Request for Amendment to License #24-32675-02E

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Testing Irradiated Diamonds

During the past year it has become apparent, through requests to Ideal Source Quality Assurance (ISQA), that manufacturers and wholesalers of irradiated diamonds are aware of the NRC regulations concerning irradiated gemstones. As far as I know, no licenses have been issued that will allow these dealers to comply with the regulations. This application is intended to address this lack, at least with respect to diamonds irradiated with electrons. The topaz license is limited to those stones over which we have direct supervision (and perform annual audits over) during their production to assure that the statistical methods employed are valid, by controlling the origin, treatment, cooling and testing procedures at their origin. In the case of irradiated diamonds, testing will be performed for any suppliers of wholesale stones.

In the original application for the ISQA licenses it was stated that we did not have sufficient data to identify the potential radioactive by-products in neutron irradiated diamonds, in the same fashion that has been applied successfully in neutron irradiated topaz. The isotope profile for topaz has been well established through more than 20 years of experience (and confirmed in 4 years of testing by ISQA). One result of that testing has been confirmation that neutron irradiated and electron irradiated topaz can be readily distinguished by the total absence of activation in the latter group, if the electron energy is less than about 15 MeV, compared with readily observable activity in neutron irradiated topaz, even when those stones have been subject to long decay times. Based on that, we believe (and have confirmed in limited testing) that electron treated diamonds can be easily tested to confirm that **no activation** is present, and hence these stones meet NRC standards and can be safely released for retail sale in the U.S.

The proposed testing uses the same equipment presently employed for topaz testing, which relies on a well calibrated and shielded NaI(Tl) detector. It has been found, using 5-10 gm batches (25-50 cts) of topaz , that activities exceeding 1 Bq/gm are easily measured using 30 sec. counts. The essential feature of the method, (after efficiency and energy calibration) is the determination of background, measured over 1800 sec., prior to any testing session. Determination of topaz activity is performed by subtracting this background (proportional to measuring time) from the observed spectrum, after which any excess activity, (above background) is quantified, using matrix calculations to distinguish the isotopes present.

