APPENDIX A-7

Additional RF Report, September 5, 1999

RICHARD TELL ASSOCIATES, INC.

A Reevaluation of Radiofrequency Fields on the World Trade Center North Tower

A Supplemental Report

September 5, 1999
Revised March 21, 2000

Prepared for

Motorola
Land Mobile Products Sector

By

Richard A. Tell
Richard Tell Associates, Inc.

(702)645-3338•FAX(702)645-8842•8309Garnet Canyon Lane•Las Vegas, NV 89129

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Background

During June 1997, a comprehensive study of radiofrequency (RF) fields produced by both broadcast and wireless telecommunications antennas located on the roof of the World Trade Center (WTC) North Tower was completed.[1] That study was focussed on examining the aggregate RF fields at roof-level resulting from the normal operation of the various FM radio and VHF and UHF television broadcast stations. In addition, a tower maintenance mode of operation[2] that is used during times that personnel must climb the central antenna mast on the roof to conduct various maintenance activities was investigated. In the interim since that study, some communications transmitters were removed from operation. The purpose of this study was to reevaluate the expected RF field environment on the roof of the north tower under these two operating modes.

Review of the Method

The approach used in the initial study included measurement and analysis components. Measurement teams collected the field measurement data using isotropic, broadband, conformal electric field probes. Analysis was accomplished with a modified version of the RoofView® RF modeling program[3]. Detailed measurements of the RF fields resulting from broadcast transmitters were performed in a grid-like fashion on the roof during normal and tower maintenance modes of operation. These measurement data, collected at approximately five-foot intervals for a total of 889 measurement points, were then interpolated to arrive at estimates of field levels for every one foot of dimension on the roof. The measurement data were obtained with all wireless communications antennas turned off, except for several 72 MHz band paging link antennas. The contribution of the many wireless communications antennas to the RF environment was assessed by calculation, taking into account the location of each antenna and other technical information such as frequency, aperture height, mounting height and input power. The modified RoofView® program was used to combine the results of the extensive measurement data with the calculated results for the wireless antennas to arrive at an overall picture of the RF environment that would be expected to exist from the simultaneous operation of all transmitting equipment for both operating scenarios.

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[1] Tell, R. A. (1997). *An Evaluation of the Radiofrequency Environment at the World Trade Center North Tower*. Prepared by Richard Tell Associates, Inc. for Motorola, 53 p. September 29, 1997.

[2] During the tower maintenance mode of operation, UHF TV stations cease operation and VHF TV stations operate from much lower mounted auxillary antennas and channel 4 operates from the Empire State Building.

[3] RoofView® is a registered trademark of Richard Tell Associates, Inc.

Graphic representation of the composite RF field levels on the roof are depicted as a colorized map with various colors representing different ranges of RF field levels. For purposes of this reevaluation, the RF exposure limits prescribed in Federal Communications Commission (FCC) rules for occupational/controlled exposures were used[4]. Thresholds in the RoofView® program were set to obtain RF field ranges of 0 to 20% of the MPE, 21-50% of the MPE, 51-100% of the MPE and fields exceeding 100% of the MPE. The software automatically converts computed RF power densities into an equivalent percentage of the applicable MPE for each transmitter allowing convenient summing of the aggregate fields relative to the exposure limits.

Notes on Reevaluation Methodology

Prior to any subsequent analysis, the antenna and transmitter inventory at the WTC was once again studied by physically examining the roof-top and determining the number of transmitters combined on each antenna and their power levels. In this process, three-way antennas[5] were modeled as though they were three separate antennas having the same x-y coordinates on the roof but with different mounting heights. In the earlier study, these antennas were modeled as a single antenna having an overall vertical aperture height equal to the sum of the three separate apertures with a total power equal to the sum of the antenna input powers delivered to all three antennas. The antenna data used in this reevaluation are presented in Table 1. The inventory was obtained during March, 1999.

Another factor, relevant to the reevaluation, is that the RoofView® modeling software has been improved since the earlier study. The program now has the ability to more accurately model the spatially averaged fields as a function of aperture height and antenna mounting height. These changes, in addition to the changes in the number of active transmitters, will tend to introduce differences in the results. In some cases, these enhancements may result in higher computed fields while for certain conditions may result in lower computed fields for some antennas.

