General Steel Industries (GSI) SEC-00105 Co-Petitioner
Dan McKeel's Critique of Appendix BB Rev 1 (6/6/14)

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Introduction

This document is a scientific critique of Appendix BB Rev 1 (hereafter abbreviated "AppBBr1") dated 6/6/14 by David Allen of DCAS/NIOSH. SEC Counselor Josh Kinman e-mailed the PA-cleared version to Dan McKeel on June 25, 2014. Mr. Kinman noted he had sent a copy to "one other" person (not named). Presumably this person was the primary GSI SEC-00105 petitioner, Patricia (formerly Coggins) Jeske. As of this date, Mrs. Jeske has not confirmed receipt to McKeel of receiving a copy of AppBBr1.

The original AppBr1 document sent to McKeel was a 38-page PDF file he converted to plain text and Word .doc formats. Tables and diagrams were captured using the Apple Grab utility and then copied and pasted into the manuscript without alteration.

The original material is reproduced as (original)11.5 pt. New Times Roman text and McKeel's commentary is reproduced using the Microsoft Word (Office 2011 for Mac) Cambria 12 pt. font. The final, distributed Word .doc file was converted to PDF.

Executive Overview of This Critique

The parent document to AppBBr1, Battelle TBD-6000, was released on June 11, 2011. The 38-page AppBBr1 by Dave Allen of DCAS (NIOSH) is dated June 6, 2014. The preceding version of Appendix BB, Rev 0, by Dave Allen and Sam Glover of DCAS (NIOSH), is 12 pages long and is dated June 25, 2007, almost seven years earlier. NIOSH had no GSI site monitoring data at this time. Compared to other EEOICPA sites, this is a very prolonged interval between major TBD revisions. All but four of the NIOSH dose reconstructions completed for the GSI AWE site to date have been based on AppBBr0. The four earlier DRs that were not based on AppBBr0 are covered in GSI PER-24.

The Dose Reconstruction standing Subcommittee (DRSC) of the ABRWH under its chairmen Mark Griffon and David Kotelchuck has steadfastly refused to review any GSI completed DRs. Approximately five GSI cases were scheduled to be reviewed, including two GSI DRs that SC&A identified as having very flawed NIOSH DR methodology. The DRSC chair wrote McKeel earlier this year to say no GSI cases would be reviewed until AppBBr0 could be revised. That happened 6/6/14.

AppBBr1, similar to the predecessor document, has many serious scientific flaws. Mr. Allen ignores vast amounts of new, informative DR and SEC data that has been provided by the GSI SEC-105 petitioners, site experts and workers. The largely ignored material includes 53 white papers by SEC-00105 co-petitioner McKeel.

Detailed Critical Analysis: Allen DCAS AppBBr1 Paper

DOE Review 06/17/2014

Division of Compensation Analysis and Support	Document Number: Battelle-TBD-6000 Appendix BB Effective Date: 06/06/2014 Revision No. 1
Site Profiles for Atomic Weapons Employers that Worked Uranium Metals **Appendix BB – General Steel Industries**	Page 1 of 38
Document Owner: David Allen Approval: Signature on file J.W. Neton Associate Director for Science	Date: 06/06/2014 Supersedes: Appendix BB Revision 0

RECORD OF ISSUE/REVISIONS			
ISSUE AUTHORIZATION DATE	**EFFECTIVE DATE**	**REV. NO.**	**DESCRIPTION**
6/25/2007	6/25/2007	0	Appendix to Battelle-TBD-6000 describing the use of the TBD for claims at General Steel Industries
6/6/2014	6/6/2014	1	Revised to incorporate resolution of issues raised by the Advisory Board on Radiation Worker Health.

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BB.1 Introduction

This document serves as an appendix to Battelle-TBD-6000, Site Profiles for Atomic Weapons Employers that Worked Uranium Metals. This appendix describes the results of document research specific to this site. Where specific information is lacking, research into similar facilities described in the body of this Site Profile is used.

MCKEEL COMMENT to BB.1 Introduction: The parent Battelle TBD-6000 document should be identified by Rev 0 or 1 and by the release date in 2006 (Rev 0) or 2011 (Rev 1). The meaning of the term "document research" is not clear. There should be allusion to the previous Appendix BB version, Rev 0 (June 2007) to make the context of this Rev 1 version entirely clear and transparent. It would be better to include a statement as to why this Rev 1 document was necessary. This is pertinent background information.

BB.2 Site Description

General Steel Industries (GSI) performed quality control work for the Atomic Energy Commission (AEC) from October 1952 until June 1966. Utilizing two 25 MeV betatron machines, it performed x-rays on uranium metal of various forms including uranium ingots and betatron slices to detect metallurgical flaws for the Mallinckrodt Chemical Company (DOE Web Site). The x-ray films were processed, but not interpreted, at General Steel Industries. The facility is located at 1417 State Street in southwest Granite City, Illinois, northeast of St. Louis, Missouri, east of the Mississippi River. The use of the facility for these services was on an as-needed basis controlled by purchase orders with limits but no indication of actual frequency or duration (ORNL 1990).

MCKEEL COMMENT to BB.2 Site Description: This brief paragraph does not capture the scope of the work performed at GSI from Oct. 1, 1952 through 1973. Such an expanded site description is necessary because part of the exposures were due to Betatron nondestructive testing (NDT) on non-uranium metal (primarily steel) castings. The Betatron would be more correctly classified as a type of electron particle accelerator developed by Donald Kerst in 1939. The term used "Betatron machine" is imprecise (too general). The allusion to "(DOE website)" is also meaningless without providing a URL. There are multiple DOE websites, actually. Also, one doesn't "perform x-rays", one carries out nondestructive testing (NDT) radiography that includes the production of x-ray films as an end product. Thus, more precisely, the two GSI Allis-Chalmers 24 and 25 Mev betatrons were used to examine uranium metal and steel castings by generating penetrating x-ray films of the surfaces and deep structures using novel NDT Betatron radiography methods.

BB.2.1 Site Activities

During the late 1950s and early 1960s, General Steel Industries used a betatron to x-ray uranium metal for the AEC under purchase orders issued by Mallinckrodt Chemical Works. Purchase orders were issued by the Uranium Division, Mallinckrodt Chemical Works, from February 1958 through June 1966, first to General Steel Castings Corporation and later (July 14, 1961 and after) to General Steel Industries, Inc., at the same address. The uranium to be x-rayed was owned by the AEC and provided by Mallinckrodt (DOE 1991).

MCKEEL COMMENT to BB.2.1 Site Activities:

1. The reference "(DOE 1991)" is so imprecise to be meaningless. What reference document is being referred to should be spelled out with author, title, report/SRDB number and date, and specific page/s being referred to. Preferably a URL link to the report would be provided.

2. The fact that GSI began Betatron R&D work with the AEC using MCW uranium billets and a uranium shield furnished by MCW as early as October 1, 1952 is well established by both NIOSH and McKeel documentation. Thus, the phrase in the first sentence *"during the late 1950s."* is incorrect; the Betatron AEC-MCW uranium work began in the early 1950s. This error needs to be corrected. The phrase is true based on work done under MCW purchase orders that DOE provided to NIOSH for 1958 through 1966. The text should state that NIOSH was unable to locate any MCW Uranium Division purchase orders earlier than 1958 and what efforts were made to retrieve them.

3. Allen here omits the key fact that MCW purchase orders covering the GSI uranium work for 1952 through 1958 were never located by DCAS/NIOSH or anyone. Yet the fact that the GSI Betatron was in use during the last quarter of 1952 for AEC-MCW uranium nondestructive imaging R&D is indisputable from the three AEC operational reports furnished to DOL by McKeel (November and December reports) and by NIOSH two days later for October 1952.

4. To be fully accurate about the site description, it should be noted the original GSI 1417 State Street, Granite City, IL, A-C 24 Mev Betatron and the facility it was housed in was owned by the "US government." The GSI site expert and SEC co-petitioner furnished this information to Dave Allen and the TBD-6000 WG based on official GSI Board of Directors minutes they retrieved from the Missouri Historical Society on Lindell Blvd. in St. Louis, Missouri. We also have newspaper evidence that the Chicago District of the US Army Corps of Engineers built the original ("old") Betatron building and installed the A-C 24 Mev Betatron during 1951. The news accounts stae the first GSI betatron was put into operation Jan. 14, 1952. Allen mentions none of this information.

BB.2.2 Frequency of uranium X-rays

General Steel Industries work with uranium was performed under purchase orders with Mallinckrodt Chemical Works starting in March of 1958. These purchases orders cover the time period March 1, 1958 through June 30, 1966 (Mallinckrodt 1958-1965). These purchase orders indicate that the work was to "X-ray material as requested by Mallinckrodt…" They also contained "Betatron labor charges, including operation and maintenance and all overhead shall be billed at $16.00 per hour." The last purchase order covering the period of July 1, 1965 to June 30, 1966 indicated a billing rate of $35.00 per hour. The purchase orders also indicated that the work was not to exceed a set cost. The first purchase order, covering the period March 1, 1958 to June 30, 1958 stipulated a monthly limit of $500. That purchase order was extended to October 31, 1958 and added $1800 to the total limit (an additional $450 per month). A new purchase order covered the period November 1, 1958 to June 30, 1959 and stipulated a monthly limit of $450 and a total limit of $3600 (equal to $450 per month). The next purchase order covered July 1, 1959 to June 30, 1960 and stipulated a monthly limit of $450 with a total limit of $7200. It should be noted that the total limit does not add up to 12 months at the monthly limit. This is the only purchase order with this conflict. Since these are limits and not estimates, the most limiting of the two values will be used in this appendix which is consistent with purchase orders written both before and after this one.

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From that point on, the purchases orders were written annually covering a period of July 1 to June 30 of the next year. All but the last order stipulated a billing rate of $16 per hour. The purchase order starting in 1960 stipulated no total limit. Only a monthly limit of $450 per month was specified. After that, only a total limit was specified. These limits were $7000 for the purchase order starting in 1961, $2000 for the purchase order starting in 1962, and $450 for each of the remaining purchase orders. From this information, it is possible to determine the maximum hours per month that General Steel Industries spent on operations, maintenance and overhead associated with x-raying uranium for Mallinckrodt Chemical Works. A summary of that information is contained in Table 1.

Table 1 – Summary of Mallinckrodt Purchase Orders

Start Date	End Date	# of months	Monthly limit ($)	Total limit ($)	Charge rate ($/hour)	Max hours/month
3/1/1958	6/30/1958	4	500		16	31.25
6/30/1958	10/31/1958	4	450		16	28.13
11/1/1958	6/30/1959	8	450		16	28.13
7/1/1959	6/30/1960	12	450		16	28.13
7/1/1960	6/30/1961	12	450		16	28.13
7/1/1961	6/30/1962	12		7000	16	36.46
7/1/1962	6/30/1963	12		2000	16	10.42
7/1/1963	6/30/1964	12		450	16	2.34
7/1/1964	6/30/1965	12		450	16	2.34
7/1/1965	6/30/1966	12		450	35	1.07

These estimated hours are considered the maximum hours that could have been spent x-raying uranium. These are considered maximum because the purchase orders set these costs as a limit. There is no indication how much of the available funds were actually used. Also the cost was to include maintenance down time and overhead as well as the cost of film.

For the remainder of the year, it is assumed that various alloys of steel were x-rayed. The operators reported that overtime was very frequent. Operators indicated that an 8 hour work day was "not the norm". They indicated overtime was frequent (Simmons Cooper 2006). During one meeting, workers estimated that they worked an average of 65 hours per week (Minutes 2007). This document will assume workers spent 65 hours per week on average for 50 weeks per year for a total of 3250 hours per year. This equates to an average of 406.25 eight hour shifts per year. From the information contained in Table 1 the number of hours for each calendar year can be calculated and expressed as a number of shifts per year GSI employees worked with uranium and steel. The covered period for GSI starts 10/1/1952 while the first purchase order found starts on 3/1/1958. The time period prior to March 1958 is considered to be equal to the highest monthly rate in Table 1. Table 2 lists the uranium work hours and the total number of eight hour shifts per year associated with uranium or steel.

MCKEEL COMMENT BB.2.2 Frequency of uranium X-rays: The GSI SEC co-petitioner and site expert dispute Dave Allen and DCAS/NIOSH's assertion as to the exact reasons GSI was hired by MCW and the AEC to examine uranium metal. The phrase Allen uses: *"X-ray material as requested by Mallinckrodt…"* fails to capture the complete story. We believe there were probably three purposes for the uranium NDT inspections: (1) for the period 10/1/52 through 12/31/52, DOE operational reports clearly indicate GSI was partnering with MCW and AEC on experimental work to improve the quality of x-ray imaging of uranium using a special uranium shield built at MCW, (2) for dingots, the purpose of NDT x-ray radiography was to identify the interface between the outer crust (slag, mg-fluoride) and the inner pure uranium metal as an aide to machining on a lathe[1], and (3) for betatron slices, *perhaps* the main purpose of Betatron radiography to examine the interior of the metal for fractures, casting voids and other imperfections. Again, Mr. Allen's site activities description is so truncated and imprecise that it fails to adequately serve the central purpose of technical dose reconstruction TBD guidance.

• The last sentence on page 5 indicates that AppBBr1 will use a 65 hour average work week (3250 hours per year). Allen needs to make explicit this is a *major change* from AppBBr0 (2007), where the average GSI work week was designated to be only 46 hours. Because of this fact alone, all denied GSI part B claims with DRs completed under AppBBr0 (2007) must be reopened and reworked, and a PER has to be issued to allow this to happen. DCAS Director Hinnefeld confirmed in a recent e-mail to Dan McKeel that a GSI PER based on TBD-6000 Rev 1 (2011) and AppBBr1 would be issued as a "high priority" activity.

It should also be noted that NIOSH has no documentation other than 1958 through 1966 MCW-AEC purchase orders to confirm the amount of uranium source term material used at GSI during the operational period (10/1/52 through June 30, 1966). There are no shot records, no shipping manifests, no

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[1] **The GSI SEC-00105 co-petitioner and site expert provided quotes from the "Fuel for the Atomic Age" report by the MCW President, Harold Thayer, testifying that radiography was was done to assist maching the uranium dingots by MCW. We thus dispute SC&A and Bill Thurber's opinion that x-ray inspections were not necessary to define the slag (crust) and uranium dingot interface. Written expert knowledge testimony by the President of MCW should be afforded the greatest credence.**

documentation at all for the years 1952 through 1958 before the first Purchase order. There are DOE operational reports which describe the 1952 uranium R&D work GSI performed with MCW and the AEC *qualitatively* but not *quantitatively*. Allen ignores these missing GSI uranium source term data and assumes, without any valid scientific rationale, that it was acceptable to back extrapolate the uranium source term for 1952-1958 using 1958 through mid-1966 MCW purchase orders. The GSI SEC co-petitioner and main site expert strongly disagree with that assumption we equate with irresponsible and unscientific speculation which we believe is *scientifically indefensible*.

I need to point out again the 1952 Betatron R&D work with MCW uranium differed markedly from the MCW NDT production work that was covered by the 1958 through 1966 purchase orders, a fact that Mr. Allen again ignores.

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Table 2 – Uranium Work Hours by Year

Year	Uranium work (hours/yr)	Uranium work (shifts/yr)	Steel work (shifts/yr)	Total work (shifts/yr)
1952[a]	109	13.7	87.9	101.56
1953	438	54.7	352	406.25
1954	438	54.7	352	406.25
1955	438	54.7	352	406.25
1956	438	54.7	352	406.25
1957	438	54.7	352	406.25
1958	367	45.8	360	406.25
1959	338	42.2	364	406.25
1960	338	42.2	364	406.25
1961	388	48.4	358	406.25
1962	281	35.2	371	406.25
1963	76.6	9.57	397	406.25
1964	28.1	3.52	403	406.25
1965	20.5	2.56	404	406.25
1966[b]	6.43	0.80	202	203.13

a – 1952 only covers 3 month of contract period at the site starting 10/1/1952
b – 1966 only covers 6 months of contract period at the site ending 6/30/1966. The remainder of 1966 is covered as a residual contamination period.

BB.3 Occupational Medical Dose

No detailed information regarding occupational medical dose was found in any of the site research or telephone interviews. Information to be used in dose reconstructions, for which no specific information is available, is provided in ORAUT-OTIB-0006, the technical information bulletin covering diagnostic x-ray procedures.

MCKEEL COMMENT to BB.3 Occupational Medical Dose: I believe this boilerplate language in many NIOSH TBDs is highly misleading for several reasons. First, the CATI interviews should have contained some information about employment, hiring and termination x-rays. In addition, the GSI site

expert provided the TBD-6000 workgroup with documentation from a 1974 GSA auction of GSI equipment which clearly documented three portable 250 Kvp x-ray units were for sale. One of these was a *medical* x-ray unit and the model and manufacturer and nominal output were known. Thus, a medical x-ray source term external dose for GSI employees could have been calculated and bounded as it should have been under OCAS-IG-003. NIOSH chose the easy road and used generic, less accurate dosimetry from surrogate sources that were not justified as being similar to GSI medical x-ray diagnostic equipment or procedures.

The NRC FOIA 2010-0012 documents clearly indicated there was a resident in-house GSI medical staff and that diagnostic x-ray examinations were performed. I believe that NIOSH routinely evokes ORAU-OTIB-0006 rather than do the necessary research to bound a site-specific diagnostic x-ray dose. At GSI, there was specific affidavit testimony from GSI worker Dave Woodard that file cabinets with employee medical records were spared at the time he was charged with destroying other plant records after casting work ceased in 1973 or 74. The files were taken to GSI Corporate headquarters in St. Louis. There is no indication that NIOSH tried to retrieve GSI medical records.

BB.4 Occupational External Dose

Sources of external radiation exposure at GSI included betatron x-ray machines, sealed sources (Ra-226, Co-60, Ir-192), a 250 kvp portable x-ray machine and uranium metal. Except for the uranium, all these sources were used to x-ray metal. This process requires the operator to know the intensity of the radiation source at the metal, as well as the thickness of the metal in order to determine the length of time necessary to produce a clear x-ray image. Additional concomitant sources of radiation would interfere with the process and it is therefore assumed that workers are only exposed to one source of radiation at a time.

In estimating the external dose at GSI, the dose was estimated for a variety of exposure scenarios for the primary sources of external radiation. The limiting dose estimate for each scenario and job category will be used to estimate an individual's external dose. For some scenarios, no numerical dose estimate was made because an analysis of the scenario compared to other numerical estimates was sufficient to eliminate it as a limiting scenario. This could be done by analyzing parameters that would be used in a numerical estimate for example determining less exposure time with all other parameters being equal.

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Doses will be assigned based on one of two job categories. The administrative category consists of people that spent most of their time in an office environment and did not routinely access the operating areas of the plant. The operator category consists of everyone that does not fit the administrative category. It is expected that the majority of workers will fall into this category.

<u>MCKEEL COMMENT to BB.4 Occupational External Dose</u>: The description of these various non-Betatron exposures is qualitative and inexact. Thus, I do not see how this section is useful at all to dose reconstructors. Allen evades the actual *quantitative calculation and bounding* of all of these sources with sufficient accuracy.

The phrase "*a portable 250 Kvp x-ray machine*" is inaccurate. The 1974 GSA auction of GSI equipment showed there were <u>three (3) portable 250 Kvp x-ray units</u>, two industrial and one for medical diagnosis (such as chest films).

There were <u>two (2)</u> <u>Ra-226 sources</u>. NIOSH does not know when leak tests were preformed, when these units were purchased or how long they had been used, or what was the actual strength between 1952 and 1962. Of course, the strength declined over the course of these 10 years, and NIOSH does not know the start point or who the vendor was for these sealed source isotopic gamma NDT sources.

There were <u>two small (0.5 Ci)</u> <u>Co-60 sources</u> and <u>one (1)</u> <u>large 80 curie Co-60 source</u> at GSI. The period of operation for the large Co-60 source is contested: 6 workers provided direct eyewitness affidavit evidence, which Allen and NIOSH disregarded, that they used or assisted with the 80 Curie Co-60 source *in 1964 through 1966,* whereas the GSI license agreement on paper says the large Co-60 80 Curie source was not authorized by the AEC until 1968. We do know GSI personnel did a radiation survey of the New Betatron building with the large 80 Curie Co-60 source in 1971.

The St. Louis Testing Company <u>Ir-192 source</u>, according to Paul Sinn 2014 testimony, was employed at GSI at least 25 to 50 times that he knows about. There is added testimony from 6 GSI workers that <u>GSI owned and used its own Ir-192 source</u>. However, there is no written or testimonial information about how frequently the GSI Ir-192 source was used. The Ir-192 sources were used to inspect pipe welds as one documented use at GSI. A 1972 GSI by-products material license documents states "this facility *is licensed for iridium and cobalt.*" Allen-NIOSH also disregarded this fact that McKeel put on the record.

We reject the type of reasoning implicit in the final two sentences on page 6 of 38 beginning with "*…For some scenarios, no numerical dose estimate was made…*" Those sentences affirm a common NIOSH technique that avoids calculating actual delivered doses, that is identifying "scenarios" and "parameters", both vague qualitative terms. OCAS-IG-003 by Dr. Neton mandates NIOSH must accurately <u>bound *all*</u> radiation source terms.

<u>Summary</u>: NIOSH-Allen failed to calculate doses for any of these sources in AppBBr1 in direct violation of Neton/NIOSH OCAS-IG-003 guidance.

BB.4.1 Betatrons

[MCKEEL PRELIMINARY COMMENT ON SECTION 4.1] -- Key phrases I wish to comment upon at the conclusion of section BB4.1 Betatrons are bolded, assigned a number and are enclosed in square brackets to serve as reference points for the concluding comments.

[1. GSI had two betatron x-ray machines]. **[2. The machines produced high energy x-rays (up to 25 MeV)]** by accelerating electrons in a circular orbit then causing them to collide with a platinum target. The x-ray beam was measured by an ion chamber attached to the machine and the beam was "flattened" by an aluminum compensator designed to shield the high intensity center of the beam more than the lesser intense edges. This produced a usable area of relatively uniform intensity.

While the head of the betatron can be moved throughout the shooting room, the betatron units were not mobile. They consisted of various components housed in a **[3. specially designed shielded building]**. The shooting room was surrounded by 10 foot thick walls consisting of 8 feet of sand sandwiched between 2 one foot thick concrete walls. **[4. The "old betatron" was built in 1952]** and **[5. stood alone separated from other buildings on site]**. **[6. The "new betatron" was built in 1962]** and was attached to building 10 by an equipment tunnel. **[7. Figures 1 and 2 provide drawings]** of the old and new betatron buildings, respectively.

The intensity of the x-rays from the new betatron **[8. was reported to be 250 R/min at 3 feet from the platinum target with the aluminum compensator removed].** The compensator reportedly reduced the intensity by a third (Schuetz 2007). **[9. The intensity of the old betatron was reported to be less.]** However, **[10. to avoid trying to place workers in one betatron versus the other]**, this appendix will use 250 R/min at 3 feet for all calculations. **[11. Since the betatrons are not the limiting dose estimate prior to the construction of the new betatron, this is not an overestimate]**. **[12. Betatron x-rays are of sufficient energy to produce nuclear interactions in material being x-rayed causing some atoms to become radioactive]**. That material then creates an **[13. additional source of external radiation]**. The external exposure scenarios explored for betatron operations include a scenario for the betatron operators and the layout man. The **[14. layout man is a person assigned the duty]** of marking the casting to determine what portions of the casting need to be x-rayed again, as well as marking any defects found in the previous shots. Several scenarios of workers working outside the betatron building were also evaluated, including working on the roof of the betatron building but **[15. were found not be the limiting dose estimate due to limited exposure time or limited dose rates (DCAS GSI web page)]**.

This document will refer to the process of x-raying metal as shooting the metal or taking a shot. This is the vernacular used by former radiographers and avoids confusing an x-ray exposure with worker exposure to x-ray radiation. The betatron operator shooting scenarios consisted of a shooting scenario for uranium and a separate one for steel castings. The scenario for the steel castings includes two different durations and distances, which were based on [**16. interviews with former workers at GSI (SC&A 2008)]**.

<u>MCKEEL COMMENT ON BB.4.1 Betatrons (Part 1)</u>: My comments on the 16 foregoing bracketed passages are as follows. As a preface, it is not self-serving to state the following facts that support the assertion that McKeel and Ramspott, the GSI SEC co-petitioner and John Ramspott, the chief GSI site expert (refrerred to as the "GSI expert team"), were more knowledgeable about the GSI Old and New Betatrons than was anyone at DCAS NIOSH: (a) DCAS Director Hinnefeld at a GSI worker meeting (p. 25, 8/21/06) stated that Betatrons were not particle accelerators akin to a cyclotron. This is factually untrue; (b) McKeel-Ramspott (GSI expert team) and other SINEW steering committee members site visited the GSI Old and New Betatron facilities in September 2006 and took photos and videos of what they observed, (c) the GSI expert team interviewed Jack Schuetz at length in Wisconsin at the office of Dr. Vincent Kuttemperoor, who subsequently provided testimony to the Radiation Advisory Board; (d) the GSI expert team site visited NDT Specialties at the former Allis-Chalmers West Allis, WI betatron facility in 2007 and viewed one of the few remaining in use 24 Mev betatrons in the United States;

[1. *GSI had two betatron x-ray machines*] -- This statement of fact is too brief and omits the facts the GSI betatron x-ray units were <u>electron particle accelerators</u>, that the manufacturer was Allis-Chalmers, and the two GSI Betatron serial numbers, which were provided to the TBD-6000 WG by the GSI expert team. He also omits the fact that the "new Betatron" was built by Allis-Chalmers in 1951 or 1952 and was installed at the Eddystone, PA division of GSI and used for *ten years*. The unit was moved to GSI in Granite City, IL, in 1963 when the Eddystone Division in PA ceased castings operations;

[2. *The machines produced high energy x-rays* (up to 25 MeV)] -- Allen omits the key fact the two betatron beams at GSI *also produced neutrons* and emitted electrons by stray leakage. Evidence supporting this statement of fact is the Schuetz St. Louis hospital-based betatron unit diagram provided to DCAS and Sam Glover, the co-author with David Allen of AppBBr0. Jack Schuetz was a paid NIOSH contractor and betatron service person. He was not a certified health physicist. His contract terms have not been released to the public.

