EFFECTS OF NOISE ON VHF SATELLITE COMMUNICATIONS

Dr. Roger Dalke

Ph: 303-497-3109

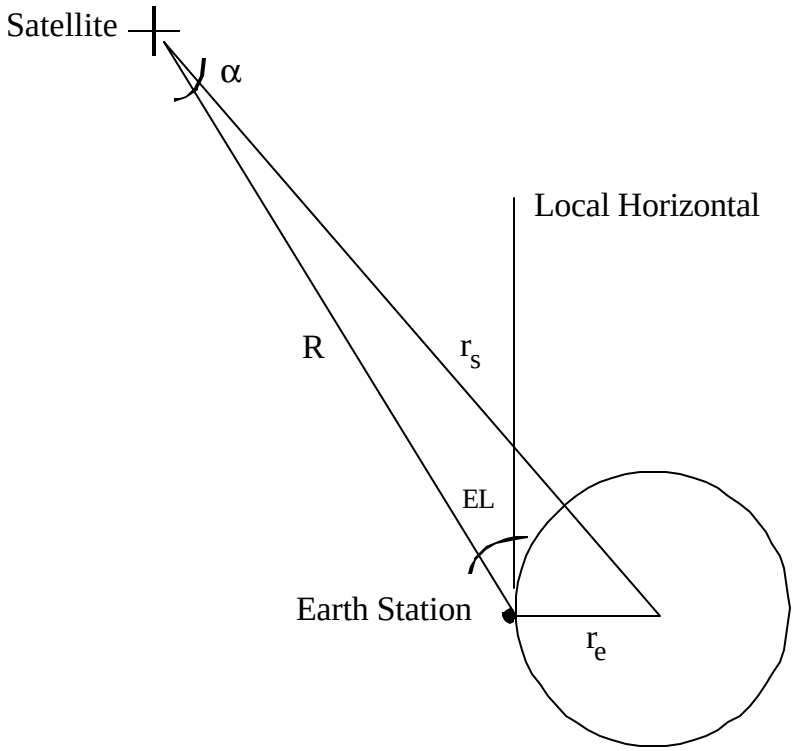
email: rdalke@its.bldrdoc.gov

INTRODUCTION

- MOTIVATION FOR MEASURING MAN-MADE NOISE AT VHF (137 MHz)
- PREDICT LINK MARGIN FOR SATELLITE BROADCAST OF DIGITAL WEATHER SATELLITE IMAGES
- PUBLIHSED NOISE DATA

  MAN-MADE - 25+ YR. OLD MEASUREMENTS
- MAN-MADE NOISE = **T**(TECHNOLOGY)
- VHF MEASUREMENT RESULTS
- UHF MEASUREMENT RESULTS
- SUMMARY

