SC&A DRAFT FOR WORKING GROUP REVIEW

February 6, 2007

COMPLETENESS OF RECORDS FOR 1969 AND 1970

Disclaimer

This document is made available in accordance with the unanimous desire of the Advisory Board on Radiation and Worker Health (ABRWH) to maintain all possible openness in its deliberations. However, the ABRWH and its contractor, SC&A, caution the reader that at the time of its release, this report is pre-decisional and has not been reviewed by the Board for factual accuracy or applicability within the requirements of 42 CFR 82. This implies that once reviewed by the ABRWH, the Board's position may differ from the report's conclusions. Thus, the reader should be cautioned that this report is for information only and that premature interpretations regarding its conclusions are unwarranted.

COMPLETENESS OF RECORDS FOR 1969 AND 1970

During the course of SC&A's review, a number of former workers from RFP were interviewed. Many of them expressed particular concern over the May 11, 1969 fire and its relevance to their dose reconstruction. Where available, DOE records were reviewed for individuals raising this particular concern. In some cases, it was noted that on the Occupational Dose Report (handwritten external data summary), the shallow and deep dose were blank. Computer printouts of deep dose results within the Health Physics file were recorded as zero when 1969 results were listed, in place of the blanks. Hence, some records contain blanks and zeros, while others, for the same worker and the same badging period, contain zeros only. SC&A has verified that this situation applies to a number of claimants whose employment period included 1969. An additional observation made by SC&A was that doses during 1970 were significantly lower than those for 1968 or 1971.

SC&A interviewed workers with 1969 gaps asking them if they were assigned a dosimeter in 1969. The individuals indicated that there was no break in their monitoring, and that they did enter radiological areas during 1969 and 1970. Because this situation was encountered in several individual files, a review of the number of zeros in the *RFP Coworker Data Stat (NDRP included, HIS20 Data)* (NIOSH 2006x) was conducted. It was found that there was a sudden increase in the percentage of zeros from 1968 to 1969. The high percentage of zeros continued during 1970 then dropped significantly in 1971.

These facts about the 1969 and 1970 (first part) of the external dose record raise some questions:

- What was the reason for the blanks in the records?
- How were blanks recorded in dosimetry logs and HIS_20?
- Was there a common reason for increase in blanks and zeros in 1969 in the individual raw data files?
- What were the reasons for the increase in the zeros recorded in 1969 (relative to 1968)?
- What were the reasons for the increase in the zeros recorded in 1970 (relative to 1968)?
- Did the blank records that were assigned zeros correspond to exposure potential below the limit of detection (LOD) for the badges of the time?
- How are the zeros in the dose records from unread and read badges to be distinguished, assuming that the zero results for read badges are less than the LOD?

As a result of the preliminary concerns raised by SC&A, NIOSH evaluated potential hypotheses to explain the gaps and if they were related to the May 11, 1969 fire and its subsequent cleanup.

Summary of the NIOSH Analysis of the 1969 Data Gap

In response to SC&A's concern, NIOSH determined that 136 claimants had gaps in dosimetry records for 1969. Further analysis of these individuals indicated they held a wide variety of jobs from administrative to production. In a few cases, the individual arrived at RFP within the last month of 1969, and may not have had dosimetry results for 1969. They investigated the radiation files of each worker in an attempt to ascertain reasons for the apparent "gap." The

investigation centered on 136 claimant files that had been identified as missing data for 1969. Of the 136, 35 had no external dosimetry data at all for 1969 for reasons that could not be readily explained. As NIOSH stated (NIOSH 2006x2):

> *Only 26% of the records tentatively identified as "missing" were completely missing. Four of those in the table were not RFP employees during 1969 and another 17 were employed for less than a calendar quarter. For nearly 60% of the records there was some data reported, albeit sometimes only a single zero entry of a badge coding of "01" which indicated that the badge was not returned. Therefore, the putative gap is considerably smaller than it seemed originally.*

A number of hypotheses were tested by NIOSH to explain the gap, including data having been lost as a result of the 1969 fire, a computer reporting problem, and the possibility that some badges were simply not read. Since data exists for first responders and employees who participated in clean-up operations related to the 1969 fire, NIOSH concluded the gap was not connected with the May 11, 1969 fire. NIOSH stated (NIOSH 2006x2):

> *The external dose monitoring patterns observed in 1969 are consistent with a combination of the policy to not read badges for staff in non-Pu areas on quarterly badge exchange cycles, and a computer problem that arose during this period resulting in dose being reflected only in cumulative dose totals. The programming error that reportedly resulted in a loss of monthly and quarterly detail data for 400 workers certainly would have created an apparent gap in the records for those staff, but would not have impacted their cumulative doses because the gap was discovered and addressed.*
>
> *NIOSH concludes (1) the 1969 data gap is much smaller than originally estimated, (2) the patterns observed in the 1969 dosimetry data are consistent with the administrative decision to not read film badges from employees stationed in non-Pu areas with low exposure potential, and (3) a computer programming error may have contributed to the lack of detail in the dosimetry data, but this was discovered and corrected in the cumulative dose totals. Therefore, NIOSH concludes that dose reconstructions can be performed with sufficient accuracy for claimants employed at Rocky Flats in 1969.*

SC&A was asked by the working group to review the NIOSH analysis.

Evidence of Systemic Data Gaps

SC&A identified a sudden jump in zero entries from 1968 to 1969. The high proportion of zeros continued into 1970 and then fell back in 1971. These data were compiled from the RFP dose data posted on the O-drive [*ABdoc review->RF->coworker data->RFP coworker data Stat (NDRP included, HIS20 data) posted 4/17/06]*. Table X-1 below provides a summary of the number of zero entries each year in the HIS-20 database. As can be seen in this table, the percent of zero entries increases dramatically for these two years. 1969 and 1970 both had over 36% zero entries for penetrating (neutron + photon) external doses while the previous 5 years (1964-68) showed an average of 9.7% zero entries and the post 5 years (1971-75) had an average of 10.5%. This is especially relevant considering that numerous workers were involved in a major fire that occurred during the second quarter of 1969.

