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An Aerial Radiological Survey of the Las Vegas Strip and Adjacent Areas

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for the U.S. Department of Energy
National Nuclear Security Administration

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Reviewed by

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Derivative Classifier

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RSL-Nellis Analysis of Aerial Survey Radiological Data of the Las Vegas Strip

Overview

As proficiency training for the Radiological Mapping mission of the Aerial Measuring System (AMS), a survey team from the Remote Sensing Laboratory–Nellis (RSL-Nellis) conducted an aerial radiological survey of the Las Vegas Strip and adjacent areas on December 29, 2008. This survey was one of the bi-annual surveys carried in support of the city of Las Vegas Police Department (LVPD) before significant events on the Las Vegas Strip: e.g., the annual New Year's Eve and July Fourth celebrations. The AMS operation and appropriate law enforcement agencies selected this area as an appropriate urban location to exercise AMS capability for mapping environmental radiation and searching for man-made radioactive sources.

The surveys covered approximately 11 square miles. Each survey required a 2.5-hour-long flight, performed at an altitude of 300 ft above ground level (AGL) at a line spacing of 600 ft. Water line and test line flights are conducted over the Lake Mead and Government Wash areas to determine the non-terrestrial background contributed by aircraft, radon, and cosmic activity, and to determine the altitude-dependent air mass correction.

The data were collected by the AMS data acquisition system (REDAR V) using an array of twelve 2" x 4" x 16" sodium iodide (NaI) detectors flown on-board a twin-engine Bell 412 helicopter. Gamma energy spectral data were collected second-by-second over the survey area. This spectral data allows the system to distinguish between natural terrestrial background contributions and man-made radioisotope contributions. Spectral data can also be used to identify specific man-made radioactive isotopes. Data geo-locations were determined with a Real-Time Differential Global Positioning System (RDGPS).

Flight Path

The flight path for the December 29, 2008, survey is presented in Figure 1. The flight paths for all surveys are nominally the same as in the previous survey, except near McCarran International Airport where air traffic sometimes has restricted access and the north-western boundary of the city which was extended in the last survey to better cover known medical facilities.

Exposure Rate Derived from Measured Gross Counts

The estimated wide-area exposure rate was derived from the total count rate activity measured at helicopter flight altitude. Corrections were applied to the total count rate to remove non-terrestrial background, to correct for air attenuation, and to convert the resulting net counts to a nominal ground-level exposure rate. Mathematically, the exposure rate relation can be written:

$$ER = \frac{(GC - Bgr)e^{-((RA-300)\times 0.001616)}}{1383}$$

Where,

ER = estimated exposure rate in microR/hr at 1 meter above ground level (AGL),
GC = gross counts/second (cps) measured at altitude by the survey system (38 to 3026 keV),
Bgr = background cps due to aircraft, radon, and cosmic (38 to 3026 keV),
RA = aircraft altitude in ft AGL,
0.001616 = altitude correction coefficient in inverse feet,
1383 = exposure rate conversion number in counts per second (cps) @ 300 ft AGL (survey altitude) per (microR/hr) @ 3 ft AGL.

Exposure Rate Maps

Figure 2 is a color-coded, exposure-rate map for the surveyed area. The exposure rate variability observed within each map is typical of that produced by differences in geology, building and paving materials, and natural ground cover. The exposure rate patterns from this and previous surveys are in substantial agreement.

Man-Made Activity Algorithm

Radiation emitted by man-made sources is often hidden within the relatively large variations of gross counts observed from normal environmental radioactivity. A special "man-made" algorithm utilizes gamma spectral information to suppress environmental background activity and highlight man-made activity. In regions with only natural environmental activity, the indicated man-made activity is nominally zero. For elevated, low-energy activity (below 1400 keV, typical of man-made isotopes), the algorithm gives a positive number. For elevated high-energy activity (above 1400 keV, atypical), the algorithm gives a negative number. For the Las Vegas Strip surveys, the man-made "lowest statistically significant" level was set at +/- 500 cps to allow only a few false indications out of 1,000 measured values. The "bullseye" features of the man-made maps show activity far in excess of the 500 cps threshold. Mathematically, the man-made algorithm has the form,

$$MM = A - K \times B$$

Where, MM = manmade activity in counts per second,
A = total counts in the spectral window 38 keV through 1394 keV,
B = total counts in the spectral window 1394 keV through 3026 keV,
K = empirical constant from flight data in an area where no man-made activity resides.

