WITNESS STATEMENT
(CJ Act 1967, s.9; MC Act 1980, ss.5A(3) (a) and 5B; Criminal Procedure Rules 2005, Rule 27.1)

Statement of: HARRISON JOHN DAVID

Age if under 18: OVER 18 (if over 18 insert ‘over 18’) Occupation: RADIATION PROTECTION SCIENTIST

This statement (consisting of page(s) each signed by me) is true to the best of my knowledge and belief and I make it knowing that, if it is tendered in evidence, I shall be liable to prosecution if I have wilfully stated anything in it, which I know to be false or do not believe to be true.

Signed: J.HARRISON Date: 27/10/2010

Tick if witness evidence is visually recorded □ (supply witness details on rear)

I am Dr John HARRISON of the Health Protection Agency, Centre of Radiation, Chemical and Environmental Hazards (HPA CRCE), Chilton, Didcot, Oxon, OX11 0RQ. My qualifications are Bachelor of Science (B.Sc) and Doctor of Philosophy (Ph.D) degrees in Biochemistry. I have over 30 years experience of work on the behaviour of radioactive materials (radionuclides) in the body. I am a recognised expert in the field of radionuclide dosimetry and effects and I am a member of the committee on dosimetry of the International Commission on Radiological Protection.

I have compiled this statement at the request of Detective Chief Superintendent Clive TIMMONS of the Counter Terrorism Command (SO15) of the Metropolitan Police Service. This statement supplements a previous statement dated 26th April 2007 (26/04/2007), and presents additional results of measurements of polonium-210 in samples of body organs from Mr LITVINENKO. Comparisons are made between measurement results and model predictions. The questions addressed are:
1) Are the additional measurement results consistent with those reported previously?
2) Do the additional measurements support the original estimate of polonium-210 intake by Mr LITVINENKO?
3) Do the additional measurements support the original conclusions regarding cause of death?

Signed: J.HARRISON
2006/07(1)
Colleagues at HPA CRCE were responsible for making measurements of radioactivity, calculating model predictions of retention of polonium-210 in organs and re-estimating the likely intake of radioactivity:

1) Measurements of polonium-210 in organ samples were made by Dr Michael YOUNGMAN, using gamma-ray spectrometry. Dr YOUNGMAN has over 25 years experience of gamma-ray spectrometry and has been responsible for the measurement facility at HPA CRE since 1989. The laboratory has accreditation for measurement of gamma-emitting radionuclides in environmental and biological materials (UK Accreditation Service No. 1269). In addition, measurements using alpha spectrometry were made by, or under the supervision of Mr George HAM. Mr HAM has over 25 years experience of radiochemistry and alpha spectrometry on environmental and biological samples.

2) Calculations of model predictions of organ content of polonium-210 were done by Mr Timothy FELL. Mr FELL has over 30 years experience of the application of internal dosimetry models in computer codes for the calculation of radiation doses. The computer code he used for polonium-210 calculations is that used to calculate doses for the International Commission on Radiological Protection, and European and UK legislative purposes.

3) Calculations of the estimated intake of polonium-210 by Mr LITVINENKO were done by Dr Matthew PUNCHER. Dr PUNCHER has over 10 years experience of the interpretation of body organ and excretion measurements to estimate intakes and radiation doses, and the developments of computer code for this purpose. The software used for polonium-210 calculations was developed by HPA CRCE and is used widely around the world.

Assistance was also provided by Dr Richard LEGGETT (Oak Ridge National Laboratory, USA) on aspects of the use of a model that he has developed and published which describes the behaviour of polonium-210 in the body (LEGGET and ECKERMAM, 2001). This model was used to estimate intake and organ content.

This statement provides a summary of the relevant information. Measurement reports prepared by Dr YOUNGMAN are provided separately, for the samples analysed to provide the original assessment of intake and radiation doses (report number IR/02/07/GRS) and the additional
samples for which results are reported here (report number IR/03/07/GRS). I produce these documents as exhibits JDH/3 and JDH/4 respectively.

