NATIONAL PHYSICAL LABORATORY
Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

Test Report

UKAS TESTING
0002

Determination of Attenuation Properties of Materials using Diagnostic X-Radiation

FOR: Infab Corporation
1040 Avenida Acaso
Camarillo, CA 93012
USA

DESCRIPTION: Determination of Attenuation properties of Lightweight Lead material according to BS EN 61331-1:2014 using the INVERSE BROAD BEAM geometry.

DATE OF MEASUREMENTS: 03-06 June 2016

Reference: 2016060384_3
Date of Issue: 01 August 2016
Checked by:

Signed:
Name: G A Bass

(Authorised signatory)
on behalf of NPLML

CONDITIONS:

Distance from x-ray tube to target sample: 0.8m
Ionisation chamber used: PTW TW34060-2.5 s/n 000259

All equipment associated with the measurements performed in this report has direct traceability to UK national standards or UKAS accredited calibration facilities.

Table I
61331-1:2014 X-ray beam qualities

X-ray Tube Voltage kV	Total filtration mmAl*
50	2.5
70	2.5
90	2.5
110	2.5
120	2.5

*The inherent filtration of the x-ray tube was determined to be 0.5mmAl equivalent

RESULTS:

$$\text{Attenuation ratio } F_{IB} = \frac{\dot{K}_0 - \dot{K}_B}{\dot{K}_1 - \dot{K}_B}$$

$$\text{Attenuation \%} = 1 - \left(\frac{\dot{K}_1 - \dot{K}_B}{\dot{K}_0 - \dot{K}_B}\right)$$

where $\dot{K}_0$ = Air Kerma Rate without the test object in the beam
$\dot{K}_1$ = Air Kerma Rate with the test object in the beam
$\dot{K}_B$ = Background Air Kerma Rate with the test object replaced by a sheet of material with an attenuation ratio greater than 10^5.

Table II
KIARMOR Bi-layer Low Lead, sample 2, 0.25mm nominal Lead equivalent

kV	Equivalent Lead thickness mm	Attenuation Ratio F_{IB}	Attenuation %	PASS/FAIL
50	0.2450	98.20	99.0	PASS
70	0.2717	28.04	96.4	PASS
90	0.2801	12.84	92.2	PASS
110	0.2712	8.197	87.8	PASS
120	0.2653	7.023	85.8	PASS

Table III
KIARMOR Bi-layer Low Lead, sample 3, 0.35mm nominal Lead equivalent

kV	Equivalent Lead thickness mm	Attenuation Ratio F_{IB}	Attenuation %	PASS/FAIL
50	0.3709	458.9	99.8	PASS
70	0.3758	63.97	98.4	PASS
90	0.3773	22.18	95.5	PASS
110	0.3619	12.94	92.3	PASS
120	0.3530	10.79	90.7	PASS

Table IV
KIARMOR Bi-layer Low Lead, sample 2 doubled over, 0.50mm nominal Lead equivalent

kV	Equivalent Lead thickness mm	Attenuation Ratio F_{IB}	Attenuation %	PASS/FAIL
50	*	*	*	*
70	0.5401	169.3	99.4	PASS
90	0.5459	44.35	97.7	PASS
110	0.5096	23.31	95.7	PASS
120	0.4952	19.02	94.7	PASS

*The ionisation current was too low to be accurately measured compared to the background leakage current. This implies that the attenuation is greater than 99.9%. Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

UNCERTAINTIES

The uncertainty in the Lead equivalence is ±5%. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%.

Clause 5.5.3 of IEC 61331-1:2014 states that a relative standard uncertainty of 7% be taken into account in the decision of conformity in assigning the class of the Lead equivalent thickness to the material under test. If t_{Pb} is the standard Lead equivalent thickness class (0.25mm, 0.35mm, 0.5mm or 1mm) and δ_{IB} is the Lead equivalence of the material under test, the condition can be written as:

$$\delta_{IB} \geq 0.93 t_{Pb}$$