Man Made Activity Maps

Figure 3 is a color-coded, man-made activity map for the surveyed area. Only a few areas indicate statistically significant man-made activity. Spectral data were taken from the revealed man-made activity regions.

Anomalies

During the flight, a significant radiological anomaly (defined as a count rate over 6 times sigma over background) was detected at latitude 36.163112 and longitude 115.16987. Further analysis put that geographical location just west of Valley Hospital Medical Center in the parking lot. The spectrum collected over the anomaly was submitted to Triage for analysis as event number TE-08-280. The net collected summed spectrum and triage report is presented in Figure 4.

Final Products

RSL-Nellis final map products include paper and electronic (pdf format) contour maps of gross-count derived exposure rates and man-made gross counts for the Las Vegas Strip and vicinity. In addition, a CD with GIS shape files in ESRI ArcMap 9.2 format, Adobe pdf images, and some aerial photographs of the surveyed areas are being provided.

Summary

The radiation background survey carried out over the Las Vegas Strip and vicinity shows typical variations in the natural background radiation. The measured values varied from 0 to 5 microR/h, with radon and cosmic contributions removed. For comparison, Figure 5 shows the levels of the terrestrial natural background levels across the United States covering the same range of values as measured during this survey. One significant area of man-made activity was detected during the survey activities and was analyzed by Triage. Scattered low-level indications were not statistically significant.

Table 1. Personnel

Name	Position
Piotr Wasiolek	AMS Mission Manager
Craig Marianno	AMS Mission Manager
Joseph Ginanni	Federal AMS Manager
Karen McCall	AMS Manager
Tom Selfridge	Pilot
Tom McKissack	Pilot
Tuyet Nguyen	Data Analyst
Tom Stampahar	Electronic Technician
Joe Cummings	Mechanic

Table 2. Survey Parameters

Location	
Name of Location	**Las Vegas Strip and Vicinity**
Nominal Elevation	2,175 feet
Dimensions	
Length	Irregular, max = 36,400 feet
Width	Irregular, max = 15,200 feet
Perimeter	Las Strip with 270s at North and South Ends
Survey	
Type of Survey	Background/proficiency
Number of Areas	One
Coverage	~14 square miles
Altitude	300 feet AGL
Speed	70 knots
Line Spacing	600 feet
Average Line Length	Irregular, max = 36400 feet
Number of Lines	29
Total Line Miles	~125
Total Flight Hours	~1.9 on line + access time (15 min/each way)
Total Survey Days	One day (Dec 30, 2008)
Steering	
Base latitude (degrees)	36.125000
Base longitude (degrees)	-115.166667
H offset (feet)	2755
V offset (feet)	6797
Angle (degrees)	61.960797
Min bounds (x,y) (feet))	(-21320, -7300)(-24258, -1678)(-2250, 9800)
Max bounds (x,y) (feet)	(-16860, -7300)(-8960, -3000)(13300, -3000)(13300,9800)
Flight Lines	-12 through +16

