Comments of the value of the UNEP survey of Lebanon for weapons-derived Uranium (WDU)

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1. Background

There has been significant and widespread concern over the possible use of Uranium weapons by the Israel Defence Force (IDF) in the recent (Summer 2006) offensives in Lebanon. Following reports in the Lebanese newspaper Daily Star of a bomb crater in Khiam showing elevated radiation levels, a sample of soil from this crater was collected by Dai Williams and brought back to the UK for testing. In October 2006, Busby and Williams reported the finding of enriched Uranium in this sample, and in November 2006, follow up testing of this and other samples collected at the same time and also during a further field trip confirmed the presence of enriched uranium in both soil and water samples from this site and also in the engine air filter of an ambulance which had been wrecked in south Beirut. However, the existence of uranium in the Lebanese battlefield was being denied by the Lebanese authorities and reference was made to surveys made by UNEP which were to report in December. UNEP has now reported on its findings [UNEP 2006]. This short communication discusses the choice of measuring instruments deployed by the UNEP survey. Green Audit has conducted field surveys for uranium from weapons both in Iraq in 2000 and in the Balkans in 2001 and so has some idea of what is necessary to detect radiation signals from weapons uranium in field conditions.

2. UNEPs choice of field instruments

The recent UNEP report described the instruments used as follows:

Extract from the UNEP report: *" UNEP Mission to Lebanon – October 2006"*
Equipment used in the field

The choice of instruments used in the environmental assessment in Lebanon was driven by UNEP's in-depth experience of such equipment in past DU missions in the Balkans and the joint IAEA/UNEP mission to Kuwait. Thanks to their high sensitivity, effective sound alarm, durability, and robustness, these instruments have proven ideal for such missions.

The ***Saphymo-SRAT S.P.P.2 NF scintillometer*** *is manufactured by Saphymo-PHY (Massy, France). It is designed for uranium exploration in rugged conditions. The detector is a 1 x 1.5 inch (15.2 cm^3) NaI(Tl) (sodium iodide activated with thallium) scintillation crystal. The operation range for gamma radiation is 0.02 to 30 microsieverts per hour (µSv/h). The instrument has a built-in audible alarm that gives a high signal. The threshold and the frequency of the sound alarm can be varied according to the strength of the radiation. The time constant for the sound alarm is 0.25 seconds. The SRAT's unit of measurement is cps (counts per second). It is 32 x 13 x 12 cm in size and weighs 3.6 kg. From UNEP's point of view, it is one of the world's most effective instruments for reconnaissance.*

*The **Inspector** instrument is manufactured by S.E. International Inc. (Summertime, TN, USA). This instrument was chosen because of its high sensitivity to beta radiation, which is due to its pancake GM-tube, and for its rather large window, as it is necessary to measure very close to the source to detect beta radiation from DU. This detector is a halogen-quenched Geiger-Müller tube of the pancake type that has an effective diameter of 45 mm. The detector window is covered by a mica foil, which is protected against damage by a metal net. The window has a diameter of 50 mm. It can be covered by a metal lid which only allows gamma radiation to reach the detector, preventing beta and alpha rays from penetrating. When the lid is removed, the Inspector measures gamma, beta and alpha radiation. Units of measurement are cpm, cps, mR/h or µSv/h. The instrument can be used in direct reading mode or as a counter. The counting time can be set for a range of one minute to 24 hours, and a timer can be set at the desired counting time. The instrument is equipped with a sound alarm, which clicks for each radiation event detected. The Inspector measures 15 x 80 x 30 mm and weighs 272 g.*

*The **Automess Dose Rate Meter AD 6** and its **Alpha-Beta-Gamma Probe AD-17**, which are manufactured by Automation und Messtechnik GmbH (Ladenburg, Germany), were used and tested by UNEP in previous missions and have proven to be well-adapted equipment allowing good quality measurements of radioactivity – dose rates and contamination levels. The AD 6 can be used with a wide range of probes. It is calibrated according to internationally accepted standards, allowing direct comparison of results measured with this instrument. In Lebanon, this instrument was mainly used to measure ambient dose rates.*

*The **Fieldspec Instrument identiFINDER-N/He-3** is manufactured by Target Systemelectronics GmbH (Solingen, Germany). The identiFINDER is a hand-held gammaspectrometry system with a dose rate meter and neutron counter. It includes a multi-channel analyser with memory, amplifier, and an NaI(Tl) scintillation crystal (Ø 1.2" x 1.5"). The identiFINDER can measure gamma spectrums and perform gammaspectrometric analysis, including radionuclide identification, by using radionuclide libraries.*

3. The sensitivity of the UNEP instruments to uranium contamination from weapons use.

3.1 The detection of uranium from weapons usage

Uranium from weapons use is either (rarely) in the form of pieces of unburned metal, as in the case of penetrator material or (mostly) in the form of a black dust comprising oxides of uranium. Weapons Uranium primarily consists of U-238 which is an alpha emitter. There are however two beta ray emitting daughter isotopes of U-238, namely Protoactinium-234m and Thorium-234 which are in secular equilibrium, which means that for each U-238 decay, there is also a beta decay from each of the Pa-234 and Th-234 isotopes which decay to U-234. Thus the emissions from uranium are a single alpha and two beta particles. There is no detectable gamma ray emission from U-238 although there are very weak gamma emissions from the Pa-234m. The range of the alpha emission from uranium is about 2cm in air and alpha particles are stopped by paper. The range of the beta particles from the daughter isotopes are about 30cms in air and so these might be detected by a suitable instrument. The result of this situation is that it is entirely impossible to detect WDU uranium contamination from weapons use with a gamma ray detecting instrument. It is possible to employ such an instrument for uranium exploration when looking for large deposits since then the contribution from the weak U-235 peak at

185keV can be detected if the deposit is sufficiently large and the uranium content high and commercially worth extracting (e.g. thousands of Bq per kg). The only instrument that can be employed for field survey work involving looking for dust contamination from WDU oxides is a sensitive beta particle detector. We have shown that this is the case by attempting to measure radiation from weapons uranium contaminated soils and dusts in the laboratory using Geiger Counters, thin window Scintillation Counters, and gamma scintillometers. It is only possible to detect uranium with an instrument that has (a) a large surface area window and (b) a window thin enough to allow significant beta ray detection.