[3. ... *specially designed shielded building*] -- Allen omits the facts that the design parameters and construction techniques differed between the Old and New Betatron buildings at GSI Granite City, IL. The Chicago District, US Army Corps of Engineers, built the Old Betatron facility owned by the US government in 1951. The Old Betatron unit was placed into operation in January 1952, according to several local newspaper stories the GSI expert team provided to Allen and the TBD-6000 WG. GSI built the New Betatron facility in 1963. No blueprints exist of either GSI Betatron building.

[4. *The "old betatron" was built in 1952*] -- As outlined above, NO, the Old Betatron <u>building</u> was constructed during *1951* not 1952. Betatron *operations* for steel and MCW uranium R&D commenced in January 1952 at IL GSI.

[5. (OBB) *... stood alone separated from other buildings on site*] -- Allen omits several facts. The GSI Old and New Betatron buildings were separated from one another by only 300 feet. Also, signs on the Old Betatron building indicated "Do Not Approach This Building within 100 Feet." McKeel photographed these signs in September 2006. Furthermore, it is known that unobstructed neutrons may travel 3000 feet in air. The GSI expert team therefore believes that workers at both Betatron facilities, which could both be operating at the same time during 1963-1973, could be cross-irradiated by photons and neutrons emanting from the other Betatron facility (both units ON at the same time).

[6. *The "new betatron" was built in 1962*] -- It is not clear whether "new betatron" refers to the A-C Betatron *particle accelerator* unit itself or to the *building* that housed it. The New Betatron unit was built by A-C in 1951 or 1952. The New Betatron *building* at 1417 State Street, Granite City, IL may have been constructed by GSI as early as 1962. These points need to be clarified in the AppBBr1 text.

[7. *Figures 1 and 2 provide drawings*] -- Actually, Figures 1 through 5 inclusive provide GSI Old and New Betatron building drawings. Allen omits the source documents for these cartoon sketches. They were not drawn based on any extant blueprints. To the knowledge of the GSI expert team, NIOSH made no effort to obtain Old Betatron building blueprints or purchase orders or construction permits or, in fact, any records about the Old Betatron Building and installation from USACE. The agency should have made this effort; that is part of their job. The quality of reproduction of these figures is poor and better drawing copies should be substituted. Some of the lines and labels are indistinct. In all cases, exact citations should be given as to the reference source documents for each of the Old and New Betatron building drawings used in AppBBr1, which is, after all, a scientific technical document. The various Betatron building sketches were done at different time points and they vary in significant ways that need to be pointed out explicitly (as has been done by the SINEW expert team) by Mr. Allen and DCAS/NIOSH.

[8. *was reported to be 250 R/min at 3 feet from the platinum target with the aluminum compensator removed*] -- Allen omits the source of this key information which should be included (and referenced) in this report.

[9. *The intensity of the old betatron was reported to be less.*] -- What is the source document reference that validates this statement? The phrase *"... to be less"* is merely qualitative. *Quantitative data* is required in a dose reconstruction guidance whose audience is professional health physicists. Jack Schuetz provided some GSI donut tube output data that indicated the Old

Betatron output was closer to 100 R/minute. It is good to be exact rather than vague and indefinite in scientific writing as a scientific "best practice."

[10. ... *to avoid trying to place workers in one betatron versus the other*] -- The reason Allen has to resort to this ploy is that NIOSH or DOL cannot possibly place individual radiographers relaiably at the Old and New Betatrons. There is conflicting information about which Betatrons were used how often for MCW (AEC) uranium contract work. No related shot records, shipping manifests, or uranium work lists apparently exist at either GSI or MCW current records repositories. Again, the Betatrons and the Betatron buildings at GSI differed structurally, mechanically and electronically. OCAS-IG-003 mandates that external x-ray photons, neutrons and beta be determined ("bounded") for each facility to allow a valid quantitative comparison to be made.

[11. *Since the betatrons are not the limiting dose estimate prior to the construction of the new betatron, this is not an overestimate*] -- Once again, Mr. Allen leaves key information to the imagination by using this double negative statement. If the betatrons are not (dose limiting), what *is* dose limiting? I assume Allen is referring to the radium-226 sources. The doses NIOSH assigns to the Old and New Betatrons and two radium-226 sources at GSI need to be stated. It needs to be reiterated that the 2008 Betatron operator doses assigned by both NIOSH and SC&A were vastly (~10-fold) higher than than doses they are using in AppBBr1 apparently, which are based on 2012 modeling based in part on Landauer Program #2084 film badge monitoring data on GSI radiographers. Since NIOSH declared it would abandon use of the GSI Landauer FB data in 2014 based on the Hinnefeld-Yoder interactions reported by Neton, the 2012 lower , film-badge normalized Betatron external doses compared to 2008 values are no longer valid in my opinion. The 2012 GSI Betatron radiographer dosimetry data should be retracted and recalculated omitting any reference to, or use of, Landauer FB data. AppBBr1 (June 6, 2014) errs in being replete with references to and use of GSI Landauer FB data. It is as though the Neton memo of the Hinnefeld-Yoder decision for NIOSH to not use Landauer FB data at GSI never existed. The hard and inconvenient fact is this memo does exist. See the excerpt below:

[Begin quote] **Dear Josh (from Dan McKeel to Kinman 12.19.2013),**

Could you please provide me with the Jim Neton original e-mail itself so I can learn when the message was transmitted to the work group including the Board members and SC&A. That action was completed in time for Bob Anigstein to incorporate the Neton message into the revised Appendix BB issues SC&A matrix everyone on the WG, including me, apparently received yesterday, the day it was dated is Dec. 18, 2013. Thank you.

Sincerely -- **Dan McKeel** 12.19.13

Daniel McKeel
Phone: 573-323-8897
Fax: 573-323-0043
Email:danmckeel2@aol.com
P.O. Box 15, Van Buren, MO 63965 [end quote]

[<u>Note</u>: *The original Neton e-mail was <u>not</u> provided to McKeel*]

Kinman, Josh (CDC/NIOSH/DCAS) Decemb
To: CC Dr Dan McKeel
FW: Landauer Inquiry

December 19, 2013

To members of the TBD 6000 working group and other interested parties:

During the October 11 working group discussion of open items on SC&A's review of the GSI site profile, NIOSH raised an issue concerning the correct interpretation of Landauer control film badge readings. Based on an interview with a former Landauer official, who is now a member of the SC&A staff, SC&A's position is that measured exposure on control badges were reported to the customer as "M", if the control film read less than 50 mrem and was lower than half of the badges issued to workers. As has been discussed, Landauer's practice is to report film badges with exposures less than the detection limit as "M". Because SC&A's write up on this issue left some room for interpretation, NIOSH proposed that we contact Landauer to verify that this was actually the practice. It was important to verify this point, because NIOSH's approach to bounding a worker's betatron exposure relies on the fact that the control badges never received a detectable exposure. After some discussion, it was decided that Stu Hinnefeld, the director of DCAS, would contact Landauer for clarification.

Shortly after the working group meeting, Mr. Hinnefeld sent an e-mail to Craig Yoder, a Senior Vice-President at Landauer. Dr. Yoder has been with Landauer for 30 years and possesses an in depth knowledge of the company's current and past dosimeter processing practices. Through a follow-up phone conversation and subsequent e-mail exchange, it was learned that SC&A's characterization of the reporting of control badges was accurate. The following bullets summarize the salient points of the conversation between Mr. Hinnefeld and Dr. Yoder:

- Pieces of film were kept at Landauer from each batch of film to be used as internal controls.
- When a set of customer films were returned, internal controls from that batch of film were included in the development and reading process.
- Optical Density (OD) from internal controls is subtracted from the OD of all customer badges.
- During the 1960s, ODs of customer badges are converted to units of dose.
- The customer control result in mR is subtracted from all customer badges, <u>including customer control.</u> Customer control is reported as M.
- For example, if a customer control read 30 mR after subtraction of internal control, it would it be reported as M.
- If the customer control read 50 mR or higher, the customer would be told what it read and what value had been subtracted from all customer badges, but the customer control would still be reported as M.

<u>Based on Landauer's practice of subtracting the control badge result from itself, the NIOSH proposed method for bounding exposures to betatron workers at GSI cannot be used. Thus, NIOSH proposes to adopt the limiting value for exposure to betatron operators proposed by SC&A, which does not rely on the use of film badge data</u>.

Jim [Neton, last name/underlining added by Dan McKeel 7.13.14]

[12. *Betatron x-rays are of sufficient energy to produce nuclear interactions in material being x-rayed causing some atoms to become radioactive*] -- The process being described is that of ACTIVATION and it should be labeled as such. Actually, studies have shown that almost all known elements can be radiation-activated. This is the basis for the subsciences of photon and neutron activation elemental analysis widely used in academia, industry and

medicine. This branch of analytic chemistry applied physics is robust and mature and is supported by a vast scientific literature.

• What Mr. Allen unfortunately omits in this statement is that in the case of MCW uranium-238, 24-25 Mev betatrons are energetic enough (the threshold is around 6 Mev) to cause <u>fission</u>, producing two daughter radioisotopes (the Sugarman references the GSI expert team provided to NIOSH and the TBD-6000 WG and Board in 2006) as well as activation. Allen omits the key information that many activation products produced as a result of Betatron bombardment of steel and uranium have half -lives that are much longer than the 2 hours NIOSH restrictively allots in a claimant unfavorable way. The GSI expert team believes the activation contribution to external dose caused by the Betatron x-irradiation of high nickel content steel, including the x-ray cassettes used in Betatron x-ray NDT radiography, and uranium is significantly underestimated by NIOSH. In fact. The chief GSI site expert persuaded St. Louis Testing Company to quantitatively analyze whether the GSI Betatron team x-ray film cassettes indeed had a high nickel content. The data answered this question "YES" in a positive manner.

[13. *([that material then creates] an additional source of external radiation*] -- This passage is referring to activation products as "that material." As stated in item 12, McKeel, in his 3/15/12 TBD-6000 WG meeting <u>Powerpoint</u>™ presentation, and in the GSI SEC-00105 AR and several McKeel white papers, showed data proving that activation products caused by linear (Ziemer and Guo 2004) or circular particle accelerators (Kuttemperoor 1974) produce radioisotopes with half-lives longer than 2 hours, the claimant adverse cutoff for Betatron activation-product external exposure embraced by NIOSH.

[14. *layout man is a person assigned the duty…*] -- The layout man concept, as promoted by SC&A and adopted by NIOSH and the TBD-6000 WG, is deeply flawed and impossible to implement, as stated elsewhere in this critique of GSI AppBBr1. <u>There is no exclusive union job category of Layout man at GSI, a strong union shop</u>. Radiographers did Betatron and isotope and often Magnaflux NDT work. Layout man is not at all representative of many of the 163 job categories we know existed at GSI. Most of these workers had nothing to do with Betatron operations except, and importantly, welders, chippers, grinders and burners were exposed to activation products of steel that NIOSH underestimated in a claimant unfavorable way. Finally, DOL will not be able to identify Layout Man claimants from their database. Rachel Leiton, DEEOIC Director at DOL, explained to Dan McKeel that the DEEOIC/DOL computer system was not capable of identifying GSI radiographers, many of whom were listed as "chemical operators." The Layout Man concept is an impossible to implement non-categorical, jargon term that does not represent all 3000 to 5000 (estimates veried) workers other than radiographers at the GSI plant.

[*15. were found not be the limiting dose estimate due to limited exposure time or limited dose rates (DCAS GSI web page)*] -- Again, Allen should provide the

actual measured exposure values in mRem or other units to validate this qualitative statement. GSI made single measurements at the GSI New Betatron building using an atypical 80 Curie Co-60 source (not a 24-25 Mev Betatron which may have caused higher values of exposure) in 1971, outside of the operational period at GSI which ended in June 1966. The GSI expert team has contended all along the Co-60 source data is not a suitable surrogate for two 24-25 Mev Betatron electron particle accelerators operating with platinum targets in x-ray mode. The Co-60 source is omni directional (radiates in 360 degrees), whereas the Betatron beam is sharply focused in one direction. The Co-60 sources produce gamma photons but essentially no neutrons in contrast to the Allis-Chalmers 24-25 Mev twin Betatrons at GSI which produced x-rays and neutrons and stray (column leakage) electrons. There was residual column and component activation radiation from the Betatron sources <u>after</u> the power was turned OFF, in contrast to the Co-60 sources where there was no residual gamma radiation once the sources were replaced in their lead shilded "pigs." The SINEW teams contends the Betatron components were chronically activated as the source of the "OFF" power source radiation.

[16. *interviews with former workers at GSI (SC&A 2008)*] -- The date of the SC&A Collinsville, IL GSI worker satellite meeting was October 9, 200<u>7</u> not 2008. NIOSH needs to change the date error.

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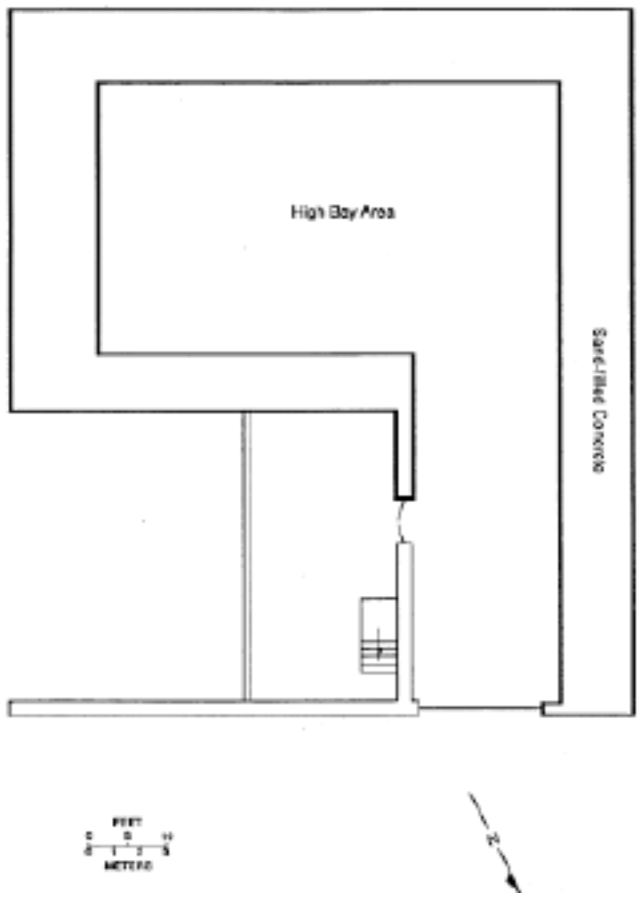
[**1. The uranium shots took 60 minutes for the actual shot as well as 15 minutes between shots to allow for setting up the next shot**]. The shots were taken at a distance of six feet from the betatron target to the material. This scenario would allow for an average of 6.4 shots per 8 hours shift of continuous uranium operations. It also results in the betatron being energized 80% of the time while uranium is being x-rayed. [**2. The steel casting scenario consists of two types of shots.**] The first type (short shot) is 3 minutes in duration with 12 minutes between shots. These shots are taken at a distance of nine feet between the betatron target and the material. With one short every 15 minutes (3 minute shot plus 12 minutes between), an average of 32 shots can be taken during an 8 hour shift. The second type of shot was the long shot. Just like the uranium shots, these shots were taken at six feet and lasted 60 minutes with 15 minutes between. [**3. Long shots were assumed to account for 10% of the steel casting shots while short shots accounted for the other 90%**]. This combined with the shot scenarios results in an average of 20.57 short shots and 2.29 long shots per 8 hours shift. It also results in the betatron being energized 41.43% of the time while x-raying steel.

Figure 1 – Drawing of the Old Betatron Building
Drawing of the old betatron building from FUSRAP documentation
(See following page)



<u>MCKEEL COMMENT on Figure 1</u>**. This drawing above appears to be an MCNP construct rather than a FUSRAP drawing. Allen needs to provide more exact reference to a specific FUSRAP report title, number and page to refute this interpretation.**

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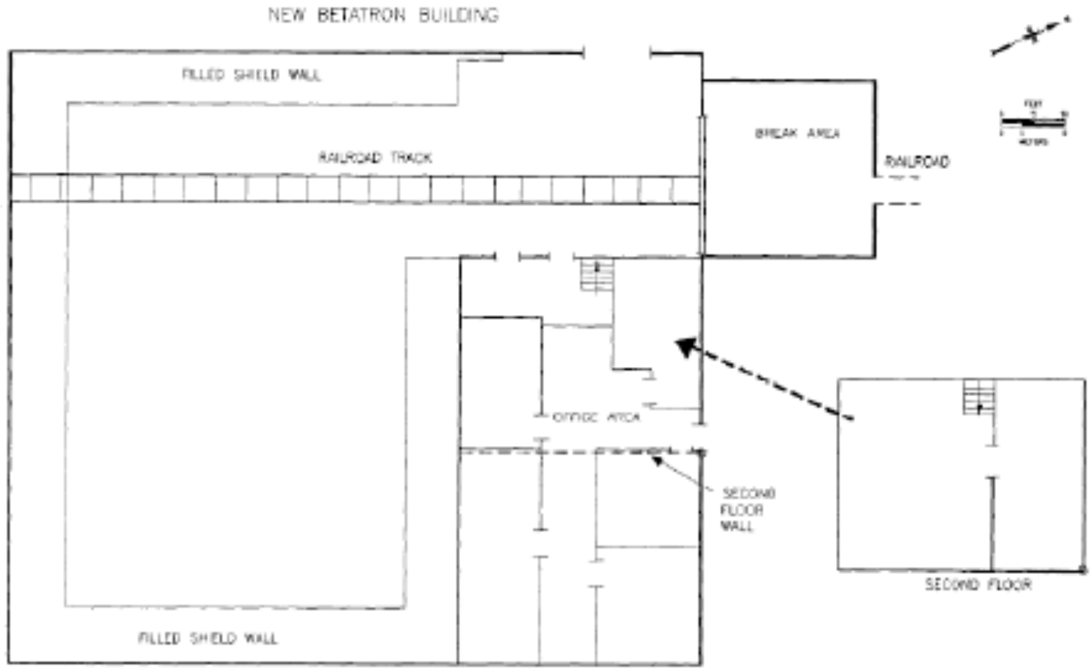
Figure 2 – Drawing of the New Betatron Building



Drawing of the new betatron building from FUSRAP documentation

As previously stated, the layout man is a person assigned the duty of marking the casting to determine what portions of the casting need to be x-rayed again, as well as marking any defects found in the previous shots. [**4. This is a limiting exposure scenario because the layout man can be working in close proximity to freshly x-rayed castings. While the layout man is a duty performed by radiographers, other classes of employees can also be working in close proximity to these freshly x-rayed castings**]. This is due to the fact that defects found during radiography are often repaired (for example, grinding out the defect and adding good metal back in by welding). Also, betatron operators were radiographers but others were also associated with the betatron operators and could receive the same type of exposure. For example, riggers may be used to move the castings in and out of the betatron building as soon as the x-ray is done. [**5. Therefore, the dose estimate for betatron operators and for the layout man is applied to essentially everyone working at the site**]. [**6. The exception is administrative personnel**].

Betatron operators are modeled as being in the betatron control room during the shots and near the freshly x-rayed material between the shots starting 5 second after the end of the x-ray to allow travel time to the material.

During x-rays, the layout man is assumed to be in the #10 building near the railroad tracks used to move castings into and out of the new betatron building. [**7. The layout man is not assumed to be in the middle of the doorway since that would not be a credible location for a casting. That would block the path to and from the betatron building.**] Instead, he is assumed to be 10 feet to the side of the railroad tracks. Both sides were modeled and the higher dose rate side was used in the estimate. [**8. This scenario for the layout man would only be applicable after 1962 when the new betatron was built. A similar location for the old betatron would be outdoors and it is unlikely this work routinely occurred there year around**]. It is much more likely the work was done in another building then the casting transported to the old betatron building. This would result in a considerably lower dose to the layout man before 1963. [**9. However, Ra-**

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226 radiography resulted in an exposure estimate higher than the new betatron layout man estimate so the lower exposure scenario was not explored further].

<u>MCKEEL CONCLUDING COMMENT to BB.4.1. Betatrons (part 2 pages 8-10)</u>: (passages marked off with numbers, square brackets and bolded):

[1. *The uranium shots took 60 minutes for the actual shot as well as 15 minutes between shots to allow for setting up the next shot*] -- These time intervals are from but a sigle radiographer out of three who gave specific testimony about GSI uranium Betatron shots. The GSI expert team, especially the main chief site expert, challenged these numbers. Again, David Allen and the TBD-6000 chose to disregard this added/alternate testimony which provided more shots and shorter intervals between shots. The selected testimony is NOT the most claimant favorable.

• The comment should be made that Betatron shots records were never located. Worker testimony about shot times varies. It is difficult to understand how NIOSH seemingly arbitrarily accepts certain worker testimony (one of three versions of the uranium shot time intervals) and rejects other testimony (about the GSI Ir-192 source and the large Co-60 source 1064-66), for example.

• I sense that Mr. Allen's mind was set long ago on the "facts" as he chose to view them, and that subsequent testimony was disregarded as the default position of DCAS/NIOSH. This is not acceptable porfessional scientific behavior.

[*2. The steel casting scenario consists of two types of shots.*] *-- This narrative leaves out completely the facts that all GSI Betatron and isotopic shot records and log books were destroyed or lost. No worker was in a position to accurately know the "big picture" of what the ratio was of short and long steel shots. The definitions used by Allen in AppBBr1 may be challanged as well. Where is the exact quote recorded that supports his version of reality? This key testimony should be cited, the affidavit number and place and date of the worker meeting identified, and the full citation should then be included in the References.*

[3. *Long shots were assumed to account for 10% of the steel casting shots while short shots accounted for the other 90%*] -- Refer to issue 2. Some steel castings

imaged by GSI were huge and required dozens of separate exposures that required days to complete. There is no way of knowing with any degree of accuracy the ratio of short and long shots. Even the concept is simplistic as I am sure real GSI shot records would prove and confirm. NIOSH could have obtained shot records from the operating A-C Betatron the GSI expert team observed being operated in West Allis, WI (NDT Specialties). NIOSH and the TBD-6000 WG was informed about this real world current Betatron resource. NIOSH and SCA again chose to ignore the information provided to them in good faith by the SINEW site expert team.

[4. *This is a limiting exposure scenario because the layout man can be working in close proximity to freshly x-rayed castings. While the layout man is a duty performed by radiographers, other classes of employees can also be working in close proximity to these freshly x-rayed castings*] -- Direct eye witness testimony indicates layout men and plant welders, grinders, chippers and burners worked with freshly x-irradiated Betatron inspected steel castings. Sometimes this work was performed on a RR transfer car waiting on the tracks within the tunnel that house railroad tracks inside the building perimeter but located in a tunnel that extended into the Betatron shooting rooms (see item 7). However, many non-radiographer GSI workers did not come into contact with Betatron x-ray'd steel and worked in buildings far away from building 10 which adjoined the New Betatron facility. Layout man does not apply to them, so how will such workers be handled by DR personnel?

[5. *Therefore, the dose estimate for betatron operators and for the layout man is applied to essentially everyone working at the site*] -- The entire paragraph that contains this passage is very confusing. If everyone at the GSI plant will be assigned the same external *photon* dose, does this also apply to *neutrons*? Why not just make a single class of GSI workers and give them the highest value of the triangluar photon distribution? I doubt that dose reconstructor health physicists will fully understand the rationale for this confusing guidance.

[6. *The exception is administrative personnel*] -- Dr. Ziemer first suggested making this a separate category of GSI personnel for dose reconstruction purposes. No such designation was included in AppBBr0. Allen should have stated that fact, and why an administrative personnel category was necessary in the 2014 revised version of AppBB. There is abundant testimony at GSI that the job category "secretary" included personnel who never visited the production area (very rare) and many persons who needed to go into the rest of the plant on a regular basis. <u>One major problem is the CATI interview is not designed to reliably distinguish between these two types of individuals</u>. I predict that errors will be on the side of reducing doses to persons the individual dose reconstructor believes never visited the plant. The information in most cases to decide this question will be lacking in most cases. An overall criticism of AppBBr1 is that by June 2014, NIOSH should be able to

certify how many individuals among those with already completed dose reconstructions could be classified as administrative personnel. That information has not been forthcoming to my knowledge.

[7. *The layout man is not assumed to be in the middle of the doorway since that would not be a credible location for a casting. That would block the path to and from the betatron building*.] -- According to worker testimony, some layout work was indeed done on castings that were just outside the shooting room door inside the tunnels of both Old and New Betatrons (see also item 8). It was possible to fit two electric transfer cars in the New Betatron building interior (one in the shooting room and one outside the ribbon door). The shooting room steel door could be closed between the first and second transfer cars and betatron shots could be made on either car *en place*.

[8. *This scenario for the layout man would only be applicable after 1962 when the new betatron was built. A similar location for the old betatron would be outdoors and it is unlikely this work routinely occurred there year around*] -- Again the second sentence should be amended to read "... *when the new betatron* <u>*building*</u> *was built.*" GSI radiography supervisor Ed Holshouser testified in 2014 that he observed trucks bringing groups of 8 to 12 MCW uranium ingots on wood palettes to the Old Betatron tunnel doorway.

[9. *However, Ra-226 radiography resulted in an exposure estimate higher than the new betatron layout man estimate so the lower exposure scenario was not explored further*] -- This statement needs to be supported in the text by a Table or an explicit listing of the gamma photon doses assigned to the New Betatron layout person and to a Ra-226 radiographer who, again, might be the same individual at different times. However, the external neutron dose would be higher for the New Betatron (and Old Betatron) layout men because Ra-226 is primarily a gamma photon source and gives off neutron doses that are usually considered negligible. Allen ignores the facts in his tables that GSI 1952-1962 radiographers operated both Ra-226 and Betatron NDT sources. The photon doses for layout man as calculated in 2012 (but not in 2008) were highest when using Ra-226 sources because these sources could only be bounded according to then current AEC radiation safety limits. The <u>neutron doses were significant;y higher</u> for Betatron NDT operators compared to Ra-226 isotope NDT source operators. Allen needs to incorporate these neutron dose facts.