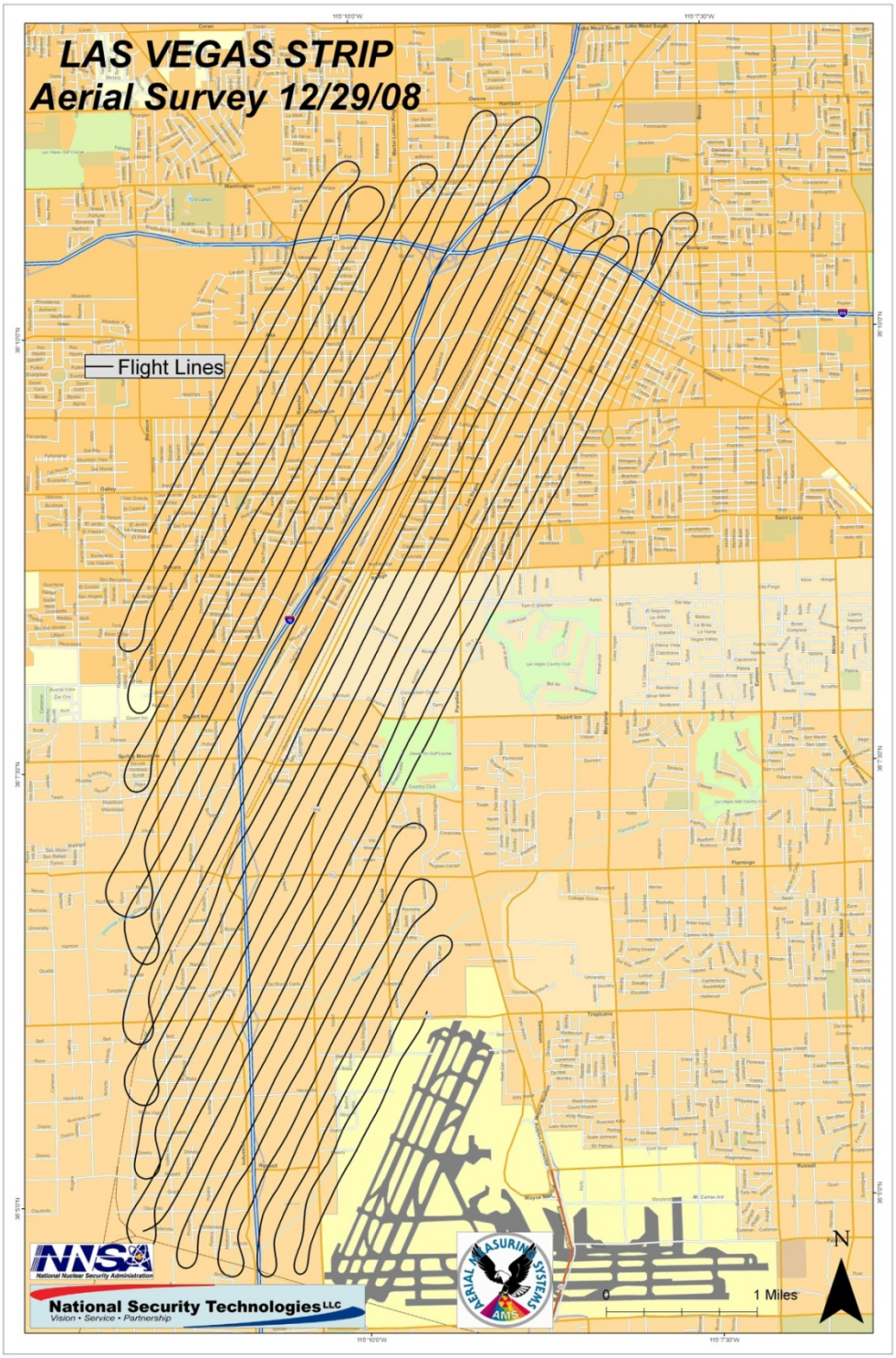


Figure 1. Helicopter Flight Path. December 2008

