

**RESPONSE TO “BATTELLE-TBD-6000 APPENDIX BB GENERAL STEEL
INDUSTRIES: DOSE ESTIMATES FOR BETATRON OPERATIONS”**

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March 12, 2012

HISTORY OF DCAS AND SC&A STUDIES

Allen, D., and S. Glover. 2007. "Site Profiles for Atomic Weapons Employers That Worked Uranium and Thorium Metals - Appendix BB: General Steel Industries," Battelle-TBD-6000, Appendix BB, Rev. 0. (June 25, 2007)

S. Cohen & Associates (SC&A). 2008. "Review of 'Site Profiles for Atomic Weapons Employers That Worked Uranium and Thorium Metals - Appendix BB: General Steel Industries,' Battelle-TBD-6000, Appendix BB, Rev. 0." (March 17, 2008)

Allen, D., (NIOSH/DCAS). 2012. "Battelle-TBD-6000 Appendix BB General Steel Industries: Dose Estimates for Betatron Operations." (January 2012)

Anigstein, R. and R. H. Olsher. 2012. "Response to 'Battelle-TBD-6000 Appendix BB General Steel Industries: Dose Estimates for Betatron Operations'" (March 12, 2012)



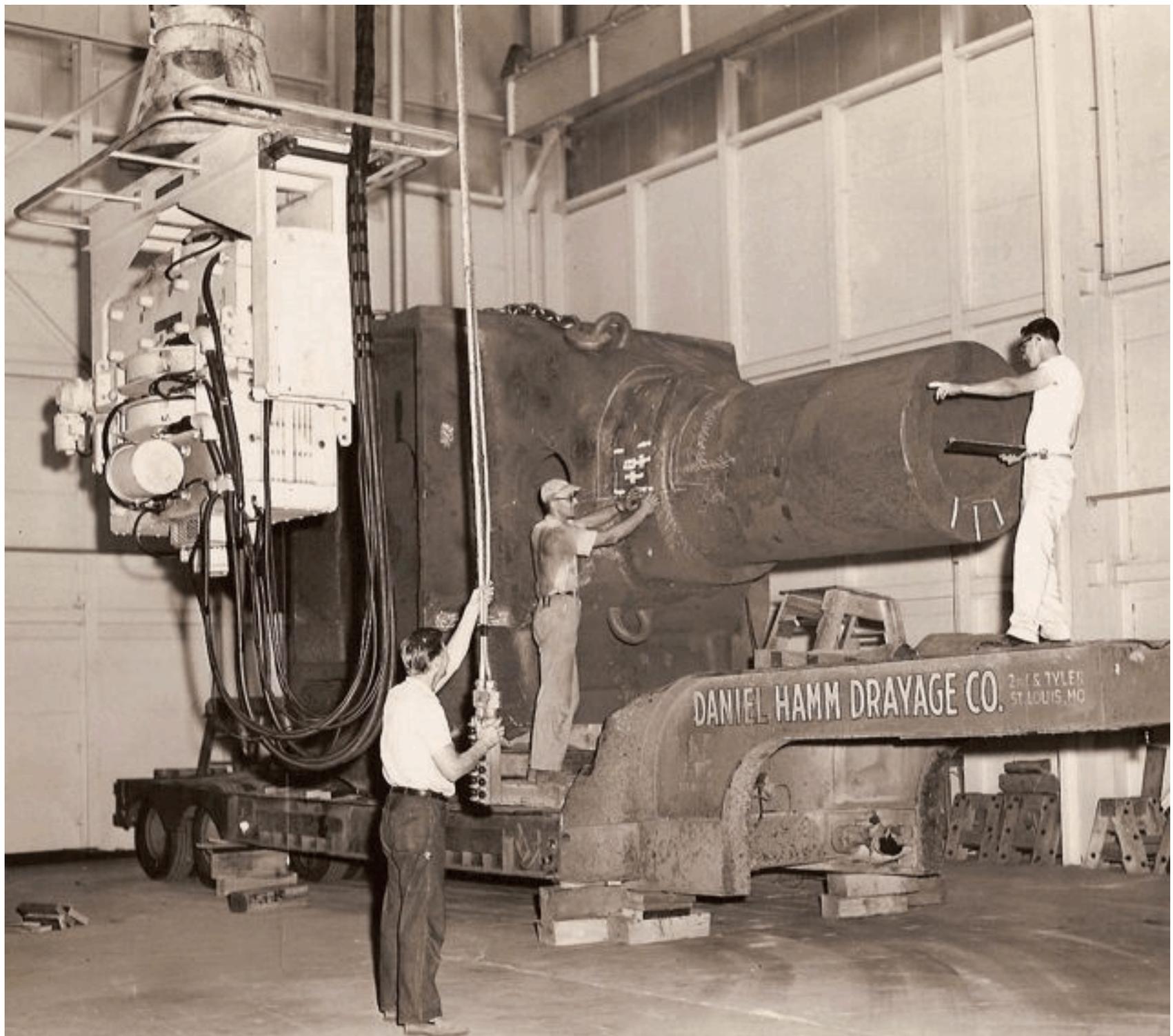
Aerial View of General Steel Castings Division in Granite City