POLAR ORBITING SATELLITE LINK

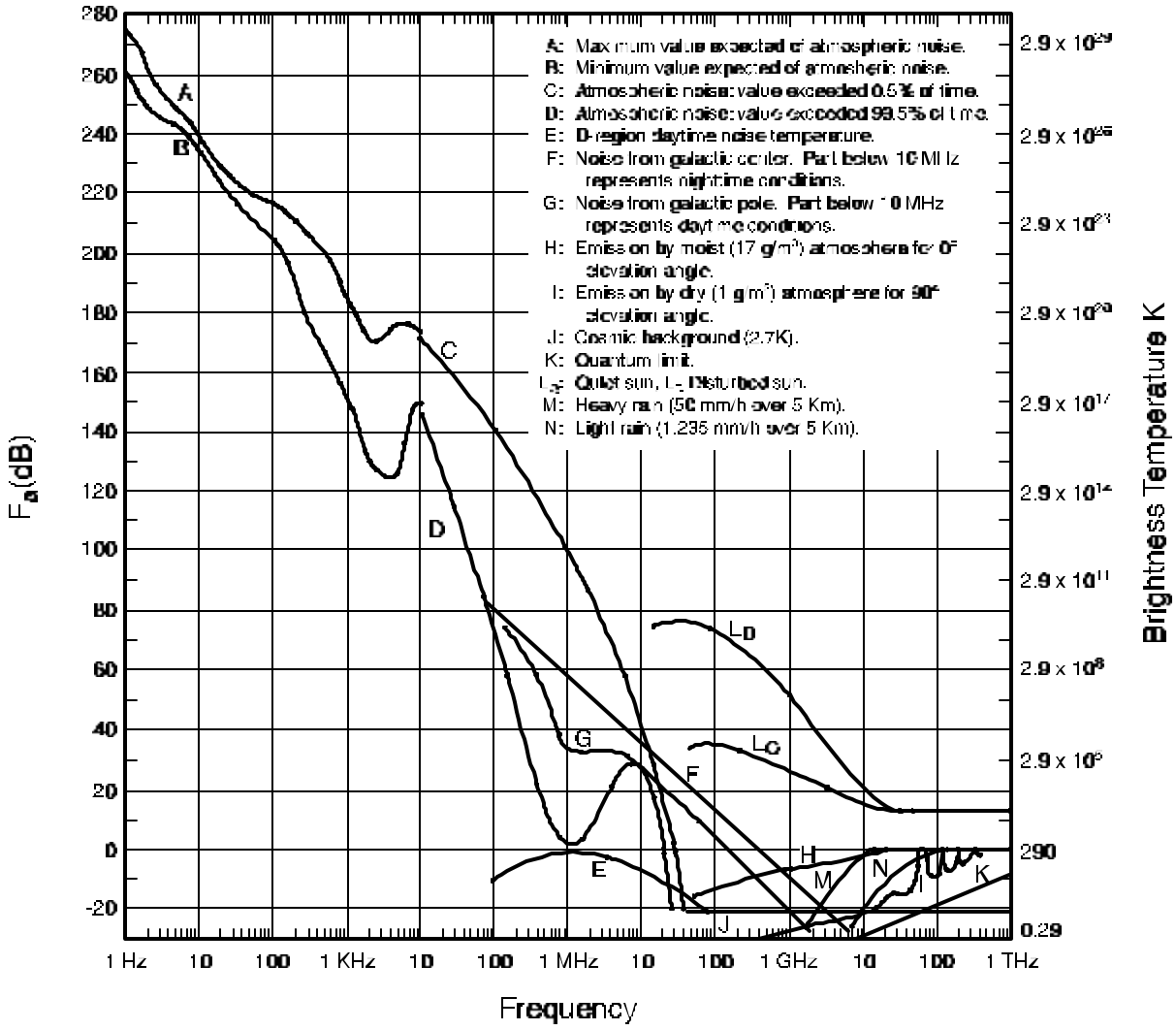


CNR at the Earth Station = EIRP - L_b - NOISE
Basic Transmission loss L_b = $L_{free\ space}$ + Attn
NOISE = ?

RADIO NOISE

- **NATURAL RADIO NOISE**
  - Atmospheric (distant lightning)
  - Galactic
  - Sun
  - Rain
  - Cosmic Background
- **MAN-MADE RADIO NOISE**
  - Business
  - Residential
  - Rural
  - Quiet Rural

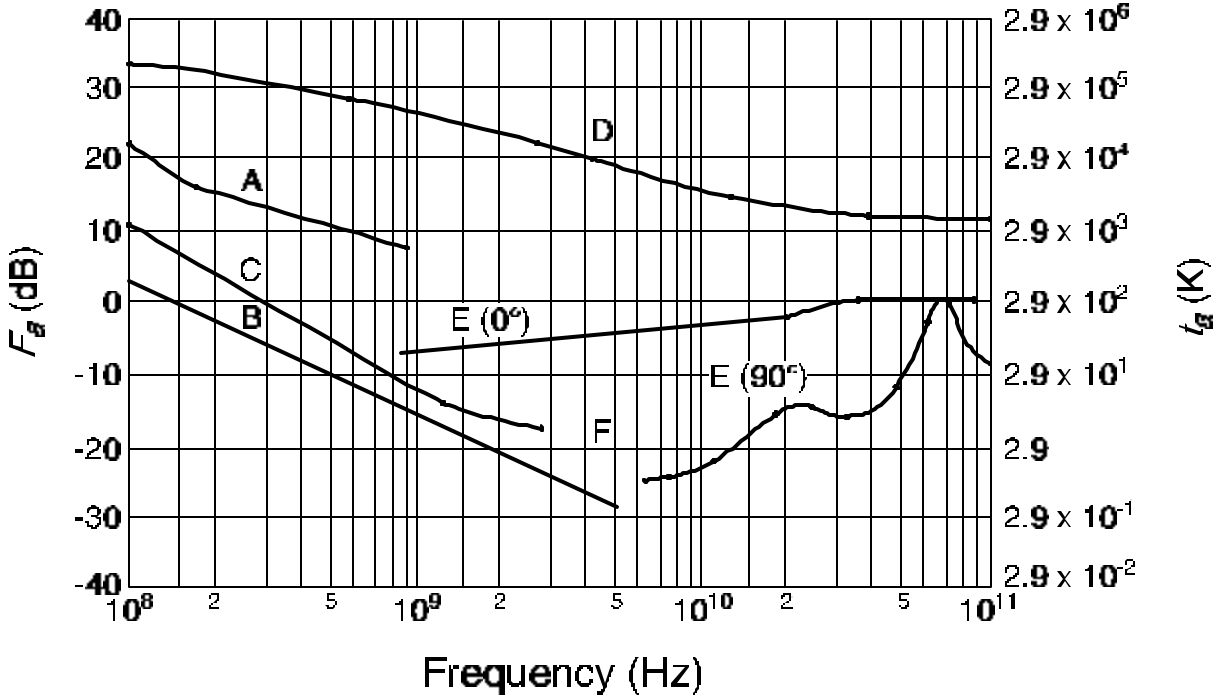
NATURAL RADIO NOISE



Spaulding, A.D. and G. Hagn, *Worldwide Minimum Environmental Radio Noise Levels*, Proceedings of the 1978 Symposium on Effects of the Ionosphere on Space and Terrestrial Systems, ONR/NLR, Arlington, Virginia, Jan 24-26, 1978

NATURAL RADIO NOISE

F_a versus frequency (100 MHz - 100 GHz)