Reevaluation Results

The results of the new reevaluation are presented in Figures 1 and 3 for the normal and tower maintenance modes of operation of the broadcast stations respectively. For each figure, a chart beneath the roof field map summarizes the extent of the roof area, in terms of square footage and as a percent of the area, that is projected to have calculated, composite RF fields within the ranges described above. These figures provide a convenient way for envisioning the aggregate RF fields at each one square foot pixel on the roof. The roof area used in computing the percentages represents the total study area

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[4] The Maximum Permissible Exposure (MPE) represents a particular plane wave equivalent power density and is specified in the FCC rules according to frequency.

[5] A three-way antenna is an antenna containing three physically separate apertures located along the vertical axis of the antenna that can be separately driven with transmitters.

minus the areas associated with the stairwell, the central antenna mast area and the window washer equipment well (this amounts to a total area of 27,205 square feet).

These results, similar to those obtained in 1997, again show that only a very small portion of the roof, less than 1% (0.72%), is projected to have RF fields exceeding the MPE. One area located to the upper right of the central antenna mast area on the figures accounts for half of the total area potentially exceeding the MPE. This is due to the presence of wireless antennas but also a relatively intense background produced by the broadcast operations. The chart below summarizes the differences in roof areas subject to various RF field levels obtained in 1997 and the present reevaluation.

Summary of differences in WTC roof areas subject to different RF field levels obtained during 1997 study and 1999 reevaluation.

Normal broadcasting operations

Percent MPE range (%)	Roof area in this range (ft^2) in 1997	Roof area in this range (ft^2) in 1999	Percent change in 1999 (%)
0-20	4502	5490	+21.9
21-50	16454	17508	+6.4
51-100	5963	4012	-32.7
>100	286	195	-31.8

Tower maintenance mode of operations

Percent MPE range (%)	Roof area in this range (ft^2) in 1997	Roof area in this range (ft^2) in 1999	Percent change in 1999 (%)
0-20	130	194	+49.2
21-50	5695	6283	+10.3
51-100	16891	16948	+0.5
>100	4489	3780	-15.8

The present reevaluation indicates a reduction in the roof area that is subject to RF fields that may exceed the MPE limit. During normal broadcast operations, a projected 32% decrease in roof area above the MPE is obtained relative to the 1997 study. For the tower maintenance mode of broadcast operations, the area above the MPE is projected to decrease by 16%. The effect of this change results in the tendency of increasing the field levels in the lower power density ranges on the roof. The maximum RF field levels at a single point on the roof were found to only marginally reduce in value compared to the 1997 study (see figure captions for the maximum field anywhere on the roof).

Figure 1 was examined in considerable detail to determine what changes in antenna mounting heights would be required to reduce the calculated composite RF field levels to less than the MPE limit at all points on the roof. By using the RoofView® software in an interactive mode, individual hot spots shown on the roof were studied by increasing those antenna mounting heights in one foot increments and recalculating the entire roof until the area near the antenna no longer indicated a blue spot meaning that the composite fields were now below the 100% MPE threshold. Twenty-four antenna mount locations were analyzed to find alternative mounting heights that could reduce roof level fields below the MPE limit. These results are shown in Figure 2 and Table 2. Seven of the

eight three-way antennas were included in Table 2 indicating that low mounted, relatively high power apertures can lead to high RF fields on the roof, unless mounted sufficiently high above the roof. The right hand column in Table 2 shows the final mounting height determined by successive recalculation to bring the composite field below the MPE limit. A common finding during this phase of the work was that VHF band antennas, and especially those with high power, typically led to the areas exhibiting fields exceeding the MPE limit. It must again be emphasized, however, that the relatively high ambient background of RF fields produced by the broadcast stations exacerbates the issue and makes it more problematic to mitigate the roof level fields.