BB.4.2 Betatron Building Model

Documents obtained from AEC license applications contained building dimensions and other details for the new betatron building (Figures 3 through 5). The documents also included a survey of the new betatron building with an 80 curie cobalt-60 source exposed that was conducted on January 29, 1971. The survey, which included measurements taken at various points around the building, is reproduced in Table 3. The letters in parentheses correspond to the locations identified in Figures 3 through 5.

The building design information contained in the AEC license application was used to modify a previously constructed MCNP model of the new betatron building. MCNP is a general purpose Monte Carlo radiation transport computer code designed to track many particle types over a broad range of energies. It was developed at Los Alamos National Laboratory with new versions released periodically. MCNP calculations for this document were performed using MCNPX versions 2.6 and 2.7 as well as MCNP6. This document will refer them generically as MCNP.

Once the model of the new betatron building was modified, an 80 curie Co-60 source was added at the position labeled as an X within a circle in Figure 3. Radiation levels were determined, using MCNP, at many of the same locations surveyed by GSI in 1971. Table 3 provides a comparison between the actual survey results and the modeled results.

<u>MCKEEL COMMENT to BB.4.2 Betatron Building Model</u>:

• FIRST PARAGRAPH: Mr. Allen should provide “ML” document numbers and specific page citations for the AEC license documents he refers to.

• SECOND PARAGRAPH: The information about MCNPX software is very incomplete and sketchy and thus is necessarily misleading. A major problem is that photon, neutron and beta doses varied depending on which specific software version of MCNP was used. That is, the doses changed over time. Left out by Allen is the fact that MCNPX NIOSH and SC&A dosimetry values always varied *significantly* and *by a different amount in 2008 and 2012*.
• Allen should have admitted that neither DCAS nor SC&A had any measured A-C 24-25 Mev Betatron photon, neutron or beta data to compare with, or to validate their MCNPX results. The GSI expert team stated many times on the record that peer reviewed scientific journals always require validating measured data which agrees with the modeled data by ± 10 to 20% maximum. <u>Neither the 2008 nor the 2012 NIOSH or SC&A MCNPX modeled data values met that crucial test</u>. NIOSH (Allen) should reiterate here why they rejected use of NYO-4699(Suppl. 1) HASL/AEC generated 22 Mev Betatron photon and neutron and film badge measured data from three surrogate sites.
• Allen should have compared Betatron radiographer and other plant worker doses modeled with MCNPX versions by both SC&A and NIOSH in AppBBRev0 (June 2007), in 2008 and in 2012 in AppBBr1. The differences are large and it is up to Allen and NIOSH to justify using this highly discrepant data for future dose reconstructions including reopened “rework” GSI DRs that will result from the new PER issued as a result of revising TBD-6000 Rev 0 (in June 20011) and Appendix BB Rev 0 (in June 2014).

• THIRD PARAGRAPH: The analysis in the final paragraph of this section shows “reasonable agreement” between measured and MCNPX modeled photon data using a cobalt-600 omnidirectional gamma photon source that emits essentially no neutrons. The GSI 80 Curie Co-60 source according to documents in NRC FOIA 2010-0012 was not licensed until 1968, and NIOSH

thus did not assign doses to personnel from that source during the residual period. SINEW believes worker testimony should be accepted, and the 80 Ci Co-60 GSI source bounded for the years 1964-June 1966.

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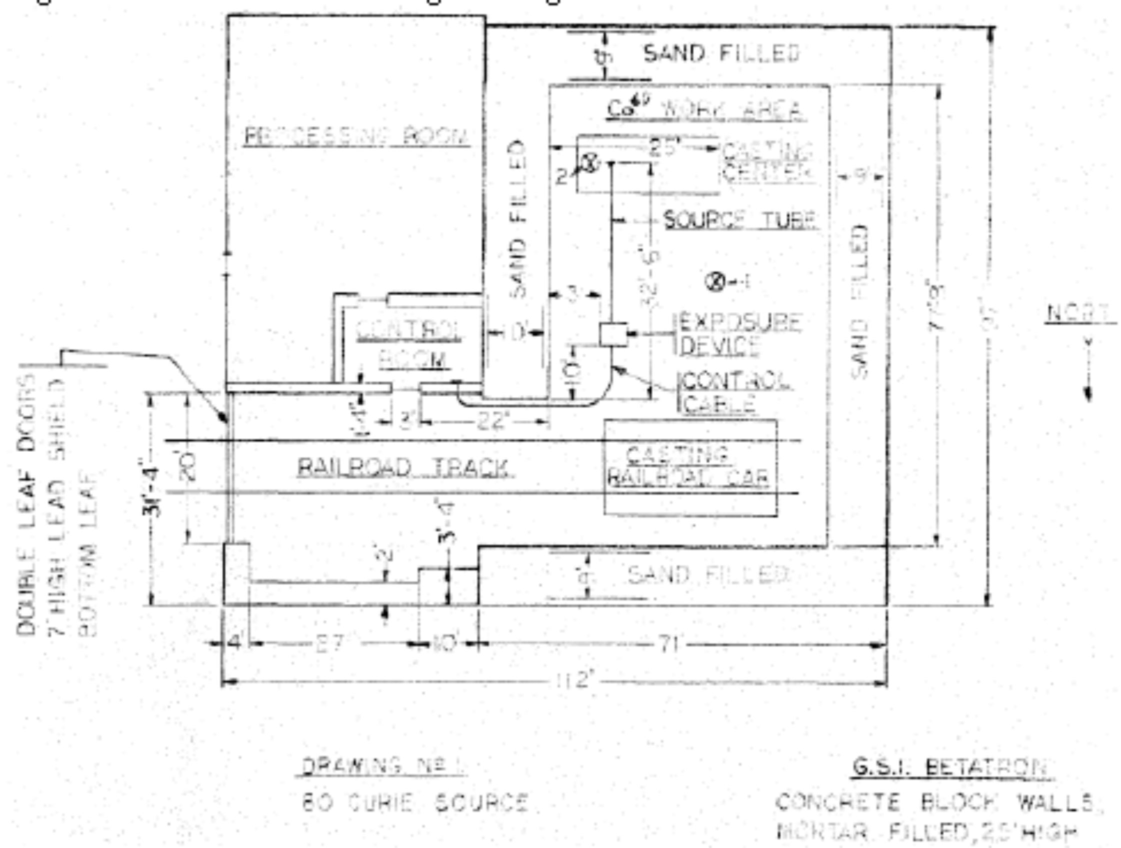
Figure 3 – New Betatron Building Drawing with Dimensions



MCKEEL COMMENT ON FIGURE 3 -- A clearer copy of this drawing needs to be substituted. The lines and text are faded and are difficult/impossible to read. The quality is unacceptable for an important scientific publication.

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Figure 4 – Drawing of New Betatron Building with Nearby Buildings

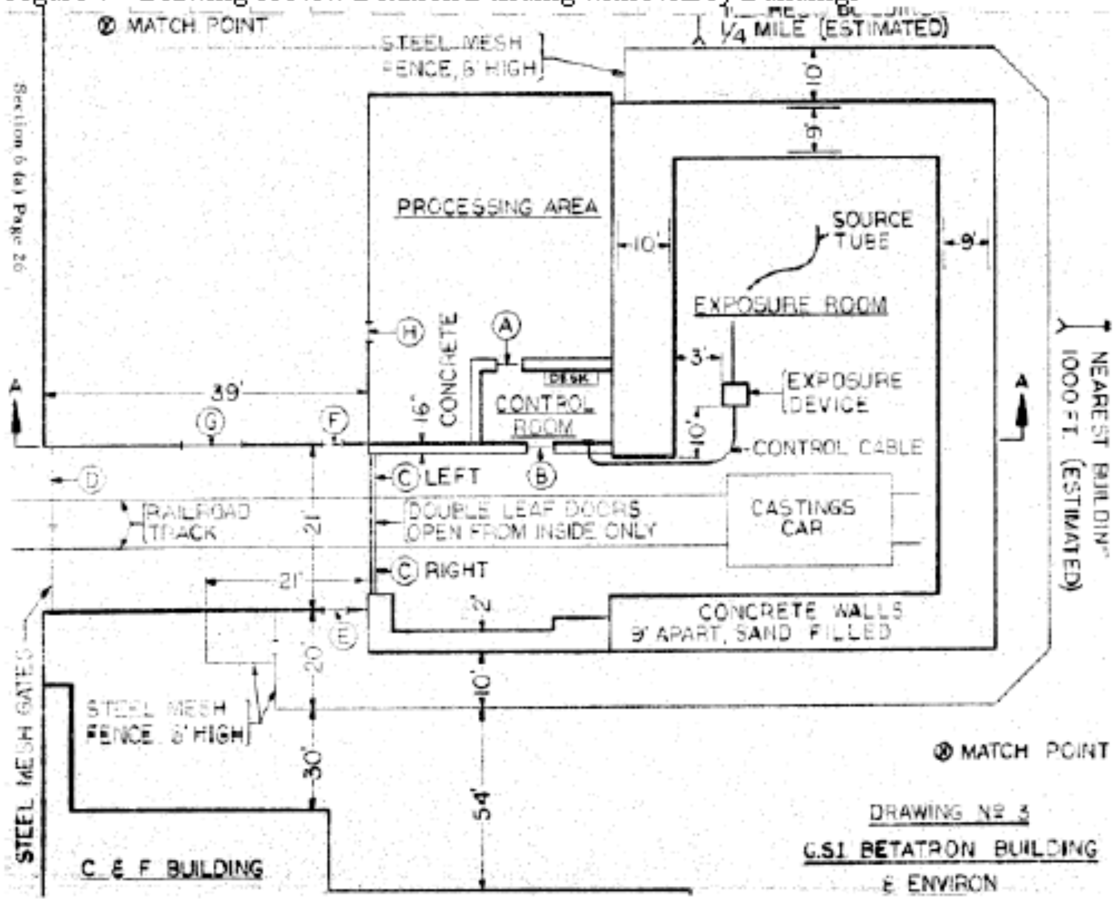
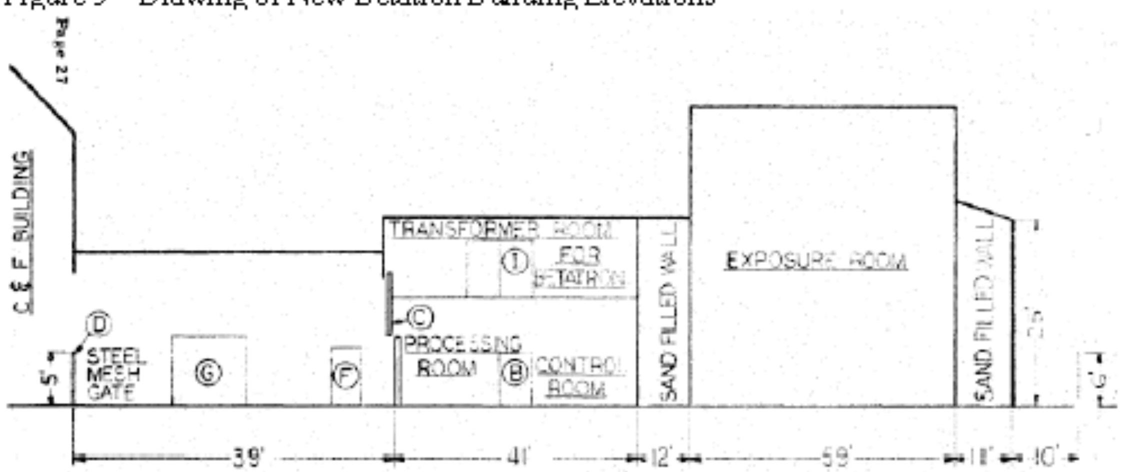


Figure 5 – Drawing of New Betatron Building Elevations



MCKEEL COMMENT ON FIGURES 4 and 5 -- Clearer copies of these drawings need to be substituted. The lines and text are faded, text is difficult or impossible to read. The quality is unacceptable for a scientific publication.

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Table 3 – Comparison of Modeled Radiation Levels to 1971 Survey

Location	1971 Radiation Level (mRr/hr)	Modeled Radiation Levels (mR/hr)	
Control Room	3.0	2.5	Meter held against door joint (B)
Control Room	0.6	1.1	2' from door
Control Room	0.1	0.2	At control desk
Outside Surface of Double Leaf Door (C)	0.3	0.4	Left side 5' high
	1.8	2.4	Left side at horizontal door joint 10' high
	2.5	2.2	Left side 2' above horizontal joint at 12' height
	0.2	2.0	Left side 10' from door 12' high
	0.4	0.6	Right side 5' high
	3.4	4.2	Right side at horizontal door joint 10' high
	4.4	4.0	Right side 2' above horizontal joint at 12' height
	1.8	2.4	Right side 10' from door 12' high
Corner at Door E	0.4	0.6	Taken against exterior surface of wall
Corner at Door F	0.2	0.6	Taken against exterior surface of wall

The modeled values were found to be either higher or within 20% of the measured values. One point located 10 feet from the double leaf door, 12 feet high showed a significant difference. Inspection of the other survey results near that door revealed that all other measured results, 10 feet or more above the floor, are at least 1.8 mR/hr. The survey measurement at that point, however, is 0.2 mR/hr. The difference between the model and the measured results could be a typographical error or an error in reading the instrument (such as the wrong scale). Since the scales on instruments are typically factors of 10, it is very possible the actual reading was 2.0 mR/hr. The other possibility is that there could be some piece of equipment mounted there (such as a door motor) creating additional shielding that is not depicted in the model. Either way, the values 5 feet above the floor are more representative of the location of workers and those values differ by no more than 0.2 mR/hr.

The reasonable agreement between the modeled and measured exposure values indicates that the building model provides a realistic representation of the shielding presented by the new betatron building. This model was used later to estimate dose rates from various shooting scenarios in the new betatron building with one notable exception. The survey description in the AEC license application indicates the double leaf door contained lead in the bottom 7 feet of the door. The MCNP model of the

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building included this lead and it explains the significant difference between the measurements taken 5 feet above the floor compared to 10 and 12 feet above the floor. However, it was reported that the lead in the door did not exist prior to the 1971 survey or years later. With the conflict between verbal and written reports, the lead was removed from the model for estimates made in this appendix.

MCKEEL COMMENT to BB.4.2 Betatron Building Model (part 2 pages 13-14): As stated previously, the statement "*The reasonable agreement between the modeled and measured exposure values indicates that the building model provides a realistic representation of the shielding presented by the new betatron building*" may apply for the Co-60 source, however, the Betatron building models are for Betatron x-ray operations. However, close inspection of the measured and computer modeled paired values in Table 3 actually shows variances ranging between 9.1% and 113.6% with a Mean ± Std Dev percentage = 67.5 ± 27.9 S.D. This level of agreement lies outside of the ideal ± 10-20% variance between measured and modeled computer dosimetric data. McKeel previously provided three such references to NIOSH and the TBD-6000 WG.

- **Also, as discussed previously, the Co-60 and Betatron source terms are not remotely comparable and do not legitimately substitute for one another: (a) the Betatron beam is sharply focused in contrast to the omidirectional Co-60 radiation pattern; and (b) Co-60 gamma sources do not give significant neutron doses, whereas neutrons are an important constituent of Betatron beams (~15%). Substituting a Co-60 source as measured data to validate a Betatron particle accelerator beam with x-rays, neutrons and electrons is scientifically invalid. *The fact that no measurement data collected at GSI exists for either GSI Betatron facility based on GSI Allis-Chalmers 24-25 Mev Betatron x-ray, neutron or beta radiation sources needs to be emphasized by Allen*.**

BB.4.3 Betatron Operations External Dose Estimate
Neutron and Gamma Dose from Scattered Radiation

[MCKEEL PRELIMINARY COMMENT: The passages I wish to comment upon at the end of this section are offset in square brackets, numbered and bolded] for later commentary.]

[**1. The neutron dose rates during radiography were evaluated using MCNP**] and the model of the new betatron building at several locations, including the control room and the location of the layout man. While shooting steel, the betatron was assumed to always be shooting a large steel object on a railcar. This angle produced the highest dose rate for the layout man location from several credible orientations. [**2. The neutron dose rate in the control room and the layout man location were determined and applied for 41.43% of an 8 hour shift to determine the dose per shift while x-raying steel**]. For uranium x-rays, the neutron dose rate in the control room was determined by assuming the uranium was near the center of the shooting area and the betatron oriented away from the control room. Only the dose rate in the control room was calculated and adjusted to a dose per 8 hour shift of uranium operations. [**3. The dose rate for the layout man location was not determined for uranium shots since for this exposure scenario it was more favorable to assume steel was always x-rayed**]. While [**4. that may appear to be inconsistent, it is actually a credible scenario since with two betatrons in operation, it is possible uranium was x-rayed in the old betatron building while steel was being x-rayed in the new betatron building**].

Gamma dose rates during radiography for the layout man location were determined in the same manner as the neutron. This model resulted in a dose rate of 6.67 mR/hr at the layout man location while the shot was in progress. [**5. The layout man is assumed to be working 100% of the time in that area and it is assumed that steel is always being shot**].

Gamma Dose to Betatron Operator

[**6. For the betatron operator, gamma dose rates were determined using film badge data**]. Workers reported that radiographers always wore film badges in the betatron building but with a few exceptions, detailed records of the film badge readings could not be located prior to 1964. The detailed records recovered from 1964 through 1973 (Landauer 1964 through 1973) indicated badges were exchanged weekly and [**7. 99.7% of them were recorded as "M"**] which means the measured exposure was less than 10 mrem. It is possible for a relatively small discrete source of radiation to exist after a shot from either the material being x-rayed or even from activation of betatron components themselves. Because of that, it may be credible that an operator could be working with his back to the primary gamma source in the area. In order to account for this, [**8. correction factors contained in ICRP publication 74 (ICRP 1996) were used**]. This publication calculates dose to various organs compared per unit air kerma for several orientations. One of the organs listed in ICRP 74 is the breast which would be a reasonable surrogate for a film badge worn on the chest. Combining the breast dose conversion factor (DCF) in the posterior anterior (PA) orientation with the effective dose DCF in the PA orientation would provide an equivalent effective dose necessary to produce a 10 mrem reading on the film badge (in the PA orientation). This value varies with energy. [**9. Table 4 provides the results of this calculation for various energy photons.**] The effective dose for 30 keV photons was calculated to be 26 mrem based on a 10 mrem reading on the film badges. Therefore, [**10. this dose estimate will use 26 mrem per week as the betatron operator dose estimate which equates to an annual exposure of 1300 mrem**].

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Table 4 – Effective Dose for Film Badge Reading at Various Energies

Energy (kev)	PA Breast DCF	PA Effective DCF	Effective dose
30	0.0489	0.128	26
40	0.181	0.37	20
50	0.328	0.64	20
60	0.439	0.846	19
70	0.511	0.966	19
80	0.545	1.019	19
100	0.574	1.03	18
150	0.6	0.959	16
200	0.625	0.915	15
300	0.663	0.88	13

Neutron and Gamma Dose from Freshly Exposed Material

Along with the exposure during an x-ray shot, layout men and betatron operators could also receive neutron and gamma radiation from freshly x-rayed material. [**11. Gamma exposure to the betatron operator is accounted for with the film badge readings.**] [**12. Neutron dose from freshly exposed steel is negligible**]; however, neutron dose from freshly exposed uranium must be accounted for to estimate the betatron operator's dose. Also, gamma dose from freshly exposed steel must be accounted for in estimating the layout man's gamma dose.

For the neutron dose to the betatron operator, the uranium is assumed to be exposed to x-rays for 60 minutes with the operator's exposure to the uranium starting 5 seconds after the shot and continuing until 15 minutes after the shot. The operators are modeled to be standing one foot from the uranium half of the time and one meter the remaining time. MCNP, which was used to calculate the neutron dose rate from the exposed uranium, found that the neutron dose rate decreases rapidly to essentially zero within 7 minutes following exposure. Since the shots lasted one hour, no buildup of neutron dose would occur from multiple shots. Using these assumptions, the dose from a single shot was estimated to be 0.0868 mrem. With each cycle taking 75 minutes (60 minutes per shot plus 15 minutes between shots) an [**13. average of 6.4 shots could be taken in one 8 hour shift**]. The dose per shift would then be 0.555 mrem while x-raying uranium. This value was then multiplied by the number of shifts per year that uranium was x-rayed to estimate the annual neutron dose to the operators from this source of radiation. It was added to the annual neutron dose received in the control room during uranium x-rays and the annual neutron dose received during steel x-rays. [**14. The total annual neutron dose varies by year due to differing amounts of steel and uranium work in each year. Table 5 provides the results**]. Next, the gamma dose to the layout man from freshly x-rayed steel was determined. [**15. The gamma dose rate from irradiated steel decreases quickly but does not decrease to zero in minutes. Therefore, a buildup of radiation could occur with repeated shots causing a higher dose rate than would occur after only one shot. To account for this, a bounding scenario was assumed which includes prior shots on castings**].

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[**16. It was reported by a former supervisor that the layout man would typically spend a full shift marking up a large casting**]. However, he might have been interrupted to mark up a casting that had just been x-rayed. The first task was modeled as short shots on steel, repeated 532 times ending just at the beginning of the layout man's shift (SCA 2014). The 532 prior exposures are intended to be a bounding estimate. Additional analysis shows it is not a significant overestimate because the decreasing dose rates cause the recent shots to have a much larger affect than the previous shots (SCA 2008). The layout man is then assumed to work on this casting for a full 8 hour shift. Since marking up the steel requires close contact with the casting, it is assumed that the layout man is within one foot of the casting 90% of the time and one meter from the casting the remaining 10% of the time.

To account for the times when the layout man is interrupted to mark up a freshly x-rayed casting, [**17. a model was developed consisting of long shots on steel**]. It is assumed the steel was x-rayed 400 times prior to being moved to the layout man. Again, this is a bounding value that does not significantly affect the results. The layout man is further assumed to mark up the casting for one long shot cycle (75 minutes) starting 15 minutes after the shots ended (time to move the casting out of the betatron building). After this 75 minute exposure, it is assumed that another freshly x-rayed casting (shot 400 times) is moved to the layout man position and he works on that one for another 75 minutes. This cycle repeats continuously for the full 8 hour shift so it could be repeated an average of 6.4 times per shift. As with the other scenario, it is also assumed he spend 90% of this time within 1 foot of the casting and 10% of the time 1 meter from the casting.

[**18. Since it was reported that the layout man would normally spend the whole shift on one large casting, the first scenario is assumed to account for 90% of his time and the repetitive scenario is assumed to account for 10% of his time**].

Beta Dose

Lastly, beta dose was evaluated for both the layout man and the betatron operator. The source of beta dose includes the beta dose intrinsically associated with uranium metal as well as beta dose from freshly x-rayed steel. The uranium metal x-rayed at GSI was cast at Mallinckrodt Chemical Works. [**19. During recasting, decay products of uranium (notably Th-234 and Pa-234m), can concentrate in the outer surfaces of the cast metal. This effect has been reported to increase the beta dose by a factor of 10 to 15 (Putzier 1982)**]. This effect is accounted for by assuming the Th-234 and Pa-234m activity is 15 times higher than what would be present at equilibrium. However, [**20. the top of the castings were normally cut off (called a top crop) so the metal sent to GSI is assumed to have been cropped and only the sides would have the concentrated decay products**]. The concentration on the top and bottom is assumed to be at an equilibrium concentration.

[**21. MCNP was used to model an 18 inch diameter ingot. The dose rate at one centimeter, one foot and one meter from the surface were calculated**]. These dose rates were calculated both as a distance from the top and a distance from the side. It was assumed that the operator was equally likely to be in front of the top or the side of the ingot. Therefore, the two dose rates at each distance were averaged. The betatron operator is assumed to spend half of his time one foot from the uranium and the remaining time at a distance of one meter. While the operator is within one foot, his hands and forearms are assumed to be one centimeter from the uranium (essentially in contact).

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Based on the shot scenario for uranium, an average of 6.4 shots per 8 hour shift could be performed. Exposure time near the uranium would be 20% of the time (15 minutes out of 75 minutes). [**22. Therefore the betatron operator average beta dose from uranium operations is estimated at 39.5 mrad per shift to the whole body and 621 mrad per shift to the hands and forearms**].

In considering beta dose from freshly x-rayed steel castings, it is important to realize shots were overlapped in order to get full coverage of the casting. Also, defects were repaired and reshot. It was reported that the same casting could be returned to the betatron building 5 to 10 times before leaving the site. Therefore, it is possible for the same location to be x-rayed multiple times. [**23. This estimate assumes the same location was x-rayed 30 times (and average of 7.5 trips to the betatron and assumed 4 overlapping shots each time)**]. It should be noted that for long shots, this would be 30 hours of shooting in the same spot while short shots would be 1.5 hours. [**24. However, because many of the nuclides formed are relatively short lived**], the dose estimate after 1 hours of shooting is approximately 92% of the estimate after 30 hours of shooting. Because the difference is small and because it is impossible to know the exact number of times each location was shot, this estimate assumes each steel casting was shot for 30 hours prior to being handled.

In order to calculate the beta dose from freshly x-rayed steel, the [**25. chemical composition of HY-80 steel was modeled with MCNP**] in order to calculate the production rate of residual nuclides in the steel. From the list of nuclides produced, those that were not radioactive and those that do not emit a beta particle were eliminated.

This production rate was used to calculate the average concentration throughout the depth of the steel of each residual nuclide based on that nuclides half-life and the shot duration. However, the intensity of the betatron beam would decrease with its depth in the steel causing the highest concentrations to be near the surface. Averaging the nuclide concentration over a thick target would dilute the surface concentration. To avoid this, the surface activity concentration was determined for each nuclide using the mass attenuation coefficient for HY-80 steel corresponding to the maximum photon energy from the betatron. This surface activity was the initial surface activity at the time the shot ended. Since some nuclides could decay quickly during the time the operators would be exposed, the nuclides with the highest initial activity may not produce the highest integrated dose. To account for this, the integrated activity from zero to 15 minutes after the shot was then calculated to provide an indication of the integrated dose. [**26. Six nuclides produced over 99% of the total time-integrated activity so these six were used for the remainder of the analysis.**]

[**27. For each of the six nuclides, the surface activity concentration was assumed to be the same for the entire depth of a thin HY-80 steel object. MCNP was then used to calculation**] the initial beta dose rate at 1 centimeter, 1 foot and 1 meter from the object. These dose rates were then integrated between 5 seconds and 15 minutes for the long shots and 5 seconds and 12 minutes for the short shots. The time-integrated dose for each nuclide was then summed to calculate the total beta dose per shot at these distances.