A: Estimated median business-area man-made noise

B: Galactic noise

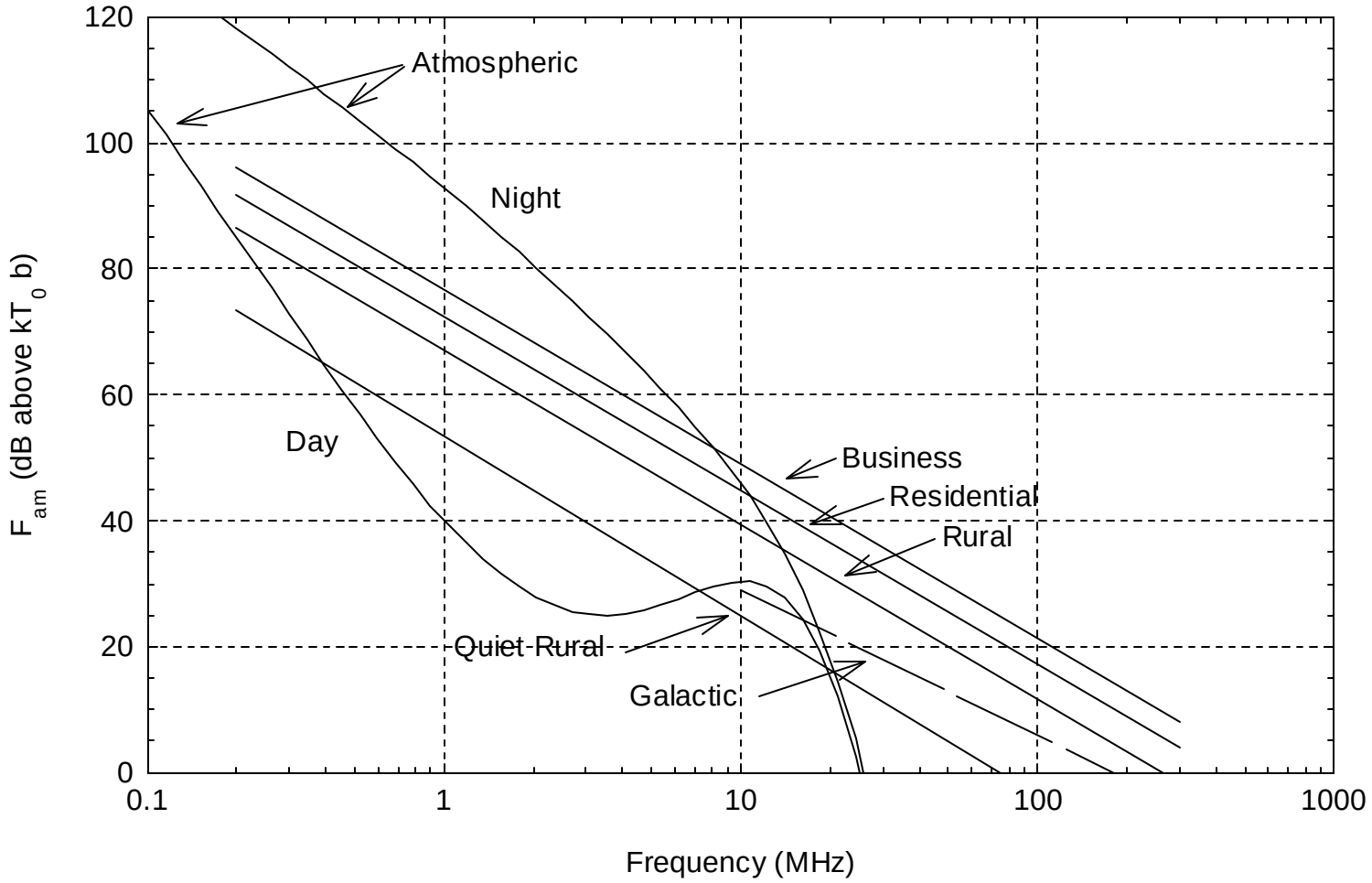
C: Galactic noise (toward galactic center with infinitely narrow bandwidth)

D: Quiet sun (1/2 degree beamwidth directed at sun)

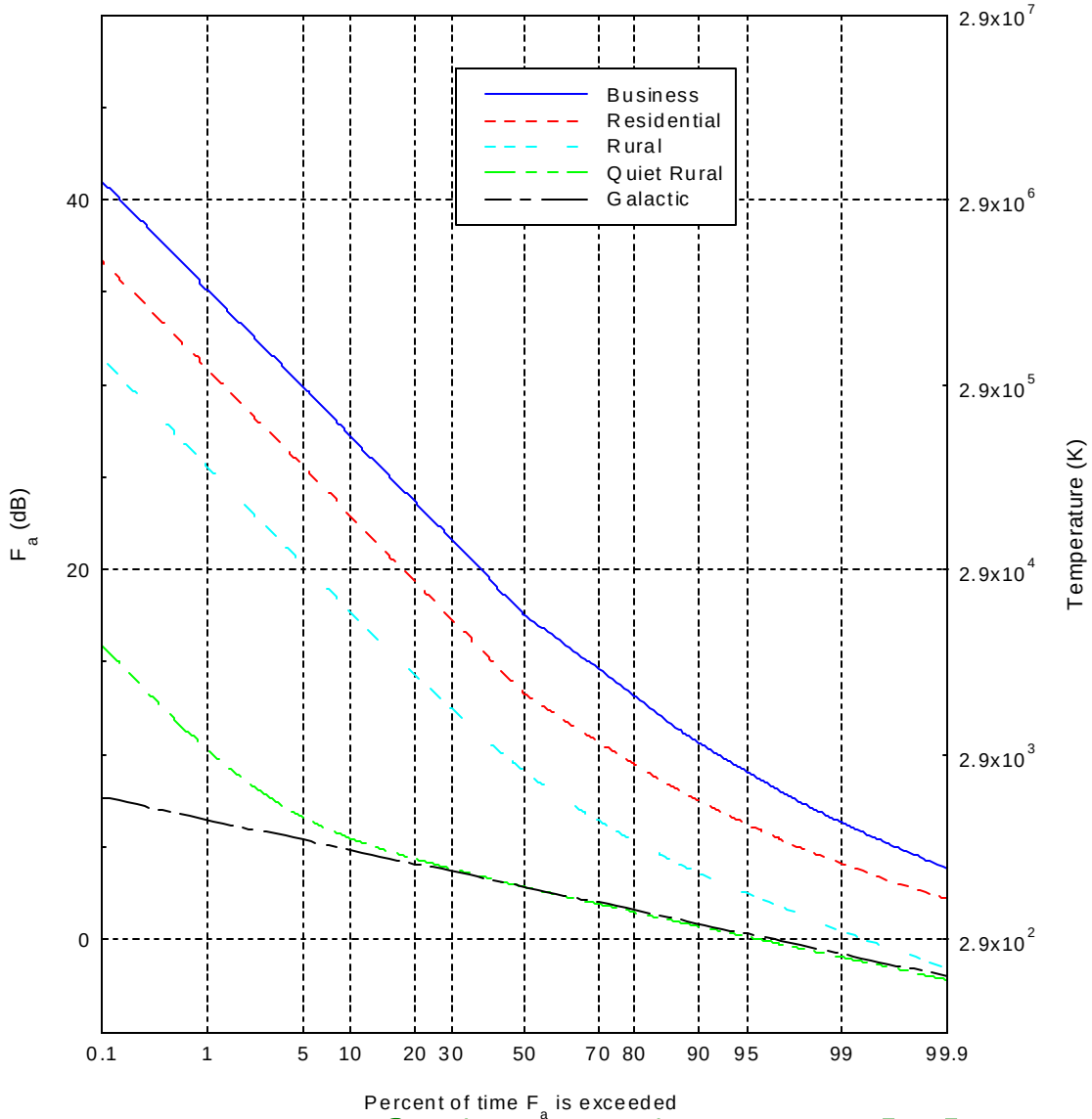
E: Sky noise due to oxygen and water vapor (very narrow beam antenna); upper curve 0° elevation angle; lower curve, 90° elevation angle