Enlarged Aerial View Showing Two Betatron Buildings



Aerial View of New Betatron Building



Betatron Radiography of the Axle of a Power Shovel Cast at GSI

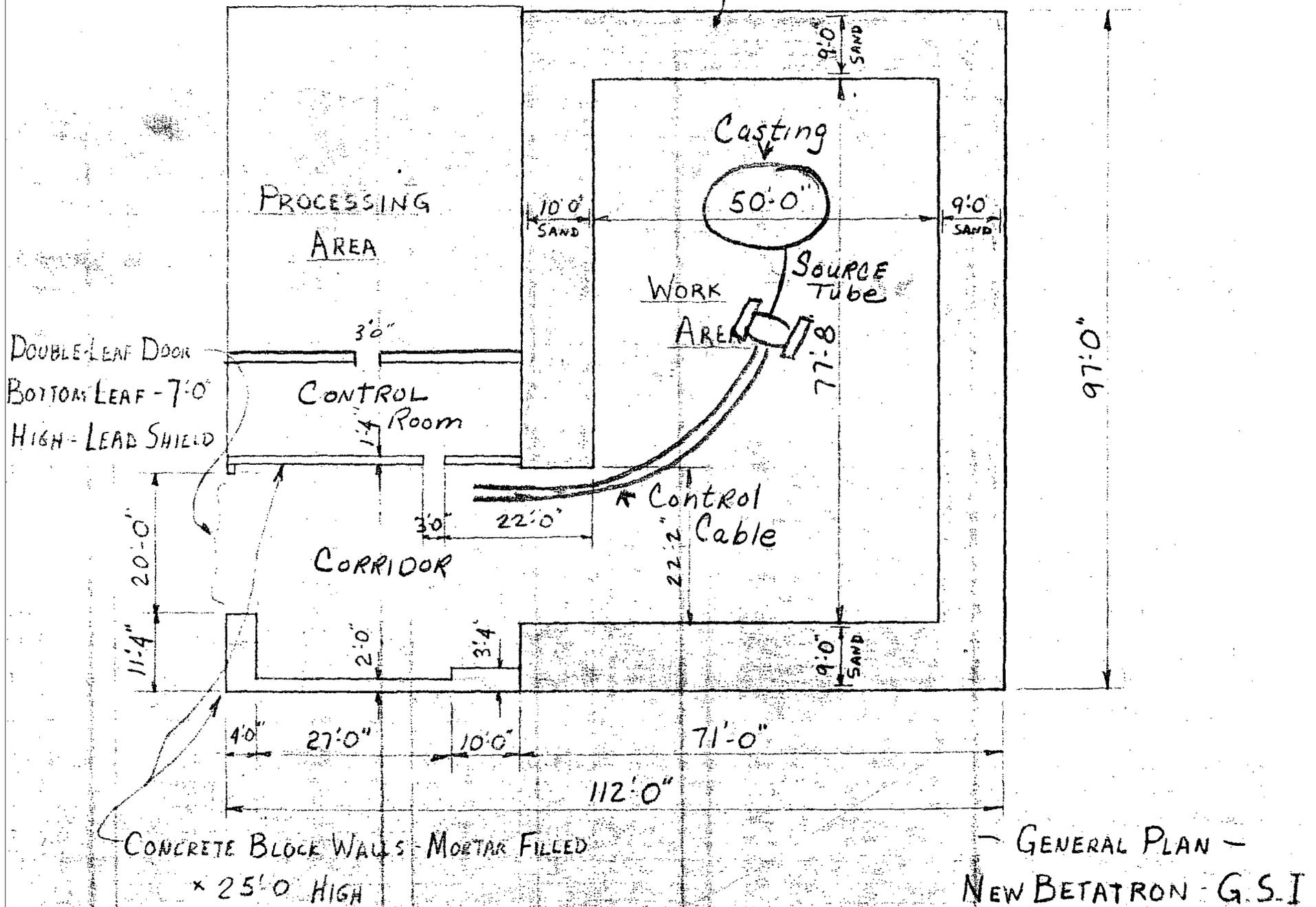
SOURCES OF RADIATION EXPOSURE FROM USE OF BETATRONS AT GSI