Conclusions

A reevaluation of the RF environment on the roof of the WTC north tower, using improved software analysis, and based on a new inventory of active antennas on the roof in 1999, shows a modest reduction in the area on the roof subject to RF fields potentially in excess of the FCC MPE limit for occupational/controlled exposures. For the normal broadcasting mode of operation, a total of 195 square feet of the roof could be expected to possibly exceed the FCC MPE limit. It is important to emphasize that these calculated results are based on an assumption that all wireless telecommunications antennas on the roof are simultaneously active; this is likely not the case most of the time. Under normal broadcasting conditions, complying with the site guideline of maintaining a minimum clearance of 3 feet from all antennas will likely suffice to control personnel exposures, most of the time. This is not the case for the tower maintenance mode of operation because of the much more intense background of RF fields produced by the lower mounted auxiliary broadcast antennas. During tower maintenance mode of operation, access to the roof should be carefully controlled with due attention paid to the roof field maps for guidance on areas of suspected maximum field levels. The use of personal RF monitors during work on the roof can provide an additional safeguard against excessive exposure and help insure compliance with FCC exposure rules.

Elevating certain antennas on the roof will tend to reduce local fields in the near vicinity of those antennas. While this approach to roof level field mitigation can be effective, personnel training in RF safety issues, the use of personal RF monitors and instigation of specific work practices may prove as effective, and more practical, for insuring compliance with FCC RF exposure rules.

Table 1. Antenna data table used for reanalysis of WTC roof.