Table X-1

	Pene. Dose w/zeros	Pene. Dose w/o zeros		
Year	**# of entries**	**# of entries**	**# of Zeros**	**% of Zeros**
1952	42	42	0	*0.0*
1953	319	290	29	*9.1*
1954	353	273	80	*22.7*
1955	529	426	103	*19.5*
1956	781	662	119	*15.2*
1957	918	804	114	*12.4*
1958	1062	927	135	*12.7*
1959	1063	1011	52	*4.9*
1960	1284	1065	219	*17.1*
1961	1638	1461	177	*10.8*
1962	2003	1779	224	*11.2*
1963	2176	2047	129	*5.9*
1964	***2834***	***2610***	***224***	***7.9***
1965	2826	2639	187	*6.6*
1966	2888	2658	230	*8.0*
1967	2902	2530	372	*12.8*
1968	3101	2690	411	*13.3*
1969	3471	2197	1274	*36.7*
1970	3308	2096	1212	*36.6*
1971	3398	2995	403	*11.9*
1972	3282	2621	661	*20.1*
1973	3020	2465	555	*18.4*
1974	2687	2658	29	*1.1*
1975	2489	2461	28	*1.1*
1976	2424	2271	153	*6.3*
1977	3740	2347	1393	*37.2*
1978	4176	1781	2395	*57.4*
1979	3893	2441	1452	*37.3*
1980	3752	1760	1992	*53.1*
1981	4060	1496	2564	*63.2*
1982	4851	2490	2361	*48.7*
1983	5360	3631	1729	*32.3*
1984	5673	3607	2066	*36.4*
1985	6140	3993	2147	*35.0*
1986	4942	4603	339	*6.9*
1987	2583	2354	229	*8.9*
1988	2778	2503	275	*9.9*
1989	5296	2891	2405	*45.4*
1990	3369	2602	767	*22.8*
1991	5641	4951	690	*12.2*
1992	5831	5429	402	*6.9*
1993	5313	4534	779	*14.7*

	Pene. Dose w/zeros	Pene. Dose w/o zeros		
Year	# of entries	# of entries	# of Zeros	% of Zeros
1994	4839	3198	1641	*33.9*
1995	4130	2502	1628	*39.4*
1996	3454	2761	693	*20.1*
1997	3718	2452	1266	*34.1*
1998	3470	2036	1434	*41.3*
1999	3655	2138	1517	*41.5*
2000	3576	1256	2320	*64.9*
2001	3443	1518	1925	*55.9*
2002	3502	1147	2355	*67.2*
2003	3373	947	2426	*71.9*
2004	2758	559	2199	*79.7*
2005	955	562	393	*41.2*

SC&A investigated whether this sudden increase and then decrease in the number of zero was indicative of data entry/credibility problems and what its implications might be for dose reconstruction.

It was also noted that similar sudden jumps in zeros are indicated from 1976 to 1977. The high proportion of zeros persists until 1985, and then drops in 1986. SC&A has not investigated these additional years with high proportions of zeros in detail; however, there were several changes in the dosimetry program that occurred around this time. In 1976, the dosimetry group implemented the Health Sciences Database (Langsted 2004). At about that time, a decision was made change the background subtraction method for TLD dose determination (Lagerquist 1975).

> *Beginning January 1, 1976 we will be subtracting background from all external radiation measurements of our employees.*
>
> *This background will be the average of the environmental measurements that we have made on plant site and in nearby communities.*

Langerquist (1976) indicated that an average background of 0.34 mrem/day was subtracted from the badge. There was also a proposal to record zero for doses less than 10 mrem (Lagerquist 1976):

> *We are considering converting all employee readings of less than 10 mrem to zero also, but we want to look at the 1976 data first.*

Further, americium operations changed in 1976 and americium recovery was stopped in the late 1970s (Rocky Flats Site Profile, Vol. 2, pp. 11-12). This would be expected to significantly reduce external dose in some plutonium areas. It should also be noted that SC&A did not discover comparably large gaps for entire years in this period in its random sampling (see Chapter 8).

Claimants with Data Gaps

NIOSH identified 136 claimant files that were identified as "missing data for 1969," with 26% of these files determined to have no external dosimetry for all of 1969 and others having data for portions of the year. NIOSH listed only one "Fire Protection Engineer" and no firefighters. Table X-2 contains a subset of the 136 individuals, all with blanks for four quarters of data on their 1969 Health Physics External Radiation Exposure Report (HPERER) in the Health Physics File. These 19 individuals worked all four quarters during 1969 and most continued employment into 1970. Each also had at least one badge reading in the 1969 Dosimetry Processing logs where there was no indication of a late or unreturned badge.

Note that "Individual 19," listed in Table X-2, is a fireman. He indicated in his CATI that he was involved in "suppressing the fire" and with subsequent fire watches. In fact, he received an in *vivo* count shortly after the fire for a "potential inhalation from the 776 fire." There is no explanation for his missing data in 1969; however, one would assume that his badge was read, and that he was changed to a monthly dosimeter cycle with the other fireman. SC&A has not confirmed this.

The case of an individual not listed in Table X-2 is also relevant.[1] In fact, he submitted an affidavit within the SEC petition in which he raised concerns that his film badge readings did not match his job duties. He worked as a Laboratory Technician supporting Non-destructive Analysis. According to the petition affidavit and the CATI, this individual performed duties in Buildings all over the site, including plutonium processing buildings. The 1969 dose on his HPERER was blank for all four quarters. The first three quarters on the 1970 HPERER were recorded as zero with a significant drop in annual exposure for that year compared to doses in 1965-1968. No 1969 data at all were available for this individual on the Dosimetry by Individual report or in HIS-20 – that is, the year 1969 was missing altogether from the Dosimetry by Individual Report and the worker was not in the HIS-20 external dose database. The recorded deep doses for 1965, 1966, 1967 and 1968 were 1512, 1804, 4130 and 645 mrad respectively, all above the 10% limit. The personnel file indicates he was assigned to Building 444 in 1965 and 1966. For portions of 1967 and 1968 the individual spent time in the plutonium areas. The individual stated in the CATI he was involved in the 1969 Fire Clean-up. Within the Health Physics file are reports indicating that he received an abrasion in 1969 and a puncture wound in 1969 in Building 777. This would indicate that during at least some portion of 1969, he was working in Building 777. It is noteworthy that for at least three quarters in 1969, the individual was formally assigned to Building 444, which was a non-plutonium area even though he was performing work in a plutonium area. There were no densitometer readings in the dosimetry processing logs and zeros were entered for three quarters in the dose readings with arrows, indicating that his badges were not read. In the fourth quarter, there is a blank in the log, with a notation that the badge was not returned. He was still listed as being assigned to Building 444 in that quarter. He was on a quarterly badge cycle. This case raises questions regarding the policy of not reading badges for non-plutonium areas that was instituted in 1969. It shows also that individuals entered areas other than those to which they were formally assigned and illustrates as

[1] He was not included in the table because his data are completely missing from the HIS-20 database, making a comparison with the other databases impossible. His name is slightly misspelled in the 1969 Dosimetry Processing logs. SC&A verified the data by reference to his badge number.

well the complexities introduced into dosimetry issues by the fire and the earlier decision to selectively not read quarterly badges.

