TO: Georgia Department of Natural Resources

ATT: Mr. Slocumb

FAX NO:

DATE: Mar 2, 1993

NUMBER OF PAGES: (incl. this sheet) x

CC: x

x

FROM: Jukka Perento

RE: Lisence application for Tapio Paper Variabilty Analyzer, State of Georgia

We have got the statement from Altlan Tech about the new BW-2h55 model. P
enclosed.

As You see they are saying that the modifications made do not effect to the radiation pro... ...red.
H... has also promised that if You do have any questions You may call directly to him for further
...ifications.

If there are a... information missing from the package I both faxed and mailed You last week,
pls let us know.

BR Jukka Perento

011 358-0-4354 2008

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MAR 02 1993
RADIOACTIVE MATERIALS PROGRAM

Measurement of the Stray Radiation Profile for the TAPIO Model BW-2h54 Basis Weight Sensor

Prepared for:
Makkonen Associates
Two Rivinia Drive
Suite 1470
Atlanta, GA 30346

October 21, 1992

Prepared by:

Robert E. Burns, Jr.

Reviewed by:

James M. O'Brien, Jr.

ATLAN-TECH, INC.
1345 HEMBREE ROAD, ROSWELL, GA 30076 P.O. BOX 2267-30077
(404) 442-1067, FAX (404) 442-8445

INTRODUCTION

Atlan-Tech, Incorporated was contracted by Dan Matics of Makkonen Associates to perform measurements for the purpose of determining the stray radiation profile of a TAPIO model BW-2h54 Basis Weight Sensor. The purpose of these measurements was to aid the effort to obtain a distribution license for this device from the Georgia Department of Natural Resources (DNR) Radioactive Materials Program. The representative of the Georgia DNR responsible for approving this device for distribution is Elizabeth Drinnon. The guidance used for performing these measurements, as specified by Ms. Drinnon, was American National Standards Institute (ANSI) Standard N538-1979 entitled "Classification of Industrial Ionizing Radiation Gauging Devices." The measurements were performed in accordance with the requirements of section 7.3 of this standard, entitled "Stray Radiation."

The model BW-2h54 Basis Weight Sensor is a device that is installed on a TAPIO paper variability analyzer for the purpose of measuring the density thickness of paper products that are being tested. The sensor essentially consists of a source of ionizing radiation and a detector. The source used is a nominal 200 mCi of the low-energy beta emitter ^{147}Pm. The source is oriented so that the electrons being emitted are directed on to the surface of the paper specimen being passed through the sensor. A photomultiplier tube on the side of the paper opposite the source then quantifies the attenuated electron fluence that passes through the specimen. This data is then used to mathematically compute the density thickness of the specimen utilizing an exponential equation. The sensor has a rotating four position shutter mechanism that is operated automatically when the device is in use. The first position is the shielded "OFF" position, while the other three are circular apertures of increasing diameter. These three aperture sizes offer different beam diameters that may be focused on to a specimen being tested.

METHODS AND MATERIALS

The detection instrument used for all measurements was an Eberline model RO-4D digital ionization chamber. The chamber was calibrated to a ^{137}Cs gamma source one day prior to performing the measurements. The source used to calibrate the ion chamber had a calibration traceable to the National Institute of Standards and Technology (NIST). After calibrating the instrument to the ^{137}Cs source, its was then characterized using a ^{147}Pm NIST secondary standard to confirm acceptable response to an electron fluence from the isotope of interest. The response of the instrument was found to be 13% lower than the actual absorbed dose rate from the ^{147}Pm standard, which is within the ±15% required by the N538-1979 standard. The entrance window of the model RO-4D has a nominal density thickness of 7 mg cm^{-2}. In order to facilitate measurements at 300 mg cm^{-2}, a 293 mg cm^{-2} attenuator was constructed using layered thicknesses of tissue equivalent material.