F: Black body (cosmic background), 2.7 K

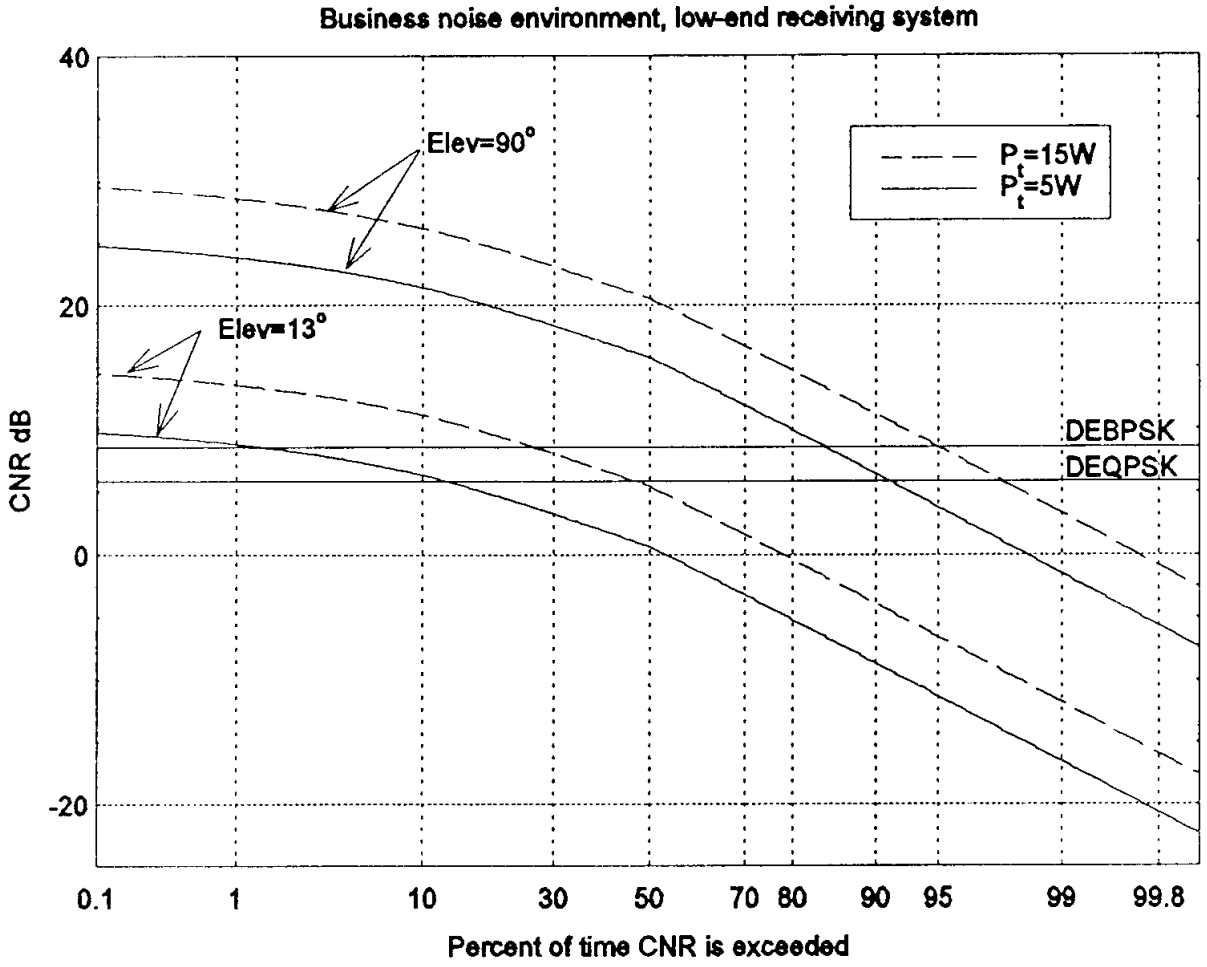
Spaulding, A.D. and G. Hagn, *Worldwide Minimum Environmental Radio Noise Levels*, Proceedings of the 1978 Symposium on Effects of the Ionosphere on Space and Terrestrial Systems, ONR/NLR, Arlington, Virginia, Jan 24-26, 1978