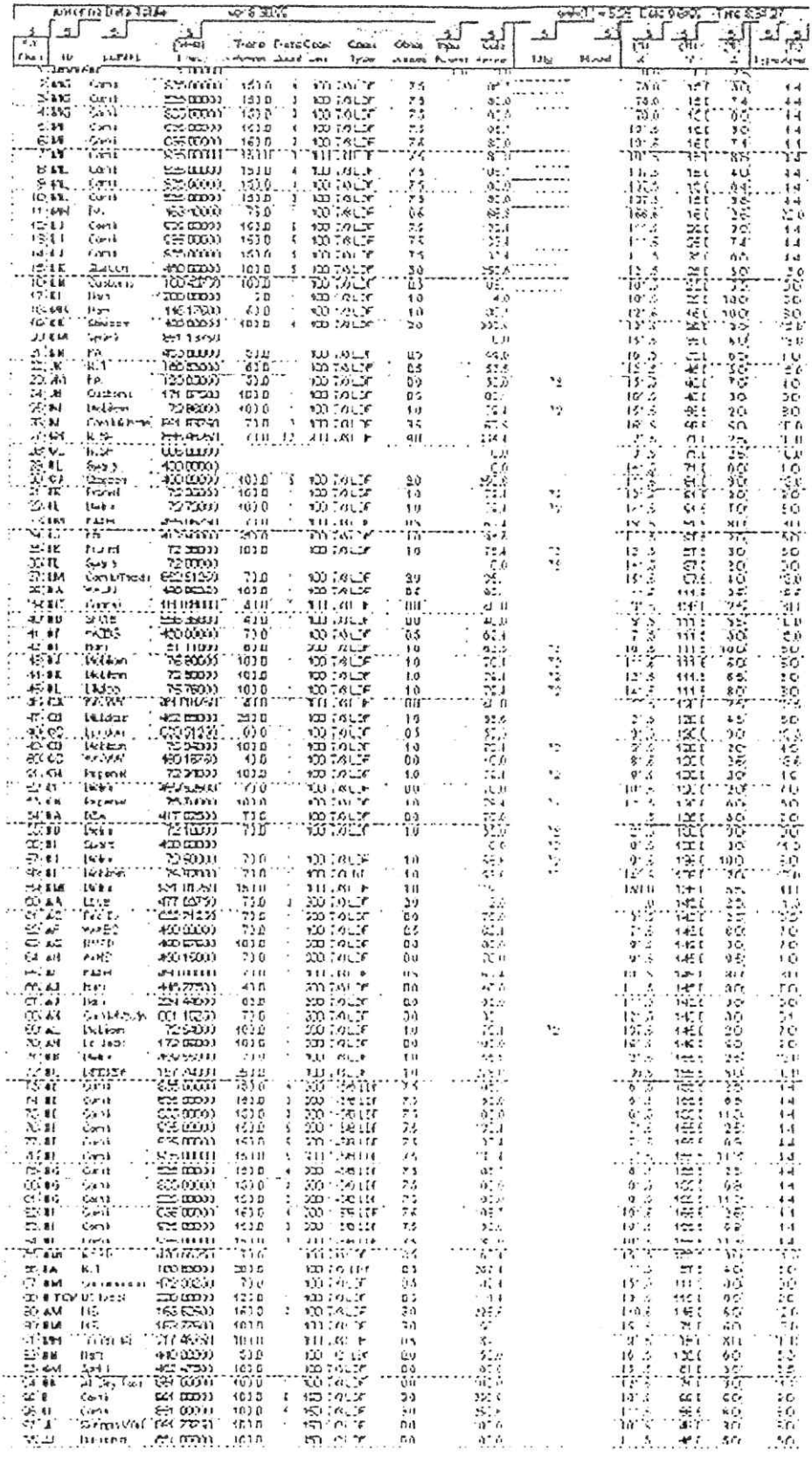

Table 2. Summary of calculated antenna-mounting heights* to achieve RF fields less than MPE.

Antenna	Old mount heights (ft)	New mount heights (ft)
2, 3, 4	3, 7.4, 8.8	4, 8.4, 9.8
5, 6, 7	3, 7.4, 8.8	5, 9.4, 10.8
12, 13, 14	3, 7.4, 8.8	5, 9.4, 10.8
15	3	6
16	5.5	6.5
19	3	6
22	3	4
24	3	5
27	2.5	4
30	3	6
34	2	8
39	2.5	6
47	4.5	6.5
52	2	4
60	2.5	4.5
63	2	5
66, 67	9, 5	10, 6
72	5	7
73, 74, 75	2.5, 6.9, 11.3	4.5, 8.9, 13.3
76,77,78	2.5, 6.9, 11.3	5.5, 9.9, 14.3
79, 80, 81	2.5, 6.9, 11.3	4.5, 8.9, 13.3
82, 83, 84	2.5, 6.9, 11.3	4.5, 8.9, 13.3
86	4	8
93	3	5

*Antenna mounting height is the height above the surface of the roof to the bottom of the active antenna aperture.