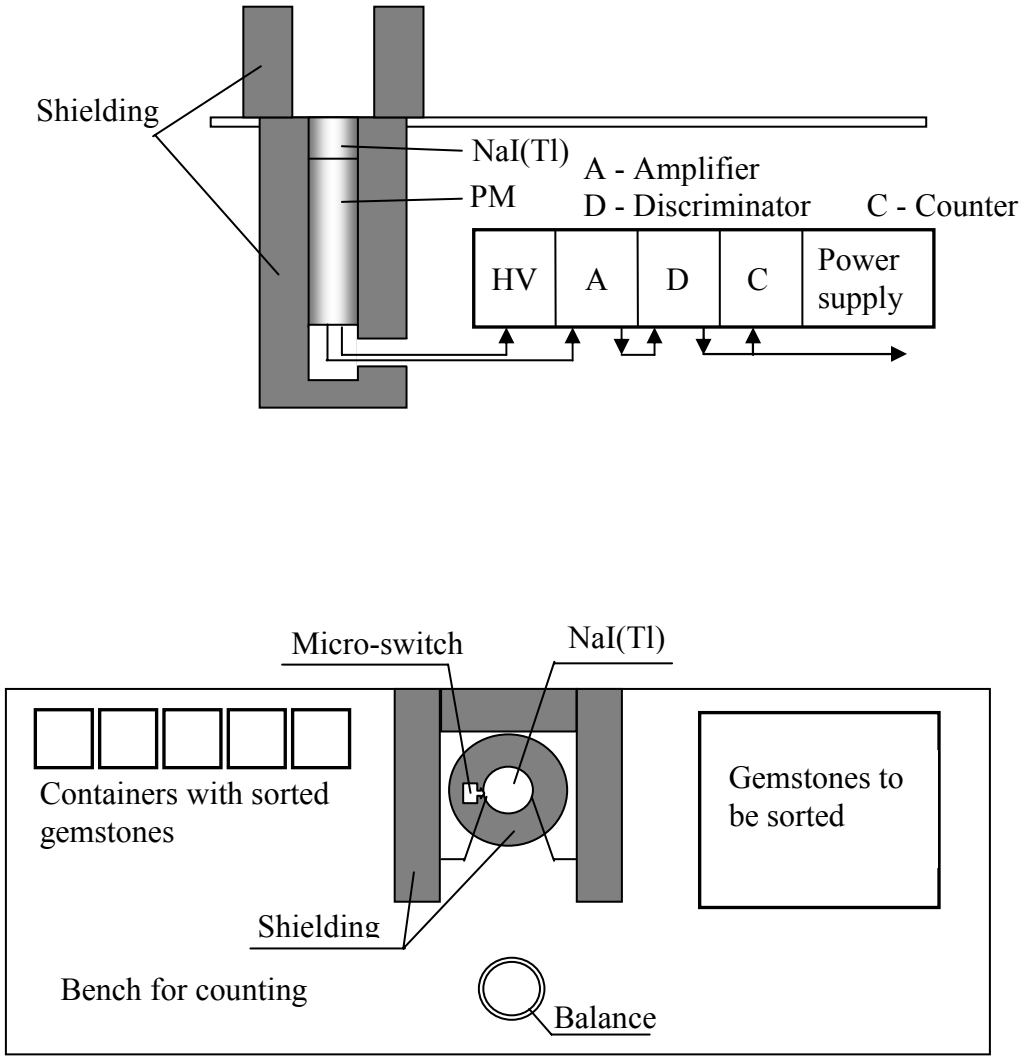

Fig. 1 Side and top schematic views of the NaI(Tl) testing station used for topaz release and for the proposed diamond release tests.

Figure 1 shows a schematic of the detector and shielding. Below the measuring platform the detector is surrounded by 2" of lead. The three sided cave surrounding the measuring platform is made from 2" thick lead bricks, the top of which is also covered, by 2" thick lead bricks. The entire interior surface of the cave is covered by Cu sheet to reduce Compton scattering. It has been found that this well shielded detector system, coupled with the Canberra Genie2K software, modified for fitting low activities, is easily capable of establishing 1 bq/g activities from the isotopes typically present in topaz using 30 sec. counts on 10 g samples. Background measurements performed with this system routinely resolve K-40 (from bricks and other geological sources) and radon decay products. Figure 2a shows the data collected from an 1800 sec. background measurement. Figure 2b, in the window labeled *background,* those activities, as well as that of Ta-182 and Sc-46 are reported. These last two are seen because, at the time of measurement, 14 Kg of

topaz, being tested for release in Aug. 2012, were present in the office, at a distance of about 2m from the testing station. In their absence, no topaz mineral signals are seen. This result emphasizes the need to take a background measurement at the start of every testing session, as the environment may change from day to day.