3.2 Saphymo-SRAT S.P.P.2 NF scintillometer deployed by UNEP
This type of instrument is a gamma detector. It cannot detect alpha or beta particles. It is almost entirely useless for the detection of uranium in the field unless there are very large deposits which would contribute to a weak U-235 gamma peak at 185keV. It is a low resolution doped Sodium Iodide gamma scintillation detector. The instrument is intended for measuring gamma rays and, in conjuction with a multichannel analyzer, to produce a low resolution gamma spectrum for determining the origin of the radiation (i.e. which element). We use a more sensitive 2 inch Crismatec sodium iodide detector for certain field work (e.g. the gamma ray emitter Caesium 137). In an experiment we conducted in the laboratory this was unable to detect a piece of weapons uranium contaminated soil which contained 200Bq/kg of uranium. This is because none of the 200Bqs were gamma decays.

3.3 The Inspector instrument deployed by UNEP (http://www.seintl.com/products/product.asp?InstID=1)
This is a versatile and useful small palm held field Geiger Counter with a pancake detector. The detection of beta particles is possible since the window of this instrument is thin. However because it is a Geiger counter and small, the effective window area is only 16 sq:cm. Because the window material, though thin has to be thick enough for Geiger use,[1] the beta ray sensitivity is not great, maybe 35%. As a field survey instrument it would be difficult to know how it could be employed to give any result since at low levels the instrument compensates for its detection area by displaying a 30second moving average. The instrument would have to be held about 10 cm from the ground and the ground surface scanned by crawling across it at a rate sufficient to present the surface of interest to the detector window for 30seconds. Thus it would take a long time to cover a small area. In principle this may be the best that UNEP could accomplish with the instruments it used. The Inspector is the only instrument they deployed that could detect weapons uranium, and it would require the operator to stay in each measurement place for a long time, several minutes.

3.4 The Automess Dose Rate Meter AD 6 and its **Alpha-Beta-Gamma Probe AD-17**
We were unable to find details of this instrument. However, UNEP apparently confined its use to measuring background gamma dose rates and so it was not employed as a survey instrument.

[1] Geiger counters contain gas at less than atmospheric pressure, so the window has to be strong enough to resist the partial vacuum.

3.5 The Fieldspec Instrument identiFINDER-N/He-3
This is another gamma ray scintillation crystal detector and cannot detect alpha and beta particles. It is effectively a small field gamma ray spectrometer with a smaller crystal (less sensitive) than that in the Saphymo instrument; again, it is useless for detecting uranium since uranium is not a gamma ray emitter.

3.6 Conclusions
The scientists who advised UNEP and who carried out the field survey are either incompetent or else designed their survey to deliberately miss the presence of uranium in the area. UNEPs 'in depth experience' resulted in them choosing instruments which could not detect that which they were looking for. It is not possible to find weapons-derived uranium with the instruments they deployed unless they were very lucky and used the inexpensive 'Inspector' instrument for long count times.

4. How do you carry out a survey for weapons-derived uranium (WDU)?
Based upon our experience in the Kosovo and in Iraq you must look for beta decays using a large window thin window scintillation counter such as those made for the nuclear industry for decontamination. We use Type DP2 4-inch Dual Phosphor probes in conjunction with an Electra 1A integrating instrument (Nuclear Enterprises, Beenham, Berkshire). These have a surface area of 100square centimeters and are capable of distinguishing alpha and beta emissions. The probe at the end of its EHT cable is trailed slowly across the area to be surveyed at a height of about 10cm from the ground. Care must be taken not to touch the window against any object as even grass can penetrate the window and damage the detector. The background rate is usually about 2 counts per second. Uranium or other contamination is signaled by an increase of the rate to about 4 counts per second or more. Care must be taken as there can be variations in signal due to cosmic ray fluctuations. The material from the Khiam crater which contained about 300 to 400Bq/kg of uranium (due to surface flash contamination) gave 4.5 counts per second compared to 2 counts per second background. The Inspector machine deployed by UNEP has a surface area 6 times lower than the DP2. If it had the same counting efficiency (which it does not) its response to this same contamination would be an increase of its 30 second integral from 0.125 counts per second to 0.28 counts per second, requiring a long count time. Having found material which gives a significantly raised signature for beta radiation, a sample has to be taken and the material examined in the laboratory.
An alternative method to detect samples containing weapons uranium is the use of CR39 plastic alpha track methods, but this is not really applicable to field surveys.

5. Is there weapons-derived uranium (WDU) in Southern Lebanon?
There is. We have now found enriched uranium with a isotopic signature of about 108 in two separate craters in Khiam, in several soil samples, and in two separate water samples and also in an ambulance air filter from southern Beirut. The results have been described in two reports and will also be reviewed in a third report which contains new measurements. This is in preparation.