1) Measurements of polonium-210 and model predictions

<table>
<thead>
<tr>
<th>Sample</th>
<th>Evidence Ref No</th>
<th>Activity, Bq per g of tissue</th>
<th>Total estimated activity in organ/tissue MBq(a)</th>
<th>Model prediction of total activity in organ/tissue MBq(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesentery</td>
<td>NRBC/4</td>
<td>740</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Testicle</td>
<td>NRBC/5</td>
<td>5800</td>
<td>0.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Muscle (psosas)</td>
<td>NRBC/8</td>
<td>1100</td>
<td>72(c)</td>
<td>73(c)</td>
</tr>
<tr>
<td>Brain</td>
<td>NRBC/10</td>
<td>5500</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Lung(d)</td>
<td>NRBC/11</td>
<td>3500</td>
<td>1.8</td>
<td>-</td>
</tr>
<tr>
<td>Spleen(d)</td>
<td>NRBC/12</td>
<td>9900</td>
<td>1.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Kidney(d)</td>
<td>NRBC/13</td>
<td>49000</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>Bile</td>
<td>NRBC/14</td>
<td>1300</td>
<td>3-14 per day</td>
<td>4(e)</td>
</tr>
<tr>
<td>Liver(d)</td>
<td>NRBC/15</td>
<td>30000</td>
<td>54</td>
<td>66</td>
</tr>
<tr>
<td>Heart</td>
<td>NRBC/17</td>
<td>2500</td>
<td>2(f)</td>
<td>-</td>
</tr>
<tr>
<td>Skin</td>
<td>NRBC/22</td>
<td>1800</td>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>Blood:</td>
<td>RI06/2003</td>
<td>3300</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>20.11.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood:</td>
<td>RI06/2004</td>
<td>1500</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>23.11.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine(d):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.11.06</td>
<td>Measurement: AWE</td>
<td>825 per ml</td>
<td>1.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Signed: J.HARRISON

Signature Witnessed by:

2006/07(1)
(a) Obtained using data for organ masses, and blood, urine and bile volumes given by ICRP (2002).
(b) For an estimated intake by ingestion of 4.4 GBq polonium-210 on 1.11.06 and 10% absorption to blood, applying a model for the behaviour of polonium-210 in the body developed by Legget and Eckerman (2001). (Mr LITVIENKO died on 23/11/2006).
(c) Assuming that the concentration of polonium-210 in muscle is representative of "Other" tissues in the model used to describe the behaviour of polonium-210 in the body after absorption to blood.
(d) Measurements reported in the original witness statement are shown in italics.
(e) Daily faecal excretion on day 22 after intake.
(f) Including blood content.

Table 1 shows the results of measurements of the polonium-210 content of post-mortem specimens obtained from Mr LITVIENKO's body. All measurements other than that for urine were made at HPA CRCE using gamma spectrometry. Thus, although polonium-210 decays to stable lead-206 with the emission of one alpha particle for each atom decaying, there is also a characteristic release of gamma rays that distinguishes polonium-210 from other radionuclides. The measurement on a urine sample from Mr LITVIENKO was reported to HPA by the Atomic Weapons Establishment, Aldermaston (AWE). Measurements on samples of lung, spleen, kidneys and liver (at HPA CRCE) and urine (AWE) were presented in the original witness statement that I provided and are repeated here. Measurements on samples of mesentery, testicle, muscle (psoas), brain, bile, heart, skin and blood (at HPA CRCE) are presented here for the first time.

Measurements reported in the original witness statement and estimated intake by ingestion

Measurements that I reported in my original witness statement are shown in italics in Table 1. These were used to estimate intake by ingestion. The low concentration of polonium-210 in lung tissue was consistent with inhalation being a minor route of intake, estimated as <5% of total intake. The possibility of a small intake by inhalation was ignored and intake was assumed to be wholly by ingestion, with absorption of blood being assumed to be 10% of intake. A best
estimate of intake by ingestion was made on the basis of results for the concentration of polonium-210 in liver, kidneys and urine; the result for spleen was not included because model predictions of retention of polonium-210 in spleen are less reliable. The best estimate was 4.4 GBq (4,400 million Bq), assuming intake by ingestion on 1.11.06 and 10% absorption to blood. More precisely, the estimated absorption to blood was 0.44 GBq (440 million Bq), with the calculation of intake being dependent on the assumed absorption to blood. If, for example, absorption was 20% instead of 10%, intake would have been estimated as 2.2 GBq. The estimates of intake based separately on the kidney, liver and urine measurements were within 30% or less of the best estimate, giving confidence that modelling assumptions had remained valid despite the gross tissue damage and loss of function implied by these activities.