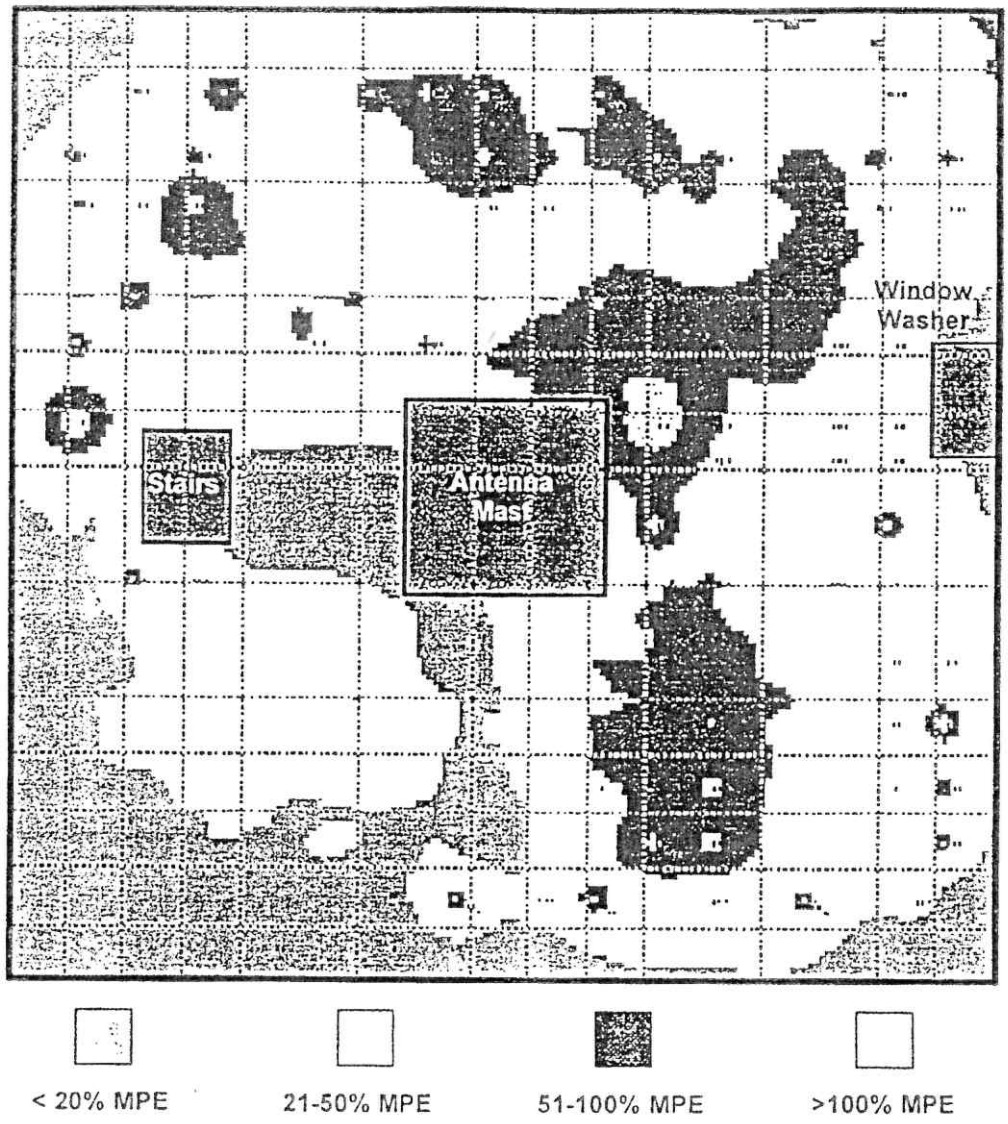

Figure 1. 1999 reevaluation of RF fields from measured ambient fields of normal broadcasting operations with calculated contribution of all wireless telecommunications antennas. Maximum field is 299.6% MPE.

1999 Statistical summary of RF Fields on WTC roof		
Percent occupational MPE range (%)	Roof area in this range (ft^2)	Percent of roof area in this range (%)
0-20	5490	20.18
21-50	17508	64.36
51-100	4012	14.75
>100	195	0.72