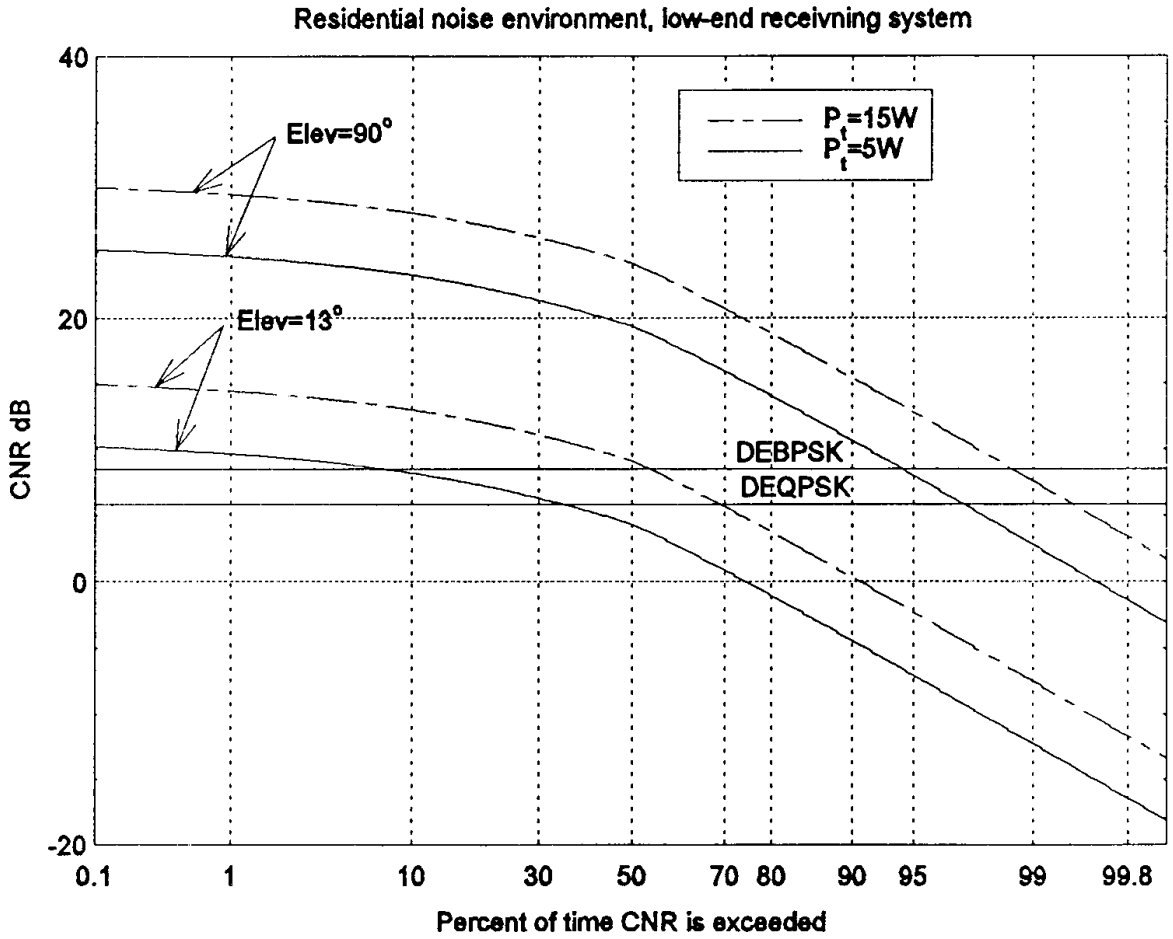
Median Values of F_a



Percent of Time F_a is Exceeded

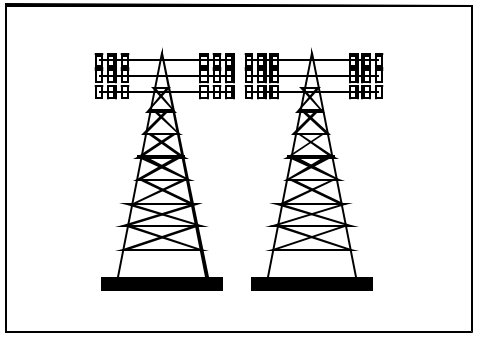


Cumulative distribution of CNR for a business noise environment with the low-end receiving system.

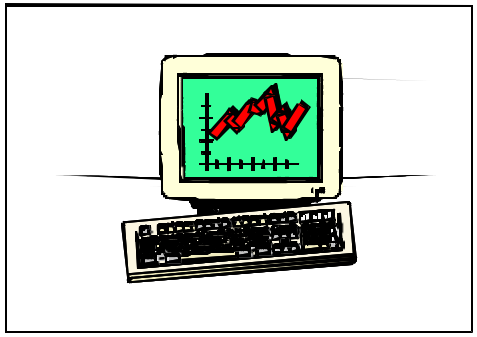


Cumulative distribution of CNR in a residential noise environment with the low-end receiving system.

