DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235

REPLY TO ATTN OF: RAH

8 November 1971

SUBJECT: X-Radiation Protection Survey, USAFSAM Centrifuge

TO: SMB/Dr. Leverett/Maj Michaelson

1. On 4-5 November 1971, an x-radiation protection survey was conducted on the radiographic x-ray unit manufactured by Picker X-Ray, Model KM2000R, Serial No. 1842, utilized on the USAFSAM Human Centrifuge, Bldg 170, Brooks AFB, Texas by Captain Robert C. Nelson and MSgt Jerry D. Siders.

2. Personnel Contacted: Major Michaelson

3. Instruments used to accomplish this survey were:

a. Survey Meter, Victoreen Model 444, Serial No. 222.

b. Portable Radiographic Health Survey System, Victoreen Model 666, Serial No. 204.

4. Findings:

a. The data sheets are included as Attachment 1 to this report.

b. This unit is designed for use in the USAFSAM Human Centrifuge during runs up to 10G. The control console and transformer are mounted on the arm of the centrifuge with the x-ray tube physically located inside of the gondola of the centrifuge. Provisions are included for operating the x-ray unit from the remote control room for all centrifuge operations.

c. Item D: The positioning of the x-ray tube behind heavy plating inside the gondola and the proximity of the x-ray tube to the metal sides of the gondola negate any hazard from leakage radiation. No leakage measurements were taken, but the tube housing with the additional plating used in mounting for this special utilization clearly meets "diagnostic" requirements set by AFM 161-4.

d. Item E: The unit is provided with a fixed aperture collimator, Picker Cat. 2095F, which provides a 13" X 16" field at 54".

e. Item G: The unit is provided with a snap-on light for alignment; however, the diffuse beam of this light limits accuracy of alignment. Since alignment is a critical factor in this operation, positive alignment using a rod is suggested.

f. The inherent filtration of the tube is unknown, but is believed to be greater than 0.5 mm Al. 2.0 mm filtration is added to the useful beam. The total filtration was measured by the addition of 0.5 mm to 3.5 mm Al in the beam. The measurements were taken at 95 kVp, 100 mA using a 1/5 second exposure time. The accumulated dose of each exposure was measured using the Victoreen Model 666 Survey Meter. A plot of the values obtained is given in Item H of the attachment. From the graph it was found that the HVL of the x-ray beam for 95 kVp was 3.75 mm Aluminum. It can be assumed that the required filtration of 2.5 mm Al is met if the HVL measured is not less than 2.7 mm Al. The HVL measured is well above that required.

g. Item I: A determination of the tube output was made at 52, 78 and 102 kVp with a beam current of 100 mA. The measurements were made at a distance of 50" from the tube head. The results are shown in Item I of the attachment. The tube output was found to be linear, as shown in the graph. The Victoreen Model 666 was utilized for the measurements.

h. Item J: The determination of mA linearity was performed at 78 kVp with the beam current being varied from 50 to 200 mA. The results are shown in Item J of the attachment. The output was linear from 50 to 100 mA but dropped off sharply at 200 mA. The unit is probably overloaded at the 200 mA setting. Measurements were again taken with the Victoreen Model 666 Survey Meter.

i. Item K: The timer terminated the exposure. The accuracy of the timer was not measured since the experimental conditions precluded the use of a spin top. However, successive films were noted to have equal densities indicating replicative exposures from the timer.

j. Item L: The switch was of the "dead man type" and does terminate the exposure when released. The switch cannot be operated from an unprotected area.

k. Item M: The tube support of the unit is mechanically sound and constructed to withstand applied G forces. All meters and switches are functioning properly.

l. Item 2A: The workload of the unit is undetermined. It will be utilized during experimental determinations.

m. Item 2B: The unit is used for AP's and lateral chest films during centrifuge experiments.

n. Item 3A: The unit can be operated both from the console on the centrifuge arm and remotely from the control room. In both cases the operator is adequately shielded. Remote communications and closed circuit TV are provided.

o. Item 4B: No significant scattered radiation was measured external to the gondola of the centrifuge.