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[**28. Lastly, the betatron operator was assumed to be 1 foot from the object for half of the time he was exposed and 1 meter from the object for the remainder of the time**.] His hands and forearms are assumed to be 1 centimeter half the time and 1 meter the remaining time. Also, the operators could participate in an average of 32 short shots in one 8 hour shift or an average of 6.4 long shots. The short shots accounted for 90% of the shots, which would mean 36% of the time the operators were working on long shots and 64% of the time they were working on short shots. This information was combined to calculate a beta dose per 8 hour shift to the whole body and separately to the hands and forearms. That dose was multiplied by the number of shifts per year an operator was working with steel.

[**29. For the layout man, the same process was used but the scenario was altered**]. The scenario matched the scenario used to calculate the gamma dose to the layout man from irradiated steel. For the one large casting that was worked most of the shift, it was assumed the casting was x-rayed 532 times prior to the layout man marking up the casting. The layout man is assumed to work on this casting for the full 8 hour shift starting 15 minutes after the x-rays ended. This then produced a dose per shift since the single casting was worked on the entire shift.

[**30. For the interrupted scenario, it is assumed the casting was x-rayed 400 times in the long steel shot scenario prior to the layout man working on the casting**.] In this case, the layout man is assumed to work on the casting for 75 minutes starting 15 minutes after the x-rays ended. By repeating this cycle, the layout man could work on an average of 6.4 such castings throughout the course of an 8 hour shift.

Just as with the gamma dose estimate, it is assumed the operator worked 1 foot from the casting 90% of the time and 1 meter from the casting the remaining 10% of the time. For beta dose, it was also assumed his hands and forearms were 1 centimeter from the casting while the rest of his body was 1 foot from the casting (90% of the time). Also as with the gamma dose estimate, the single casting scenario is assumed to take 90% of the operator's time while the repetitive scenario takes the remaining 10% of his time.

[**31. Table 5 and 6 include the annual dose estimates from all sources for the betatron operator and the layout man respectively.]**

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Table 5 – Dose Estimate to Betatron Operator

Year	Neutron dose while x-raying steel (mrem/yr)	Neutron dose while x-raying Uranium (mrem/yr)	Neutron dose from irradiated Uranium (mrem/yr)	Total Neutron dose (mrem/yr)	Gamma (mrem/yr)	Beta dose skin of the whole body (rad/yr)	Beta dose hand and forearm (rad/yr)
1952	57	16	8	81	1300	0.97	9.19
1953	229	64	30	323	1300	3.87	36.74
1954	229	64	30	323	1300	3.87	36.74
1955	229	64	30	323	1300	3.87	36.74
1956	229	64	30	323	1300	3.87	36.74
1957	229	64	30	323	1300	3.87	36.74
1958	234	54	25	313	1300	3.56	31.31
1959	237	49	23	309	1300	3.43	29.07
1960	237	49	23	309	1300	3.43	29.07
1961	233	57	27	316	1300	3.65	32.91
1962	241	41	20	302	1300	3.19	24.76
1963	258	11	5	274	1300	2.30	9.06
1964	262	4	2	268	1300	2.09	5.35
1965	262	3	1	267	1300	2.06	4.76
1966	132	1	0	133	1300	1.01	2.09

Table 6 – Dose Estimate to Layout Man

Year	Neutron dose while x-raying steel (mrem/yr)	Gamma while x-raying steel (mR/yr)	Gamma from irradiated Steel (mR/yr)	Total Gamma (mR/yr)	Beta dose skin of the whole body (mrad/yr)	Beta dose hand and forearm (mrad/yr)
All years (a)	557	8980	20.8	9000	463	807

(a) Not applicable before 1963, 1966 dose should be prorated to half these values.

<u>MCKEEL COMMENT to BB.4.3 Betatron Operations External Dose Estimate</u>:

A general observation for this section **is that much of the data and many of the cited conditions are unfamiliar to McKeel. <u>Were all of the data elements and methodology developed by NIOSH and presented to the TBD-6000 WG in white papers, and, if so, what are the specific reference citations</u>? Similarly, did SC&A review and report on all this NIOSH data and methodology? That is,** ***is Allen presenting any of this information for the first time in AppBBr1*****?**

[1. *The neutron dose rates during radiography were evaluated using MCNP*] -- Mr. Allen needs to specify which version of MCNP, and the date of that version, was used for this neutron analysis. What measured Betatron neutron data was used to validate the MCNPx computer model? Was the agreement ± 10 to 20%?

[2. *The neutron dose rate in the control room and the layout man location were determined and applied for 41.43% of an 8 hour shift to determine the dose per shift while x-raying steel*] -- Allen fails to mention the fact that SC&A modeled the highest neutron flux in the Betatron control room, a paradoxical result

because the control room was supposed to be where the operators were the safest. One reason the control room values were so high may be the door was a flimsy standard steel office door. The door shielding of the Betatron facility at Milwaukee School of Engineering (MSOE), which was donated to the school by Allis-Chalmers, weighed *70 tons* and was filled with steel balls. We infer the GSI control rooms were poorly shielded and the workers poorly protected. The GSI expert team made these facts known to NIOSH, Allen and the TBD-6000 WG and Board through direct testimony and white papers. HASL in NYO-4699(Suppl. 1) also reports some of the highest detected doses for photons and neutrons near a similar ordinary steel control room door at one of the three analyzed 22 Mev betatron facilities.
• Mr. Allen needs to specify which version of MCNP, and the date of that version, was used for this neutron analysis. What measured Betatron neutron data was used to validate the MCNPx computer model? Was the agreement ± 10 to 20%?

[**3.** ***The dose rate for the layout man location was not determined for uranium shots since for this exposure scenario it was more favorable to assume steel was always x-rayed***] -- **I cannot understand what this sentence means. OCAS-IG-003 mandates that all radiation sources must be addressed and the doses bounded. Without specific supporting data, the phrase** "***…it was more favorable …"*** **is meaningless. Also, which dose rate is being referred to? Is the dose rate for x-ray photons or for neutrons? Where is this data specifically cited and referenced in white papers or WG or Board transcripts? What were the respective x-ray photon and/or neutron dose rates for uranium and steel that allows Allen to state steel was more favorabe? The exact report pages with a link to the citation should be provided. This DR guidance document should stand by itself as a primary information source without relying on data in any other publication. The relevant data needs to be extracted/stated in AppBBr1.**

[4. ***that may appear to be inconsistent, it is actually a credible scenario since with two betatrons in operation, it is possible uranium was x-rayed in the old betatron building while steel was being x-rayed in the new betatron building*****] -- Allen supports a fact that McKeel makes elsewhere in this document. The GSI Old Betatron building (OBB) was located only 300 feet away from the New Betatron facilty. The OBB had a sign attached to the outside of it: "DO NOT APPROACH THIS BUILDING WITHIN 100 FEET." The same caveat presumably applied to the New Betatron buiding (NBB). Thus, according to GSI signage, the radiation fields surrounding the OBB and NBB nearly overlapped. No actual GSI radiation measurements that led to the posting of the signage exists today. NIOSH never modeled the stray radiation that the many GSI workers received while traversing the road and railroad tracks and crowded space that lay between the OBB and NBB. That space included a road that was used daily by practically all personnel who drove to the GSI facility at 1417 State Street. Railroad operators and outdoor crane operators and chainmen also worked in the space between OBB and NBB. Many cars were parked in that area as well.**

[5. *The layout man is assumed to be working 100% of the time in that area and it is assumed that steel is always being shot*] -- The basis for this assumption is not clear. Allen should clarify the supporting evidence.

[6. *For the betatron operator, gamma dose rates were determined using film badge data*] -- See discussion under item #7 (above). The Neton memo of December 19, 2013 stated that <u>NIOSH will not make use of GSI Landauer film badge data</u> in AppBBr1. This passage is a direct violation of that on-the-record NIOSH policy statement.

[7. 99.7% of them were recorded as "M"] --

(a) <u>The discussion of GSI Landauer film badge applications and data is moot and should not be part of AppBBr1 (6/6/14)</u> because, as Dave Allen knows, the December 19, 2013 Jim Neton/DCAS memo written about the Hinnefeld-Yoder DCAS-Landauer interactions led NIOSH to declare it would not use GSI Landauer film badge data because of discrepancies in the way Landauer handled "control" values and subtracted background. This memo was documented in the Dec. 5, 2013 GSI Appendix BB SC&A-prepared issues matrix. McKeel filed a FOIA request through the CDC/ATSDR Atlanta FOIA office to obtain all related emails and McKeel received only a subset. The Yoder-Hinnefeld e-mails and some related records were withheld from him with no specific exemptions being cited.

• <u>ALLEN DOES NOT MENTION THIS CRUCIAL MEMO OR THE NIOSH/DCAS ABANDONMENT OF GSI LANDAUER FILM BADGE DATA IN APPENDIX BB REV 1 (JUNE 6, 2014). This is a most serious and concerning omission. It's absence in the GSI SEC co-petitoner's opinion totally invalidates all sections of AppBBr1 that mention Landauer film badge data or uses</u>.

(b) NIOSH and SC&A have never subjected their complete Landauer GSI #2084 film badge datasets to independent review. The GSI expert team does have independent knowledge of discrepancies within this dataset from reviewing a subset of year-end reports given to McKeel unredacted by Landauer in January 2007, by reviewing individual GSI radiographer Landauer and NCC/GSI records files, and by reading NIOSH and SC&A white papers about their respective Landauer-GSI datasets that differ from each other in significant respects. In addition, the sole radiographer who provided the fragmentary 1963 and 1962 18 quarter Pittsburgh Testing and GSI FB data sheets is missing all of his 1966 Landauer FB data except for a single sheet obtained through a PA/FOIA request. The GSI SEC co-petitioner challenges the accuracy of this statement that 99.7% of all GSI radiographer photon data was "M." I have outllined the majority of my FB evidence in McKeel white papers.

[8. *correction factors contained in ICRP publication 74 (ICRP 1996) were used*] -- Allen needs to define exactly which "correction factors" were used and note the pages on which the conversion factor data are listed.

[9. *Table 4 provides the results of this calculation for various energy photons*.] -- Table 4 is labeled "effective Dose for Film badge readings at various doses." Allen should state the exact citation (page number) in the referenced publication.

[10. *this dose estimate will use 26 mrem per week as the betatron operator dose estimate which equates to an annual exposure of 1300 mrem*] -- An invariant external dose estimate of 26 mrem per week for Betatron operators is absurdly low based on 2008 MCNP calculations by NIOSH and, especially by SC&A. These 2008 data did not include use of GSI landauer film badge data. Due to the Neton memo and NIOSH's decision not to use Landauer FB data at GSI, the <u>2008 SC&A Betatron dose assignments need to become the default values in AppBBr1</u>. Allen may not use Landauer film badge data in any of his AppBBr1 dose calculations as a categorical statement based on his employer's on the record policy to ban use of GSI Landauer FB data in AppBBr1.

- **<u>Footnote</u>: NIOSH could still utilize NYO-4699(Suppl. 1) surrogate photon and neutron data measured by HASL in their AEC Accelerator Survey Program from three 22 Mev betatrons of the same vintage as the two GSI A-C Betatrons. NIOSH and the Board previously rejected using this data that was recommended for use by the SINEW GSI expert team. We regard not using this unique NYO-4699 measured Betatron data to be a *serious scientific error of omission* on the parts of NIOSH, the Board and its contractor SC&A.**

[11. *Gamma exposure to the betatron operator is accounted for with the film badge readings*.] -- NIOSH announced policy in the Neton December 2013 memo was that NIOSH will NOT use GSI Landauer #2084 program film badge data in AppBBr1 for future dose reconstructions or reworked DRs. <u>This section needs to be modified or retracted.</u>

[12. *Neutron dose from freshly exposed steel is negligible*] -- Allen limits his analysis to freshly exposed steel. However, many (unknown percent) of GSI Betatron NDT shots were repeated shots on very large castings that might require 400 exposures and 10,000 R being delivered to capture an x-ray image array that covered the entire casting. Such simplistic analyses (a) are not claimant favorable, (b) underestimate neutron exposures and large casting activation products, and (c) fail to conform to reality. NO radiation dose is negligible from a cancer risk perspective using the worldwide accepted "linear no threshold" statndard for radiation safety. All radiation doses are cumulative and additive. The BIER VII report for the first time confirms that chronic, very low levels of diagnostic x-rays significantly increase the risk of developing a future cancer.

[13. *average of 6.4 shots could be taken in one 8 hour shift*] -- Again, these assumptions are based on testimony from one of three GSI radiographers who testified about Betatron MCW uranium shots. There is testimony that more

than 6.4 shots could be delivered in 1 hour. For example, 4 corner shots at each end of the dingot/ingot uranium were described that could be done in rapid succession minus any added layout time. The metal might have to be rotated into position with the Betatron room overhead crane. The 6.4 shots per 8 hour shift are too few and the low number is not claimant favorable.

[14. *The total annual neutron dose varies by year due to differing amounts of steel and uranium work in each year. Table 5 provides the results*] -- NIOSH and SC&A and the TBD-6000 WG have no way of knowing the total steel castings tonnage or volume or number of shots or castings that were shot at GSI each year. The MCW purchase orders merely outline a plan; they do not substitute for lost or destroyed GSI shot logs and shipping manifests and x-ray report records and Betatron log books, none of which NIOSH sought or had in their possession. The amount of steel subjected to Betatron NDT at GSI is a pure guess. Note that GSI, according to plant metallurgists interviewed by the SINEW GSI expert team, did Betatron NDT radiography work on <u>dozens</u> of types of steel and alloyed steel products, HY-80 being but one of them. Also, the chemcial composition of different types of alloy steel changed over time.

[15. *The gamma dose rate from irradiated steel decreases quickly but does not decrease to zero in minutes. Therefore, a buildup of radiation could occur with repeated shots causing a higher dose rate than would occur after only one shot. To account for this, a bounding scenario was assumed which includes prior shots on castings*] -- Allen is correct. Activated steel and chronically activated CONCRETE forming the Betatron shooting room walls would emanate secondary (scattered, activated) photons and neutrons that must be, but have not been, bounded by NIOSH in AppBBr1. Allen should provide a specific reference to a directly related source WG transcript with date and pages that details the methodology described in this section.

[16. *It was reported by a former supervisor that the layout man would typically spend a full shift marking up a large casting*] -- Elsewhere Allen surmises that only 10% of Betatron shots were "long shots." Thus, the dose calculation should be based on the 90% of "shorts shots" and the two results added because individual GSI radiographers did both types of work. They also accumulated photon external doses resulting from work exposures to other portable GSI NDT sources (conventional x-ray, Ra-226 (1952-62), Ir-192, Co-60), which should be added to their Old and New Betatron doses to serve as IREP total dose input. I perceive this is not the way GSI DRs have been carried out to date. The Dose Reconstruction subcommittee of the ABRWH should investigate this matter if and when they review any completed GSI DRs.

[17. *a model was developed consisting of long shots on steel*] -- Where is this model reported: Allen should cite WG meeting transcript date and pages?

[*18. Since it was reported that the layout man would normally spend the whole*

***shift on one large casting, the first scenario is assumed to account for 90% of his time and the repetitive scenario is assumed to account for 10% of his time*] -- This represents spurious reasoning on the part of Mr. Allen. Layout work on huge castings that required an entire shift was unusual. There is no documentation of who made this statement, or the data he was relying on to make this questionable assertion, and the statement defies common sense and what is known by the GSI expert team about GSI work practices by radiographers. It is likely the repetitive scenario occupied a far greater fraction of a Layout man's total work effort. Allen needs to explicitly cite and reference the person, time and transcript pages or affidavit number and source documents that support the initial contention Allens alludes to that Layout men spent 90% of their 8 hour shift laying out single castings. I do not believe the evidence I know supports this simplifying assumption, which is akin to a guesstimate by one anonymous GSI worker. There is no record of this "fact" in the NRC FOIA 2010-0012 license documents I am aware of.**

[*19. During recasting, decay products of uranium (notably Th-234 and Pa-234m), can concentrate in the outer surfaces of the cast metal. This effect has been reported to increase the beta dose by a factor of 10 to 15 (Putzier 1982)*] -- Where (what pages) of the long referenced book that is Reference 25 contains the description of the "putzier effect?" Allen cites the year 1982 twice but fails to note the specific pages that describe the Putzier effect. What is the complete citation, please?

[20. *the top of the castings were normally cut off (called a top crop) so the metal sent to GSI is assumed to have been cropped and only the sides would have the concentrated decay products*] -- The direct eyewitness and written and photographic evidence the GSI expert team is aware of refutes this unsupported statement by Allen. All evidence I am aware of, in fact, shows that only intact, uncropped uranium dingots and ingots were shipped from MCW to GSI. MCW documents show that other (not sent to GSI) Ur ingots *were* top cropped after being removed from the bomb. *Where is Mr. Allen's proof of this statement of the cropped status of MCW <u>GSI</u> Ur ingots and dingots*? To be explicit, we also believe repeated assertions by SC&A's Bill Thurber that cropping always occurred as the ingots or dingots were removed from the bomb is NOT true in the case of uranium metal forms bound for GSI. The fact is, no one knows the answer to this question. Many GSI workers testified the MCW uranium had "rough surfaces" all over. This is consistent with uncropped surfaces. Newly exposed pure uranium cut surfaces are shiny and smooth, not dull and shaggy as was described for the U-238 that was shipped to GSI. Allen makes many such unsupported and challengeable assumptions in AppBBr1 that we believe have no place in a scientific document where observations must be supported by discrete reference citations. Allen either needs to provide such documentation or retract this assumption that Ur-238 ingot/dingot cropping had aways occurred before shipment to GSI.

[21. ***MCNP was used to model an 18 inch diameter ingot. The dose rate at one centimeter, one foot and one meter from the surface were calculated*****] -- GSI also worked with rough surfaced U-238 MCW dingots, billets (in 1952) and betatron slices made at MCW. They need to be modeled separately in MCNP.**

[22. ***Therefore the betatron operator average beta dose from uranium operations is estimated at 39.5 mrad per shift to the whole body and 621 mrad per shift to the hands and forearms*****] -- This comment also applies to item 23 below. Beta skin doses were calculated first by SC&A and later by NIOSH almost as an afterthought in 2014 essentially after the TBD-6000 WG had finished its work on GSI matters.** ***Has all of this beta skin dose data been calculated on the record in DCAS white paper reports?*** **If the answer is YES, then would Allen please give a detailed methods reference as to the source report author(s), number, date and pages?**

[23. ***This estimate assumes the same location was x-rayed 30 times (and average of 7.5 trips to the betatron and assumed 4 overlapping shots each time)*****] -- See comment to item 22. A detailed citation by Mr. Allen to this methodology is needed.**

[24. ***However, because many of the nuclides formed are relatively short lived*****] -- Allen misses the point, the major x-ray and neutron exposure was from the other longer lived nuclides caused by betatron activation and fission of uranium and betatron activation of various types of steel.**

[25. ***chemical composition of HY-80 steel was modeled with MCNP*****] -- Modeling one type of steel out of dozens of types used at GSI is insufficient.**

[26. ***Six nuclides produced over 99% of the total time-integrated activity so these six were used for the remainder of the analysis*****.] -- Allen needs to identify the six nuclides and state their fractional amounts based on specific radioactivity and give their radionuclide half-lives.**

[27. ***For each of the six nuclides, the surface activity concentration was assumed to be the same for the entire depth of a thin HY-80 steel object. MCNP was then used to calculation*****] -- "The word "calculation" should be "calculate." What distance below the surface was modeled with MCNP? Allen provides almost no details of NIOSH's extensive MCNPx modeling with respect to software version, parameters and assumptions used, or what was measured (photons, neutrons, electrons [beta], alpha). If SC&A input data was used, that information should be appended.**

[28. ***Lastly, the betatron operator was assumed to be 1 foot from the object for half of the time he was exposed and 1 meter from the object for the remainder of the time.*****] -- Why do these speculative and arbitrary NIOSH assumptions make sense? The claimant favorable assumption would be the betatron operators**

were 1 inch from the target object (casting, uranium metal) during the entire time.

[29. *For the layout man, the same process was used but the scenario was altered*]. The claimant favorable assumption would be the layout men were 1 inch from the target object (casting, uranium metal) during the entire time.
• *Has this methodology been described in a WG meeting, a white paper, or a Board meeting*? Has SC&A reviewed the methodology on the written record in Docket 140 (GSI)? If the answers are Yes, then Mr. Allen should provide direct references to the transcript date and pages that support his AppBBr1 DR methods.
• I believe the overriding assumption is that ALL AppBBr1 NIOSH dose reconstruction methodology in all sections has been reviewed and approved by SC&A, the TBD-6000 WG and the full Board. Proof that this has occurred should be provided by Allen and DCAS/NIOSH in all sections of AppBBr1.
• I will state again that major parts of some sections in AppBBr1 appear to Dan McKeel, as part of the GSI expert team and GSI SEC-00105 co-petitioner, to have been inserted for the first time. That observation prompted comment 29.

[30. *For the interrupted scenario, it is assumed the casting was x-rayed 400 times in the long steel shot scenario prior to the layout man working on the casting.*] -- Perhaps I misunderstand the English, but this assumption appears to an absurdity. Layout men layout by necessity (and logic) marked castings before, not after, the castings are x-rayed with the GSI Betatrons.

[31. *Table 5 and 6 include the annual dose estimates from all sources for the betatron operator and the layout man respectively*.] --

(a) McKeel Comment on Table 5 -- GSI Betatron operator dose summary: The external dosimetry data in this table lacks face validity for several reasons, as follows:
ERROR #1: No data at all exists for other production activities at GSI with respect to MCW uranium apart from the three NIOSH/McKeel DOE operational reports that led to an extension of the covered period. Thus, these back extrapolations are invalid. With respect to photons while x-raying and from uranium, for example (columns 3 and 4), GSI did R&D image improvement "research" on uranium-238 billet sections that was different from production Betatron MCW uranium NDT work in later years ;
ERROR #2: The neutron data was erroneously not compared to NYO4699 (Suppl. 1) measured neutron data and was not validated for MCNPx;
ERROR #3: The column 6 gamma dose assigned in all years of 1300 mrem/yr is based on NIOSH normalizing Betatron data using Landauer film badge data that was declared invalid by Neton/NIOSH in his 12/19/13 emailed memo (see PAGES 13-15). The values are grossly different by ~ 8-fold from NIOSH 2007-2008 gamma photon external dose assigned to Betatron operators in AppBBr0. Allen fails to acknowledge this central fact. Also, a

contant gamma dose in the face of changing production rates at GSI leading to closure in 1973 lacks statistical face validity. The assigned value is not plausible or claimant favorable or scientifically defensible. This is especially so because of the variable values assigned to highly variable neutron and beta doses in columns 2, 3, 4, 7 and 8.

ERROR #4. Most implausible are the sharply declining neutron doses listed in columns 3 and 4 for 1963-1966.

(b) McKeel Comment on Table 6 -- GSI Layout man dose summary: Allen erroneously states that layout work could not have been done in the Old Betatron tunnel or just outside. Worker testimony (Dave Woodard) indicates that, in fact, some layout work near or inside the Old Betatron facility in the tunnel and shooting room and just outside did take place. He was on rail cars that backed up inches away from the Old Betatron ribbon door while shots were occurring inside in the shooting room. Another unknown fraction of the Old Betatron layout work, presumably on the massive castings. was done in Building 10 before the castings were returned to the Old Betatron. Workers describe a constant supervisory imperative to expedite "hot" or rush NDT castings work. Rush "hot job" work would not include a trip back to Bldg. 10 for further layout markups. The layout was done in or near the Old Betatron building. TABLE 6 needs to be expanded to include layout man exposures in the Old Betatron facility based on this information.

BB.4.4 External Dose Estimate for Isotope Source Operations
[1. *Radium-226 Radiography*]
Prior to 1963, GSI used two Ra-226 sources for radiography. These sources were 500 mg (500 mCi) each (AEC 1962, pg. 9). The sources were reported to have been held in a container that looked like a plumb bob (see figure 6 for an example of such a container). According to GSI's AEC license application in 1962, the Ra-226 sources were used with the "fishing pole" technique. This technique involves attaching the source to the end of a string and attaching the other end of the string to the end of a pole in a configuration that resembles a fishing pole (figure 7). A former operator indicated the shot was set up so that the film was in place and a small cup was positioned where the source was to be placed. The operator then moved the source from a shielded container to the cup using the fishing pole where it was placed for the duration of the shot. When the desired exposure time was achieved, the

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process was reversed to remove and store the source. The operator reported that the pole was 4 to 6 feet long and it took 12 to 15 seconds to place the source (DCAS 2011). Assuming the midpoint distance of 5 feet and the midpoint time of 13.5 seconds the dose to the operator for placing the source would be 0.67 mR. He would receive the same dose again when removing the source so his total dose per shot would be 1.33 mR.