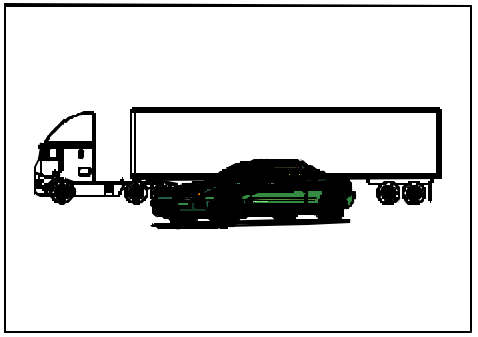
NOISE



POWER LINE



COMPUTER PART
15 & 18 DEVICES



AUTOMOBILE

CELLULAR

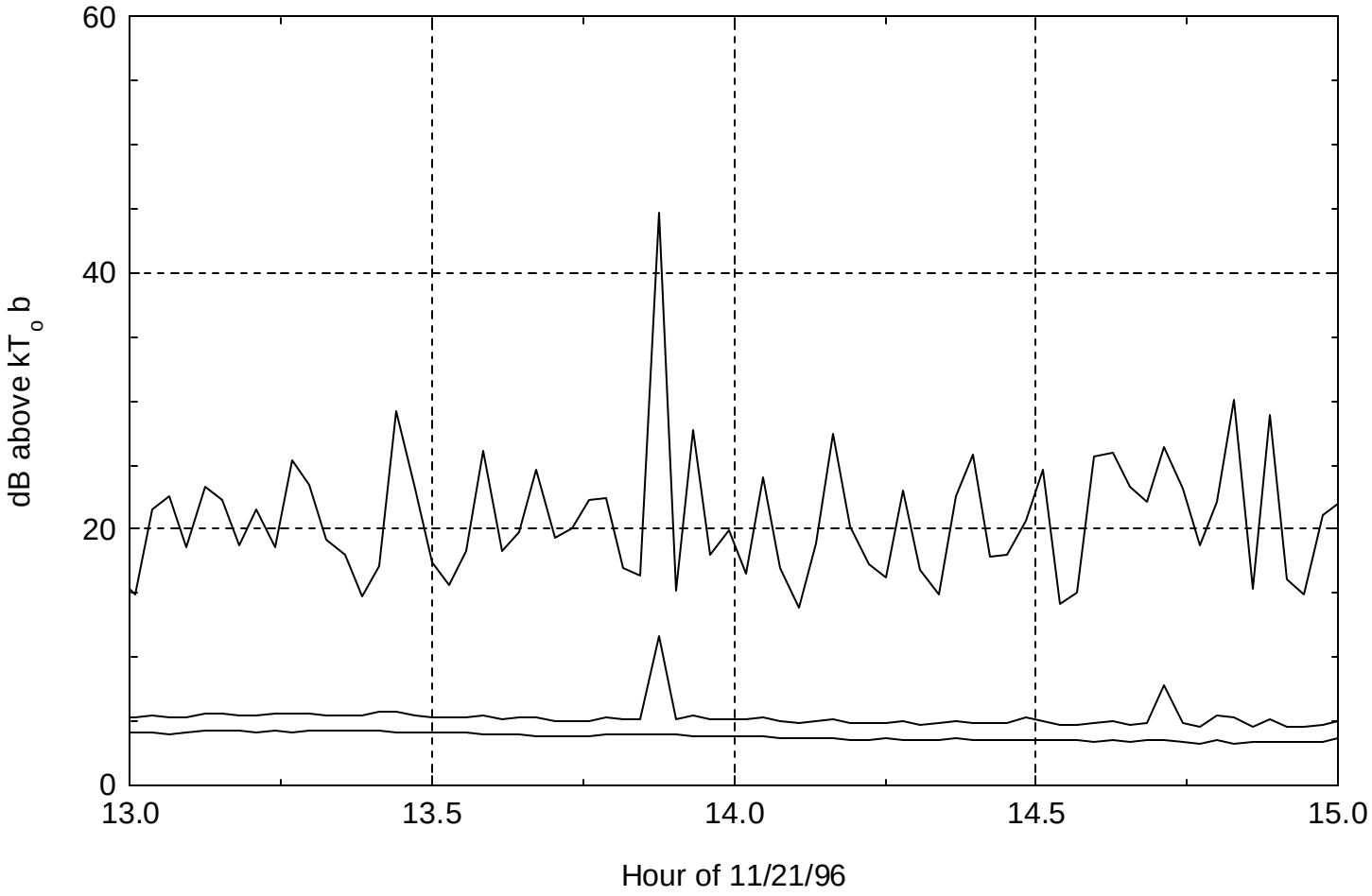
ISSUES:
CURRENT NOISE LEVELS & TRENDS
SPECTRAL CHARACTER OF NOISE

⇒

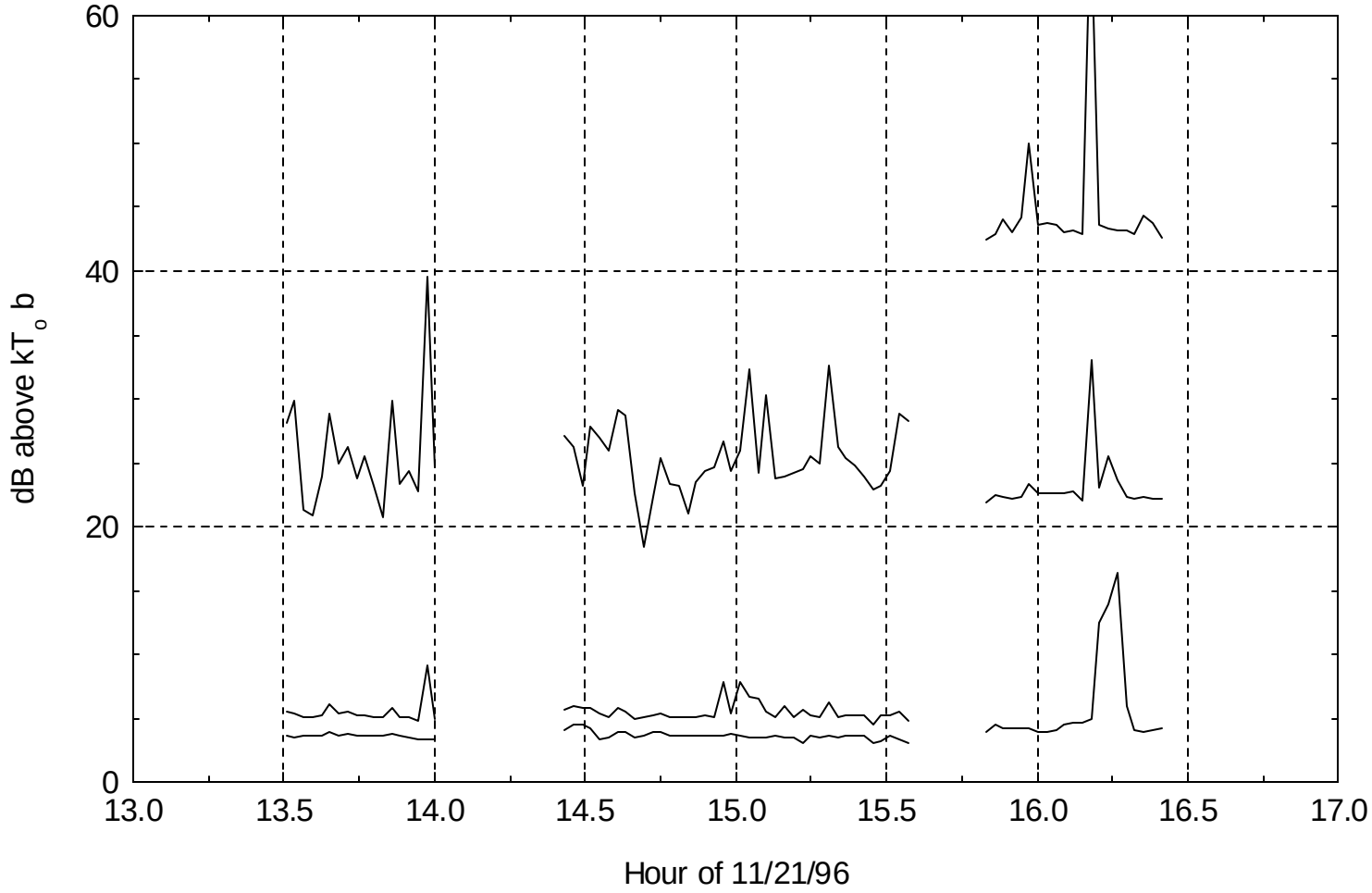
EFFECTIVENESS OF
COMMUNICATIONS SYSTEM

MEASUREMENTS