5. Recommendations:

a. Care should be taken in all cases to align the x-ray beam prior to exposures with the unit.

b. The unit should not be operated above 100 mA until it is checked for proper calibration at 200 mA.

ROBERT E. TATSCH
Radiation Protection Officer

1 Atch
Survey Data

Cy to: SCM
Dir of Nuclear Safety/IGDNM

RADIOGRAPHIC UNIT

INSTALLATION	BLDG. NO.	ROOM NO.
USAESAM CENTRIFUGE	170	

1. EQUIPMENT			
	MANUFACTURER	MODEL	SERIAL NO.
A. CONSOLE	Picker	KM 2000R	1842
B. TUBE	Picker	PX9E (K53775)	2500
C. RATINGS	Maximum tube potential		110 KVP
	Maximum tube current		200 MA
D. TUBE HOUSING LEAKAGE	Maximum leakage at 1 meter (KVP, MA)		mR/hr
	Duty cycle at above settings		
	Leakage in one hour (Product of above)		mR
	Meets "Diagnostic" requirements?		
E. BEAM SIZE CONTROL	None provided		
	Cones, fixed aperture Picker Cat. 2095E		Yes
	Variable aperture collimator		
	Variable aperture collimator w/light field		
F. BEAM SIZE	Collimator set for 8 x 10 in. film-36 in. FFD		NA
	Collimator set for 14 x 17 in. film-72 in. FFD		NA
G. ALIGNMENT	Can beam be accurately aligned?		With care.
H. FILTRATION	Inherent filtration of tube		~0.5 mm Al
	Added filtration		~2.0 mm Al
	Total filtration		2.5 mm Al
	Half value layer of beam : 95 KVP 100 mA		3.75 mm Al
	Meets filtration requirements		Yes

I. TUBE OUTPUT	KVP	MA	TIME	DISTANCE	R	
	52	100	1 Sec	50"	.07	.07 R/100mas
	78	100	1/2 Sec	50"	.12	.24 R/100mas
	102	100	1/2 Sec	50"	.23	.46 R/100mas

J. MA LINEARITY	KVP	MA	TIME	DISTANCE		
	78	50	1/2 Sec	50"	.07	.14 R/Sec
	78	100	1/2 Sec	50"	.12	.24 R/Sec
	78	200	1/2 Sec	50"	.08	.16 R/Sec

K. TIMER	Does timer terminate exposure?	Yes
	Is timer accurate? (Spin-top)	
L. SWITCH	Is switch a dead-man type?	Yes
	Can it be operated from unprotected area?	No
M. OTHER	Is tube support system mechanically sound?	Yes
	Do meters, switches, etc. function properly?	Yes

2. OPERATION		
A. WORKLOAD	Average number of exposures per month	?

B. DESCRIPTION OF WORKLOAD:

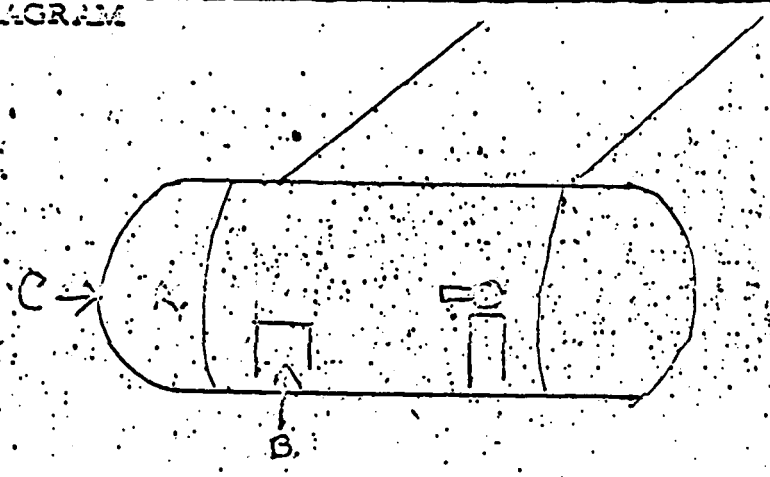
Experimental x-rays under G.