On May 11, 1969, a large self-ignited fire occurred in Building 776 with contamination spread to Building 777. A total of 33 fireman and Security Guards were used at various time in fighting the fire. Personnel were contaminated at levels from a few hundred to greater than 100,000 dpm alpha/60 cm^2. Dow medical personnel, Radiation Monitors, Body Counter technicians, and six AEC personnel assisted in decontamination, monitoring, and contamination control. Following decontamination, the employee was sent to the *in vivo* counter. Forty-one employees were decontaminated and checked with the body counter in the first 24-hours. Initial counts indicated that 15 of the 41 employees counted had positive plutonium results. The only significant inhalation of plutonium attributed to the fire involved a fireman (AEC 1969).

Several Radiation Monitors relayed to SC&A that they discarded contaminated badges, or badges on significantly contaminated clothing were discarded (See Attachment 5). Logbook entries reviewed for other time periods support the practice of destroying contaminated badges in the field (See Attachment 3). This would be a reasonable solution if badges could not be decontaminated because the facility would not have wanted to contaminate the Dosimetry Processing Laboratory. The destruction of contaminated badges may also have contributed to the gaps in 1969. The Dosimetry Processing logsheets for 776 are divided into 776A and 776B. For May 1969, 776A and 776B had a total of 90 and 192 individuals listed, respectively. 776A had 16 badges identified as "not returned." 776B had 59 badges identified as "not returned." This high level of "not returned" badges may be indicative of badge destruction in the field when badges were contaminated. This would not be restricted to specific areas on the plant site, and would have implications for plutonium as well as non-plutonium area workers.[2]

Computer Error

Individuals responsible for data processing were actively involved in development of computer programs for TLD dose calculating programs, data management, and sample scheduling during the early part of 1969. In some cases they were experiencing difficulties. The *Status Report – Dosimetry – February, 1969* (Mann 1969a), indicates a data processing error for the year end [presumably 1968] external exposure data.

> *The year end external exposure data program appears to be correct now. Corrections necessary to the periodic film badge runs have not been made yet. We are not getting satisfactory service from this group (Data Processing).*

In *Status Report – Dosimetry – April, 1969* (Mann 1969b), a computer error was noted.

> *The entire film badge program is being rewritten to take care of recent programmer errors. We are furnishing accumulated dose to date data on 400 "lost" employees to up-date their master tape*

[2] Note that partial year missing data, such as that created by discarding one or two badges in a year, is not included in SC&A's minimal data completeness screening analysis in Chapter 8.

NIOSH has associated the computer error with 1969; however, no definitive documentation was provided to substantiate this hypothesis. Specifically, it appears from the early 1969 dosimetry progress reports that they were having difficulties with the year end external data for 1968. Furthermore, letters in Health Physics files document a computer error occurring in 1968 (RI, 1976). It is possible that the error NIOSH is associating with 1969 is actually related to 1968 data. Adjustments to dose (cumulative or otherwise) were often documented on a letter and placed in the individual Health Physics file. There is no indication of an adjustment in accumulated dose for 1969; however, letters were present in the Health Physics files for adjustments made as a result of a computer error in 1968 (RI, 1976).

Non-Plutonium Area Badges Not Processed

SC&A concurs with NIOSH that RFP decided not to read non-plutonium area badges in early 1969. In a letter to Mann, Vogel (1969) recommended that non-plutonium area film badges not be processed because most of the individuals received less than 10% of the in-plant working level.

> *It is recommended that the film badge continue to be issued and worn as it has been but that the film not be processed except for a few specific groups or for particular circumstances…..The circumstances that might require processing of film for some individuals or groups would include accidents, special operations work involving special material, or to reaffirm the validity of this approach (Vogel 1969).*

Below is a listing of "non-plutonium" area buildings and a brief description of what activities occurred in these buildings.

Table X-3: Description of Non-Plutonium Buildings as Determined by RFP Radiological Control

Badge Storage Area Building No.	Description of Activities
111	Administrative Building
121	Plant Security and Armory
122	Emergency Medical Services Facility
123	Analytical Health Physics Laboratory
125	Standards Laboratory
331	Vehicle Maintenance and Fire Station
334	Central Shop and Maintenance
440	Transportation Modification Center
441	Production Support
442	Filter Test Laboratory and Warehouse
444	Depleted Uranium Processing
551	General Warehouse
705	Coatings Laboratory
750	Production Engineering Support
881	Manufacturing and General Support
883	Uranium Rolling and Forming Operations
865	Metal Research and Development Laboratory

The specific groups in the non-plutonium areas who were exempted from this practice included Health Physics Electronics, Health Physics Operations, Nuclear Safety, Mfg. – Uranium

Chemistry, Mfg. – Production Control, and Quality or Non-destructive testing. While it was not considered necessary to wear the film badge to measure this very low level chronic exposure, they felt it desirable to wear the film badge to measure accidental exposure. Vogel (1969) indicated that implementation of this policy would result in a reduction in film processing workload by at least 1,000 packets per quarter.
The film was to be retained for a several weeks after the regular film badge change before it was discarded (Vogel 1969).

The *Status Report – Dosimetry – March, 1969* (Mann 1969c) indicates this practice was implemented.

> *Quarterly badges for the non-Pu areas will no longer be read routinely, except for a few higher risk groups. The film will be changed as usual, but will not be read unless circumstances warrant.*

A memorandum from Mann to the Dosimetry Technicians (Mann 1969d) states the policy will be effective with the first quarter change of 1969. The memorandum continues:

> *Film from the badges of all other groups [those not processed] is to be saved for three weeks after the exchange, then discarded.*

SC&A notes that this policy of not reading some workers' badges was instituted *before* the May 11, 1969 fire. SC&A partly concurs with NIOSH in that many of the gaps in data are not related to the fire. However, as noted above in the case of the fireman, it appears external dose data related to the fire may also be missing.