- External exposure to direct penetrating radiation from betatron operations
 - Stray radiation during betatron operation: photons and neutrons
 - Residual radiation from activated betatron apparatus (?)
 - Delayed radiation from photoactivated metals
- External exposure of skin to non-penetrating (beta) radiation
 - Natural uranium and photoactivated uranium isotopes
 - Activated steel

OVERVIEW OF SC&A ACTIVITIES ON GSI IN 2012

- Revised MCNPX model of New Betatron Building, using drawings in AEC licensing records
 - Compared to 1971 ^{60}Co survey report: January 29, 1971
 - Revised photon & neutron dose rates from betatron in control room & No. 10 Building
 - Revised neutron doses to betatron operators
 - Revised doses to layout man from all pathways
- Revised 2007-08 MCNPX analyses of photoactivation of uranium and steel due to new developments of MCNPX code
 - Calculated new beta doses to skin activated steel
 - Beta doses from irradiated uranium unchanged
 - Photon doses from photoactivation of steel and uranium unchanged
- Bounding estimate of residual radiation from betatron
- Compared results to NIOSH dose estimates

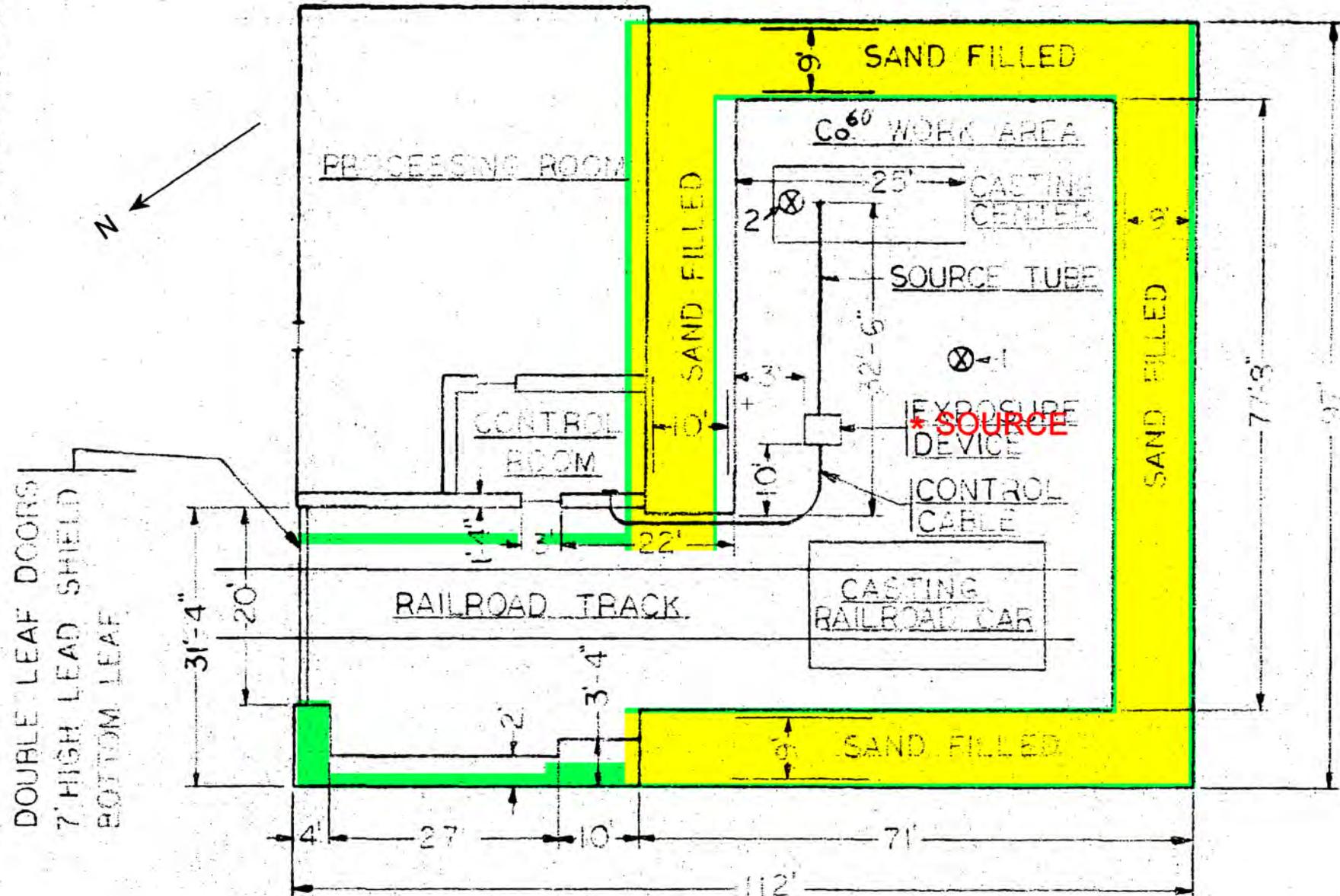
SAND-FILLED WALLS *25'0" HIGH



GENERAL PLAN -
NEW BETATRON - G.S.I

1-10-68

Sketch of New Betatron Building, Showing ^{60}Co Source and Lead-Lined Double-Leaf Door (1-10-68)