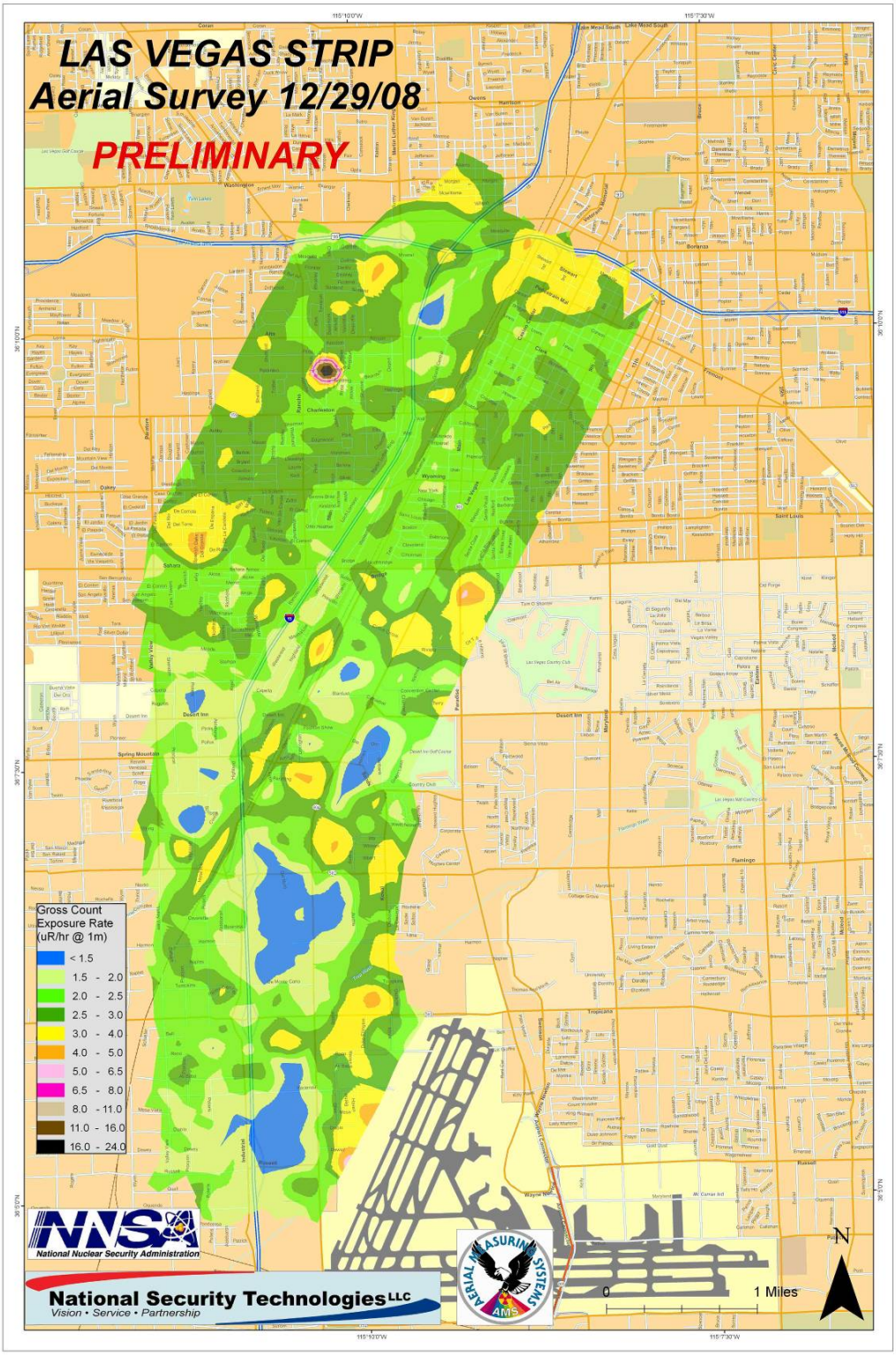


Figure 2. Exposure Rate at 1 m above Ground Level. December 2008