Unread badges also appear to be indicated when zero is recorded for the dose result, but no density readings are listed for the particular badge as they are with those that are clearly read. After review of the Dosimetry Processing logs, it was noted that quarterly badge results are primarily recorded as zero for Buildings 111, 121, 331, 334, 441, 444, 750, 865, 881, and 883. The lack of density readings persisted through 1969 and 1970. Furthermore, badges from plutonium area workers did have density readings recorded. One difference between 1969 and 1970 was that handwritten Occupational Dose Reports would indicate zero in 1970 rather than blank, which was the case in 1969. It is possible that the zeros in the dose columns for deep and shallow dose in the dosimetry processing logs were entered without a corresponding density entry as a matter of convenience. However, it is much more likely that they were zero entries when badges were not being read, since a policy to this effect was instituted in 1969. Other evidence, discussed below, clearly leads to this conclusion. NIOSH's reading of these logs is the same as SC&A's – that these zero entries represent unread badges:

> *Monthly "Status Reports" prepared by John Mann, the manager of the Dosimetry Program addresses the issue of data sheets with zeros written at the top and with arrows down the entire page. The status report dated April 8, 1969, Item A.3 states: "Quarterly badges for the non-Pu areas will no longer be read routinely, except for a few higher risk groups. The film will be changed as usual, but will*

not be read unless circumstances warrant." [NIOSH, undated, *Summary of Investigations Regarding 1969 Data Gap*, published in 2006]

Table X-2 lists nineteen claimants with 1969 gaps from among the 136 individuals initially identified as having data gaps in the Occupational Dose Report. These individuals worked all four quarters during 1969 and most continued employment into 1970. SC&A examined four different data records for these 19 individuals for 1969:

1. The Occupational Dose Report, which is the handwritten summary dosimetry report in the HP file;
2. Dosimetry History by Individual, which is a computer print out generated prior to the HIS-20 database creation
3. Health Physics External Radiation Exposure Report (HPERER), quarterly summary reports.
4. The HIS-20 computerized database, which NIOSH is using for its co-worker model.[3] The individuals also had dose values for 1969 in the *RRFP Coworker Stats (NDRP Included, HIS-20)* file located on the O-drive. In each case, all the blank values in the HPERER were recorded as zeros in the HIS-20 database.

Examples of the Occupational Dose Report, Dosimetry History by Individual, and Health Physics External Radiation Exposure Report are available in the External Dosimetry TBD (Langsted 2005, pp. 52-55, 61). The individuals also had dose values for 1969 in the *RRFP Coworker Stats (NDRP Included, HIS-20)* file located on the O-drive. Each of the four external dosimetry sources (Occupational Dose Report, Dosimetry History by Individual, Health Physics External Radiation Exposure Report (HPERER) was reviewed to determine the dose values entered for 1969.

In all 19 cases, the HPERER data show blanks for the entire year (indicated as "Null" in the Table X-2). Sixteen show blanks in the handwritten Occupational Dose Report in their Health Physics file, while three individuals did not have such a report in their Health Physics file. Note that a typed version of an Occupational Dose Report under a different name is not referred to here since it was available for only a few individuals. Null is indicated in Table X-2 only when a blank was documented for each quarter of 1969. Hence both Occupational Dose Report and the HPERER data show by their blank entries that the badges of these workers were not read.

In contrast, the Dosimetry History by Individual computer printouts show the following (see Table X-2):

- Zeros for ten individuals having 1969 data for the deep dose instead of blanks and a blank for the shallow dose.
- No Dosimetry History by Individual in the Health Physics file for nine individuals (indicated by N/A).

[3] At this stage SC&A has not established whether the external HIS-20 has been used in individual dose reconstruction .

Finally, the HIS-20 database shows zeros in all 19 cases for both shallow and deep dose. This would demonstrate that in both the processing logbooks and the computerized databases, that unread film was entered as a zero. The entry of zeros for unread badges to the conclusion that the sudden increase in zeros in 1969 in the HIS-20 database (Table X-1 above) is very likely mainly due largely to a zero entry in the database in place of the blanks in the Occupational Dose Reports and the HPERER data. This conclusion is buttressed by the fact that the decision no to read a certain category of badges resulted in a large decline in the number of badges read (1,000 packets per quarter – see above).

The other bases for this conclusion include:

- The increase in the number of zeros from 1968 to 1969 from 13.3 percent to 36.7 percent.
- Quarterly cycles badges were not read starting in 1969 (Mann 1969c)
- The blanks in some databases show up as zeros in others, notably the HIS-20 database and in the data showing Dosimetry History by Individual
- Workers with blanks (subsequently zero in the HIS-20 database) were assigned to areas considered non-plutonium work and fit the profile of those referred to in the memo for non-reading of issued badges. While the fire caused a stoppage of plutonium operations, this cannot account for non-plutonium workers with gaps in their dosimetry records.
- The same workers had densitometer readings in earlier periods, but none in 1969.

The practice of recording zeros for dose and providing no densitometer readings in the Dosimetry Processing logs continues into 1970. The existence of non-zero doses for the same workers in the HPERER records in 1970 indicates that it may have changed before the end of the year. This is also reflected in the reduction in the percentage of zeros from 1970 to 1971. SC&A has not come across any document that allows a definitive date for the ending of the practice of not reading issued badges to be established. Further, it is to be noted that the non-reading of badges of at least some workers started earlier than 1969 and continued later than 1970, as evidenced by the case of a secretary who had blanks in her dosimetry record from 1963 to 1973, inclusive (November 6, 2006 Working Group meeting transcript, pp. 76-78). This raises the possibility that the 1969 policy change was a formalization or continuation of an earlier practice that may have affected a smaller number of workers.