3. SHIELDING

A. OPERATOR	Is operator shielded?	Yes
	Lead equivalent of shield?	
	Can operator see patient from shield?	Yes
	Can operator communicate with patient?	Yes
	Is size and arrangement of shield satisfactory?	Yes
B. BARRIERS		

4. RADIATION SCATTER

A. DIAGRAM



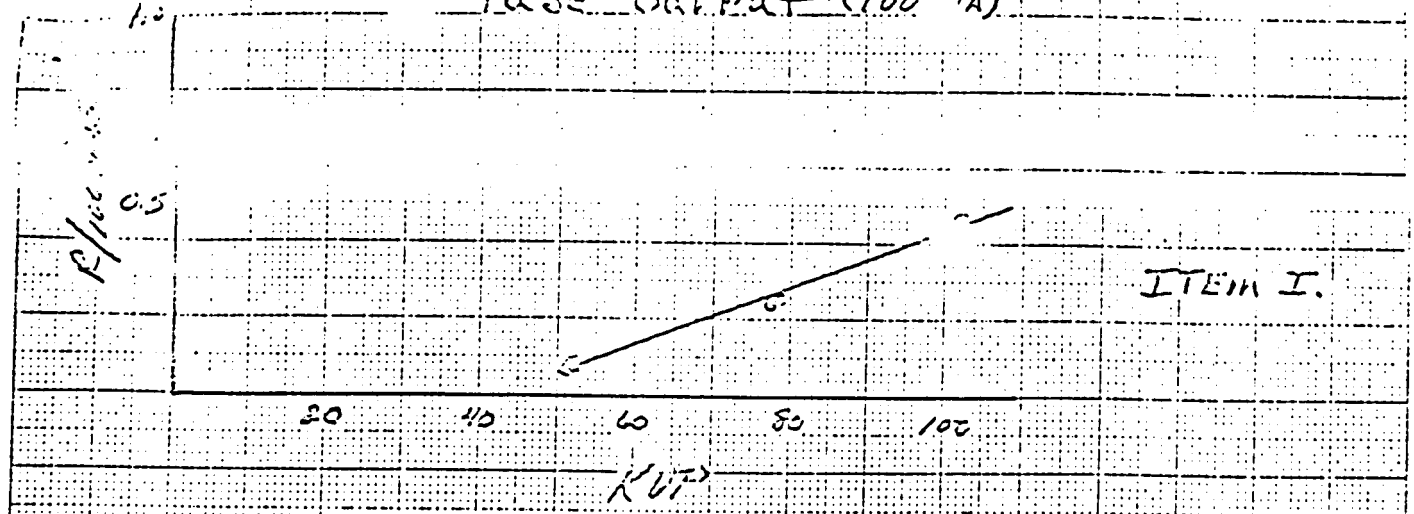
D. MEASUREMENTS

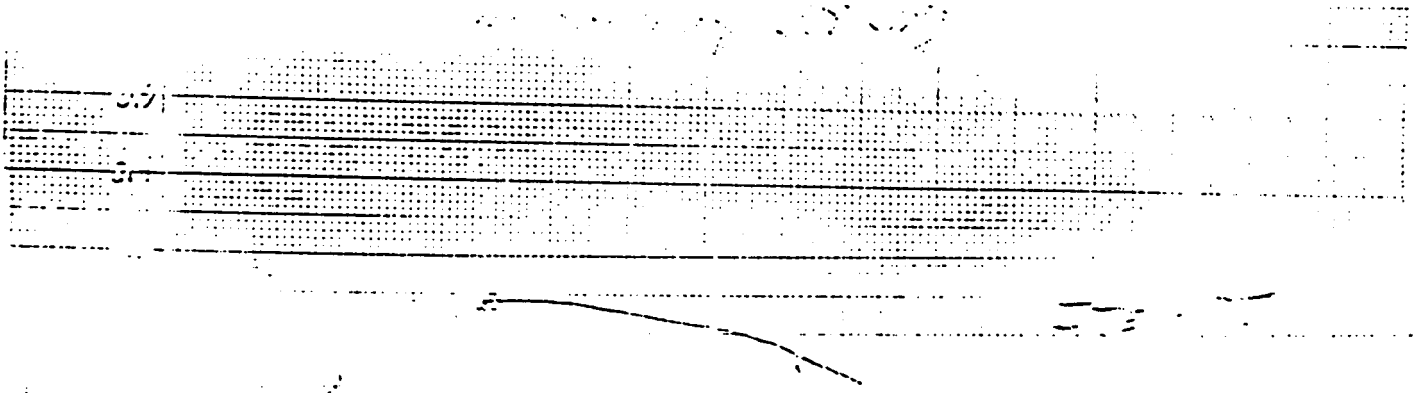
SITE	CONDITION	EXPOSURE
A		0.06 mR
B		0.02 mR
C		0.04 mR