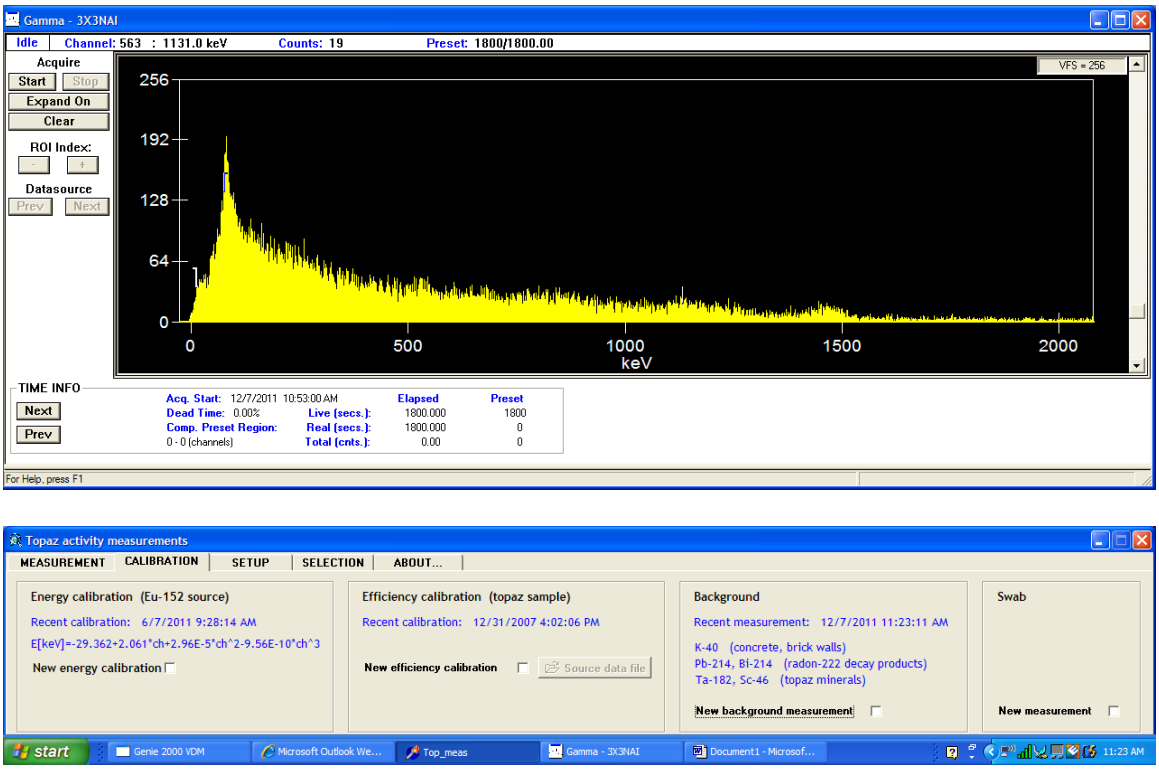

Figure 2. Background measured for 1800 seconds (with 14 Kg of neutron irradiated topaz in the vicinity). The isotope profile is reported in the section labeled *background*.

Proposed procedure:

We propose to test and release electron irradiated diamonds through a simple procedure as justified above. The testing will employ 5-10 gm batches counted for 120 sec. to improve statistics relative to those employed for topaz testing (where the isotope profile is well established). If and only if **no signal is observed** (above background) will the parcel be cleared for release. Any evidence for radioactivity will be taken to imply that these stones have been treated with neutrons. In that case, the data will be analyzed using the isotope library in the Canberra Genie2K software and stored until sufficient information is obtained to develop a "standard" activation profile for diamonds, similar to that employed for topaz. If such a profile is established, the same methods as employed for topaz will be applied for diamonds. Prior to that, however, the data will be provided to the NRC in a further application for license amendment. Until such time, stones that show evidence for neutron irradiation will be returned to their owners with a statement that they are not eligible for sale in the U.S.

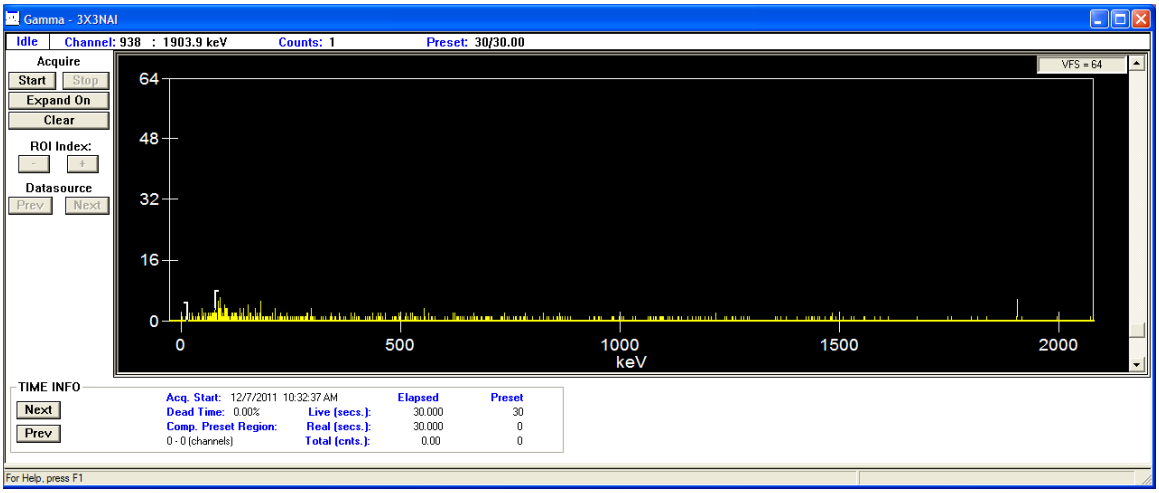

Figure 3. 30 second background.

