RAD/IRID INCORPORATED

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October 6, 1977

Mr. Frederick Combs
Radioisotope Licensing Branch
Division of Fuel Cycle & Material Safety
U.S. Nuclear Regulator Commission
Washington, D.C. 20555

Re: Your letter to Rad/Irid dated 9/28/77

Dear Mr. Combs:

In response to your above referenced letter, herewith we are sending the supplementary information of our letter dated August 12, 1977.

1. A Capintec well-type ionization chamber, Model CRC-2 isotope calibrator is used for the calibration of each of the Ir-192 seeds. This information is used to segregate the seeds so that seeds of similar activity grouped together in the same ribbon. The instrument is calibrated against a 5 mg Ra eq (13.5 mCi) Cesium-137 source. The experimental range of the measured activities was $\pm$ 5% at a confidence level of 95%. Mr. J. Rao Nibhanupudy will certify the instrument calibration. He has a Masters Degree in Chemistry and a Masters Degree in Nuclear Engineering. He has 5 years experience in Atomic Energy Establishment of India and has 6 years experience as Chief Clinical Physicist of the Radiotherapy Department, Howard University Hospital, Washington, D.C. He is also certified by the American Board of Radiology in Therapeutic Radiological Physics.

2. As Iridium 194 has an half-life of 19hrs only, compared to 74 days half-life of Iridium 192 after irradiation and a two week cooling period, the activity of Iridium 194 goes down by a factor of 2^{17}. Our previous measurements at NBS showed that after two weeks, Ir-194 is not detectable. Hence, the most we can say about the maximum amount of Ir-194 is that it does not exceed the minimum detectable limit of less than 0.0001 mCi.

3. The minimum activity of 0.3 mCi and maximum activity of 1 mCi quoted in our letter to you dated 9/20/77, refers to the range of activities of seeds we may have in our possession at a given time. However, each batch of seeds is segregated based on the activity of each seed. Seeds of similar activity are loaded into nylon ribbons.

4. To assure the integrity of cold welds, at least 70% of seeds will be visually inspected by optical magnification prior to irradiation. Loose iridium pieces which may be adhering to the seeds will be removed by agitating them in an alcohol bath. The results of the random examinations under magnification will be posted in a ledger by the person performing the inspection. Information will

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include: shipment number, date, and finding. Monthly review of the ledger will be made by the Radiation Safety Officer for the purpose of assuring that the required number of samples have had the integrity of the cold welds visually inspected.

The Iridium-192 activity and activity of various trace elements in our Iridium-192 seeds was recently determined at the National Bureau of Standards Laboratories, Gaithersburg, Maryland, using a 30 cc Ge-Li Detector with fractional efficiencies of 2.467×10^{-5} at 316 KeV; and 4.1536×10^{-6} at 1.33 MeV. The accuracy for calibration of Iridium-192 is $\pm$ 5%. The following is the result:

Ir-192:	0.225 mCi (100%)
Cr-51:	0.0069 mCi (3.1%)
Fe-59:	0.0002 mCi (0.09%)
Co-60:	0.00069 mCi (0.31%)
Co-58:	0.00036 mCi (0.16%)
Mn-54:	0.000146 mCi (0.065%)
Ir-194:	Not detectable
Fe-55:	Not detectable

Based on these results and assuming a maximum possession of 4 Curies (approximately 5000 seeds) of Iridium 192 at any given time, we arrive at the following values:

Cr-51:	124 mCi
Fe-59:	3.6 mCi
Co-60:	12.4 mCi
Co-58:	6.4 mCi
Mn-54:	2.6 mCi

Hereby, we request to amend our license number 08-14043-01 to include:

Radioisotope	Maximum amount at one time
Chromiun-51	150 mCi
Iron-59	5 mCi
Cobalt-60	15 mCi
Cobalt-58	10 mCi
Manganese-54	5 mCi

We hope the information contained in this letter is satisfactory for the requirements of the amendment.