Figure 6 – Example of a Common Radium Industrial Radiography Source

ORAU Collection

Close up photograph of source container commonly used for industrial radiography radium sources

Figure 7 – Radiography using the Fishing Pole Technique

ORAU Collection

Photograph of a man performing radiography using the fishing pole technique

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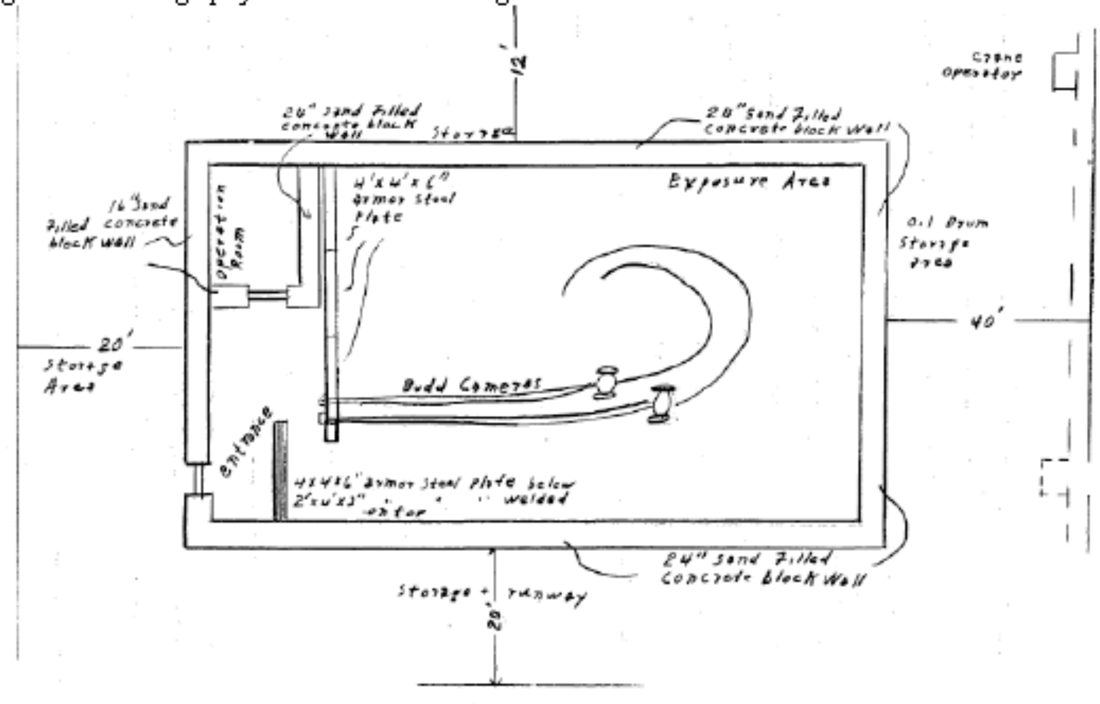
[**2. A special radiography room was built within the #6 building**]. The room measured 22 feet by 60 feet and contained a separate room for the operators as well as armor steel plates for shielding (AEC 1962 pg 8 & 9). The [**3. walls of the room were constructed with 24" thick sand filled concrete blocks**]. The top of the room was open to allow an overhead crane to lower items into the room. Figure 8 provides a drawing of this room. Former workers at GSI also reported that the sources were sometimes used outside of the radiography room. They reported that, when that occurred, they would rope off an area 1.5 times the required distance. Additionally, it was reported that the radiographers would leave the area unattended at times and other people would then ignore the boundary and walk through the area (Transcript 2009; pg 137).

Figure 8 – Radiography Room in #6 Building



[**3. Drawing of the radiography room in the number 6 building from AEC license documentation**]

In addition to receiving a radiation dose while placing and removing the source, when working outside the radiography room, radiographers would also receive a dose while waiting at the boundary. [**4. A boundary was reportedly set up at 1.5 times the required distance. The required distance would be the point where the radiation levels fell below 2 mR/hr**.] One and a half times this distance would set the boundary at a dose rate of 0.89 mR/hr. Assuming the radiographer stayed at the boundary for the duration of the shot, an additional dose would be received. To estimate that dose, it is first necessary to determine how many shots were taken and the total duration of those shots.

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No direct records were found as to how often the radium sources were utilized at GSI (such as a shot log), however, some indirect information does exist. In 1962, GSI transitioned from using two 500 mg Ra-226 source to using two small Co-60 sources. The stated purpose for the transition was a State of Illinois request that GSI stop using the radium sources (Kleber 1962). Some key dates associated with the transition are:

- 3/7/1962 Applied for an AEC source license (Kleber 1962)
- 4/18/1962 License granted by the AEC (AEC 1962 pg 2)
- 5/21/1962 Purchased two Co-60 sources (AEC 1962a, pg 3)
- 6/24/1962 survey of radiography room with 2 Co-60 sources exposed (NCC 1962)
- 8/1/1962 survey of radiography room with 2 Co-60 sources exposed (NCC 1962)
- 11/6/1962 inspected by the AEC (AEC 1962a)

[**5. The frequency of the radiographic examinations at GSI was driven by the rate at which products were produced. There is no reason to believe that this production rate would change due to the purchase of the Co-60 sources.**] The purpose of the source change was to discontinue the use of radium, not change the testing program. Also, the date of the AEC inspection is less than six months after the Co-60 sources were purchased. This makes the inspection contemporaneous with the use of radium sources since they would have been used at least until the Co-60 sources were purchased. Therefore, [**6. the frequency of radiographic examinations discussed in the 11/6/1962 AEC inspection is considered the same frequency that the radium sources were used**.]

The AEC inspection, conducted on 11/6/1962 indicated that [**7a. approximately 10 radiographic examinations were conducted per work shift and these examinations varied from one minute to 70 minutes in duration (AEC 1962a, pg 3). Another report indicated a maximum of 30% of each shift is used for actual examinations. That report also indicated exams ranged from 1 or 2 minutes up to 1.5 hours (AEC 1962 pg 12). The examination durations in the two reports are reasonable consistent.**] The first report gives no indication of the total duration per shift while the second report indicates 30% of an 8 hour shift (144 minutes). [**7b. Therefore, it will be assumed that Ra-226 and Co-60 radiography consisted of 10 shots per shift for a total duration of 144 minutes**].

[**8. An estimate of the radiographer dose during Ra-226 radiography can then be made by assuming 1.33 mR/shot (from placing and retrieving the source)**] times 10 shots per shift times 406.25 shifts per year for an annual dose of 5411.25 mR. Added to that is the boundary dose rate of 0.89 mR/hr times 144 minutes per shift times 406.25 shifts per year for an annual dose of 868 mR. This results in a total annual dose of 6279 mR.

[**9. That estimate is very dependent on time and distance associated with placing and retrieving the source. Those parameters are not well known**.] While the recollection of the former radiographer is likely to be accurate for his own experience, it is not necessary accurate for others. Therefore, an additional estimate using worst case time and distance from the worker's recollection was calculated. Using the same technique as before but substituting 4 feet and 15 seconds for placing and retrieving the source, [**10. a new estimate of 9.40 R/yr can be calculated for placing and retrieving the sources**]. In addition, [**11. it was reported that the majority of radiography occurred in the radiography room of the number 6 building**]. An MCNP model was constructed of the room and used to estimate a dose rate of 0.303 mR/hr in the

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control room. The radiographer was reported to spend most of his time during the shot in this control room. The model was based on a [**12. drawing from the AEC license application (figure 8).**] Using the results of this model and the source utilization time of 144 minutes per shift, the annual dose received during the shots can be calculated to be 295 mR/yr. Combining that dose with the dose from placing and retrieving the source results in an annual dose estimate of 9.69 R/yr.

[**13. Also, while dosimetry data for this time frame could not be located (with the exception of a few examples), there were indications that a dosimetry program did exist. The application for an AEC license indicated that using this technique, no one had ever exceeded the annual limit applicable at the time and the average was always below 25% of the limit**]. The exposure limit from 1952 through 1961 was 15 rem per year. After that, [**14. the limit was changed to a lifetime limit not to exceed 3 rem per calendar quarter which equates to no more than 12 rem per year**].

[**15. A former radiographer provided a report summarizing his radiation dose while the radium sources were still in use. The record indicated that at GSI, he received 9.1 rem in 18 calendar quarters or 2.022 rem per year on average. An interview with the radiographer indicated he only performed radiography on a part time basis and estimated he did this between 40 to 90 shifts per year (SC&A 2011)**]. Receiving 2.022 rem in 90 shifts is equivalent to 0.0225 rem/shift. This would result in an estimate of 9.12 rem per year to a full time radiographer.

To account for the variation in these estimates, a triangular distribution will be used as the dose estimate for radium radiography. [**16. The minimum values will be the 6.279 R/year**]. The [**17. likely value will be 9.69 R/yr**] and the maximum will be the AEC limit (15 rem/yr or 12 rem/yr depending on the year). [**18. It should be noted that this is consistent with the GSI statement in the AEC License application indicating the applicable limit has never been exceeded. It is also consistent with the dose received by the part time radiographer discussed above**.]

Cobalt-60 Radiography

By 1963 the use of radium for radiography at GSI had ended and the sources were replaced with two Co-60 sources. The Co-60 sources were purchased in 1962 and a survey was conducted of the number 6 building radiography room on 6/24/1962 and 8/1/1962. It is likely the Co-60 sources had begun being used soon after and the Ra-226 sources retired. However, since an exact date is unknown, this estimate uses the favorable assumption that the Ra-226 sources continued to be used through the end of 1962.

[**19. It was reported that the majority of Co-60 radiography occurred in the radiography room of number 6 building. Some may have been done outside of that room but it appears to have been infrequent**]. The surveys conducted on 6/24/1962 and 8/1/1962 showed a maximum dose rate on the exterior of the radiography room of 1.2 mR/hr. The maximum dose rate in the control room was 1.15 mR/hr (NCC 1962). While the operators were reported to spend most of the time during the shot in the control room, it is also possible they left the building and **[20. could have been in the 1.2 mR/hr area]**. Since the difference is small, this estimate assumes the operators spend 100% of the time the sources were exposed, outside the room near the wall where the [**21. reading was 1.2**

mR/hr.] Multiplying this by 144 minutes of exposure per shift and 406.25 shifts per year gives an annual dose of 1170 mR.

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Iridium-192 Radiography

[**22. An Ir-192 source was also reported to have been used on site. No Ir-192 source was ever added to GSI's AEC license or requested to be added**]. A former worker for a local company, [**23. St. Louis Testing, reported that he was contracted at times to bring sources (including an Ir-192 source and a Co-60 source) on site to perform radiography**]. He later reported that this did not occur before 1963 and that St. Louis Testing personnel would perform the operation without GSI personnel. He also reported a boundary would be set up and guarded by St. Louis Testing during the shot. [**24. The boundary was setup at a distance that would result in an exposure rate of 2 mR/hr**.] [**25. Even if St. Louis Testing used a source full time and a GSI employee stood at the boundary full time, the annual gamma dose would be less than that of the layout man estimate. Therefore, dose estimate of these sources would not be the limiting estimate and thus will not be included in the GSI estimate**].

<u>MCKEEL COMMENT to BB4.4 External Dose Estimate for Isotope source Operations</u>:

[1*. Radium-226 Radiography… sources were 500 mg (500mCi)*] -- This source intensity figure was applicable to the Ra-226 sources when they were first purchased (date unknown). It is not known whether any leakage occurred or what the exact 1962 decay level had become. GSI stated the Ra-226 sources were rented, but not who the vendor was. There are no GSI shot records, leak test results from St. Louis Testing Co. (the GSI site expert team asked for them from Paul Sinn), or sealed source maintenance records of any kind.

[2. *A special radiography room was built within the #6 building*] -- Allen needs to note the structure was <u>built in 1955</u> (two eyewitnesses) and at first had walls only 8 inches thick composed of perforated 8 inch concrete blocks. A GSI 1957 master engineering drawing clearly showed an inner "radiography room" within the confines of Bldg. 6 (from a McKeel white paper).

[3. *walls of the room were constructed with 24" thick sand filled concrete blocks*] -- Allen needs to cite the NRC ML report number, date and page numbers for this statement. As stated in item 2, two eyewitnesses stated the original concrete block walls were only 8 inches thick. Several other workers (John Dutko, deceased, was one of them) thought the walls were only 8 inches thick while he worked at GSI as a radiographer (1963-1966). The GSI site expert team challenges the accuracy of the 24 inch thick inner structure Radiography room walls in the Bldg. 6 radiography room. The Ra-226 and Co-60 dose delivery outside would be higher with thinner 8 inch walls compared to thicker 16 or 24 inch thick walls shown in some inner Bldg. 6 structural

sketches. Again, these are not "as-built" certified blueprints.

[4. ***A boundary was reportedly set up at 1.5 times the required distance. The required distance would be the point where the radiation levels fell below 2 mR/hr.*****] -- Allen needs to also include the NRC mandated 100 mR/hr barrier.**

[5. ***The frequency of the radiographic examinations at GSI was driven by the rate at which products were produced. There is no reason to believe that this production rate would change due to the purchase of the Co-60 sources.*****] -- It is equally true there is no reason to assume the production rate <u>would NOT change</u>, or in what direction according to current contracts, after the switch from Ra-226 to Co-60 NDT sealed sources occurred in 1963. Allen is guessing and his logic is flawed. An unchanging production rate is an invalid, scientifically indefensible assumption. An unchanging production rate across Ra-226 and Co-60 source eras should NOT be assumed. What is required is measured data that NIOSH does not have. GSI merited an 83.14 SEC all along due this gross deficiency of area or individual monitoring or process or source data. OCAS Director Elliott in 2005 admitted GSI was a "unique site."**

[6. ***the frequency of radiographic examinations discussed in the 11/6/1962 AEC inspection is considered the same frequency that the radium sources were used.*****] -- Since all GSI log books, job lists, and shot lists are lost or destroyed, there is no independent GSI data corroboration of the number of shots the AEC inspector assessed to be the case in 1962. None of the GSI workers the GSI site expert team interviewed remembered being interviewed by, or meeting, AEC inspectors. The same workers deny such regular AEC inspections took place during the operational period. This is reinforced because no such records are available for the MCW site concerning the Betatron contract work done at GSI in Illinois. This analysis also applies to comments on items 7a and 7b below.**

[7a. ***approximately 10 radiographic examinations were conducted per work shift and these examinations varied from one minute to 70 minutes in duration (AEC 1962a, pg 3). Another report indicated a maximum of 30% of each shift is used for actual examinations. That report also indicated exams ranged from 1 or 2 minutes up to 1.5 hours (AEC 1962 pg 12)*****] -- See McKeel comment item 6.**

[7b. ***Therefore, it will be assumed that Ra-226 and Co-60 radiography consisted of 10 shots per shift for a total duration of 144 minutes*****] -- See McKeel comment to item 6.**

[8. ***An estimate of the radiographer dose during Ra-226 radiography can then be made by assuming 1.33 mR/shot (from placing and retrieving the source)*****] -- Where is the 1.33 mR/shot value derived (cite DCAS or SC&A white paper report, AppBBr1 page number, reference number, author, title, SRDB number, page(s) cited? The detailed complete citation is needed.**

[9. *That estimate is very dependent on time and distance associated with placing and retrieving the source. Those parameters are not well known.*] -- These terms are not known from shot records, log books, etc., <u>at all</u> because all such records are missing or destroyed at GSI. The testimony about the use of Ra-226 sources by GSI radiographers is very sketchy. McKeel's view is the record is so skimpy as to be totally unreliable for assigning doses with suffcient accuracy in a plausible, claimant favorable way. Allen has not met this standard.

[10. *a new estimate of 9.40 R/yr can be calculated for placing and retrieving the sources*] --Allen again has made a too brief statement about an exceedingly important dose assignment. A fuller detailed citation of the data source is required: author, report number and title, SRDB number, date, and pages need to be stated here. "Can be calculated" should be replaced by "was calculated as follows" citing the detailed reference.

[11. *it was reported that the majority of radiography occurred in the radiography room of the number 6 building*] -- (a) It is tedious to have to state that once again Allen has ignored the affidavits of two GSI workers (Dave Woodard and Danial Churovich), who both were eye witnesses to the inner concrete block "radiography room" marked on the GSI 1957 master engineering drawing that the GSI site expert team provided to the TBD-6000 WG and documented in McKeel white papers. Both GSI workers stated the inner, roofless building 6 radiography facility was constructed in the year 1955 and had 8 inch thick concrete block walls filled with "Miss. River sand."

(b) Allen ignores this fact, which mandates that doses from two (2) GSI Radium-226 source gamma photon external doses he calculated for the covered period Oct. 1, 1952, through some time in 1955, be re-calculated for shots in the open areas anywhere within the GSI building complex.

(c) The GSI expert team has provided the TBD-6000 WG photos from the GSI company magazine showing rows of railroad trucks, a major component manufactiured and examined at GSI by both Ra-226 and Co-60 NDT isotope radiography, in an open building consistent with Bldg. 6.

(d) Neither NIOSH nor SC&A have calculated open space external photon doses for 10/1/52 through 1955 when the Bldg. 6 inner block building was built at GSI.

(d) It should also be noted that SC&A alone calculated Ra-226 photon exposures for radiographers stationed within the Bldg. 6 radiography room after 1955 through 1962, who worked on NDT jobs. SC&A did NIOSH's job.

(e) Finally, GSI radiographer (Leroy Dell) testimony indicates that Ra-226 and Co-60 shots done outside of the Bldg. 6 radiography room were often NOT roped off and were often NOT monitored. The claimant favorable position would involve passerby workers being in close proxity to the open Ra-226 sources.

[12. *drawing from the AEC license application (figure 8).*] -- The cited document

"ML" and/or SRDB numbers, author, title, report number, year and pages needs to be referenced.

[13. ***Also, while dosimetry data for this time frame could not be located (with the exception of a few examples), there were indications that a dosimetry program did exist. The application for an AEC license indicated that using this technique, no one had ever exceeded the annual limit applicable at the time and the average was always below 25% of the limit*****] -- NIOSH cites non-specified "indications" and infers "that a dosimetry program exists" but has not provided any written evidence for this supposition. Allen needs to spell out what these indications are? It is the job of NIOSH and DOE to locate through research, and/or otherwise provide, the real measured monitoring data for each AWE and DOE site. Allen also needs to note that GSI radiographers JEP and Ron Elliott initially provided their personal film badge reports to the GSI site expert team, who in turn shared these data with NIOSH, the TBD-6000 WG and the Board. This voluntary sharing was not reciprocated. NIOSH to date has witheld the Landauer Dataset #2084 1963-1973 to itself and SC&A. The complete dataset listing, including the not "M" values, has NOT been published by NIOSH. Allen and DCAS need to acknowledge the original data sources for information they use in TBDs. In this case, the attribution should be to SINEW (McKeel and Ramspott), members of the GSI expert team.**

[14. ***the limit was changed to a lifetime limit not to exceed 3 rem per calendar quarter which equates to no more than 12 rem per year*****] -- What is the authority for this statement and where is the change officially announced?**

[15. ***A former radiographer provided a report summarizing his radiation dose while the radium sources were still in use. The record indicated that at GSI, he received 9.1 rem in 18 calendar quarters or 2.022 rem per year on average. An interview with the radiographer indicated he only performed radiography on a part time basis and estimated he did this between 40 to 90 shifts per year (SC&A 2011)*****] -- Dan McKeel is the recognized representative (by the CDC/ATSDR Atlanta GA FOIA office) for film badge matters for the radiographer alluded to (James E. Powers or JEP). That person filed a PA request on June 19, 2013 to obtain his complete Landauer GSI #2084 film badge data set. To date (7/15/14) he lacks his 1966 Landauer badge data (DCAS sent him single page). The brief report alluded to was NOT generated by Landauer. The alluded to film badge raw data has NOT been located by NIOSH.**

[16. ***The minimum values will be the 6.279 R/year*****] -- What data supports this lower limit value? Allen needs to specify report title and SRDB number, year published, author(s) and pagination. The citation should be included in the References.**

[17. ***likely value will be 9.69 R/yr*****] -- What does "likely" mean? What criteria can DOL use for assigning this "likely dose?" McKeel believes this will be**

difficult or impossble in many cases. Having three values will lead to unfavorable dose underestimates in his opinion. The claimant favorable position would be to assign everyone except administrative personnel at GSI the upper value of the triangular distribution (12 or 15 REM/year).
• What data supports this middle limit value for the triangular distribution? Allen needs to specify the report title and SRDB number, year published, author(s) and pagination. The citation should be included in the References.

[18. *It should be noted that this is consistent with the GSI statement in the AEC License application indicating the applicable limit has never been exceeded. It is also consistent with the dose received by the part time radiographer discussed above.*] -- The specific citation for the "GSI statement in the AEC license application" is buried within 1,016 pages ofNRC FOIA 201-0012 obtained by Dan McKeel. References to particular material in that set of 37 documents in the INDEX NRC provided, and that McKeel posted on the DCAS website. need to be referenced by Mr. Allen by "ML" document number, date and page(s).
• The GSI expert team's strong objections to accepting this statement by a GSI official, who needed to persuade the AEC to grant a By-Products material license, should not be accepted in the complete absence of any corroborating hard evidence. Specifically, there are no other film badge reports than the Landauer GSI #2084 dataset, and Powers-Elliott personal AEC/NCC/GSI data reports rendered in a completely different format. NIOSH never located the raw film badge data from a second badge vendor and believes the other badge reports came from GSI. McKeel FOIA'd NCC license data from DOE but received no responsive documents. In fact, DOE was unable to confirm an AEC license for NCC existed even through NRC FOIA 2012-0012 contained a specific AEC license number for NCC. The FOIA officer could not confirm NCC existed as a corporate entity. I mention all of this background to highlight how unscientific it is for NIOSH to naively accept a naked statement from a biased GSI official, who gave no details to back up the veracity of his "never exceeded limits" and "25%" statements (uncorroborated claims). *NIOSH has rarely, if ever to Dan McKeel's knowledge, resorted to using AEC limits to determine a bounding photon dose at any other EEOICPA site*. The GSI letter cited did not state whether the reference was to photons, neutrons, beta or alpha or to all four. The Landauer GSI FB dataset #2084 included only <u>photon</u> dosimetry data. <u>Neutron and beta and alpha doses were not determined for any GSI worker 1952 through 1973</u>.

[19. *It was reported that the majority of Co-60 radiography occurred in the radiography room of number 6 building. Some may have been done outside of that room but it appears to have been infrequent*] -- Different radiographers gave varying testimony on the frequency of Co-60 NDT shots performed outside the Bldg. 6 radiography room. Mr. Dell told the GSI site expert team the outside Co-60 shots he knew about were <u>frequent</u> (not infrequent/rare) and, more importantly, from a radiation exposure point of view, shots were frequently <u>unattended</u>. The radiographer often set up the Co-60 shot and then

returned to one of the Betatron facilities to continue doing NDT radiography there. The GSI expert team made the TBD-6000 WG and Mr. Allen aware of this information, and DCAS and SC&A jointly interviewed Mr. Dell with McKeel as a silent non-participating observer.

[20. *could have been in the 1.2 mR/hr area*] -- Paul Sinn of St. Louis Testing Company testified he was present at 25 to 50 Ir-192 shots his company was hired to perform at GSI. He testified to the GSI expert team that NRC required a <u>second, more stringent and constantly guarded safety barrier</u> where the source term dose was 100 mR/hr. Allen as a member of the TBD-6000 WG received this vital information but chose to omit it from AppBBr1 (6.6.14). It is Mr. Allen's job to know and use this type of information.

[21. *reading was 1.2 mR/hr.*] -- Please refer to item 20 comment.

[22. *An Ir-192 source was also reported to have been used on site. No Ir-192 source was ever added to GSI's AEC license or requested to be added*] -- This statement is patently untrue. Dan McKeel and the GSI site expert team specifically reported to the TBD-6000 WG the wording in a GSI 1972 AEC license renewal. Specifically, NRC ML093480290 Page 2 of 2, License Number 12-08271-01, Amendment No. 08 dated 3/15/72 reads as follows:

> **"12. The licensee is authorized to receive, possess, and use sealed sources of <u>Iridium 192</u> or Cobalt 60 where the radioactivity specified in item 8 of this license provided: A. Such possession does not exceed the quantity per source specified in item 8 by <u>more than 20% for iridium 192</u> or 10% for Cobalt 60; ... [B, C follow to end item 12 of 13]). The complete first two pages of the NRC document is attached on PAGES 78-80 as MCKEEL EXHIBIT 1." (*added emphasis*)**

- **Mr. Allen needs to <u>retract statement 22</u> and modify AppBBr1 accordingly. Again, the TBD-6000 WG was knew about this information.**

[23. *St. Louis Testing, reported that he was contracted at times to bring sources (including an Ir-192 source and a Co-60 source) on site to perform radiography*] -- Paul Sinn testified to the GSI expert team in 2013 that he personally was aware of 25 to 50 NDT jobs that St. Louis Testing Co. did at GSI using their Ir-192 source. Sinn stated that St. Louis Testing Co. performed only one Cobalt-60 10 Curie NDT job outside the 10 building with the casting mounted on a railroad car. This job required Co-60 shots for 8 days to cover the entire casting. GSI men participated. The TBD-6000 WG got this information.

[24. *The boundary was setup at a distance that would result in an exposure rate of 2 mR/hr.*] -- Mr. Sinn testified to the GSI site expert team that NRC required

an inner safety boundary, to be constantly monitored by St. Louis Testing Co., at the 100 mR/hr boundary. This added barrier was set up and monitored at all St. Louis Testing Co. GSI NDT jobs.

[25. *Even if St. Louis Testing used a source full time and a GSI employee stood at the boundary full time, the annual gamma dose would be less than that of the layout man estimate. Therefore, dose estimate of these sources would not be the limiting estimate and thus will not be included in the GSI estimate*] -- (a) Again, Mr. Allen cannot just make qualitative declarations in order to dismiss the need to comply with OCAS-IG-003 and to bound external doses for all radiation sources. Only after quantitative dose estimates have been finalized is it proper to make statements such as item 25; (b) GSI personnel were used to monitor the 2 mR/hr but not the 100 mR/hr source safety boundary for St. Louis Testing Co. Ir-192 NDT jobs; and (c) exactly what comparative external photon doses will be assigned to personnel for St. Louis Testing Co. GSI NDT Ir-192 shots compared to the same type of doses that GSI layout men would be exposed to? <u>To my knowledge, neither NIOSH nor SC&A have bounded or been directed to bound any Ir-192 source external doses at GSI. This would include shots delivered by the St. Louis Testing Co. and GSI owned Ir-192 gamma NDT sources</u>. GSI badged radiographers also used the American Steel Ir-192 source to perform NDT inspections of flaws in GSI steel products on an "overflow" basis. GSI Betatron uranium radiographer Ed Brawley was one who gave this American Steel-GSI testimony.