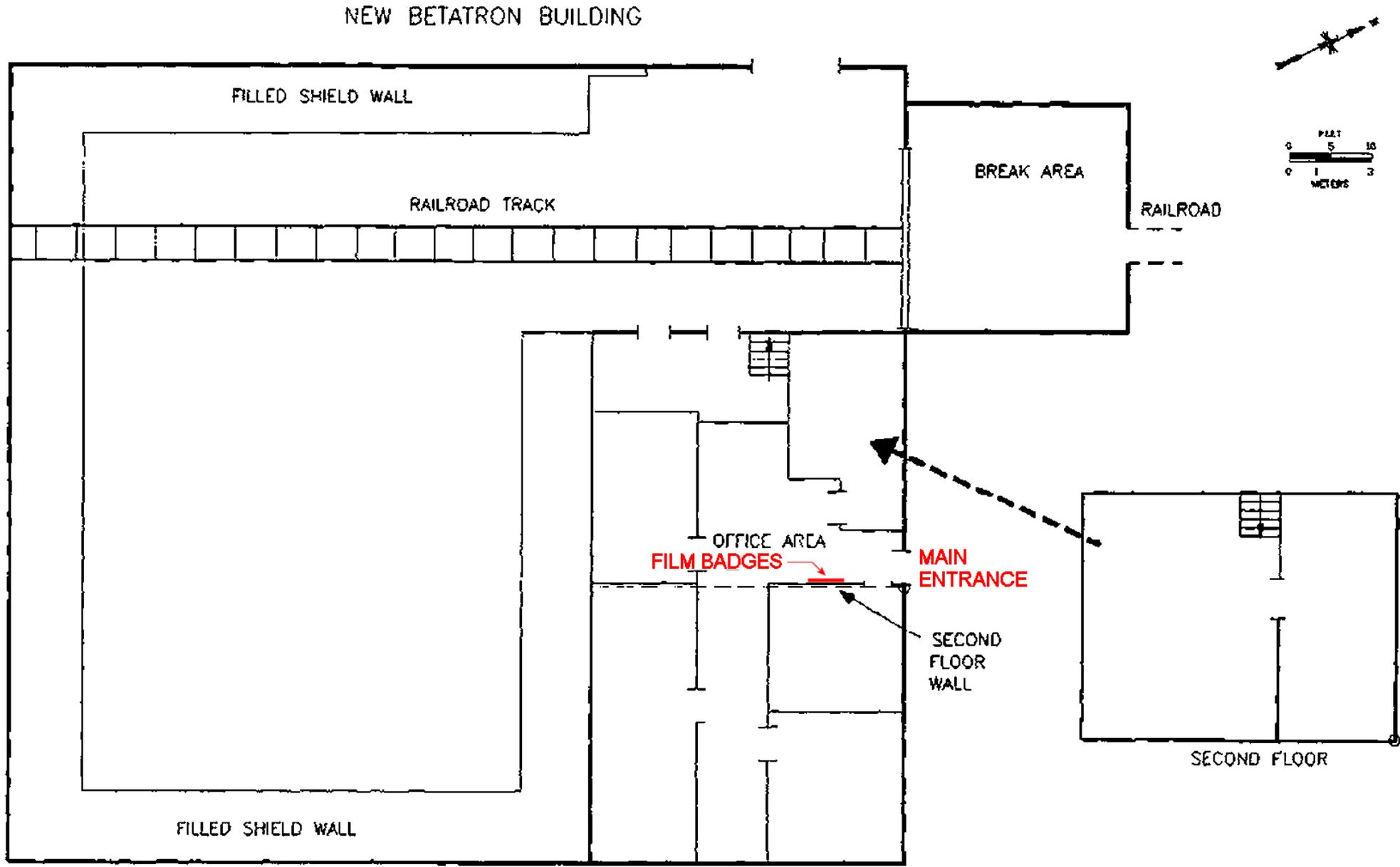
DRAWING NO. 1
80 CURIE SOURCE

G.S.I. BETATRON
CONCRETE BLOCK WALLS
MORTAR FILLED, 25' HIGH