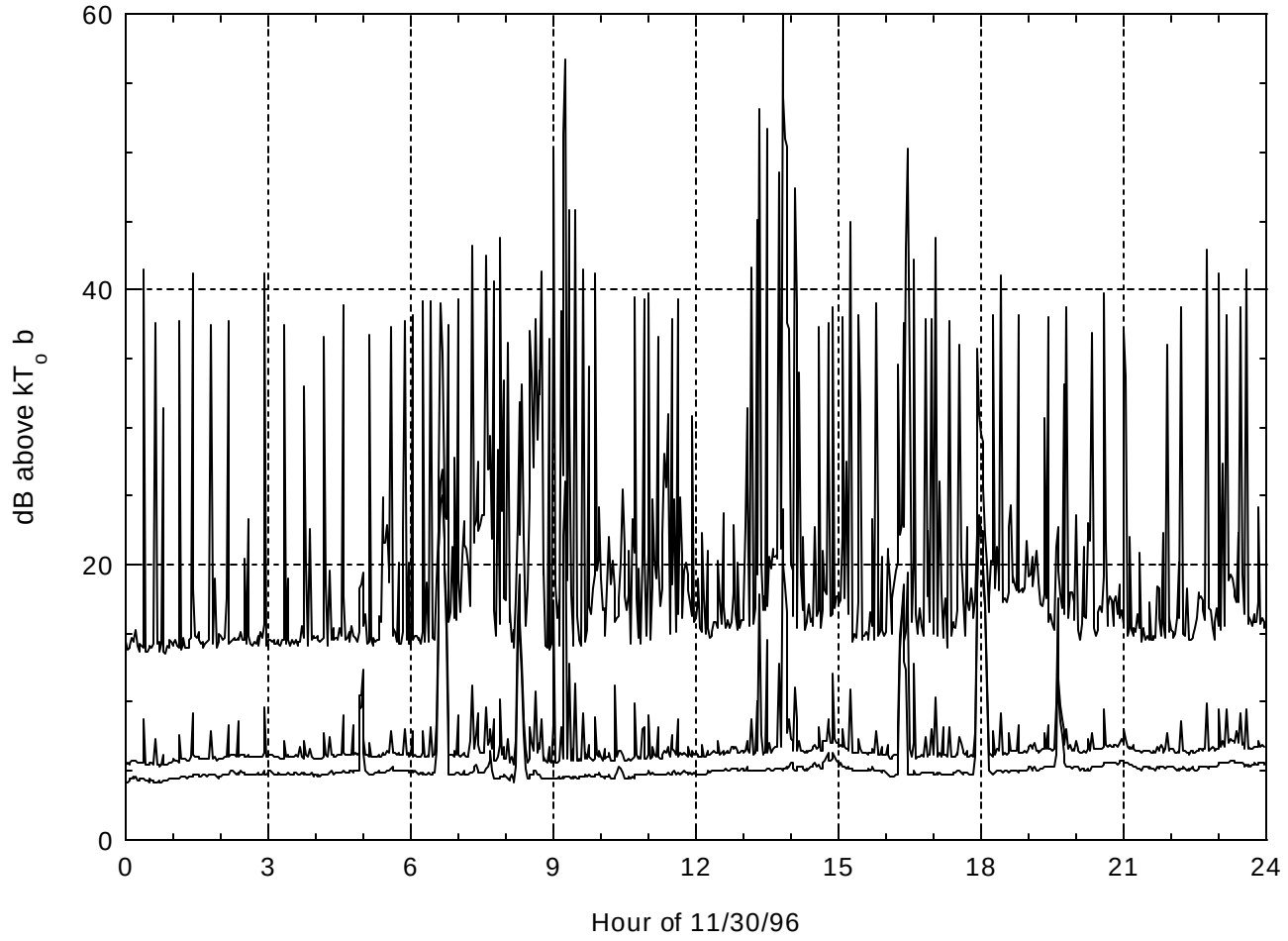
- CUSTOM RECEIVER 2.9 dB NOISE FIGURE AND ABOUT 80 dB DYNAMIC RANGE
- MEASURED FIRST ORDER STATISTICS FOR LONG PERIODS OF TIME (E.G., DAYS)
- ~30,000 ENVELOPE SAMPLES/MIN
- BUSINESS, RESIDENTIAL, AND RURAL ENVIRONMENTS
- DEVELOPED STATISTICAL NOISE MODELS FOR SIMULATION