BB.4.5 External Dose Estimate for portable x-ray machines

[**1. The existence of a portable 250 kvp x-ray machine was reported at GSI. It was also reported that more than one of these machines had existed**]. As with other sources of radiation, the purpose of these was to produce a radiograph of metal for quality control purposes. In order to produce a clear radiograph, the film cannot be exposed to stray sources of radiation so these machines would not have been used in the same vicinity at the same time. Nor would they have been used near [**2. Others**] sources of radiation.

[**3. Details about the use of these machines are limited. A few former radiographers recall using the machines but they were reported to be used rarely**]. The x-ray beam is not of sufficient energy to activate nuclides in the material being x-rayed, so no source of exposure from freshly x-rayed material would exist. The maximum x-ray energy of a 250 kvp x-ray machine would be 0.25 MeV. This x-ray beam would have considerably less penetrating power than the betatron or the Co-60 sources. As such, it would only be used to x-ray relatively thin metal and [**4. such an x-ray would be short in duration.] With the reported limited use and short durations when it was used, [5. the annual dose to a worker from using this machine would be less than that estimated for the Ra-226 sources or working as a layout man. Therefore, dose estimate of this machine would not be the limiting estimate and thus will not be included in the GSI estimate**].

<u>MCKEEL COMMENT to BB4.5 External Dose Estimate for portable x-ray machines</u>:

[1. *The existence of a portable 250 kvp x-ray machine was reported at GSI. It was also reported that more than one of these machines had existed*] -- Yes, the GSA 1974 auction list for GSI after plant operations ceased listed three (3) GSI conventional x-ray units for sale. The specific model numbers, manufacturers, and nominal output voltages were supplied to the TBD-6000 WG by the GSI site expert team in oral testimony and McKeel white papers. NRC FOIA 2010-0012 reports also documented that two of these conventional voltage x-ray units were industrial x-ray units and one was a medical x-ray unit. Mr. Allen should have included all this detail in AppBBr1 since the details were not available when AppBBr0 was issued (June 25, 2007).

[2. *Others*] -- The word “Others “ should be changed to “other.”

[3. *Details about the use of these machines are limited. A few former radiographers recall using the machines but they were reported to be used rarely*] -- The scant worker testiimony does not provide a clear and persuasive picture of useage of the two 250 Kvp NDT x-ray machines. All GSI shot records, job records, and exposure log books were lost or destroyed. Mr. Allen resorts to cherry picking. I believe “rarely” is his term. The worker testimony source he is referrring to needs to be cited by transcript date and page number. The frequent use by Allen of unsupported, not referenced, worker statements is a major scientific weakness of AppBBr1.

[**4. *such an x-ray would be short in duration.*] -- Qualitative and vague terms such as “short” are meaningless in a scientific DR guidance document. Quantitative data and operating parameters such as the delivered dose rate and exposure time (in minutes, seconds) are needed. What was the millamperage of the x-ray machines duing x-ray delivery?**

[5. *the annual dose to a worker from using this machine would be less than that estimated for the Ra-226 sources or working as a layout man. Therefore, dose estimate of this machine would not be the limiting estimate and thus will not be included in the GSI estimate*] -- The first sentence is pure supposition. Allen/NIOSH have no specific information on frequency of use, building locations, or job types (what castings were examined) the 250 Kvp industrial x-ray units were used for at GSI. OCAS-IG-003 mandates the doses from both 250 Kvp x-ray units be calculated. Allen/NIOSH need to provide these data.

BB.4.6 External Dose Estimate for Administrative Personnel.

[1. **The dose estimate for administrative personnel is based on the reported practice of performing radiography in the main buildings outside of the #6 building radiography room. It is not clear how frequently this occurred.**] It is also unclear if the reported practice of making a boundary at the point 1.5 times the required distance was always done. Therefore, this [**2. estimate assumes the boundary was set at the required distance (2**

mR/hr)]. It was also reported that the boundary was not always respected. People would at times cross the boundary and walk through the area if the boundary was unattended.

As indicated previously, the sources are estimated to be in use an average of 144 minutes per 8 hour shift. As a favorable assumption, it is assumed that every administrative person walked through the area twice (one round trip) every shift. The Ra-226 sources would produce a gamma dose rate of 4440 mR/hr at one foot. [**3. A distance of 47.1 feet would be required to reduce the dose rate to 2 mR/hr**.] It should be noted that the presence of castings and other materials in the area would likely reduce this distance in one or more directions.

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However, assuming no shielding is favorable for this calculation. Since the purpose of traveling through the area would presumably be to take a shortcut through the restricted area, it is assumed that the person could have traveled through the area at any distance from the source within the restricted boundary. Therefore, the dose for traveling through the area was calculated assuming the path took the person within 1 foot of the source (see Attachment A). The same calculation was performed assuming the person came within 2 feet, 3 feet, etc. of the source until all possibilities were calculated (in 1 foot increments). The average of these doses was calculated, multiplied by 2 trips per shift and then multiplied by 406.25 shifts per year to arrive at an annual dose of 84 mR.

[**4. It is also possible an administrative person stood at the boundary during the radiography**.] Since this estimate is intended for people that did not spend their entire work day in the production areas, assuming 100% occupancy would be unrealistic. A favorable estimate of 25% is therefore assumed. This is considered favorable because it does not imply they only spend 25% of their time in the production area, it only implies they spend 25% of their time next to a radiography boundary. The remaining time could have been elsewhere in the production area or outside of the production area in their normal work area. Since the sources were exposed an average of 144 minutes per shift and the dose rate at the boundary was 2 mR/hr, the person could have received 487.5 mR per year during the 406.25 shifts per year. Combining this with the 84 mR received traveling through the area results in a dose estimate of 571.5 mR per year.

MCKEEL COMMENT to BB4.6 External Dose Estimate for Administrative Personnel:

[1. *The dose estimate for administrative personnel is based on the reported practice of performing radiography in the main buildings outside of the #6 building radiography room. It is not clear how frequently this occurred.*] -- At least three different GSI radiographers testified about this point, giving somewhat different accounts of the facts. Uncontested (but not acknowledged yet by NIOSH) is the fact that all NDT examinations using the Ra-226 twin sources (nominal 500 mCi, decayed values not known) performed at GSI prior to sometime during 1955, when the inner Bldg. 6 radiography structure was constructed), were done in the open 6 through 10 plant buildings among many

workers. The walls of the structure were built of a single layer of concrete sand-filled blocks that two eyewitness observers noted to be only 8 inches thick. One radiographyer (Leroy Dell) stated that unmonitored Ra-226 and Co-60 NDT work was often done outside the Bldg. 6 roofless radiography structure. More exact details are lacking as Allen states.

[2. *estimate assumes the boundary was set at the required distance (2 mR/hr)*] -- There was a more rigorously monitored, NRC mandated safety barrier marked at the 100 mR/hr boundary of NDT shots (Paul Sinn St. Louis Testing Co. testimony) for 25 to 50 Ir-192 shots he supervised at GSI. Allen omits mention of this inner higher dose safety barrier or its ramifications.

[3. *A distance of 47.1 feet would be required to reduce the dose rate to 2 mR/hr*.] -- <u>Observation</u>: This would create a 94.2 foot diameter safe circle, a huge area in the crowded GSI open-space buildings 6 through 10. The diameter of the "safe zone" circle almost guarantees frequent incursions would occur.

[4. *It is also possible an administrative person stood at the boundary during the radiography*.] -- Many scenarios can be imagined. Facts are lacking. What is the point of adding this particular statement? Mr. Allen should expand the text to clarify the point he is making.

BB.4.7 External Dose Estimate Summary

The limiting external dose estimates depend on the worker category as well as the year in which they worked and the organ of interest for dose reconstruction. The results of the external dose estimates are provided below.

Administrative Workers

This dose estimate is to be assigned for all years of AEC operations (October 1952 through June 1966). The years 1952 and 1966 are prorated for the partial year of operations. Partial years of employment within this time period should be prorated for each case. The dose should be assigned as 30 to 250 keV photons as a constant distribution. This estimate is assigned to Administrative Workers which are defined as anyone normally working in an office environment not routinely entering the production areas. [**1. All other employees will be assigned the dose estimate for Operators**].

Table 7 – Administrative Worker Dose Estimate

Year	Gamma (mR/yr)
All years	571.5

For Operators, the bounding estimate from the estimates derived above is used. Tables 8 and 9 provide those estimates. [**2. The bounding estimate in the early years at GSI is the dose estimate to the Ra-226 radiographers.**] [**3. After 1962, the bounding estimate is the**

layout man dose estimate for most cases]. [**4. In the case of the skin to the hands or forearms, the betatron operator dose estimate is limiting**]. This is due to the much larger beta dose estimate for handling uranium. For a case of multiple cancers, if one or more but not all of the cancers include the skin of the hands or forearms, the dose estimate should be from only one of the tables below. That is, it should not be assumed that the skin received the betatron

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operator dose while the other organs received the layout man dose. Both tables should be used to estimate the dose to each organ and the more favorable overall estimate used.

Table 8 – Operator Dose Estimate for Organs Other Than Skin of the Hands and Forearms (H&F)

Year	Gamma Dose (R/yr)	Neutron Dose (mrem/yr)	Beta Dose (mrad/yr)	Source of Estimate
1952	15/ 9.69/ 6.279 (a)	0	0	Radium source
1953	15/ 9.69/ 6.279 (a)	0	0	Radium source
1954	15/ 9.69/ 6.279 (a)	0	0	Radium source
1955	15/ 9.69/ 6.279 (a)	0	0	Radium source
1956	15/ 9.69/ 6.279 (a)	0	0	Radium source
1957	15/ 9.69/ 6.279 (a)	0	0	Radium source
1958	15/ 9.69/ 6.279 (a)	0	0	Radium source
1959	15/ 9.69/ 6.279 (a)	0	0	Radium source
1960	15/ 9.69/ 6.279 (a)	0	0	Radium source
1961	15/ 9.69/ 6.279 (a)	0	0	Radium source
1962	12/ 9.69/ 6.279 (a)	0	0	Radium source
1963	9.002	557	463	Layout man
1964	9.002	557	463	Layout man
1965	9.002	557	463	Layout man
1966	4.501	278.5	232	Layout man

(a) Triangular distribution maximum/most likely/minimum

<u>MCKEEL COMMENT on Table 8</u>: The data presented in this Table is fundamentally incomplete and flawed. "Operator" refers to an NDT source term radiographer. All radiographers at GSI during 1952 through 1962 also were operators of the 24 Mev A-C "Old" Betatron that was in use from 1952 through 1973 when the plant ceased castings operations. Approximately 15% of the Betatron beam consisted of neutrons generated from the internal platinum target. Betatrons, as basically electron particle accelerators, also released stray electrons. Some clinical Betatrons had two output tubes that were fitted to generate either electrons (no internal target) or photons (x-rays) and neutrons (target inserted). Table 8 incorrectly ignores this fact. Our previously cited evidence was the St. John's hospital (St. Louis, MO) Betatron data in Scheutz 2007 and data from three similar betatrons in the NYO-4699 (Suppl. 1) paper that McKeel introduced to the TBD-6000 WG. NIOSH (Jim Neton was the spokesperson) rejected using this reference source on grounds that McKeel vigorously rebutted as not being valid. For example, Dr. Neton claimed the diagrams of betatron facilities in NYO-4699 (Suppl. 1) were too simplistic. McKeel pointed out the drawings were as detailed as the Old and

New Betatron building diagrams (Figures 1 through 5) in this paper. McKeel's view is the NYO-4699 Betatron building diagrams were equally informative. The *co-petitioner's perception* is that NIOSH had been upstaged once again in gaining key GSI-related information, and was resistant to admitting this had occurred. NIOSH's negative response to the two NYO-4699 papers was not open and transparent "best practice" science, where new information is respected and valued. *Note that NYO-4699(Suppl. 1)1957, the main extant measured Betatron photon, neutron and operator film badge data, is not among the included NIOSH references for either AppBBr0 (2007) or AppBBr1 (2014)*.

GSI radiographers also operated the GSI Iridium-192 (sworn GSI worker affidavit testimony) gamma source (which is noted in the GSI license that McKeel first obtained and shared with the TBD-6000 WG under NRC FOIA 2010-0012) and two 250 Kvp industrial portable x-ray machines. Allen's paper does not properly attribute this important contribution made by the GSI petitioners regarding the discovery and revelation of these facts.

Table 9 – Operator Dose Estimate for the Skin of the Hands and Forearms (H&F)

Year	Gamma Dose (mR/yr) (a)	Neutron Dose (mrem/yr)	Beta Dose (mrad/yr)	Source of Estimate
1952	1300	81	9186	Betatron Operator
1953	1300	323	36743	Betatron Operator
1954	1300	323	36743	Betatron Operator
1955	1300	323	36743	Betatron Operator
1956	1300	323	36743	Betatron Operator
1957	1300	323	36743	Betatron Operator
1958	1300	313	31310	Betatron Operator
1959	1300	309	29074	Betatron Operator
1960	1300	309	29074	Betatron Operator
1961	1300	316	32908	Betatron Operator
1962	1300	302	24760	Betatron Operator
1963	1300	274	9062	Betatron Operator
1964	9002	557	807	Layout man
1965	9002	557	807	Layout man
1966	4501	278.5	404	Layout man

(a) 1952 to 1963 readings are actually mrem/yr rather than mR/yr

<u>MCKEEL COMMENT to Table 9</u>: Claimants should be credited with the highest bounding doses for photons, beta and neutrons. There was no exclusive, full-time job classification at GSI as "layout man." Radiographers took turns as operators, assistant operators and layout men. Also there were twice as many Betatron operations and operators during 1963-1966 at GSI when two A-C 24-25 Mev Betatrons were operating. It will not be possible for DOL to identify a job category of layout man at General Steel Industries. Dr. Anigstein of SC&A adopted this new term "layout man" that was not used by NIOSH in AppBB Rev 0 (June 2007).

Dan McKeel suggested many times that Appendix BB Rev 1 should contain a

detailed listing of the changes between Rev 0 (2007) and Rev 1 (2014). I note this entirely reasonable suggestion continues to be ignored in AppBBr1.

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Except for triangular distributions described in Table 8, all doses should be assigned as a constant distribution. Gamma doses should be assigned as 30 to 250 keV photons. Neutron doses should be assigned as 100 keV to 2 MeV neutrons and beta doses should be assigned as >15 keV electrons.

MCKEEL COMMENT TO BB. 4.7 External Dose Estimate Summary:

[1. *All other employees will be assigned the dose estimate for Operators*] -- My criticism of this assignment is that 1963-1966 Betatron Operator external photon doses were incorrectly lowered by NIOSH based on new MCNP computer code modeling. Dosimetry values obtained in 2012 compared to 2008 were ~10-fold lower. This was due to the introduction of Landauer-GSI radiographer film badges for 89 individuals during the AEC operational period and for 19 more individuals during the GSI residual contamination period. Betatron doses were somehow "normalized" to film badges by Allen and DCAS/NIOSH in 2012. Then, on December 19, 2013, Jim Neton issued his Yoder-Hinnefeld memo in which NIOSH declared it would not use GSI-Landauer FB data and would use instead an (unspecified) SC&A method that did not rely on film badges. Refer to Pages 13 to 15. The specific SC&A substitute method that does not rely on FB data needs to be cited by Allen.

[2. *The bounding estimate in the early years at GSI is the dose estimate to the Ra-226 radiographers*.] -- Allen needs to show the actual dosimetry values and pedigreed data that support this statement. The 2012-13 triangular distribution dosimetry values for Ra-226 Operators overlaps the early 2008 Betatron Operator photon values SC&A made before the introduction of Landauer FBs that NIOSH (Jim Neton) announced on December 19, 2013, to the TBD-6000 WG it would no longer be using. AppBBR1 needs to respect and conform with this NIOSH memo, as unusual a precedent as it espouses.

[3. *After 1962, the bounding estimate is the layout man dose estimate for most cases*] -- Allen needs to show and compare the 2008 and 2012 data on the Betatron operators with similar data for 2008 and 2012 layout/other workers (from AppBBr0). Allen's presentation of these quantitative data are required before statement 3. can be accepted as being scientifically valid. What does "most" signify: which workers other than administrative are included?

[4. *In the case of the skin to the hands or forearms, the betatron operator dose estimate is limiting*] -- Again, what values are being compared, Betatron Operators to whom, Layout men? This statement requires quantitative data and a clearer explanation of what is being compared to what.

BB.5 Occupational Internal Dose

The primary source of internal dose at GSI is handling uranium metal. No data was found related to occupational internal dose during AEC work at GSI. In addition, no records of air monitoring were found in the site research database. Since no intentional cutting, machining, or abrading of uranium was involved, **[1. there was a low potential for producing elevated air concentrations of uranium]**. **[2. Another source of potential internal dose is the grinding of steel castings soon after being x-rayed in the betatron.] [3. The betatron photons are of sufficient energy to interact with materials and cause the creation of radionuclides]**.

MCKEEL COMMENT to BB.5 Occupational Internal Dose:

[1. *there was a low potential for producing elevated air concentrations of uranium*] - This statement is not necessarily true. Adley 1952 at the Hanford melt plant, showed higher airborne uranium levels in three types of Ur -238 handlers: the crew that unloaded railroad cars, sweepers, and fork lift operators (the exhausts kicked up dust). There were similar jobs at GSI. McKeel argued the Adley 1952 data, that is a part of TBD-6000 Rev 1 (June 2011), should have been considered for use as surrogate uranium intake data at GSI.

[2. *Another source of potential internal dose is the grinding of steel castings soon after being x-rayed in the betatron*.] -- To grinding as a source of internal dose from machining steel, should be added dose to welders, burners and chippers. These jobs involved direct air intakes and all also released large amounts of uranium metal fumes and particulates into the air as they worked. Allen needs to allow for these types of jobs that were represented at all steel plants.

[3. *The betatron photons are of sufficient energy to interact with materials and cause the creation of radionuclides*] -- Allen ought to employ the most exact scientific terminology. The process he is describing that can "cause the creation of radionuclides" is called either photon or neutron *activation* and those terms should be used to differentiate activation from nuclear fission which is caused by 24-25 Mev betatrons in materials such as uranium and thorium. Doses assigned should be based on the full range of radionuclides released by elemental activation, and the resulting full range of half-lives and degree of radioactivity induced (*specific radioactivity*) should be used in dose calculations.

BB.5.1 Intakes from handling uranium metal

Unlike many Atomic Weapons Employers (AWE) the AEC contracted work at GSI did not involve forming or shaping of uranium metal through processes such as rolling, machining, cutting, or straightening. The work at GSI consisted solely of taking x-rays of uranium metal that were used to evaluate the integrity of the cast uranium metal manufactured at Mallinckrodt Chemical Works. Thus, the only potential for generation of airborne uranium at GSI would be from the movement of the metal into position for the examination.

No air samples were found at GSI so data from the movement of uranium metal at other sites was compiled. Samples that may have been interfered with by other operations in the vicinity or associated with the movement of heated uranium metal were avoided since they would not be representative.

Twenty-five samples from three different sites were found to be represent the airborne activity associated with the movement of cold (i.e., unheated) uranium metal. The samples represent several shapes and sizes of metal varying from one inch diameter by eight inch long slugs weighing a little over 4 pounds to 18 inch diameter by 18 inch long dingots weighing over 3000 pounds. An analysis of the airborne caused by moving these different forms found that the size and shape did not significantly affect the airborne concentration created by moving the metal (Attachment B).

The data reasonably fit a lognormal distribution with a geometric mean of 17.5 dpm/m3 and a geometric standard deviation of 2.29. This distribution has a 95th percentile of 68.7 dpm/m3. The 95th percentile will be used in this estimate and applied as a constant.

MCKEEL COMMENT to BB.5.1 Intakes From Handling Uranium Metals: The GSI expert team contested the use of uranium slug facilities as surrogate data at GSI, which did not use this form of the metal. The GSI expert team also stated that higher uranium airborne intakes as documented in the Adley 1952 Hanford melt facility report would be more claimant favorable surrogate uranium handling intake data. In particular, the high doses documented for crew members that unloaded U-238 from railroad cars were exposed to particularly high levels of airborne uranium dust. Shift hours needed to be curtailed at Hanford due to the high Ur dust levels in this worker subset. Forklift operators and sweepers also were exposed to high Ur dust levels at Hanford. NIOSH completely ignored the complete “uranium transport pathway” at GSI that extended from the rail and truck unload areas, through the loading dock and weighing stations, then along the foundry through multiple buildings (5 through 10), before the uranium metal entered the Old and New Betatron facilities. Uranium-238 airborne doses needed to be calculated all along these routes. Also, intakes for crane operators and chain men and workers who cleaned the transport cars were exposed to high levels of uranium dust. These latter Ur-238 intakes were not calculated by NIOSH or SC&A as they should have been. All source term exposures need to be bounded, and these were not (OCAS-IG-003).

BB.5.2 Intakes from Fission Products

Intakes of fission products must also be considered. Because there are many different isotopes produced as fission products, it makes it difficult to estimate internal dose from this process. Internal dose from uranium is caused by a low dose-rate delivered over years. Many fission products on the other hand have a relatively short half-life so they do not deliver a dose for a long period of time.

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An analysis conducted for revision 0 of this document determined that increasing the uranium airborne activity by 1% would be a favorable method of accounting for uranium fission and activation products. An independent review of this assessment agreed with NIOSH's conclusion (SC&A 2008). Therefore, this revision will increase the uranium airborne activity by 1% in all calculations.

MCKEEL COMMENT to BB.5.2 Intakes from Fission Products: Fission and elemental activation are two different processes. In fission, heavy elements such as uranium and thorium and plutonium are split into smaller radioactive molecules called daughter products. Allen does not identify the specific fission daughter products that result from 24-25 Mev A-C Betatron x-irradiation, their specific activity or half-lives. The GSI expert team provided multiple relevant literature references on this topic to the TBD-6000 WG and cited them in McKeel white papers.

BB.5.3 Intakes from Activation products in Steel

The purpose of x-raying steel castings was to detect internal flaws. Once found, they could be ground out and repaired. This implied the steel could be ground out soon after the x-ray while it is still radioactive, which would cause radioactive dust to be inhaled by the person grinding the casing. To estimate this intake pathway the layout man's work scenario was utilized. It was assumed that someone was grinding on the freshly x-rayed casting the entire time and that the airborne activity produced during the grinding was 4 mg/m3. The 4 mg/m3 was derived from Table 7.5 of TBD-6000 which lists uranium airborne concentrations from uranium machining operations. Of the three grinding operations, centerless grinding had the highest results of 4000 to 5000 dpm/m3. This equates to a mass concentration 3.571 mg/ m3 to 4.286 mg/ m3.

The steel was assumed to be x-rayed with the betatron for 30 continuous hours prior to the layout man working on the casting. MCNP was used to determine the production rate of radionuclides in HY-80 steel and the specific activity of each radionuclide in the steel was determined. The activity was allowed to decay after the shot. It was assumed 4 mg/m3 of steel was always in the air from the casting and inhaled. This intake resulted in an annual internal dose less than one mrem for all organs. Therefore, no internal dose will be assigned from the inhalation of steel.

MCKEEL COMMENT to BB.5.3 Intakes from Activation products in Steel: Activation implies displacement of one or more orbital electrons or other atomic particles, thus creating a host of new "daughter" radionuclides. The GSI expert team provided the TBD-6000 WG several related literature references by Ziemer and Guo (2004) and by Kutemperoor (1974). Tables in McKeel white papers illustrated the important fact that the half lives of multiple activation daughter products of steel and uranium exceed 2 hours, the

arbitrary limit set by NIOSH: Eu 151 13.4 yr, Eu 153 8.5 yr, Co 59 5.27 yr. and Cs 133 2.65 yr = examples of this principle (McKeel white paper, p. 20).

BB.5.4 Summary of Intakes of Radioactive Material

Based on worker input, x-ray shots of uranium took 60 minutes each with 15 minutes between them. Furthermore, it was reported that 4 shots were taken on each piece of uranium. This implies the uranium was being moved only about 5% of the time the uranium was in the building (15 minutes out of 300 minutes). Since the uranium had to be properly positioned in the betatron building and not just moved, it may be reasonable to think that the manipulation of the uranium in the betatron building took more time than moving the same uranium to and from the building. [**1. That would imply the time involved in moving uranium around the site would be less than 5% of the time it was in the betatron building**].

However, there are several possibilities that could change that assumption. First, it is possible the handling inside the betatron building was more efficient than outside even if inside work involved proper placement and not just movement. Second, it is possible the uranium was moved from conveyance to conveyance within the site (fork truck, rail car, crane, etc.) thus representing multiple episodes of handling rather than once in each direction. It should however be noted that it is unlikely this occurred in one area. [**2. More likely, the uranium would be moved some distance with each conveyance before being transferred to another conveyance and airborne activity would thus not accumulate in a single area**]. Lastly, it possible that [**3. while the uranium is being moved on a conveyance, additional airborne activity could be produced by vibrations. Again however, this would not occur in a single area but rather all along the path**].

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[**4. With these uncertainties in mind, this estimate will assume workers are exposed to uranium airborne contamination as if the uranium were handled 100% of the uranium contract time**.] The uranium contract times vary by year as described in Table 2. The airborne concentration is assumed to be the 95th percentile of the uranium handling airborne distribution discussed in section BB.5.1. That value was increased by 1% to account for fission product activity (section BB.5.2). The annual intake was divided by 365 days per year to derive an intake rate per calendar day. The intake values are presented in Table 10.

In between uranium work episodes, it is still possible to create uranium airborne contamination by resuspending any uranium surface contamination left behind by the uranium handling. Intakes from this scenario were calculated by first estimating the surface contamination by assuming the uranium airborne was deposited at a rate of 0.00075 m/s for 30 days. [**5. A resuspension factor of 1E-5 m-1 was then used**] to calculate the airborne concentration due to resuspension. This concentration was assumed to be inhaled 100% of the time during the operational period. The value was converted to dpm per calendar day and is presented in Table 10.

Intakes due to ingesting uranium contamination were also calculated. [**6. The ingestion intake was calculated using OCAS-TIB-009**] and the 95th percentile of the uranium handling airborne distribution increased to account for fission products. These values are included in Table 10.

