in red ink in the record-graph. If the individual annual dose rate (for the period since the person started working) does not exceed 5 rems per year, the red line should fall under the black line. In case the red line is observed to approach the black line corrective measures should be taken. The total cumulative dose for an individual is always given by 5 (N-18) with an allowable maximum of 12 rems in one year, the black line indicating when 5 rems per year average is exceeded during the period covered since starting to work).
3. On the back cover of the folder is printed a table (Form PRNC-HPD (PM) 604c) indicating all the records of the person in regard to radiation safety. Space is provided for at least 20 year records. The columns shall be filled as follows:
   (1) "Kardex" record. This column shall be filled twice a year (July and January).
   (2) Cumulative summary. This column shall be filled twice a year (July & January).
   (3) All others as needed (see instructions in the folder).

PUERTO RICO NUCLEAR CENTER

SUMMARY OF RADIATION EXPOSURE RECORDS

Name Division Date

The radiation exposure records of the Health Physics Division show that the above-named person received, during the time indicated, the following doses of external radiation. The complete radiation exposures of this employee are kept in the files of the Health Physics Division, PRNC.

INCLUSIVE DATES	NO. WEEKS	BETA	GAMMA, X-RAY (rem)	THERMAL NEUTRON (rem)	FAST NEUTRON (rem)	CUMULATIVE DOSE (rem)
TOTALS						

Remarks

FORM PRNC-HPD(PM)605

Director, Health Physics Division

PUERTO RICO NUCLEAR CENTER

Personal Exposure Record Folder

A check mark in the corresponding space below opposite the date indicates the records in the folder for the period indicated. If none write none.

DATE INVOLVED	"KARDEX" RECORD	CUMULATIVE SUMMARY	SPECIAL REPORT	FECES REPORT	URINALYSIS REPORT	REMARKS

DATE INVOLVED	"KARDEX" RECORD	CUMULATIVE SUMMARY	SPECIAL REPORT	FECES REPORT	URINALYSIS REPORT	REMARKS

Form PRNC-HPS (PM) 604c

4 - Peña

VI-07