In summary, based on information in dosimetry correspondence, the site implemented a practice of not reading the assigned quarterly dosimetry badges of non-plutonium workers. As NIOSH has stated, the Dosimetry Program addresses unprocessed dosimeters by recording zeros on the log sheet and/or arrowing down the page, with zeros recorded at the top. Figure 4-1 is an example of a log sheet where arrowing down the page is shown. In the evaluation of nineteen claimants with 1969 data gaps, it was determined that the HIS-20 and Dosimetry History by Individual data files contain zeros in cases where badges were not read, contributing to the significant increase in the number of zeros from 1968 to 1969. This brings into question the integrity of those data records and partially substantiates worker claims that RFP recorded zeros when badges were not read (and not just when they were not handed in). Moreover, as discussed below, some job types among this group of workers clearly had significant dose potential. This is also illustrated by the case of the worker not included in Table X-2, discussed above.

The individuals whose badges were not read were assigned to "non-plutonium" areas as defined by Rocky Flats Radiological Control staff. As shown in Table X-2, many of these individuals were located in uranium areas where uranium was handled or processed (e.g., 444, 881, 883). Others were employees who were housed in non-plutonium area or administrative building, but visited Radiological Areas (including plutonium areas) as a part of their job responsibilities.

To further evaluate the exposure to non-plutonium area workers, SC&A compared doses from the fourth quarter 1968 Dosimetry Processing sheet and the first quarter 1969 Dosimetry Processing sheet for eighteen individuals. The individuals were assigned to Buildings 111, 331, 441, 444, or 883 during this period of time. The policy for not reading non-plutonium area badges was implemented the first quarter of 1969. A comparison the Fourth Quarter 1968 and First Quarter 1969 logsheets was completed. Also included in the table is the result recorded for Fourth Quarter 1968 and First Quarter 1969 from the HPERER in the Health Physics file. Table X-4 provides the results of this comparison. Figures 4-2 and 4-3 are examples of the Fourth Quarter 1968 logsheets and the First Quarter 1969 logsheet. With a few exceptions the same individuals are included on both sheets. All individuals were on a quarterly exchange cycle and there was no indication of a late or unreturned badge. The results from the 1969 First Quarter logsheet were all zeros or zero with an arrow down the page. As can be seen from the table and the figures, doses were not zero in the fourth quarter of 1968 prior to the implementation of the no-read policy. This review also indicated that although badges were not read in the first quarter of 1969, the individual may have readings for later quarters. In these cases, the annual dose for 1969 would reflect the dose from the quarters where badges were read. This indicates gaps in 1969 can occur for only a portion of 1969. Hence the problem of zeros in the 1969 data record when badges were not read is larger than that indicated when only blanks for the entire year are considered.

External dose exposure potential, notably shallow external dose in some uranium areas, could be very high. This is noted in the Rocky Flats site history (Putzier, 1982):

> *In earlier years in handling large quantities of depleted uranium, and to some extent this is true in more recent years, we did have a significant radiation control problem in Building 444. This was not experienced so much in the machining areas but in the part of the foundry operations we call burnout and breakout. Castings were removed by breaking them out of the molds. This operation and the recovery of the material from the casting and handling the molds themselves resulted in very high beta radiation levels. There was an extremely high level of beta radiation associated with this because the first two daughters of ^{238}U are beta emitters and during the molten state of the uranium there is a tendency for these two daughters to flow to the top and also to show up at the interface of the uranium and the mold itself thereby enhancing the amount of beta radiation coming off from the chunk of the material. We used to use as a rule of thumb that clean uranium metal in equilibrium with at least its first two daughters would give off on the order of 200 mrad per hour beta radiation at the surface of a piece of the metal. This went up by at least an order of magnitude and probably more than that. We can say that we say readings as high as 2000 to 3000 mrad/hr on castings of depleted uranium that were in the foundry area. Then, too, the dusts*

which were generated in the burnout and breakout areas settled on various pieces of equipment and from that there were additional beta radiation fields generated. This also resulted in excessive dust in the atmosphere. The housekeeping of these areas was indeed a very important control problem, and as I recall, in those days was handled very well. [Putzier 1982, pp. 74-75 of the pdf file]

This description of radiological conditions in at least some uranium areas from the 1950s into the early 1980s (though apparently with lower intensity of problems in the later years) shows that external shallow dose rates in some uranium areas were very high – much higher than the theoretical maximum of about 240 mrad/hour contact dose with U-238 metal in equilibrium with Th-234 and Pa-234m. The high dose rates and non-zero doses mean that the zeros that were put in place of blanks for unread badges cannot be generally interpreted as LOD or LOD/2.

The non-reading of badges and zeros in the data records, including the HIS-20 database, in place of blanks raise four distinct issues of data integrity:

- Not reading badges that were issued is not consonant with sound practice, especially since at least some of the workers concerned were known or should have been known to have prior exposures above the LOD of the badge. Throwing away the badge after a few weeks converted a problem of unsound practice to a problem of data integrity because it obviated any possibility of verifying the low exposure assumed in initiating the practice.
- While the non-reading of badges may have been done with the intent of minimizing work related to reading badges of workers judged to have low exposure potential, the facts relating to at least some non-plutonium work indicate that this was an erroneous belief, notably for shallow dose. The non-reading of badges that were issued was therefore a practice that partly supports a claim in the SEC petition that workers with significant exposure potential had zeros entered in their badge records.
- Entry of zeros in some data records when the badges were not read, and were in fact discarded, raises questions about the integrity of the data recording practices. It is important to note that SC&A has found no evidence that the intent was to fabricate data. However, SC&A also notes that a record containing zeros for badges that were not read is fundamentally flawed in as much as the records cannot be said to correspond to the reality of the working conditions of at least some of the affected workers. That part of the record for 1969 and 1970 cannot be said to meet the test of scientific integrity of data as it is commonly understood.
- Some workers whose badges were not read appear to have worked in plutonium areas even though their formal assignments shown on the dosimetry processing logs are indicated as being to non-plutonium areas. Non-reading of such badges, especially during the post-fire period poses additional special issues.

It is not clear whether the external dose data from plutonium areas can be used to create a co-worker model for uranium areas, given the problems of high beta radiation discussed above. Uranium beta radiation in some areas was likely to have been much higher than in plutonium areas. At the same time, some plutonium areas in some periods had high external gamma radiation (in relation to high americium content of reactor grade plutonium processed in some

periods and high fission product content on the surface of early Savannah River plutonium buttons – Putzier 1982).