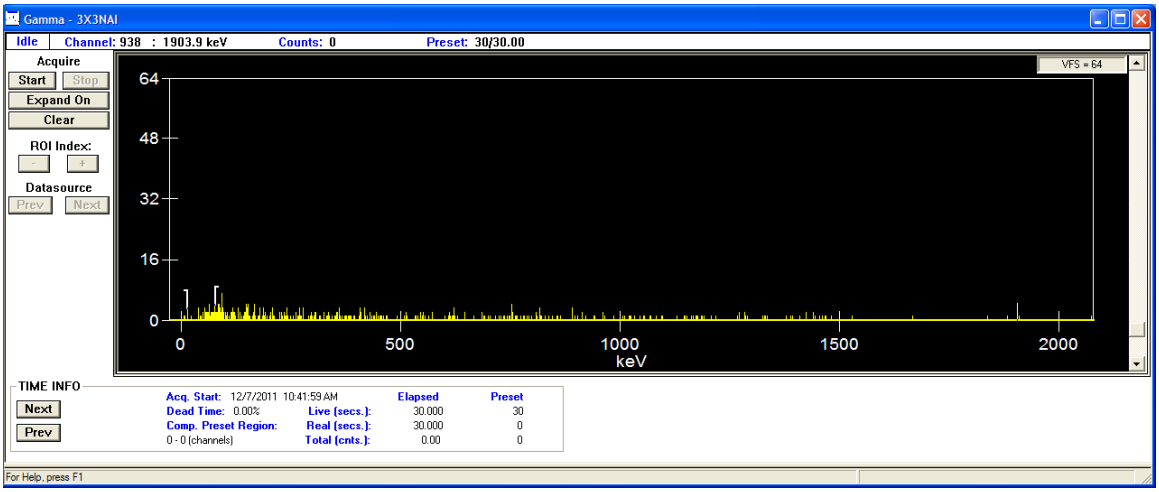

Figure 4. 30 second measurement of sky blue, electron treated, topaz (10.4 gm). Analysis reports no activity.

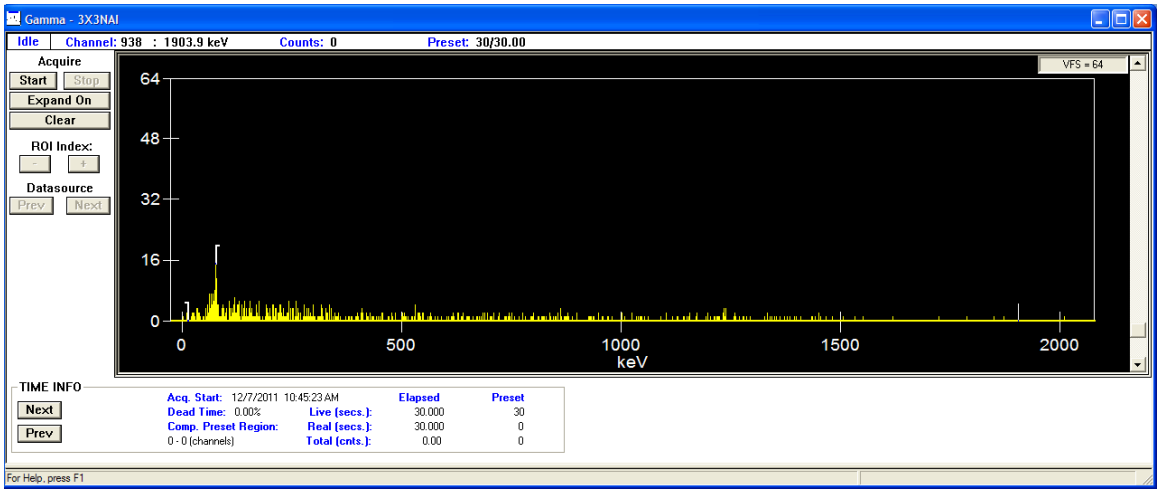

Figure 5. 30 second measurement of neutron treated, 18mm square cushion blue topaz (11.2 gm, 2 pieces). Analysis reports 2.9 Bq/gm Ta-182, (cursor marks most prominent energy peak position). No other activity reported.

Figure 3 shows a 30 second count for an empty measuring cup. No activity is reported in the analysis of these data, although some area is present in the region associated with Ta-182, due to the peaked background seen in figure 2. Figure 4 shows a 30 second count for 10.4 gms of sky blue (10 MeV electron irradiated) topaz. There is no statistically meaningful difference between these data and those shown in figure 3, and once again, no activity is reported by the data analysis program. Figure 5 shows data for 18mm square cushion neutron irradiated blue topaz (2 pieces, 11.2 gm). Additional counts are seen in the low energy region 0-300 KeV, and the data analysis reports 2.9 Bq/gm of Ta-182. The differences between the data of figures 4 and 5 are representative of those we would expect for electron and neutron irradiated diamonds, respectively, and form the basis for providing release certification for electron irradiated diamonds.

Stones that have cleared the "**no signal"** test will be returned to their owners with a certificate providing details of the quantity and date tested, along with information about their size and shape, if uniform, or listed as "various" if not. ISQA will keep full records of all shipments and testing results, similar to those stored for the topaz tests. These records will be fully available to the NRC, and will be reported to the NRC, in summary form, in the annual materials transfer report.