<u>MCKEEL COMMENT to BB.5.4 Summary of Intakes of Radioactive Materials</u>:

[1. *That would imply the time involved in moving uranium around the site would be less than 5% of the time it was in the betatron building*] -- I strongly <u>disagree</u> with this analysis. NIOSH would have to assign a time interval to each task in handling and moving MCW uranium from the shipping truck or rail car to the two Betatron facilities. The Old and New Betatron buildings at GSI are approached using different types of rail-based systems (engine and regular flat cars for Old Betatron) and electric, shorter "transfer" cars for the New Betatron.

- **Other steps for which time spent needs to be allocated include: (a) unloading MCW U-238 metal forms from the rail cars or truck, (b) picking up the uranium with a fork lift or chain and crane, (c) moving from the loading dock to the weighing station, (d) replacing the uranium on a regular flat car or on a transfer car, (e) driving the train or transfer car from the loading dock past the *mile long* foundry and buildings 5 through 10, (f) unloading at the Betatron buildings, (g) pickup and positioning with the overhead cranes in the OBB and NBB shooting rooms. The aggregate time that would be required for those steps has not been calculated by either NIOSH or SC&A to my knowledge. I believe that all these steps would obviously consume <u>far more than 5% of the time</u> the uranium was inside the Betatron buildings**.

[2. *More likely, the uranium would be moved some distance with each conveyance before being transferred to another conveyance and airborne activity would thus not accumulate in a single area*] -- <u>This type of reasoning is spurious and incorrect</u>. Successive runs of MCW uranium over the 13 year AEC operational period at GSI (1952-1966) would result in multiple cycles of resuspension and settling and buildup all along the uranium transport pathway. So, YES, uranium dust would accumulate in many different areas and probably form a continuous Ur-238 radiocative dust accumulation all along the transport pathway. NIOSH failed to calculate a uranium load along any segment of the GSI Ur transport path outside of the Betatron buildings. No radiologic surveys of this more than mile long, multi-stop and go uranium transport pathway exist (were not collected by GSI or DOE 1993 or others).

[3. *while the uranium is being moved on a conveyance, additional airborne activity could be produced by vibrations. Again however, this would not occur in a single area but rather all along the path*] -- The analysis is incorrect. The Ur transport path, with passage of years, would become "a single area," a rectangle perhaps 1+ mile long by 30 yards wide.

[4. *With these uncertainties in mind, this estimate will assume workers are exposed to uranium airborne contamination as if the uranium were handled 100% of the uranium contract time.*] -- This treatment is claimant favorable

and should increase external and internal doses (important for later PER).

[5. *A resuspension factor of 1E-5 m-1 was then used*] -- McKeel has discussed the fact in white papers (one on TIB-70 itself at GSI) that a more realistic and claimant favorable value for the resuspension factor would 1 x 10^{-4} per meter squared, as was once advocated by John Mauro of SC&A.

[6. *The ingestion intake was calculated using OCAS-TIB-009*] -- NIOSH resorts automatically to invoking OCAS-TIB-009 to assign uranium ingestion intake values in the absence of measured site data on ingestion. Many GSI workers, as did other steel plant workers, testified they ate their lunches in the plant and in the Betatron buildings. We have company magazine photos of this practice ating lunch on GSI castings. NIOSH has no realistic measured ingestion data for any GSI worker. Thus, it is impossible to state with known certainty the assumptions in TIB-009 have any relationship to GSI reality. Ingestion dose is probably underestimated by the routine uncritical use of TIB-009.

Table 10 – Intake Estimate

Start Date	End Date	Uranium work hrs/yr	Metal handling Inhalation (dpm/day)	Resuspension inhalation (dpm/day)	Total inhalation (dpm/day)	Ingestion (dpm/day)
10/1/1952	12/31/1957	437.5	99.80	14.41	114.22	15.45
1/1/1958	12/31/1958	366.7	83.64	14.41	98.06	15.45
1/1/1959	12/31/1959	337.5	76.99	14.41	91.40	15.45
1/1/1960	12/31/1960	337.5	76.99	14.41	91.40	15.45
1/1/1961	12/31/1961	387.5	88.40	14.41	102.81	15.45
1/1/1962	12/31/1962	281.3	64.16	14.41	78.57	15.45
1/1/1963	12/31/1963	76.6	17.47	14.41	31.88	15.45
1/1/1964	12/31/1964	28.1	6.42	14.41	20.83	15.45
1/1/1965	12/31/1965	20.5	4.67	14.41	19.09	15.45
1/1/1966	6/30/1966	6.4	1.47	14.41	15.88	15.45

BB.6 Residual Contamination

After uranium operations ended at GSI, uranium contamination may have been left behind on surfaces. This residual contamination would cause external and internal doses to be received by workers even after the uranium work ended. In 1989 the old betatron building was surveyed to check for residual contamination (ORNL 1990). Later the new betatron building was surveyed and in 1993, a short decontamination effort removed any detectable contamination (DOE 1994). A residual contamination period for GSI is designated from 7/1/1966 to 12/31/1993 (DOE web site).

MCKEEL COMMENT to BB.5.4 Residual Contamination (part 1, page 20): Mr. Allen and the TBD-6000 WG all have referred to December 31, *1992* rather than 1993 as being the end of the GSI residual contamination period. Those WG and full Board transcripts that contain the "1992 error" need to be corrected. December 31, 1993 is the correct date when DOE completed its Old

Betatron building cleanup work.

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The internal dose estimate for the operational period included inhalation and ingestion intakes from surface contamination. With no indication of a decontamination effort or a cleanup, it is assumed that these levels of inhalation and ingestion continued into the residual period. This level is assumed from 7/1/1966 to 12/31/1967. After that, [**1. the level is assumed to decrease at a rate of 0.00067 per day in accordance with ORAUT-OTIB-0070**]. The calculated values by year are included in Table 11.

Using contamination levels derived in section BB.5.4 and the conversation factor contained in Battelle-TBD-6000, an annual photon and beta dose can be calculated to be 0.173 mR/yr and 16.7 mrad/yr respectively. However, a 1989 survey of the old betatron also included a dose rate survey of the building. [**2. While most measurements were consistent with background levels of radiation, a vacuum cleaner in one corner measured 90 uR/hr on contact. This represents a radiation dose higher than that from the surface contamination levels calculated above.**] It is possible some uranium was vacuumed and thus concentrated in this localized area causing a localized dose rate higher than what would be expected if the contamination were distributed. Also, in that scenario, the depletion factor from ORAUT-OTIB-0070 would not be applicable. In order to account for this possibility, this estimate assumes [**3. someone is in contact with this vacuum cleaner for 3250 hours per year, resulting in an annual dose of 292.5 mR**]. This value will be assigned to each year of exposure during the residual contamination period as a constant distribution. The energy should be assumed to be 50% greater than 250 keV and 50% 30 to 250 keV. Since in this scenario [**4. the vacuum cleaner would stop beta particles the beta dose rate is considered zero in the residual period**]. It should be noted that this dose is more favorable than the combined photon and beta dose calculated from a distributed source.

[**5. Since both internal and external estimates are based on bounding scenarios, doses calculated will be entered into IREP as a constant**].

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Table 11 – Residual Period Dose Estimate

Start Date	End Date	Inhalation (dpm/day)	Ingestion (dpm/day)	External Photon (mR/yr)
7/1/1966	12/31/1967	14.41	15.88	292.5
1/1/1968	12/31/1968	11.29	12.43	292.5
1/1/1969	12/31/1969	8.84	9.74	292.5
1/1/1970	12/31/1970	6.92	7.62	292.5
1/1/1971	12/31/1971	5.42	5.97	292.5
1/1/1972	12/31/1972	4.24	4.68	292.5
1/1/1973	12/31/1973	3.32	3.66	292.5
1/1/1974	12/31/1974	2.60	2.87	292.5
1/1/1975	12/31/1975	2.04	2.24	292.5
1/1/1976	12/31/1976	1.60	1.76	292.5
1/1/1977	12/31/1977	1.25	1.38	292.5
1/1/1978	12/31/1978	0.98	1.08	292.5
1/1/1979	12/31/1979	0.77	0.84	292.5
1/1/1980	12/31/1980	0.60	0.66	292.5
1/1/1981	12/31/1981	0.47	0.52	292.5
1/1/1982	12/31/1982	0.37	0.41	292.5
1/1/1983	12/31/1983	0.29	0.32	292.5
1/1/1984	12/31/1984	0.23	0.25	292.5
1/1/1985	12/31/1985	0.18	0.19	292.5
1/1/1986	12/31/1986	0.14	0.15	292.5
1/1/1987	12/31/1987	0.11	0.12	292.5
1/1/1988	12/31/1988	0.08	0.09	292.5
1/1/1989	12/31/1989	0.07	0.07	292.5
1/1/1990	12/31/1990	0.05	0.06	292.5
1/1/1991	12/31/1991	0.04	0.04	292.5
1/1/1992	12/31/1992	0.03	0.04	292.5
1/1/1993	12/31/1993	0.02	0.03	292.5

MCKEEL COMMENT to BB.6 Residual Contamination:

[1. *the level is assumed to decrease at a rate of 0.00067 per day in accordance with ORAUT-OTIB-0070*] -- McKeel wrote and submitted to Docket 140 and the TBD-6000 WG a detailed analysis of why simple exponential or linear residual contamination decay functions in TIB-70 do not apply realistically (or validly) to the situation at GSI. The GSI site expert team provided voluminous evidence to the TBD-6000 WG to document that multiple steel companies conducted operations involved in steel making (such as pickling in acid) at GSI after castings operations ceased in 1973 up until the DOE cleanup of uranium in the Old Betatron Building in 1993. Each new business cycle caused resuspension and settling of U-238 dust all along the uranium transport pathway. TIB-70 does not model this repetitive cycling of uranium dust with variable peaks and valleys over the 20 year residual period. NIOSH chose to ignore all of McKeel's input on TIB-70 not being applicable at GSI.

[2. *While most measurements were consistent with background levels of radiation, a vacuum cleaner in one corner measured 90 uR/hr on contact. This represents a radiation dose higher than that from the surface contamination*

***levels calculated above*.] -- The GSI site expert's opinions on the significance of the residual high uranium dust levels in the vacuum cleaner in the OBB have been discussed and presented in McKeel white papers. There were several far larger industrial sweepers in use at GSI in the plant and in the Betatron buildings. Betatron workers testified there were often inches of uranium laden dust on the floors. We believe the amount of uranium in the small vacuum cleaner was representative of nothing other than the fact that uranium was indeed present at some time in the Betatron building, a known fact not dependent on the presence of a tiny industrial vacuum. It is very likely the average Betatron and transport pathway uranium dust levels over the 20 year residual contamination period were far higher than in the small industrial vacuuum cleaner. DOE only made cleanups of uranium dust in the Old Betatron Building over 1 week in 1993. DOE never made a radiological survey of the remainder of the Uranium transport path. By 1993, the New Betatron had been extensively power washed and repurposed as classrooms.**

[3. *someone is in contact with this vacuum cleaner for 3250 hours per year, resulting in an annual dose of 292.5 mR*] -- As analyzed in comment 2 of this section, the GSI site expert team believes use of the uranium concentration in the small vacuum at the end of the residual period is spurious, an underestimate that is claimant adverse, not claimant favorable.

[4. *the vacuum cleaner would stop beta particles the beta dose rate is considered zero in the residual period*] -- What does "stop beta particles" mean? Does it mean "end the passage of," or "act as a barrier to," or some different meaning? Allen needs to clarify this point in the text.

[5. *Since both internal and external estimates are based on bounding scenarios, doses calculated will be entered into IREP as a constant*] -- The meaning of "bounding scenarios" is unclear. Bounding scenario is an arbitrary construct not included in the EEOICPA Act. The standard is both internal and external radiations doses need to be determined "<u>for all workers for all types of cancer with sufficient accuracy</u>." It is not clear to the SINEW GSI site expert team that NIOSH has met this test. Also, what does "as a constant" mean - constant dose?

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<u>MCKEEL PRELIMINARY COMMENT ABOUT REFERENCES</u>: I have added numbers to Dave Allen's References to facilitate my commentary about individual citations at the end of this section.

BB.7 References

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<u>MCKEEL COMMENTS to the References</u>:

- ***References 1, 2 and 9*** **are from McKeel FOIA NRC 2010-0012 and should be so referenced.**
- ***Reference 4*** **should include this in Docket 140.**
- ***References 5 and 6*** **are <u>incomplete</u>: where are they published? Are they FUSRAP documents, and, if so, what are the document numbers, and what are the URL hyperlinks to retrieve them from a particular database?**
- ***References 10 through 19*****: These references are <u>very incomplete and inadequate</u>. Where can they be found? Are they referenced in SRDB? Is there a**

URL link to them? What is the contract number under which they were obtained? What is their source?
• *Reference 20*: Where can these MCW purchase orders be found? Are they FUSRAP records, and, if so, what is their number and URL linkage? Do they have SRDB numbers?
• *Reference 21*: What is the URL link to download this document?
***Reference 25*: This is an inexact and incomplete reference for the Putzier effect. It is a long book, and thus the page/s on which the Putzier effect is described should be given. It will otherwise be impossible for persons to find this specific reference. And is it true the effect is not also described in a peer-reviewed journal paper? What is that reference if it exists?**
***References 26 through 30*: Where are the URL links to access these 5 papers?**

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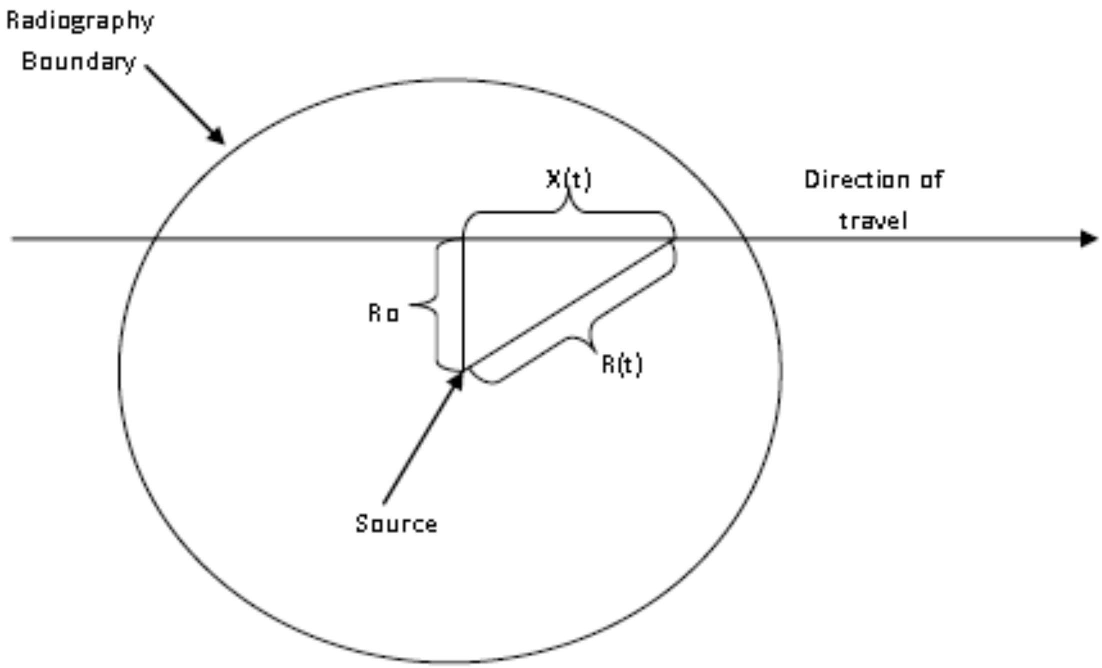
ATTACHMENT A – Dose Estimate for Walking Through Radiography Area



A picture of a circle designating boundary area. Line dissecting the circle represents the path of travel.

The dose received by an individual walking through a radiography area can be calculated using the diagram provided above. The source is represented by the center of the circle while the circle represents the delineated boundary of the radiography area. The horizontal arrow represents the path taken by the individual through the delineated area. The closest distance the person come to the source is indicated as Ro and the distance from the source at any time t is R(t).

The distance between the individual and the source can then be expressed as:

R2(t) = Ro2 + X2(t)

Or

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DR(t) = DRo * Ro2 / (Ro2 + V2*t2)

The dose received by walking through the area is then:

Dose = 2 Dose rate at the closest point of travel times the distance at the closest point squared divided by the distance at the closest point squared plus the velocity of travel squared times time squared. The entire term is integrated from time 0 to time t then multiplied by 2 to equal the dose.
With t = 0 at the time the person is closest to the source and t = t when the boundary of the radiography area is reached.
This equation can be approximated as:

Dose is equal to 2 times the dose rate at the closest point of travel times distance squared divided by the square root of the distance squared times the velocity squared. The entire term is multiplied by the arc tangent of time times the square root of the distance squared times the velocity squared divided by the distance squared.

The time t required to walk through the area varies as Ro changes. That is, it depends whether the person is walking through the middle of the area or cutting through the outer edge. Since DRo is the dose rate at the closest point, this too varies as Ro changes. The equations for both are:

Time is equal to the square root of R prime squared times minus the distance at the closest point squared all divided by velocity.

The dose rate at the closest distance is equal to the dose rate at one foot divided by the distance at the closest point squared all times 3600 seconds per hour.

Where R' is the radius of the delineated area and DR' is the dose rate at 1 foot from the source.

Substituting these two equations into the equation for dose and simplifying yields:

Dose is equal to 2 times the dose rate at one foot divided by the square root of the distance squared times the velocity squared. The entire term is multiplied by the arc tangent of the square root of 1 foot squared minus the distance at the closest point squared all divided by the distance.

MCKEEL FOOTNOTE: The text conversion software has converted formulaic representation of the original Allen AppBBr1 paper into plain text language.

<u>MCKEEL COMMENT to Attachment A</u>: The phrase at issue is: "*delineated*

boundary of the radiography area." **Paul Sinn of St. Louis Testing Company provided subsequent testimony to John Ramspott and Dan McKeel during 2013 that indicated there was a more rigid inner boundary, mandated by the AEC/NRC, where the dose from NDT gamma sources such as Ir-192 might reach or exceed 100 mRem/hr. That boundary also needed to be marked by tape. Radiographic NDT service contractors such as St. Louis Testing Company had to maintain guards constantly at the 100 mR/hr inner zone. This new information was passed along to NIOSH and the TBD-6000 WG and was incorporated into McKeel's 53 GSI white papers.**

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ATTACHMENT B – Surrogate Air Data for Handling Uranium Metal

Battelle-TBD-6000 contains an analysis of surrogate air sample data for a number of common tasks associated with uranium metal. One task not covered is the handling and movement of cold uranium metal. To fill this void, NIOSH reviewed air sample data for a number of sites and combined them into this analysis.

Most active manipulation of uranium metal requires the metal to be heated. Typically uranium in these processes is heated to well over 1000 degrees Fahrenheit. At these high temperatures, the uranium metal oxidizes readily forming a loose oxide layer that can easily create airborne contamination. An exception to heating uranium metal during operations is machining. When uranium metal is machined or cut, it is not normally preheated. Rather, the area being cut is cooled with machine oil, water or some other coolant. This not only reduces the release of airborne activity, but also cools the metal to prevent fuming.

In all cases, however, the metal is moved by various means to the furnace or equipment prior to working. The movement of cold uranium metal presents such a low potential for airborne uranium that very few air samples were ever taken. Those that were, are often taken while other operations are also occurring causing the air in the vicinity to be contaminated by the nearby operations. Therefore, samples intended to be representative of the operation at GSI must consider not only the type of operation but the potential interferences in the vicinity.

The data set used in listed in Table B.1. The samples include data collected at several facilities and cover operations involving three forms of uranium metal: slugs, billets and dingots.

Slugs were typically 8 inches long and approximately 1 inch diameter weighing approximately 4 pounds. They were intended to be used as fuel in plutonium production reactors. Operations associated with the selected samples primarily involved moving slugs into or out of a container.

A billet is a generic metallurgical term used to describe a semi-finished piece of metal. In uranium fuel fabrication, it is a piece of uranium metal that was originally cast into an ingot and rolled into a smaller dimension using a blooming mill. The billet would later be further rolled to a finished product using a rolling mill. The billets associated with the data found for this report were approximately 7 inches in diameter and 20 inches long. This would result in a billet weighing approximately 525 pounds.

A dingot (direct ingot) is a term used at Mallinckrodt to describe an ingot made directly from the metal reduction process. The alternative procedure was to remelt several derbies and cast them into ingots. The dingot is approximately 18 inches in diameter and 18 inches long weighing approximately 3300 pounds.

Figure 1 graphically depicts the average airborne value associated with handling each form of uranium found in Table B.1.

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Figure B.1 – Average Airborne Activity while Handling Cold Metal (dpm/m^3)

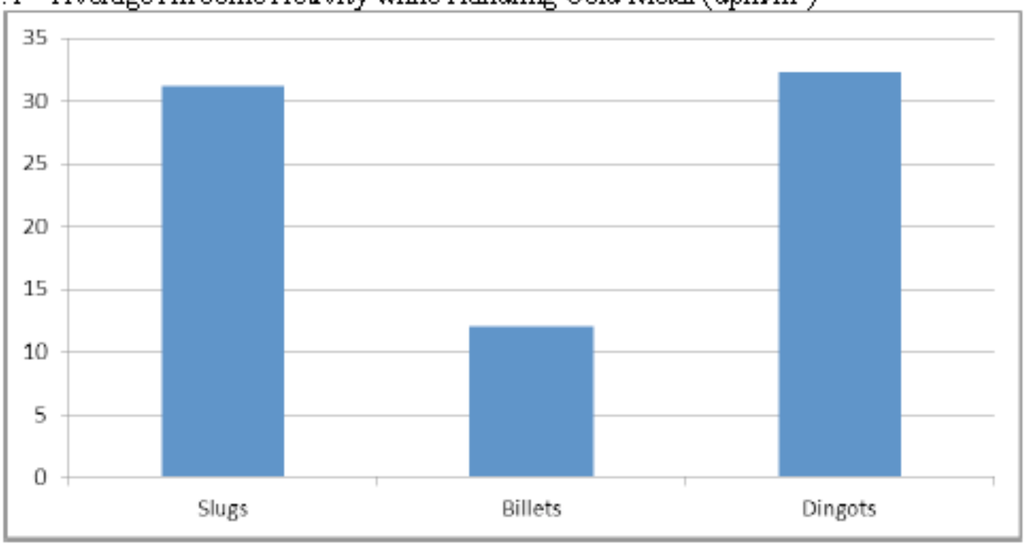

Figure B.1 – Average Airborne Activity while Handling Cold Metal (dpm/m3)
Graph showing average airborne activity from handling slugs, billets and dingots

The figure is arranged from left to right by the weight associated with each form of metal. No specific pattern can be seen that would indicate one form of metal creates higher airborne activity than another. Based on the data reviewed, however, the levels of airborne activity are relatively low and can be represented by a fairly consistent quantity regardless of the form of the metal. Therefore, to establish the range of exposures associated with the movement of cold uranium metal, all the data in Table B.1 were combined into a single distribution of airborne activity.

Table B.1 contains the results for the samples utilized in this report. The attachment includes the Site Research Database document number and page number where the sample was located. It also includes the site from which the samples were collected as well as the type of metal and the date the sample was collected. A few of the values are listed as "nd" which represents a "none detectable" sample.

The samples were analyzed assuming they can be represented as a lognormal distribution. The resulting distribution has a geometric mean of 17.5 dpm/m3 with a geometric standard deviation of 2.29. This distribution results in a 95th percentile value of 68.7 dpm/m3. This is the value NIOSH intends to use for the assessment of inhalation exposure to uranium at GSI.

[Page 38 of 38]

Table B.1 – Airborne Activity Samples

SRDB#	Pg#	Activity (dpm/m^3)	Site	type	Date
10634	11	9	Leblond	billets	8/22/1961
10634	11	Nd	Leblond	billets	8/22/1961
10634	11	Nd	Leblond	billets	8/22/1961
10634	11	15	Leblond	billets	8/22/1961
10634	11	Nd	Leblond	billets	8/22/1961
10634	11	Nd	Leblond	billets	8/22/1961
98533	129	53	Tocco	slugs	2/16/1968
98533	129	22	Tocco	slugs	2/16/1968
98533	124	9.44(1)	Tocco	slugs	6/6/1968
98533	124	69.83(1)	Tocco	slugs	6/6/1968
98533	124	9.44(1)	Tocco	slugs	6/6/1968
98533	124	45.3(1)	Tocco	slugs	6/6/1968
98533	124	Nd	Tocco	slugs	6/6/1968
98533	124	35.86(1)	Tocco	slugs	6/6/1968
12363	78	24	Weldon Spring	dingots	11/14/1960
12363	78	21	Weldon Spring	dingots	11/14/1960
12363	22	66.6 (2)(3)	Weldon Spring	dingots	7/26/1961
12363	22	46.62 (2)(3)	Weldon Spring	dingots	7/26/1961
14956	4	25	Weldon Spring	slugs	3/30/1960
14956	4	25	Weldon Spring	slugs	3/30/1960
14956	4	25	Weldon Spring	slugs	3/30/1960
14956	4	23	Weldon Spring	slugs	3/30/1960
17254	6	11.8	Weldon Spring	dingots	12/10/1956
17254	6	Nd	Weldon Spring	dingots	12/10/1956
17254	6	23.7	Weldon Spring	dingots	12/10/1956

(1) Actual values for depleted uranium increased by a factor of 1.887 to adjust to normal uranium equivalent
(2) Values listed as maximum, minimum used as two different samples
(3) Values back calculated using conversion factors at the bottom of summary report

MCKEEL COMMENT TO ATTACHMENT B: These data were the subject of extensive discussion at TBD-6000 WG meetings. Once again, AppBBr1 ignores McKeel's main objections to the use of this specific surrogate data: (a) GSI did not work with uranium slugs, hence the slug facilities are *per se* not similar and thus do not meet Board surrogate data criteria; (b) much higher air concentrations of uranium were documented in Adley 1952 (Hanford melt

plant) among the crews that unloaded railroad cars. The airborne concentrations were so high that some workers had to be placed on short shifts to avoid exceeding permissible uranium intake exposure limits. Mr. Allen ignores these discussions and McKeel's white paper on the Adley 1952.