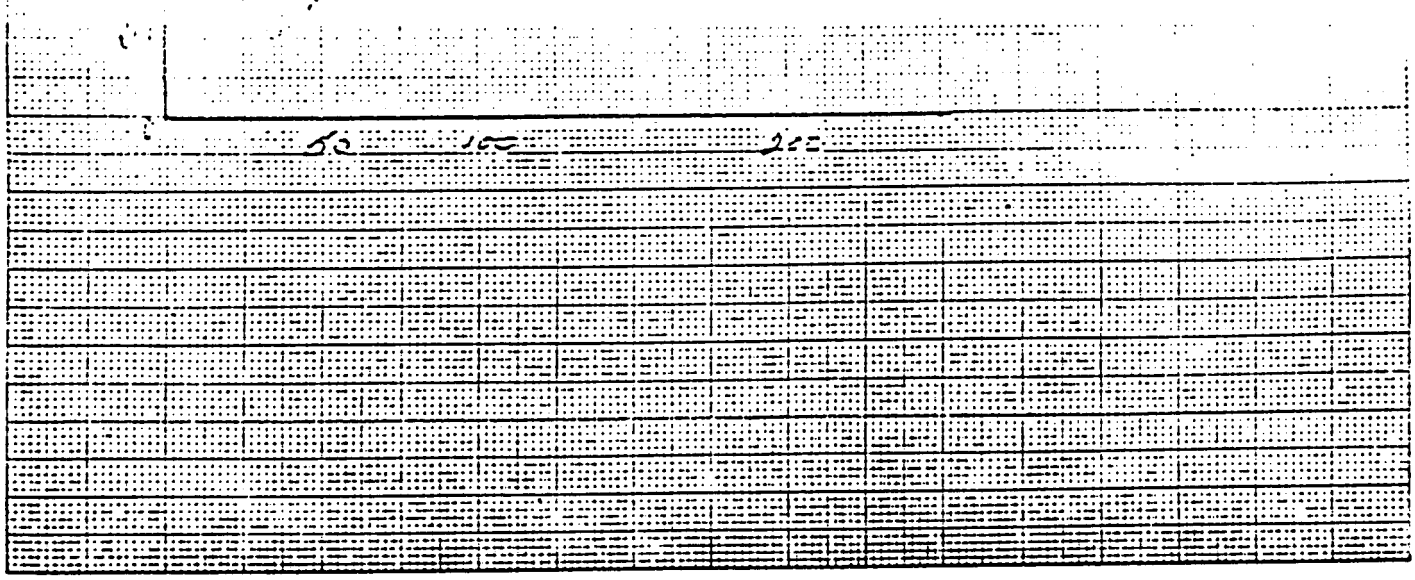
E. COMMENTS

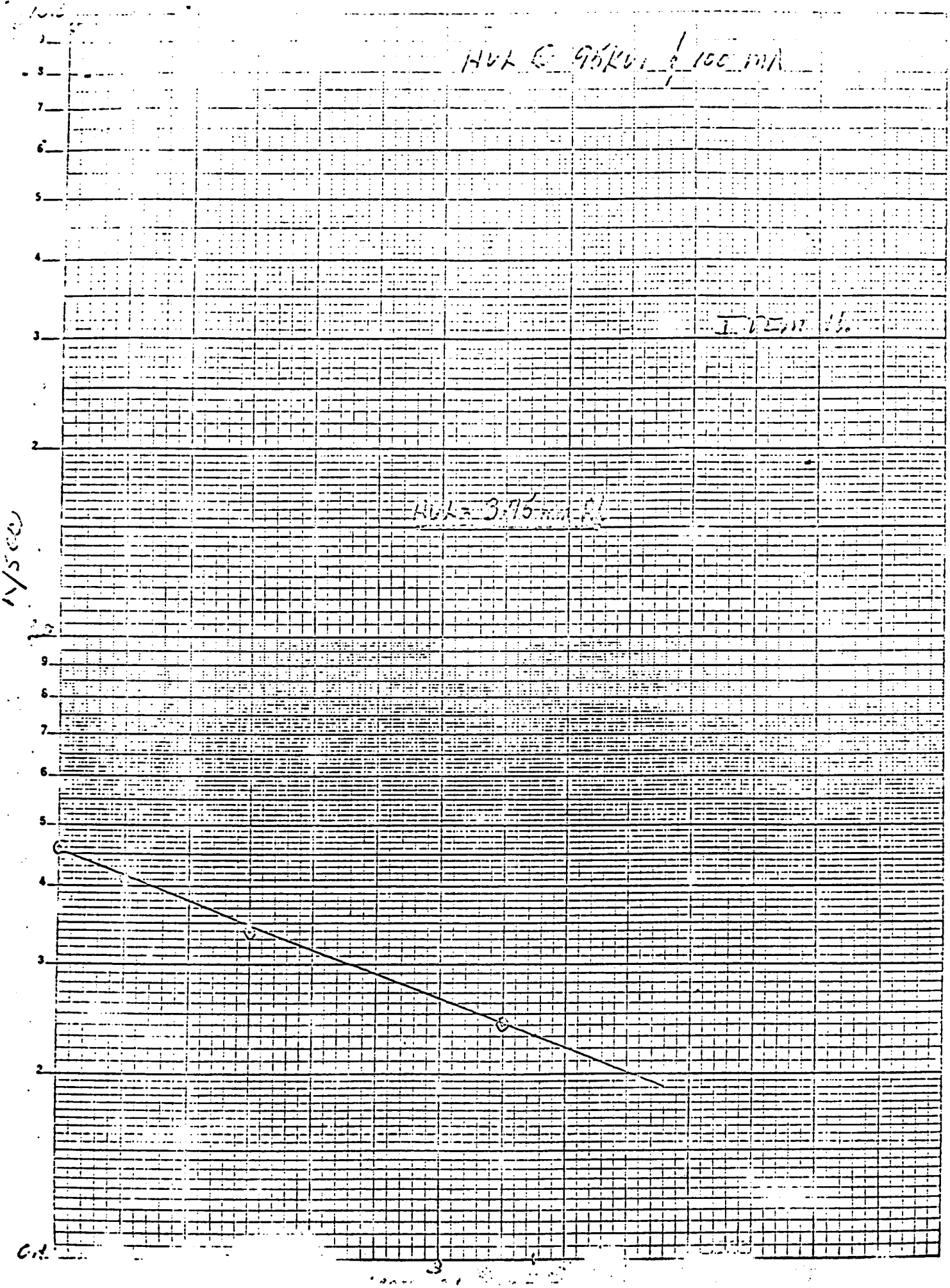
SURVEYED BY: Capt Robert C. Nelson & MSgt Jerry D. Side DATE: 5 Nov 1971

TUBE OUTPUT (100 μA)








HVL @ 95KV & 100 mA
ITEM 11.
HVL = 3.75 mm Al
1/5 cc