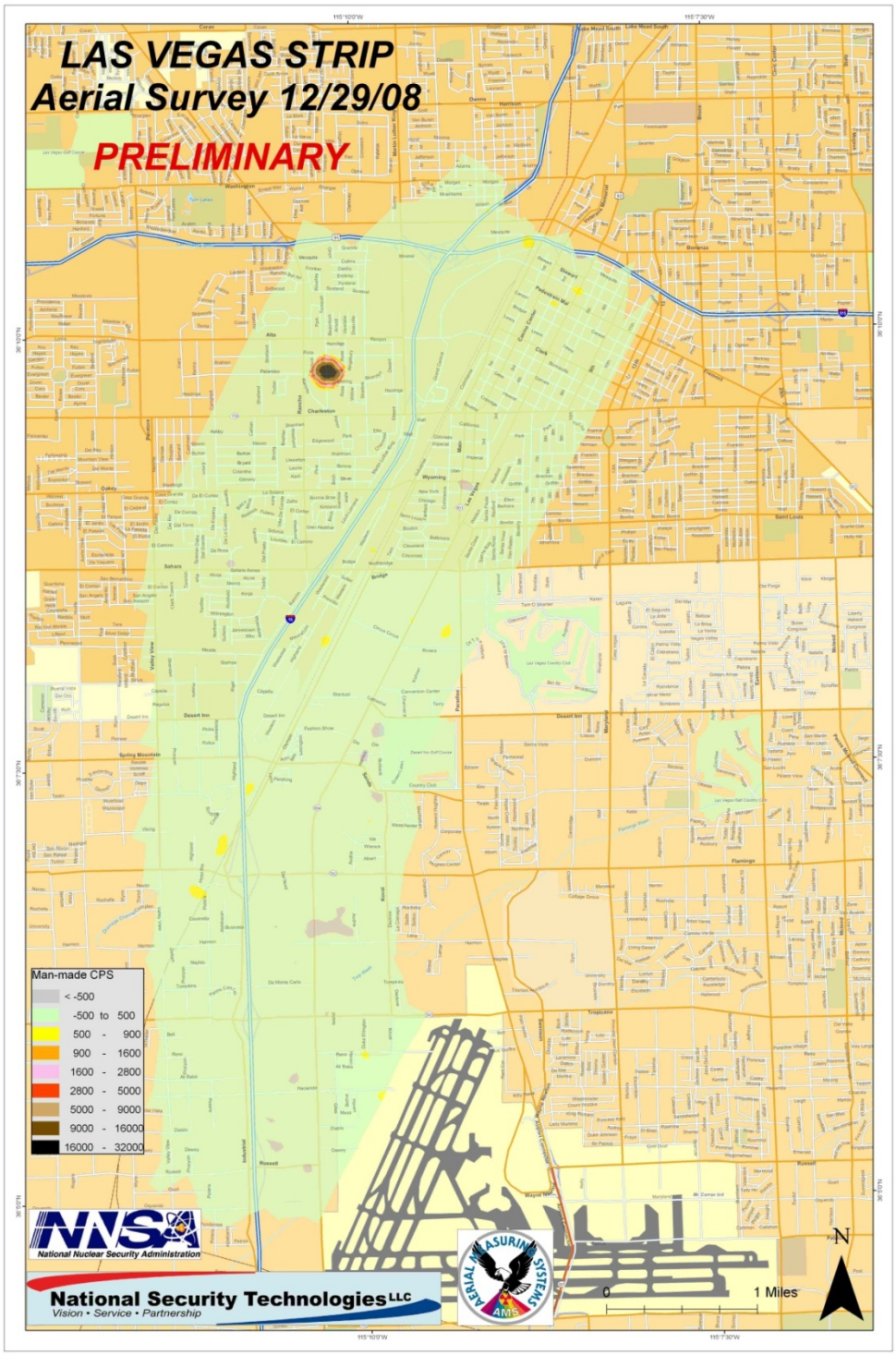
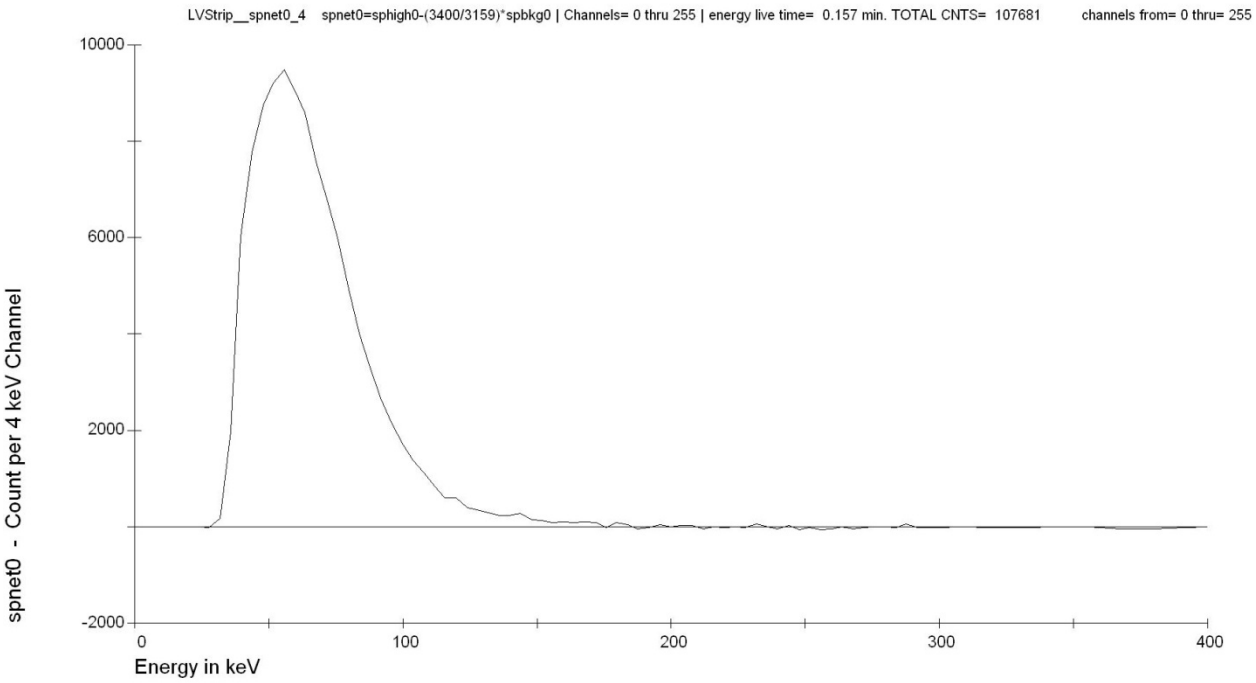