The methodology employed for the stray radiation profile consisted of performing measurements at points around the periphery of the gap through which paper passes through the sensor. These measurements were performed at distances of 5 cm and 30 cm from the surface of the sensor with the detector as close as possible to the plane of the sensor gap. All measurements were performed with the source exposed through the largest of the three aperture diameters. Due to the position of the sensor as it is installed on the paper analyzer, it was not always possible to get the detector directly in the plane of paper travel due to obstructions caused by rollers and additional sensors on the analyzer. In these cases, the measurements were performed as close as possible to the plane of paper travel with the detector either slightly above or below the travel plane. In addition to taking measurements along the sensor gap, measurements were also taken directly above and directly below the sensor and at various angles between these locations and the plane of paper travel. Whenever possible, measurements were taken both at the 7 mg cm^{-2} and 300 mg cm^{-2} depths in order to distinguish exposure from beta radiation from that due to any bremsstrahlung. Some measurements had to be taken through the side wall of the detector as this was the only way to fit the instrument between one of the rollers and the sensor while still keeping the active volume in the plane of paper travel. The wall thickness of the model RO-4D is 200 mg cm^{-2}. No measurements were performed at 100 cm from the sensor, as none of the measurements performed at 30 cm were distinguishable from background. Measurements within the gap space were not considered, as the gap thickness is less than 2 mm. Measurements were taken at the surface of the sensor housing with the source in its shielded position after all of the measurements with the source exposed had been completed.

RESULTS

The highest absorbed dose rate measured at the surface of the sensor at the 7 mg cm^{-2} depth was 13.8 mrad hr^{-1}. This value was corrected for the response of the RO-4D chamber to ^{147}Pm. The highest value measured for the 300 mg cm^{-2} depth was 0.1 mR hr^{-1}. This value occurred at the same point on the surface of the sensor as the maximum value for the shallow (7 mg cm^{-2}) depth. The point where these dose rates were found lies on the five cm isodistance line in the plane of paper travel through the sensor. It is on the left side of the sensor if facing it from the front and corresponds to the location of the ^{147}Pm source within the sensor housing. The same location on the right side of the sensor was not accessible for measurement directly in the plane of paper travel due to the location of a roller. Measurements taken directly above and below the plane of travel at this point yielded no measurable exposure. The only other location where any measurable stray radiation being emitted from the sensor was detected was the very front of the sensor at the 5 cm distance. Again, this point was in the plane of paper travel. An absorbed dose rate of 0.5 mrad hr^{-1} was measured at this point for the shallow dose depth, while there was no measurable exposure at the 300 mg cm^{-2} depth. All other points where measurements were taken yielded no measurable exposure.

In order to determine if there was any stray radiation streaming through the sensor gap at a point other than directly adjacent to the location of the source within the sensor housing, a measurement was taken on the left side of the sensor housing where it mounts to the variability analyzer. This measurement was taken with the detector active volume centered in the plane of the gap and with the side wall of the chamber in contact with the sensor housing. This measurement was thus taken at a dose depth of 200 mg cm^{-2} at a distance of 5 cm from the

sensor surface. It had to be performed through the detector wall and not its entrance window because of the location of a another sensor. This measurement yielded no measurable exposure at this point. As mentioned above, these same locations could not be accessed on the right side of the sensor because of the location of a roller, but measurements directly above and below these points yielded no measurable exposures either.

Once all the measurements performed at the 5 cm distance had been completed, measurements were taken at 30 cm from the sensor housing at points corresponding to all locations where the 5 cm measurements were made. These measurements were taken at both the 7 mg cm^{-2} and the 300 mg cm^{-2} dose depths. None of the measurements taken at any point on the 30 cm isodistance line yielded any measurable exposure. It was therefore deemed unnecessary to make any measurements at the 100 cm distance.

After all of the measurements performed with the source exposed had been completed, a measurement was taken with the source in its shielded position at the point where the maximum dose rate had been found. This measurement yielded nothing over background. Additional measurements were performed with the source shielded at other points on the sensor housing with the same result.

CONCLUSIONS

[redacted]