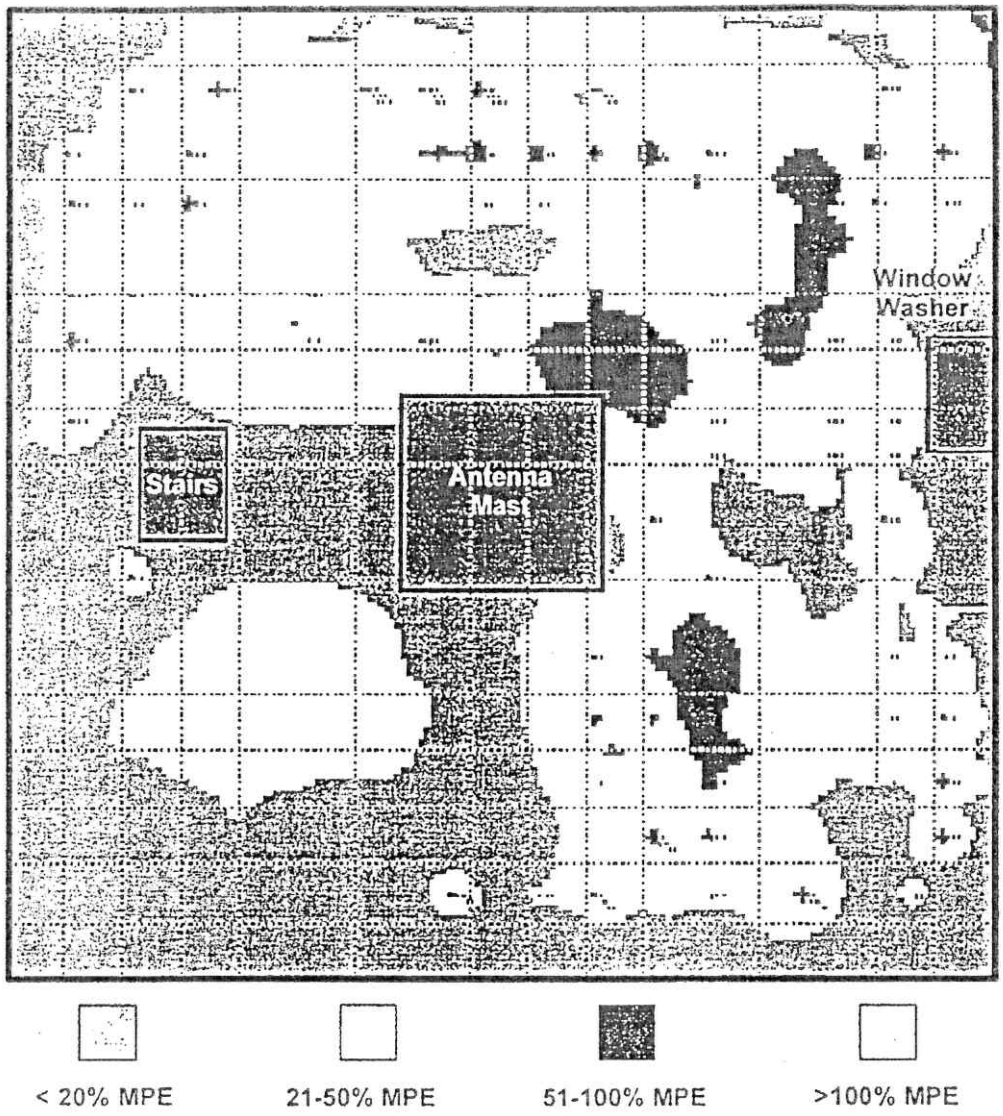

Figure 2. 1999 reevaluation of RF fields from measured ambient fields of normal broadcasting operations with calculated contribution of all wireless telecommunications antennas with selected antennas raised to eliminate fields exceeding MPE. Maximum field is 77.5% MPE.

1999 Statistical summary of RF Fields on WTC roof		
Percent occupational MPE range (%)	Roof area in this range (ft^2)	Percent of roof area in this range (%)
0-20	9810	36.06
21-50	16232	59.67
51-100	1163	4.27
>100	0	0.00