Blood

Potentially the most informative of the additional measurements presented in this statement are those for blood samples, although it should be noted that there is no "chain of evidence" prior to receipt of these samples at HPA CRCE. Model predictions of levels of polonium-210 in blood can be regarded as reliable since they are based on good data for animals and humans. The total estimated activity in blood on 20/11/2006 of 19 MBq appears reasonably consistent with the model prediction of 25 MBq. However, the observed reduction by 55% in the measured concentration of polonium-210 in blood between 20/11/2006 and 23/11/2006 compares with a model prediction of a reduction of about 9% over this 3 day period. The estimated total blood content of 8 MBq on 23/11/2006 is a substantially lower than the model prediction of 23 MBq.

Basing the estimated intake by ingestion on the blood measurement on 20/11/2006 as well as those for liver, kidney and urine decreases the value obtained from 4.4GBq to 4.1 GBq.

Bile

The measured concentration of polonium-210 in bile at death is consistent with biliary excretion being the primary or sole route of faecal loss of activity and is also consistent with a low rate of bile production at this stage.

Signed: J.HARRISON
2006/07(1)
Muscle

The measurement of polonium-210 in muscle tissue of 1100 Bq g⁻¹ is identical to an early measurement by gamma spectrometry (on 26/11/2006) and not significantly different from a measurement by alpha spectrometry on a sub-sample of the early sample (1000 Bq g⁻¹). The concentration of 1100 Bq g⁻¹ gives an estimate of total activity in tissues and organs assigned to a compartment labelled "Other" in the Leggett and Eckerman (2001) model that is remarkably close to the model prediction (72 MBq compared to 73MBq). The closeness of this agreement must be regarded as fortuitous since it is likely that polonium-210 concentrations in the organs and tissues included in "Other" in the model will be variable.

Testicle

The estimated total retention of polonium-210 in testes is a factor of 3-4 lower than the model prediction. However, as for the spleen, model predictions of gonadal retention of polonium-210 are based on limited data.

Skin

The total estimated retention of polonium-210 in skin is a factor of 6 lower than the model prediction. While it is likely that concentrations will vary between different skin regions, this estimate may suggest that model predictions based largely on animal data may overestimate retention in human skin. Another possibility is that damage to hair follicles and hair loss may have reduced retention in skin.

2) Conclusions

Potentially the most informative additional measurement result is the blood concentration of polonium-210 on 20/11/2006 although there is evidence that concentrations of polonium-210 in blood were falling more rapidly than model predictions. Taking account of the result for
polonium-210 in blood on 20/11/2006 (Table 1) would lower the best estimate of intake by ingestion, assuming 10% absorption to blood, from 4.4 GBq to 4.1 GBq, a difference of less than 10%. Measurements of the concentration of polonium-210 in muscle tissue are very close to model predictions for tissues including muscle, but the closeness of agreement should be regarded as a chance occurrence. The concentration of polonium-210 in bile was consistent with model predictions of faecal excretion via the liver. Concentrations of polonium-210 in testes and skin are at variance with model predictions, but the data used in the model are limited.

- The additional results provide supporting evidence of a large intake of polonium-210.
- The best estimate of intake by ingestion, assuming 10% absorption to blood, remains in excess of 4GBq.
- The additional results do not challenge the original conclusions regarding cause of death, with bone marrow failure likely to be an important contributor, as a component of multiple organ failure.

Radioactivity conversions:

1 GBq = 1000 million Bq
1 MBq = 1 million Bq
1 kBq = 1000 Bq
1 Bq = 1 decay per second

One becquerel (Bq) of polonium-210 releases, on average, one alpha particle per second. One megabecquerel (MBq) of polonium-210 releases 1 million alpha particles per second.

References