The problem of creating a co-worker model for the workers affected by the practice of entering zeros in place of blanks is further complicated by the involvement of some of them in the fire and cleanup in 1969. It should also be noted that SC&A has not investigated whether the same practice of entering zeros in the HIS-20 database affected other periods where significant numbers of zeros or blanks are observed in external dose records, notably the 1950s period (see Chapter 7 for a description of the completeness investigation other than for 1969). Finally, work with radionuclides other than uranium in non-plutonium areas may also have created similar issues. SC&A has not investigated this problem.

Conclusions

Based on their analyses of the problem, SC&A and NIOSH concur that there are gaps in the 1969 external dosimetry data for some workers. A significant part of the problem arises from a policy of not reading quarterly badges (with some possible exceptions) instituted in 1969. SC&A has also pointed to gaps in 1970, but no similar detailed response has been forthcoming from NIOSH.

NIOSH has concluded that although this data gap exists, dose reconstruction can be performed with sufficient accuracy in 1969. As things stand at present, SC&A is not in accord with this conclusion in as much as NIOSH has not demonstrated that it can do so, given the specific working conditions of the workers whose badges were not read.

The assumption that workers in non-plutonium areas were not at risk of high external exposure is incorrect, especially regarding beta dose in some specific uranium work areas. There is, at present, no available method for addressing the dose reconstruction corresponding to the blanks in the dose records from 1969 onward that resulted from the practice of not reading issued badges. There also does not appear to be any straightforward method to use the HIS-20 database for a co-worker model; blanks corresponding to significant exposure potential may be mixed in with “other” zeros that were entered with actual zeros corresponding to a badge reading of less than the detection limit. SC&A has concluded that the integrity of at least a portion of the 1969 and 1970 dose record has been significantly compromised by the practices discussed above.

Further, as noted above the non-reading of badges of at least some workers appears to have started earlier than 1969 and continued later than 1970, as evidenced by the case of a secretary who had blanks in her dosimetry record from 1963 to 1973 (inclusive). Given that at least some groups of 1969 workers whose badges were not read likely had significant exposure potential, it is essential to investigate the starting and ending dates of the practice of not reading assigned badges and to explicitly determine the exposure potential of the groups of workers who were affected.

Constructing a coworker model and demonstrating that it meets the test of dose reconstruction with sufficient accuracy under 42 CFR 83 for all members of the class affected by the practices

and policies discussed in this section poses significant challenges and will likely be a non-trivial task.

References

AEC (Atomic Energy Commission), 1969, *Report on Investigation of Fire Building 776-777 Rocky Flats Plant, Golden, Colorado, May 11, 1969, Volume 1*, U.S. Atomic Energy Commission, August 1969.

Lagerquist, C.R., 1975, Memorandum from C.R. Lagerquist to E.A. Putzier, *Background Subtraction on TLD Readings*, Golden, Colorado, October 29, 1975.

Lagerquist, C.R., 1976, Memorandum from C.R. Lagerquist to R.O. Williams, *Significance of Low Level External Doses*, Golden, Colorado, December 22, 1976.

Langsted, J., 2004, *Technical Basis Document for Rocky Flats Plant – Occupational External Dosimetry*, ORAUT-TKBS-0011-6, Oak Ridge Associated Universities Team, Oak Ridge, Tennessee.

Mann, J.R.,1969a, *Status Report – Dosimetry – February, 1969*, The Dow Chemical Company, Rocky Flats Division, Golden, Colorado, March 7, 1969,

Mann, J.R., 1969b, *Status Report – Dosimetry – April, 1969*, The Dow Chemical Company, Rocky Flats Division, Golden, Colorado, May 7, 1969.

Mann, J.R., 1969c, *Status Report – Dosimetry – March, 1969*, The Dow Chemical Company, Rocky Flats Division, Golden, Colorado, April 8, 1969.

Mann, J.R., 1969d, Memorandum from J.R. Mann to Dosimetry Technicians, Film *Badge Processing for Non-Pu Areas*, The Dow Chemical Company, Rocky Flats Division, Golden, Colorado, March 13, 1969.

NIOSH 2006x, *RRFP Coworker Data Stat (NDRP included, HIS20 Data)*, Office of Compensation and Analysis, Cincinnati, Ohio.

NIOSH, 2006x2, *Summary of Investigations Regarding 1969 Data Gap*, Office of Compensation and Analysis, Cincinnati, Ohio.

Putzier, E.A., *The Past 30 Years at Rocky Flats*, Rockwell International, Golden, Colorado, November 1982.

Vogel, R.M., 1969, Memorandum from R.M. Vogel to J.R. Mann, *Non-Plutonium Area Film Badge Recommendation*, The Dow Chemical Company, Rocky Flats Division, Golden, Colorado, March 3, 1969.