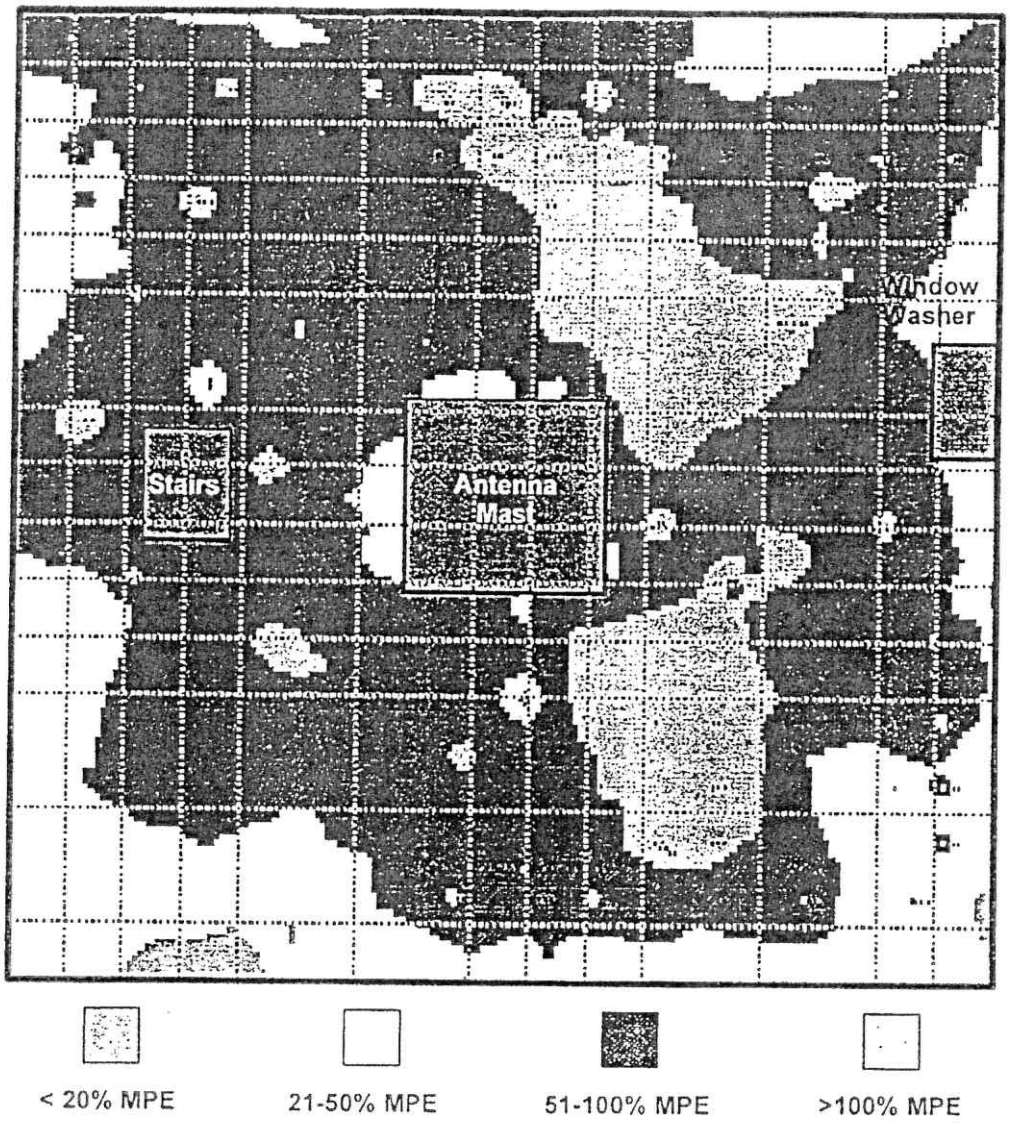

Figure 3. 1999 reanalysis of RF fields from measured ambient fields of tower maintenance broadcasting operations with calculated contribution of all wireless telecommunications antennas. Maximum field is 333.5% MPE.

1999 Statistical summary of RF Fields on WTC roof		
Percent occupational MPE range (%)	Roof area in this range (ft^2)	Percent of roof area in this range (%)
0-20	194	0.71
21-50	6283	23.10
51-100	16948	62.3
>100	3780	13.89

APPENDIX A-8

Memorandum 1/27/2000 Regarding
Radiation Safety Survey, One WTC

THE PORT AUTHORITY OF NY & NJ MEMORANDUM

TO: George Tabeek, Project Manager
FROM: Paul W. Mitchell
DATE: January 27, 2000
SUBJECT: RADIATION SAFETY SURVEY - ONE WORLD TRADE CENTER

COPY TO: N. Chanfrau, D. Karpiloff, M. Plaskon, P. Taylor, G. Wojnar

On December 21, 1999, George DeFreese of my staff conducted the semi-annual Radiation Safety Survey of the Barringer IONSCAN 400 Ion Mobility Spectrometer located in the lobby of 1 WTC. Possession and use of the instrument is in compliance with the conditions of the general license. The instrument's New York State Department of Labor registration number is X-14101.

The survey included an inspection of the storage area and of the instrument, and leak test sampling. The results of the survey are attached. Leak test sampling of the instrument was performed in order to detect removable (leaking) radioactive material from the Nickel 63 sealed source unit. The sample was submitted to Monitoring Services for analysis and the result was found to be acceptable. A copy of the report is attached for your records. A copy of the current leak testing result (not older than six months) must accompany the instrument whenever it is transported.

The next radiation safety survey will be conducted in June, 2000.

If you have any questions about this survey or require information regarding radiation safety, please call me at (201) 216-2173.

Paul W. Mitchell, CIH
Manager
Occupational Health
Inspection and Safety Division

Attachments