Sincerely yours,

David G. Mahan, Ph.D.
President

J. Rao Nibhanupudy
Radiation Safety Officer

DGM:JRN/lr

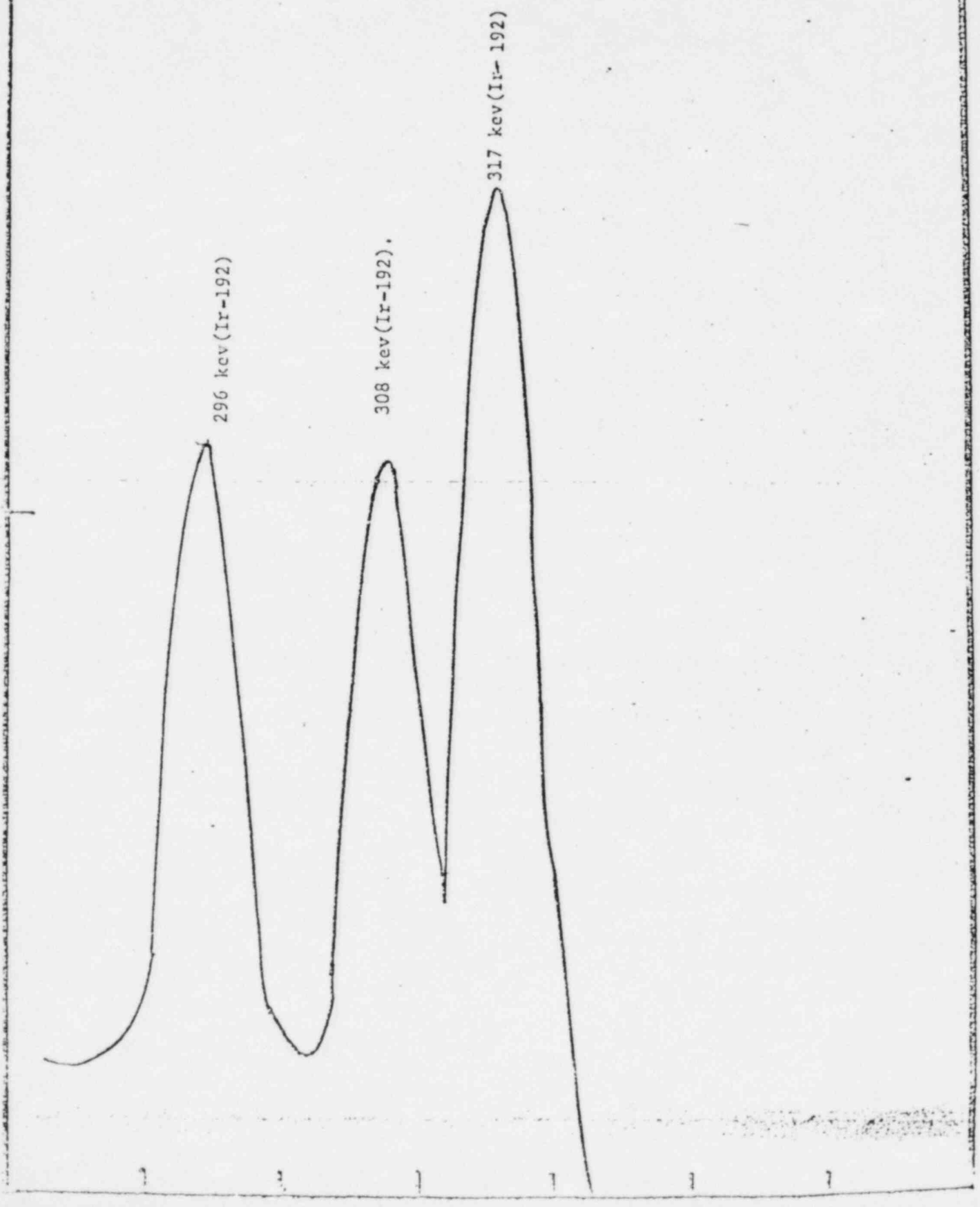
Supplement to Paragraph No. 1

The Iridium-192 seed calibration is done as follows:

We measured few Ir-192 seeds, in mR/hr, at 91 cm distance using a Victoreen Model 440 meter. The detector is an air ionization chamber with 3 1/2" diameter. The chamber depth is 2" and 314 cc volume. At this distance, 1 mg Ra Eq should give a reading of 1 mR/hr. By this way, the mg Ra Eq value of these seeds was assessed. Then using Capintec CRC-2 isotope calibrator, same seeds were measured in mCi at a window setting of 480, and when converted from mCi into mg Ra Eq, these values are within $\pm$ 3-5% of the values measured using Victoreen 440.

So for calibration of Ir-192 seeds, a window setting of 480 is used to calibrate Ir-192 seeds in mCi.

FIG.3 SPECTRA OF IRIDIUM SEED, 6½ weeks after irradiation.



Impurities

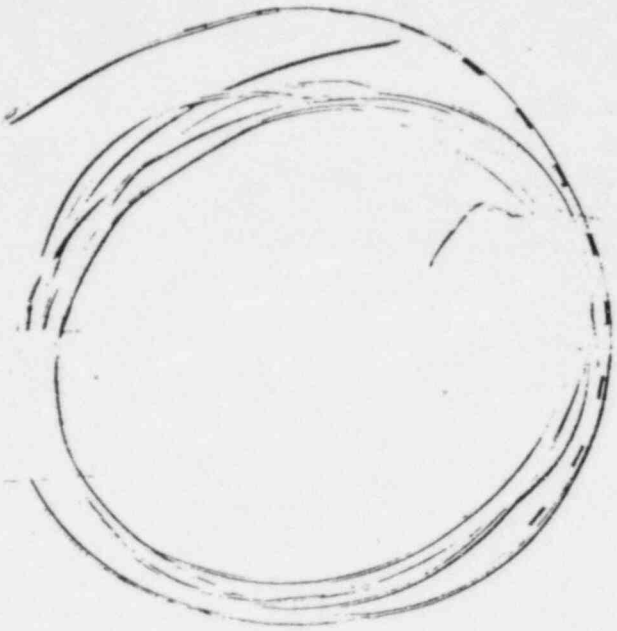
Stainless steel used for encapsulation of Iridium seed contains about 18% chromium. Also expected are manganese, and iron, and the natural Iridium consists of Iridium-193 (62%) besides Ir-191 (35%), which gives rise to Ir-194 on neutron activation.

Some of the characteristics of the above elements are given below:

Isotope	Cross-section (barns)	Half-life	Energy
Ir-192	700	74.5 d.	136 KeV, 296 KeV, 308 KeV, 316 KeV, 468 KeV, 588 KeV.
Ir-194	130	19 H.	293 KeV, 328 KeV, 640 KeV, 930 KeV, 1.14 MeV.
Cr-51	11	27 days	325 KeV.
Fe-59	1	45 days	1.1 MeV.
Mn-56	14	2.6 H.	845 KeV.

Because of the low cross-section, chromium and iron do not seem to be giving significant contribution. Of course the Mn-56, Ir-194 decay out to insignificant activity levels in 2-3 weeks.

The spectra of a previously irradiated iridium seed is given in Fig. 3. The activation of this seed is done in June 1973. Comparing Fig. 1 & 2 with Fig. 3, it is evident that the peak at 331 KeV is absent in Fig. 3 because of decay of Ir-194. Also the peak at 296 KeV in Fig. 3 is sharper, again because of



All iridium seeds shipped from our laboratory are shipped in such a nylon ribbon as this.

decay of Ir-194. The fact that at 325 KeV there is no peak in Fig. 3 is indicative of the negligible contribution of chromium to total activity and hence to tumour dose.

Based on the experiments, we conclude that the contribution from isotopes other than Ir-192 to total dose from Iridium seed in far less than 0.5 per cent.

FIG.2:SPECTRA OF IRIDIUM SEED 12 hours after irradiation.(Wt.of the seed:31.25mg.)