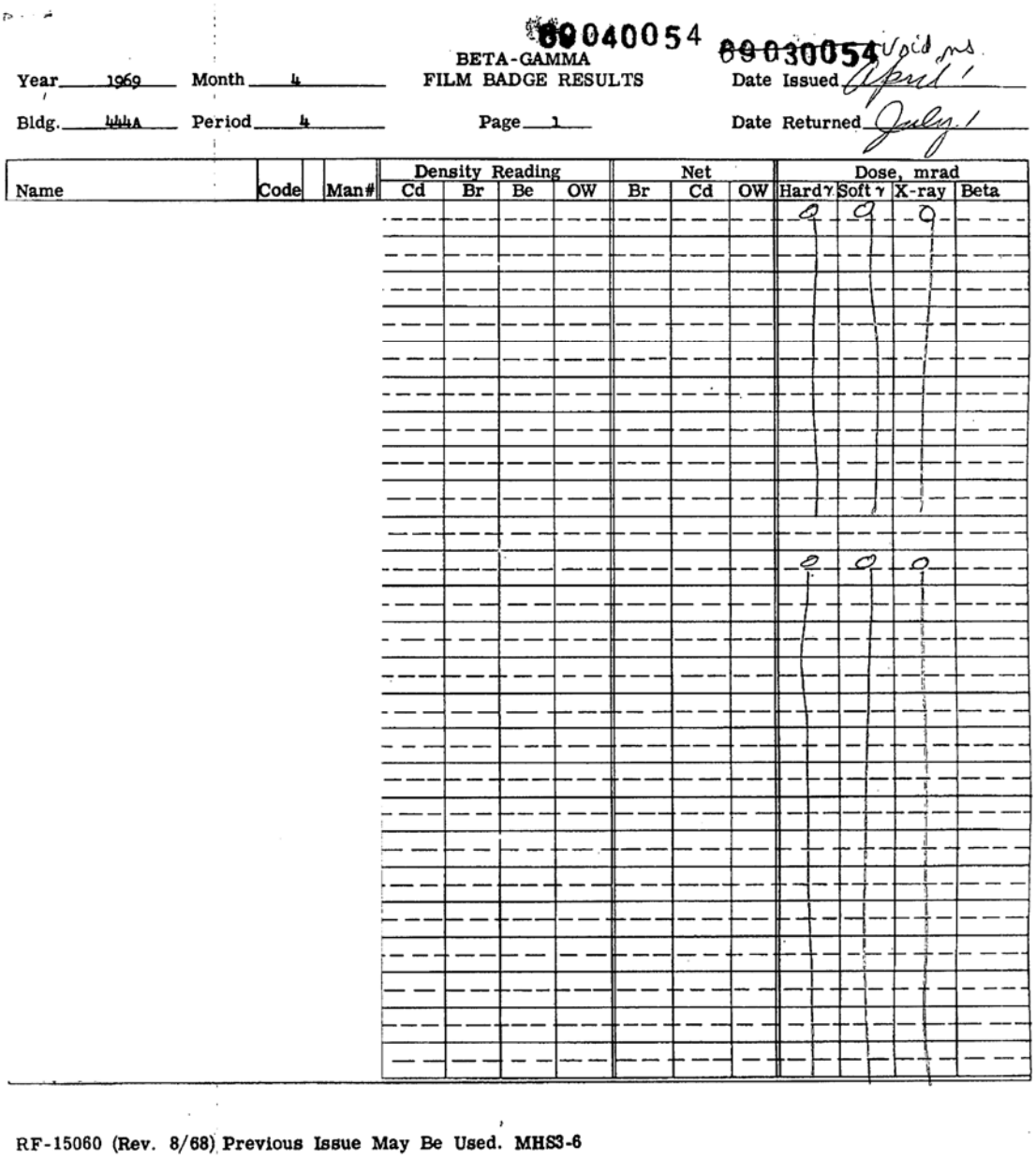
Table X-2. A Comparison of Data Sources for Claimants with 1969 Gaps.

ID	Jobtitle	Bldg	Occupational Dose Report 1969	Dosimetry History by Individual 1969	HPERER 1968	HPERER 1969	HPERER 1970	HIS_20 1969	In Vitro 5/11/1969-12/31/69	In Vivo 5/11/1969-12/31/69
1	Inspector		Null	N/A	Skin Only	Null	14	0	N	N
2	Maintenance Electrician		No 51-79 datasheet	N/A	362	Null	0	0	N	N
3	Mechnical Maintenance		No 51-79 datasheet	0	14	Null	0	0	N	Y
4	Accountant		Null	0	Null	Null	0	0	N	N
5	Cost Accountant		Null	0		Null	0	0	Y	N
6	Mechanical Development		Null	0	92	Null	23	0	N	N
7	Truck & Labor		Null	0	35	Null	0	0	N	Y
8	Civil Engineer		Null	0	10	Null	0	0	N	N
9	Tool Engineering		Null	0	Skin Only	Null	0	0	N	N
10	QA Inspector		Null	N/A	7	Null	0	0	Y	Y
11	Sr. Material Specialist		Null	0	24	Null	26	0	N	N
12	QC Inspector		Null	N/A	171	Null	0	0	Y	N
13	Production Eng		Null	N/A	38	Null	150	0	Y	Y
14	Facility Engineer		No 51-79 datasheet	N/A	137	Null	19	0	N	N
15	Sr. Fire Protection Engineer		Null	0	14	Null	0	0	Y	N
16	R & D Engineer		Null	N/A	187	Null	144	0	Y	N
17	Sr. Research Mgr.		Null	N/A	Skin Only	Null	188	0	Y	N
18	Inspector		Null	N/A	8	Null	55	0	N	N
19	Fireman		Null	0	23	Null	77	0	Y	Y

Table X-4: Non-plutonium Area Worker Dose for Fourth Quarter 1968 and First Quarter 1969.

ID	Jobtitle	Work Location	Dosimetry Log Gamma Dose Q4 1968	Dosimetry Log Beta Dose Q4 68	HPERER Deep Dose Q4 1968	HPERER Shallow Dose Q4 1968	HPERER Deep Dose 1969	HPERER Shallow Dose1969	In Vitro for 1969
101	Electrician		33	95	33	128	Null	Null	N
102	X-Process Opr		142	1240	142	1382	Null	Null	Y
103	Journeyman Machinist		33	1880	33	1913	Null	Null	Y
104	Journeyman Machinist		96	300	96	551	Null	Null	Y
105	Tool Grinder		16	95	16	111	Null	Null	Y
106	Journeyman Machinist		16	95	16	111	Null	Null	Y
107	Journeyman Machinist		16	125	16	141	Null	Null	N
108	Journeyman Machinist		42	80	42	122	Null	Null	Y
109	Inspector		42	80	42	122	Null	Null	N
110	Journeyman Machinist		33	50	33	83	Null	Null	N
111	Mtce Machinist		42	80	48	62	Null	Null	N
112	Journeyman Machinist		16	95	16	111	Null	Null	N
113	Sr. Industry Photographer		74	77	75	77	Null	Null	N
114	Advanced Facility Engineer		137	139	137	139	Null	Null	N
115	Vehicle Driver		164	173	167	173	Null	Null	N
116	Designer I		89	98	92	98	Null	Null	N
117	Equipment Opr		222	632	222	632	Null	Null	Y
118	Equipment Opr		152	832	152	832	Null	Null	Y

Figure 4-1: Example Logbook Sheet with Zeros Followed by Arrowing Down. Fourth Quarter 1968 Dosimetry Logsheet for Individuals on a Quarterly Cycle from Building 111.



~~69~~040054 ~~69~~030054 Void ms.

BETA-GAMMA
FILM BADGE RESULTS

Year 1969 Month 4 Date Issued April 1

Bldg. 444A Period 4 Page 1 Date Returned July 1

Name	Code	Man#	Density Reading Cd	Br	Be	OW	Net Br	Cd	OW	Dose, mrad Hard γ	Soft γ	X-ray	Beta
										0	0	0	
										0	0	0	

RF-15060 (Rev. 8/68) Previous Issue May Be Used. MHS3-6

Figure 4-2: Fourth Quarter 1968 Dosimetry Logsheet for Individuals on a Quarterly Cycle from Building 111.