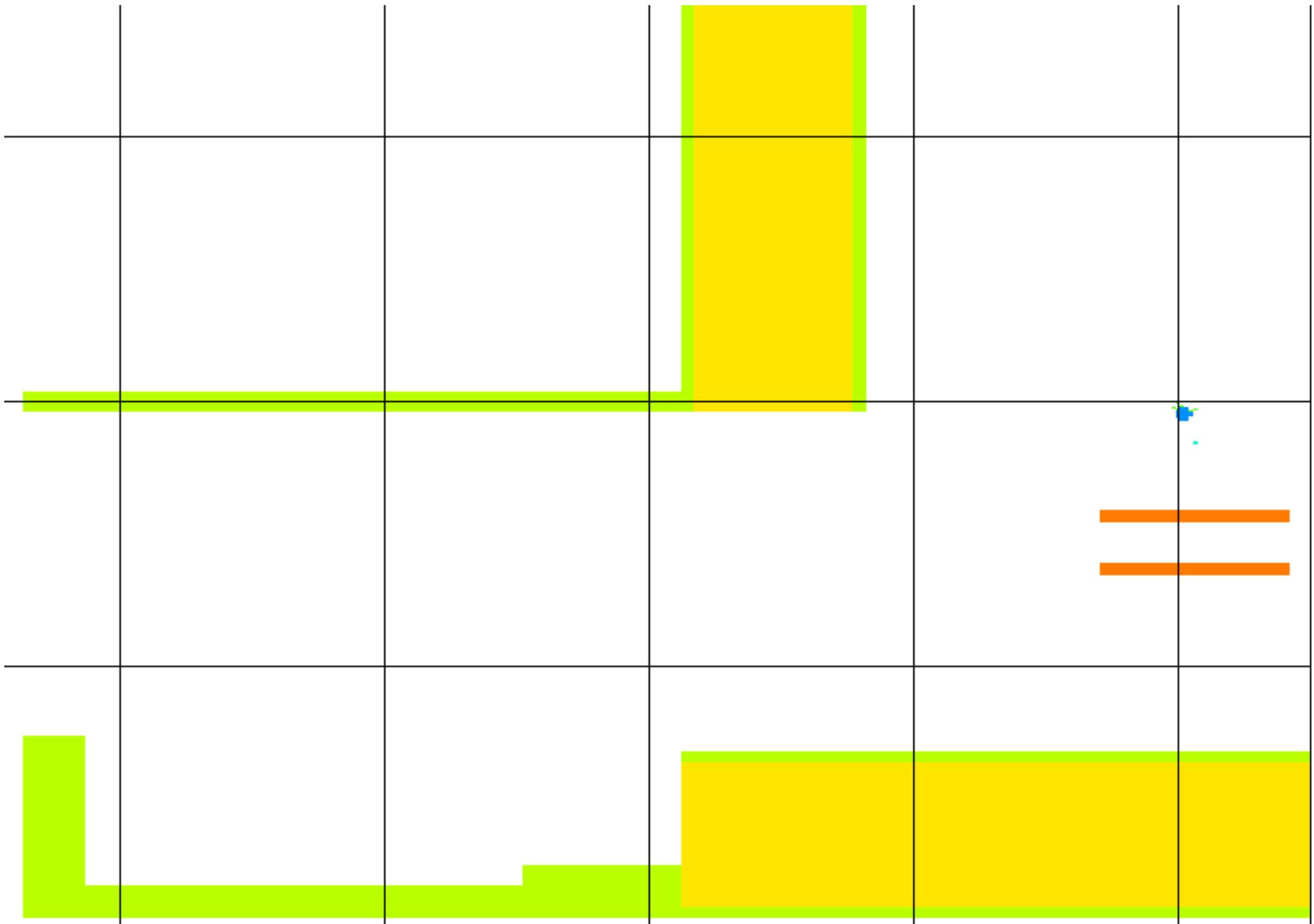
Drawing of New Betatron Building (January 1971) Superimposed Over MCNPX Cross-Section Diagram