Figure 3. Man-Made Activity. December 2008



It is our conclusion that today's data from RSL appears to be primarily caused by bremsstrahlung x-rays as may be encountered from an x-ray unit or a low energy accelerator. Although the presence of Tc-99 is a possibility, the data in that energy region of the spectra (140 keV) are only elevated in a single channel. Most NaI spectra of that isotope will spread the signal out over a few channels on either side of 140 keV. We believe there is a low probability that Tc-99 is indicated here. Finally, there are no indications of any threat materials in the data.

Figure 4. Low Energy Net Spectrum and Triage Report of the Anomaly Detected on December 29, 2008

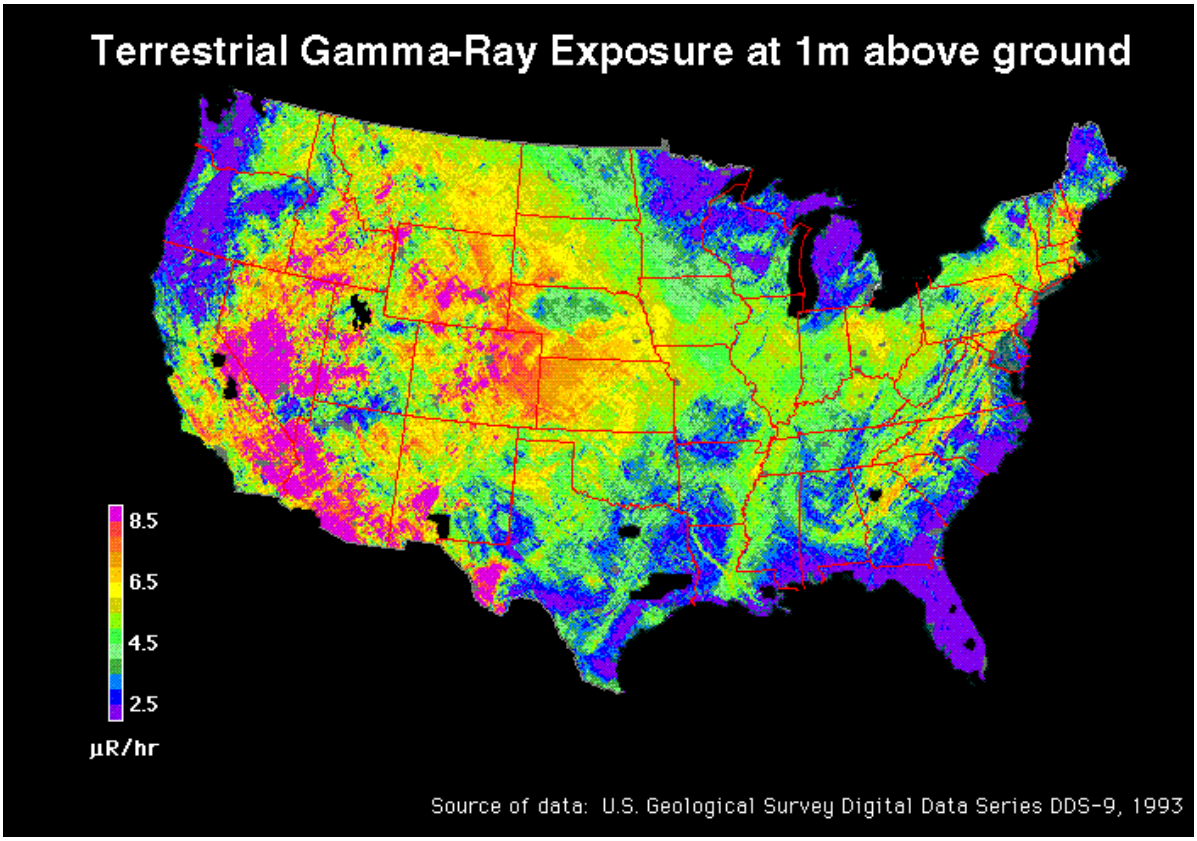


Figure 5. Terrestrial Gamma-ray Exposure at 1 m above Ground