BETA-GAMMA
FILM BADGE RESULTS

68100008

Year 1968 Month 12

Bldg. 111 Period 4 Page 4

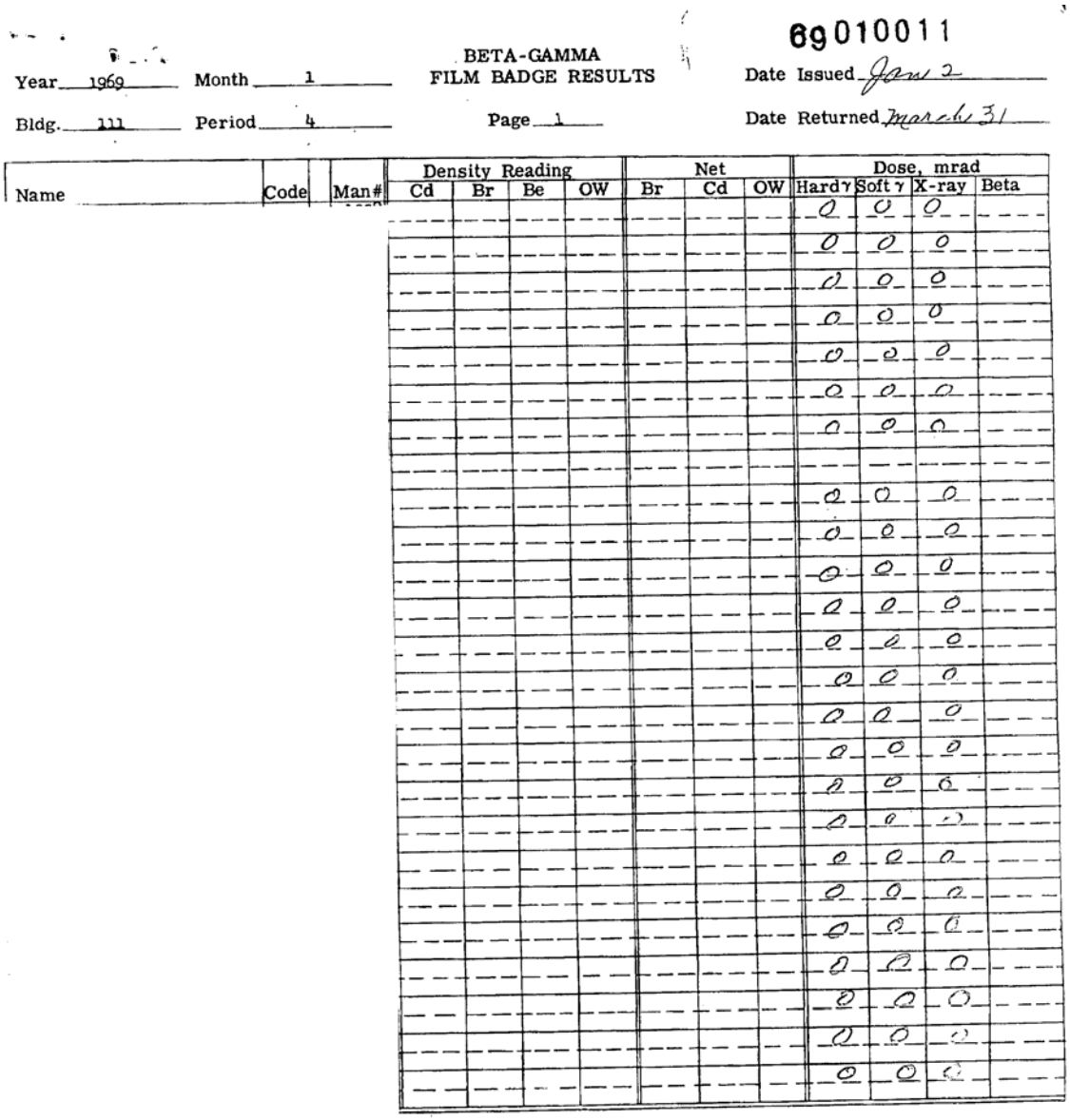
Date Issued

Date Returned

Name	Code	Man#	Density Reading Cd	Br	Be	OW	Net Br	Cd	OW	Dose, mrad Hard γ	Soft γ	X-ray	Beta
			12	12		15	0	12	12	105	0	39	
			10	13		17	3	10	3	87	4	9	
			0	2		5	2	0	1	0	3	3	
			11	14		18	3	11	3	96	4	7	
			8	8		12	0	8	4	68	0	13	
			0	5		5	5	0	0	0	6	0	
			8	14		17	6	7	1	59	7	3	
			7	9		14	2	7	5	59	3	16	
			4	6		8	2	4	1	33	3	3	
			2	4		7	3	2	2	16	3	6	
			4	8		9	4	4	0	33	5	0	
			2	4		5	2	2	0	16	3	0	
			0	2		5	2	0	2	0	3	6	
			4	5		10	1	4	5	33	2	16	
			5	7		10	2	5	2	42	3	6	
			5	8		11	3	5	2	42	4	6	
			3	5		8	2	3	2	24	3	6	
			3	7		11	6	3	0	24	7	0	
			5	5		7	0	5	2	42	0	6	
			0	0		3	0	0	3	0	0	9	
			7	9		10	2	7	0	59	3	0	
			4	4		4	0	4	0	33	0	0	
			0	0		0				0	0	0	

RF-15060 (Rev. 8/68) Previous Issue May Be Used.

Figure 4-3: First Quarter 1969 Dosimetry Logsheet for Individuals on a Quarterly Cycle from Building 111.



69 010011

BETA-GAMMA
FILM BADGE RESULTS

Year 1969 Month 1 Date Issued Jan 2

Bldg. 111 Period 4 Page 1 Date Returned March 31

Name	Code	Man#	Density Reading				Net			Dose, mrad			
			Cd	Br	Be	OW	Br	Cd	OW	Hard γ	Soft γ	X-ray	Beta
										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	
										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	
										0	0	0	
										0	0	0	
										0	0	0	

RF-15060 (Rev. 8/68) Previous Issue May Be Used.