MCKEEL SUMMARY COMMENT ON THE ENTIRE GSI APPENDIX BB REV 1 DOCUMENT

• **Following the release of Appendix BB Rev 0 in June 2007 Dan McKeel, who would later assume the role of GSI SEC-00105 co-petitioner, and GSI site expert John Ramspott, filed separate strongly critical analyses of this scientifically flawed 13 page TBD document**. NIOSH promptly posted rebuttals to both the McKeel and Ramspott critiques. Basically, NIOSH defended everything in that initial document, admitting nothing and declining to alter anything. This was despite the fact that (a) neutron dose from the Betatrons was not addressed, (b) several radiation source doses were not bounded, and (c) there was no individual or site monitoring data known to NIOSH and no measured data at all in the literature for actual operating Betatrons at the time Appendix BB Rev 0 was released. McKeel also argued that Appendix BB Rev 0, as first drafted, was so scientifically flawed it should not be released or used for dose reconstructions without immediate revisions. Again, NIOSH ignored this advice. By now, in July 2014, seven years later, all completed GSI DRs except for 4 covered in PER-24, have been completed using AppBBr0 dated June 2007 without any interim revisions having been made.

• **In these early days—2005 through early 2008—McKeel argued forcefully that GSI deserved an 83.14 self-initiated SEC.** The fact that Battelle-NIOSH had completed only a handful of individual GSI dose constructions by early 2007, despite there being hundreds of claims and cases, supported the contention that NIOSH was unable to complete DRs in a timely way and the site merited an 83.14 SEC. However, for reasons still not clear, NIOSH avoided making this well deserved site declaration.

• **In January 2007, after months of negotiations he initiated with RS Landauer film badge company, Dan McKeel obtained year end film badge reports on a subset of GSI radiographers who had Landauer weekly film badge (FB) data referred to as *Program 2084*.** The GSI FB data started in 1964 and ended with 1973 data. NIOSH contracted with Landauer (a PA-cleared version of the contract was never released) and obtained a more complete weekly GSI FB dataset (see References 9-19 on page 68 of this document) in March 2008.

The need for NIOSH to incorporate Landauer FB data into new NIOSH dose reconstruction methods was the primary basis for David Allen's Path Forward for GSI white paper in late 2010. Dan McKeel observed the need for such a paper was persuasive evidence that NIOSH could not reconstruct GSI external and internal doses with sufficient accuracy.

In 2012, NIOSH, with concurrence of the TBD-6000 WG Board members and SC&A, decided that the relatively higher (10-fold greater) external doses assigned to GSI Betatron and isotope radiographers compared to other workers in AppBBr0 in 2007 should be sharply reduced by approximately 9-fold. This was done primarily because of the availability of Landauer FB data for this tiny subset of 109 out of 3000 to 5000 GSI workers. McKeel highlighted this striking reversal of external dose radiographer and other worker external dosimetry data between 2008 and 2012 in his March 15, 2012, Powerpoint presentation to the TBD-6000 WG. McKeel stated this discrepancy was not scientifically defensible. The agreement between models over time and between NIOSH and SC&A did not meet the usual standards: (a) ± 10 to 20% agreement of measured data, (b) NIOSH did not have any measured Betatron photon, electron or neutron data and rejected NYO-4699 to validate the MCNPX or Attila (2008) Betatron models, and (c) NIOSH and SC&A could not reproduce each other's modeled data closer than 200%. The 2008 Betatron modeled doses by NIOSH (1.0-6.3 R/yr) and SC&A (12.4-13.6 R/yr) varied by much more than this.

- **AppBBr1 is replete with uses of GSI film badge data and has 11 out of 31 total references devoted to these records**. The crucial fact that Allen omits from AppBBr1 is that in 2014, based on Board initiated off the record interactions between the DCAS Director (Stuart Hinnefeld) and a senior vice president of RS Landauer (Craig Yoder), NIOSH decided to abandon use of GSI program #2084 film badge data altogether. Instead, in a 12/19/13 memo written by Dr. James Neton of DCAS at the direction of Stuart Hinnefeld, NIOSH would "adopt SC&A's method." The Neton memo did not spell out what this referred to "SC&A method" actually was. The Neton memo was first transmitted to the TBD-6000 WG members and to Dr. Bob Anigstein of SC&A to insert into the December 2013 GSI issues matrix.

Dan McKeel learned about this key memo at a TBD-6000 WG meeting and had to ask for a personal copy. This is but one of many instances where crucial NIOSH documents that were highly relevant to GSI were not provided to McKeel voluntarily as they should have been because of his role as GSI SEC co-petitioner. In the case of the Landauer FB data, McKeel initiated the contact with Landauer and led to NIOSH even being aware of these key data. Professional etiquette and fair play and FACA mandated transparency and document sharing provisions all compel NIOSH to share information and records related to RS Landauer with McKeel.

- **In October 2007** SC&A held a group session to interview GSI radiographers primarily. At this conference, there was **consensus agreement the average GSI work week should be changed from 46 hours per week in AppBBr0 to 65 hours per week in AppBBr1**. This is obviously a major change that will affect assigned doses. The revision in the average work week was not made until AppBBr1 was issued on 6/6/14. McKeel, Ramspott and GSI workers have urged NIOSH to make this simple change in Appendix BB for years.

• **Dave Allen fails to mention in AppBBr1 the key fact that Dan McKeel's FOIA NRC2010-0012 for GSI By-Products materials license documents first revealed the presence of two radium-226 NDT gamma sources at the GSI plant that were used with the fishpole technique through 1962 and perhaps for part of the 1963**. NIOSH at first was under the impression the building 6 radiography room known to be used for cobalt-60 NDT work was built in 1962. A highly detailed 1957 GSI plant engineering drawing obtained by GSI site expert John Ramspott showed definitively the "radiography room" in building 6 existed in 1957. Ramspott re-interviewed GSI workers Dave Woodard and Dan Churovich and obtained affidavits from both that conclusively showed the Building 6 inner radiography room was built in 1955. Thus, all radium NDT work done between 1952 and 1955 was done in the open buildings 5 through 10. These two affidavits cast doubt on the inner building walls being "built out" to 24 inches in 1962 by additional layers of concrete blocks and sand. Workers present in 1962 declared this did not happen.

• **As a general comment, there is a marked discrepancy observed by the SEC petitioners, site experts and workers as to many "facts" recorded on paper that differed from eye witness contemporaneous observations of those "on the ground."** All of the above persons have serious reservations about GSI declarations of radiation safety limits never being exceeded, of an active safety program with yearly written test for radiographers, and of affidavits of certain observers that agree with NIOSH's version of the facts, but which differ from their own observations. Such observations would include the presence and use of a GSI owned Ir-192 source, which is recorded in a 1972 GSI license renewal document in the NRC FOIA 2010-0012 dataset (see Exhibit 1). Numerous GSI radiographers testified they used an 80 curie Co-60 source at GSI between 1964-1966. NIOSH accepts the GSI license data that shows an 80 curie Co-60 source was licensed by the AEC in 1968. Several of those who testified using the 80 Ci source left GSI before 1968.

MCKEEL EXHIBIT 1: GSI By-Product Materials License 12-08271-01, Amendment No. 08, March 15, 1972 application, pages 1 and 2 of 2, Page 2 with NRC FOIA document URL: ML093480290 available on the NRC ADAMS website. PAGES 78-80.

MCKEEL EXHIBIT 2: A listing of Daniel W. McKeel, Jr., MD Docket 140 GSI white paper publications. From GSI SEC-00105 admininstrative review pages 81-87.

Respectfully submitted,

Daniel W. McKeel, Jr., MD **July 15, 2014**

Cofounder SINEW
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Mail: PO Box 15/#7 CR301A,
Van Buren, MO 63965-0015

EXHIBIT 1

GENERAL STEEL INDUSTRIES
AEC License 12-08271-01
Amendment No. 08
March 15, 1972

EXHIBIT 1

ML093480290_GSI_Ir192_1972.pdf

Find

EC-374A
(5)
CFR 30

U. S. ATOMIC ENERGY COMMISSIO''
BYPRODUCT MATERIAL LICENSL
Supplementary Sheet

Page 2 of 2 Pages

License Number 12-08271-01

Amendment No. 08

CONDITIONS

(continued)

12. The licensee is authorized to receive, possess, and use sealed sources of Iridium 192 or Cobalt 60 where the radioactivity exceeds the maximum amount of radioactivity specified in Item 8 of this license provided:

   A. Such possession does not exceed the quantity per source specified in Item 8 by more than 20% for Iridium 192 or 10% for Cobalt 60;

   B. Records of the licensee show that no more than the maximum amount of radioactivity per source specified in Item 8 of the license was ordered from the supplier or transferor of the byproduct material; and

   C. The levels of radiation for radiographic exposure devices and storage containers do not exceed those specified in Section 34.21, 10 CFR 34.

13. Except as specifically provided otherwise by this license, the licensee shall possess and use byproduct material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in application dated March 15, 1972, as amended May 19, 1972, and July 17, 1972.

EXHIBIT 1

AEC-374 (6) 3 30

U. S. ATOMIC ENERGY COMMISSION
BYPRODUCT MATERIAL LICENSE

License No. 12-08271-01
Page 1 of 2 Pages
Amendment No. 08

Pursuant to the Atomic Energy Act of 1954 and Title 10, Code of Federal Regulations, Chapter 1, Parts 30, 32, 33, 34, and 35, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, own, possess, transfer and import byproduct material listed below; and to use such byproduct material for the purpose(s) and at the place(s) designated below. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, and is subject to all applicable rules, regulations, and orders of the Atomic Energy Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. General Steel Industries, Inc.	In accordance with application dated March 15, 1972,
2. 1417 State Street Granite City, Illinois 62040	3. License number 12-08271-01 is amended in its entirety to read as follows:
	4. Expiration date July 31, 1977
	5. Reference No.

6. Byproduct material (element and mass number)	7. Chemical and/or physical form	8. Maximum amount of radioactivity which licensee may possess at any one time
A. Cobalt 60	A. Budd Company Model 41706 Sealed Sources	A. No single source to exceed 1 curie
B. Cobalt 60	B. Radionics Model P60-100 Sealed Sources	B. No single source to exceed 80 curies

9. Authorized use

A. For use in Budd Company Model 110 AB exposure devices for industrial radiography.
B. For use in Radionics Model P60-100-2 exposure devices for industrial radiography.

CONDITIONS

10. Byproduct material shall be used only at the licensee's address stated in Item 2 above.

11. The licensee shall comply with the provisions of Title 10, Chapter 1, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation," and Part 34, "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations."

A133

EXHIBIT 1

EC-374A
(8)
CFR 30

U. S. ATOMIC ENERGY COMMISSION
BYPRODUCT MATERIAL LICENSE
Supplementary Sheet

License Number 12-08271-01

Amendment No. 08

CONDITIONS

(continued)

12. The licensee is authorized to receive, possess, and use sealed sources of Iridium 192 or Cobalt 60 where the radioactivity exceeds the maximum amount of radioactivity specified in Item 8 of this license provided:

    A. Such possession does not exceed the quantity per source specified in Item 8 by more than 20% for Iridium 192 or 10% for Cobalt 60;

    B. Records of the licensee show that no more than the maximum amount of radioactivity per source specified in Item 8 of the license was ordered from the supplier or transferor of the byproduct material; and

    C. The levels of radiation for radiographic exposure devices and storage containers do not exceed those specified in Section 34.21, 10 CFR 34.

13. Except as specifically provided otherwise by this license, the licensee shall possess and use byproduct material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in application dated March 15, 1972, as amended May 19, 1972, and July 17, 1972.

For the U. S. Atomic Energy Commission
Original Signed By
Nathan Bassin

Date JUL 28 1972

by Materials Branch
Division of Materials Licensing
Washington, D. C. 20545

NB 7/28/72

1. NB/bm

E

EXHIBIT 2

Daniel W. McKeel, Jr., MD
Excerpt from Comprehensive C.V.

-- ***References 240 - 292*** --
GSI NIOSH Docket 140
McKeel White Papers

-- ***References 293 - 298*** --
NIOSH Ten Year Review
McKeel Comments

-- ***Reference 299*** --
ANWAG Letter to
Health Physics Journal
Vol 96: 187-188, 2009
McKeel first author

237. Comments from Daniel W. McKeel, Jr., M.D., on the Dow Chemical Co. (Madison Site) SEC Petition (NIOSH SEC-00079); July 12, 2010; PDF 1.6 MB (108 pages)

238. Comments from Daniel W. McKeel, Jr., M.D., on the Dow Chemical Co. (Madison Site) SEC Petition (NIOSH SEC-00079); June 13, 2010; PDF 6 MB (27 pages)

239. Comments from Daniel W. McKeel, Jr., M.D., on the Former Dow Chemical, Madison, IL, AWE Facility, Including NIOSH Addendum 2 to the NIOSH SEC-00079 Evaluation; SC&A Review of Addendum 2; Appendix C to TBD-6000 and the SC&A Review of Appendix C; May 11, 2010; PDF 717 KB (15 pages)

Section 8. NIOSH Docket 140 General Steel Industries (GSI)

240. Comments on the Site Profile for Atomic Weapons Employers that Worked Uranium and Thorium Metals document, Appendix BB -- General Steel Industries Critique to NIOSH of Appendix BB to Battelle TBD-6000 for the General Steel Industries SEC AWE Site; PDF 1.1 MB (23 pages)

241. Submission from Daniel W. McKeel, Jr., M.D., Reply to NIOSH/DCAS: Draft White Paper for GSI Appendix BB Review from October 31, 2008; (November 9, 2008); PDF 360 KB (16 pages)

242. Comments from Daniel W. McKeel, Jr., M.D., on the General Steel Industries SEC Petition (NIOSH SEC-00105); (December 12, 2009); PDF 7 MB (10 pages)

242a [Note: The documents mentioned in the above comment can be viewed on the U.S. Nuclear Regulatory Commission Web site.
External Link: http://adamswebsearch2.nrc.gov/idmws/ViewDocBy Accession.asp?AccessionNumber=ML093510887]

243. Comments from Daniel W. McKeel, Jr., M.D., on the General Steel Industries SEC Petition (NIOSH SEC-00105); (February 7, 2011); PDF 2.7 MB (4 pages)

244. Comments from Daniel W. McKeel, Jr., M.D., on the General Steel Industries SEC Petition (NIOSH SEC-00105); (March 12, 2011); PDF 3.5 MB (19 pages)

245. Comments from Daniel W. McKeel, Jr., M.D., on the General Steel Industries SEC Petition (NIOSH SEC-00105); (April 26, 2010); PDF 163 KB (3 pages)

246. Comments from Daniel W. McKeel, Jr., M.D., on the General Steel Industries SEC Petition (NIOSH SEC-00105); (July 22, 2011); PDF 203 KB (4 pages)

247. Comments from Daniel W. McKeel, Jr., M.D., on a new General Steel Industries related 1978 report: OSHA Regulates Betatrons & Accelerators; (September 6, 2011); PDF 97 KB (6 pages)

248. Attachment: Critique of the NIOSH January 2012 White Paper "Dose Estimates For Betatron Operations"; NIOSH Program Area - Radiation Dose Reconstruction - General Steel Industries (GSI) 1/18/14 7:28 AM; **http://www.cdc.gov/niosh/ocas/gsi.html#sec** Page 37 of 41; PDF 4.2 MB (24 pages)

249. Docket 140 (GSI) Submission from Daniel W. McKeel, Jr., M.D., regarding the NIOSH January 2012 White Paper on "Dose Estimates For Betatron Operations;" (February 27, 2012; PDF 2 MB (1 page)

250. Docket 140 General Steel Industries: Addendum 1 and 2; PDF 4.8 MB (37 pages)

251. Docket 140 (GSI) Submission from Daniel W. McKeel, Jr., M.D. (March 11, 2012); PDF 82 KB (1 page)

252. Docket 140 (GSI) Submission from Daniel W. McKeel, Jr., M.D.: presentation to the Advisory Board's Work Group on TBD 6000 on March 15, 2012; (March 17, 2012); PDF 5.3 MB (29 pages)

253. • Attachment 1: Critique of the NIOSH January 2012 White Paper "Dose Estimates For Betatron Operations"; PDF 7 MB (31 pages)

254. • Attachment 2: Docket 140 General Steel Industries - Addendum #1 to 2/28/2012 Submission; PDF 8 MB (36 pages)

255. • Attachment 3: Corrected Concrete Activation Isotopes, SEC Issues 5 and 6 From the David Allen/DCAS October 2010 "Path Forward for GSI" Report; PDF 4 MB (6 pages)

256. • Attachment 4: Memo - E-mail from John Ramspott to DWM 3/22/12 RE: MCNPx code; PDF 858 KB (4 pages)

257. • Attachment 5: Dan McKeel GSI-00105 Co-Petitioner Comments, Part 1, to David Allen Addendum 3 to his January 2012 Betatron Operations White Paper (via e-mail); PDF 9 MB (14 pages)

258. • Attachment 6: Daniel McKeel GSI Co-Petitioner Comments, Part 2: David Allen January 2012 Betatron White Paper, ADDENDUM 3: New Betatron Scenario For Layout Worker Exposures; Interpretation of McKeel-Landauer Program 2084 (GSI) Film Badge Data (March 25, 2012) by Daniel W. McKeel, Jr. PDF 8 MB (12 pages)

259. • Attachment 7: McKeel Petitioner Comments on NIOSH Allen August 2011 and January 2012 Path Forward For GSI White Papers and Addenda to Them; PDF 4 MB (7 pages)

260. • Attachment 8: E-mail from Dan McKeel to Ted Katz - Request to distribute TBD-6000 work group information to full Board; PDF 2 MB (3 pages)

261. Submission from Daniel W. McKeel, Jr., M.D. requesting that technical documents and comments he made between 2/28/12 and 3/28/12 be posted to Docket 140 and sent to the Advisory Board (May 21, 2012); PDF 3 MB (4 pages)

262. Comments from Daniel W. McKeel, Jr., M.D. on SC&A Discussion Paper dated 5/30/12 titled "Update of "Review of 'Site Profiles for Atomic Weapons Employers That Worked Uranium and Thorium Metals - Appendix BB: General Steel Industries" Battelle-TBD-6000, Appendix BB," Occupational Internal Dose; (June 1, 2012); PDF 7 MB (26 pages)

263. Comments from Daniel W. McKeel, Jr., M.D. on SC&A Discussion Paper dated 5/30/12 titled "Update of "Review of 'Site Profiles for Atomic Weapons Employers That Worked Uranium and Thorium Metals - Appendix BB: General Steel Industries" Battelle-TBD-6000, Appendix BB," Occupational Internal Dose; (June 2, 2012); PDF 7 MB (26 pages)

264. Comments from Daniel W. McKeel, Jr., M.D. on David Allen DCAS Memo Dated June 8, 2012 to the TBD-6000 Work Group of the ABRWH in Response to the SC&A Discussion Paper Update on GSI Intake Doses; (June 13, 2012); PDF 439 KB (6 pages)

265. Comments from Daniel W. McKeel, Jr., M.D. regarding the General Steel Industries Special Exposure Cohort Petition-00105; (July 10, 2012); PDF 7 MB (24 pages)

266. Comments from Daniel W. McKeel, Jr., M.D. regarding the General Steel Industries Special Exposure Cohort Petition-00105; (July 26, 2012); PDF 589 KB (14 pages)

267. Comments from Daniel W. McKeel, Jr., M.D. regarding the SC&A Memo: Alternative Model for the Calculation of Uranium Intakes at GSI; (August 5, 2012); PDF 9 MB (28 pages)

268. Comments from Daniel W. McKeel, Jr., M.D. regarding the agenda for the August 28, 2012, Meeting of the Advisory Board's Work Group on TBD 6000; (August 21, 2012); PDF 54 KB (3 pages)

269. • Addendum (August 26, 2012); PDF 1 MB (6 pages)

270. Comments from Daniel W. McKeel, Jr., M.D. regarding NIOSH: Use of Surrogate Data at GSI Response to SC&A Review Dated July 16, 2012; (August 26, 2012); PDF 4 MB (16 pages)

271. Annotated transcribed notes submitted by Daniel W. McKeel, Jr., M.D. from the August 28, 2012, meeting of the Advisory Board's Work Group on TBD-6000; (September 2, 2012); PDF 897 KB (43 pages)

272. Co-Petitioner Daniel W. McKeel, Jr., MD Presentation: General Steel Industries SEC Petition 105; (September 18, 2012); PDF 437 KB (7 pages)

273. Comments from Daniel W. McKeel, Jr., M.D. regarding his presentation at the September 19, 2012, Advisory Board meeting; (September 21, 2012); PDF 3 MB (14 pages)

274. • Addendum 1; (November 10, 2012); PDF 1 MB (4 pages)

275. • Addendum 2; (November 26, 2012); PDF 6 MB (9 pages)

276. Comments from Daniel W. McKeel, Jr., M.D. regarding NIOSH/DCAS: Evaluation of Additional Air Sample Data Applicable to GSI; (November 10, 2012); PDF 4 MB (20 pages)

277. Comments from Daniel W. McKeel, Jr., M.D. regarding GSI betatron testing; (November 19, 2012); PDF 2 MB (13 pages)

278. Comments from Daniel W. McKeel, Jr., M.D. regarding GSI SEC Petition SEC-00105 (December 11, 2012); PDF 1 MB (60 pages)

279. Annotated transcript of notes submitted by Daniel W. McKeel, Jr., M.D. from the February 21, 2013, meeting of the Advisory Board's Work Group on TBD 6000; (March 12, 2013); PDF 2 MB (139 pages)

280. Comments from Daniel W. McKeel, Jr., M.D. regarding new information on a stolen radium plumb bob source at GSI in 1953; (March 12, 2013); PDF 200 KB (6 pages)

281. Comments from Daniel W. McKeel, Jr., M.D. regarding the NIOSH/DCAS White Paper "Issues Raised in February 21, 2013, Work Group Meeting"; (April 5, 2013); PDF 785 KB (24 pages)

282. Submission from Daniel W. McKeel, Jr., M.D., General Steel Industries Radium Era: 1952-1962 New Co-petitioner and Site Expert Information on the Building 6 Inner Radiography Facility; (April 22, 2013); PDF 444 KB (13 pages

283. Submission from Daniel W. McKeel, Jr., M.D., Analysis of GSI Administrative Personnel Dose Estimates; (June 5, 2013); PDF 292 KB (9 pages)

284. Submission from Daniel W. McKeel, Jr., M.D., Analysis of the Adley et. al. 1952 Hanford Melt Plant Technical Report; (June 7, 2013); PDF 782 KB (23 pages)

285. Submission from Daniel W. McKeel, Jr., M.D., Critique of "NIOSH/DCAS White Paper: Square Function Approximation to Estimating Inhalation Intakes"; (June 2013); PDF 396 KB (15 pages)

286. Submission from Daniel W. McKeel, Jr., M.D., "Goals for the TBD-6000 Work Group" (June 21, 2013); PDF 1 MB (17 pages)

287. Submission from Daniel W. McKeel, Jr., M.D., "Annotated Personal Transcript of GSI Portion of TBD-6000 Work Group 6/20/13 Teleconference Meeting"; (June 23, 2013); PDF 1 MB (17 pages)

288. Submission from Daniel W. McKeel, Jr., M.D., "A Review of AEC Report NYO-4699: Accelerator (Including Betatron) Stray Radiation Measurements and Film Badge Data at 23 Sites"; (August 19, 2013); PDF 431 KB (19 pages)

289. Submission from Daniel W. McKeel, Jr., M.D., "Critique of NIOSH's 2013 White Paper: Summary Dose Estimates for GSI; (August 30, 2013); PDF 804 KB (22 pages)

290. • Addendum;
October 7, 2013); PDF 499 KB (13 pages)

291. Submission from Daniel W. McKeel, Jr., M.D., SEC-00105 Co-petitioner: "GSI SEC-00105 Administrative Review application to HHS," dated 4/17/13; (September 19, 2013); PDF 103 KB (184 pages)

292. Submission from Daniel W. McKeel, Jr., M.D., "Evidence that SC&A Uses Measured Data to Validate Co-60 and IR-192 MCNPX Computer Models"; (October 23, 2013); PDF 269 KB (9 pages)

<u>Footnote</u>: *These 53 papers (#240 through 292) total 1126 pages*

<u>Section 9: NIOSH Docket 194 Ten Year Program Review</u>

293. Submission to the docket from McKeel (Southern Illinois Nuclear Workers (SINEW); 5/13/10 [PDF - 77 KB]

294. Submission to the docket from Daniel McKeel (Southern Illinois Nuclear Workers (SINEW)); 6/4/10 [PDF - 13,119 KB]

295. Submission to the docket from McKeel (Southern Illinois Nuclear Workers (SINEW)) – 7/12/10 [PDF - 2.14 MB]

296. Submission to the docket from Daniel McKeel (Southern Illinois Nuclear Workers (SINEW)) – 1/21/11 [PDF - 2173 KB]

297. Submission to the docket from Daniel McKeel (Southern Illinois Nuclear Workers (SINEW)); 3/12/11 [PDF - 13,886 KB]

298.. Submission to the docket from Daniel McKeel (Southern Illinois Nuclear Workers (SINEW)); 7/31/11 [PDF - 2,917 KB]

Section 10: ANWAG Health Physics Journal
2009 Letter on NIOSH Dose Reconstruction Issue

299. McKeel DW, Williams H, Anderson J, Michel J, Barrie T, Barker K, Schwartz R, Merritt M, ANWAG (Alliance of Nuclear Advocacy Worker Groups) members, Letter to the Editor: Health Physics, Vol 96(2):187-188, 2009 [Ref 123 of academic CV]

Section 11: Local, State & U.S. Government Agency
Public Meeting Comments

Missouri Department of Conservation (MDC)

300. Daniel W. McKeel, Jr., MD. Comments on Weldon Spring Site Institutional Controls and Remediation of Busch Wildlife Conservation Area Radioactive Waste, ~2000

Missouri Department of Natural Resources (MDNR)

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