ISSUES REGARDING DCAS BETATRON MODEL

- DCAS assumed “Betatron Ctl” film badge kept in control room desk, used to limit betatron shots
 - No information on badge, assumption not claimant favorable
- DCAS assumed film badges of off-duty betatron operators kept in control room
 - Contradicted by information from betatron operator
- DCAS used 15 betatron scenarios
 - 45° angle to axis not consistent with industrial radiography
 - Selection of positions arbitrary
 - SC&A scenario leads to reasonable upper-bound exposures
- DCAS included lead-lined door in model of 1964–1966 radiation exposures
 - Earliest reference to lead door in 1968 AEC license application
 - Workers testified door was unshielded
 - Allis-Chalmers did not include lead door in design specifications
 - Claimant-favorable assumption is no lead door
- DCAS used SC&A 2008 MCNPX version 26e results for beta dose
 - Current version of MCNPX shows increased production of beta-emitting nuclides in steel



Floor Plan of New Betatron Building, Showing Location of Rack for Storing Film Badges



MCNPX Cross-Section Diagram of Betatron Shooting Steel Casting on Railroad Track

Annual Doses to Betatron Operators

Year	Exposure (R)		Neutron dose (rem)		Beta dose to skin (rads)			
					Hands and forearms		Other skin	
	SC&A ^a	DCAS	SC&A	DCAS	SC&A	DCAS	SC&A	DCAS
1953-1957	1.35	0.59	0.48	0.13	33.4	25.9	6.27	2.27
1958	1.35	0.59	0.48	0.13	32.1	25.9	6.22	2.27
1959-1960	1.35	0.59	0.48	0.13	30.9	25.9	6.18	2.27
1961	1.35	0.62	0.48	0.13	34.2	29.5	6.30	2.47
1962	1.35	0.56	0.48	0.12	27.2	21.8	6.04	2.04
1963	1.35	0.44	0.47	0.09	13.9	7.0	5.56	1.23
1964	1.35	0.41	0.46	0.08	10.7	3.5	5.45	1.03
1965	1.35	0.40	0.46	0.08	10.2	3.0	5.43	1.00
1966 ^b	0.68	0.20	0.23	0.04	4.8	2.4 [?]	2.71	0.97 [?]

^a Maximum exposure, assuming hypothetical 30-keV residual radiation from betatron behind operator's back

^b During contract period: January 1–June 30

Annual Doses to Layout Men

Exposure (R)		Neutron dose (rem)		Beta dose to skin (rads)			
				Hands and forearms		Other skin	
SC&A	DCAS	SC&A	DCAS	SC&A	DCAS	SC&A	DCAS
9.20	2.03	0.46	0.078	4.20	1.02	2.45	0.54