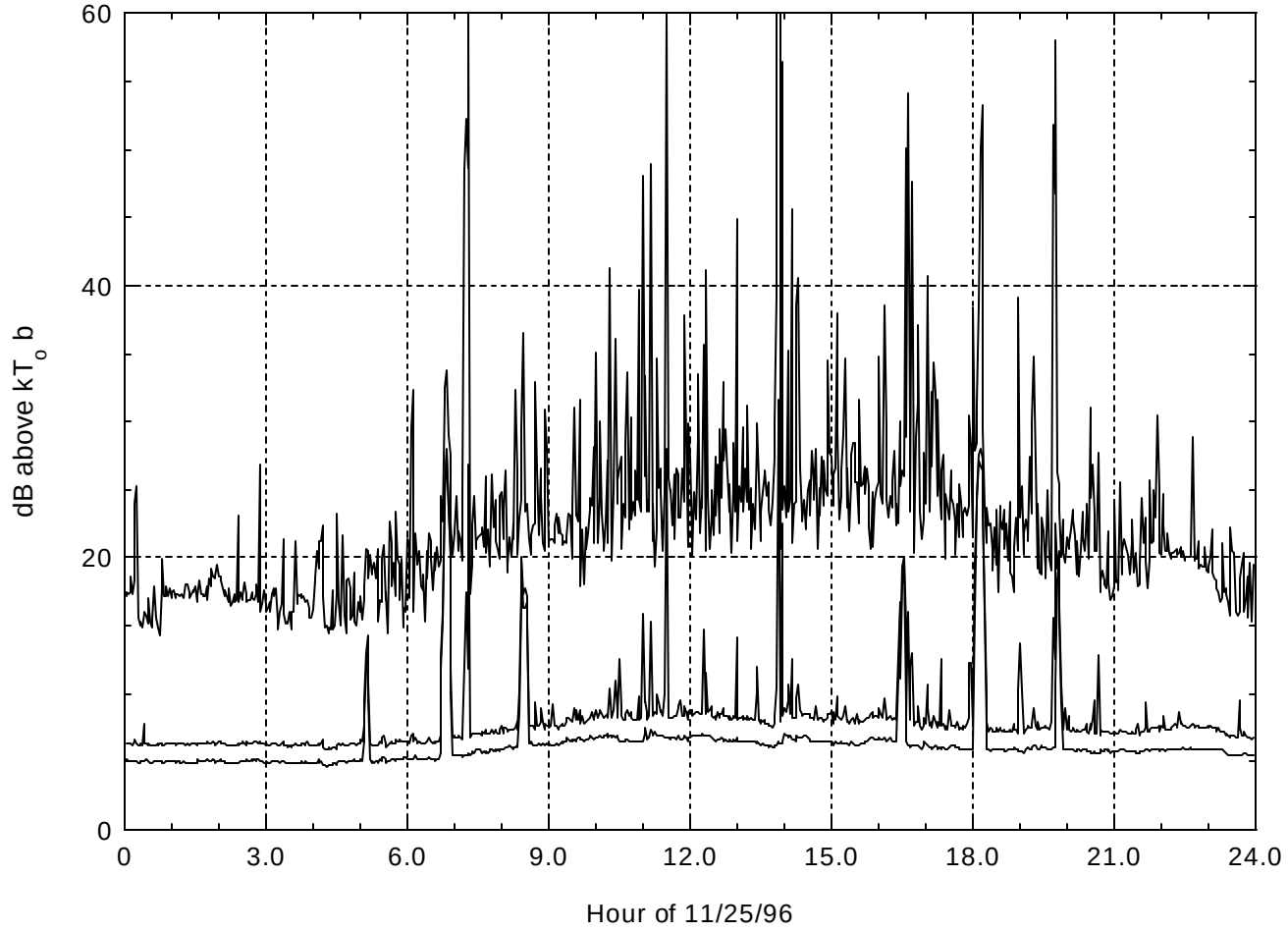
Automotive at Clear Creek Canyon



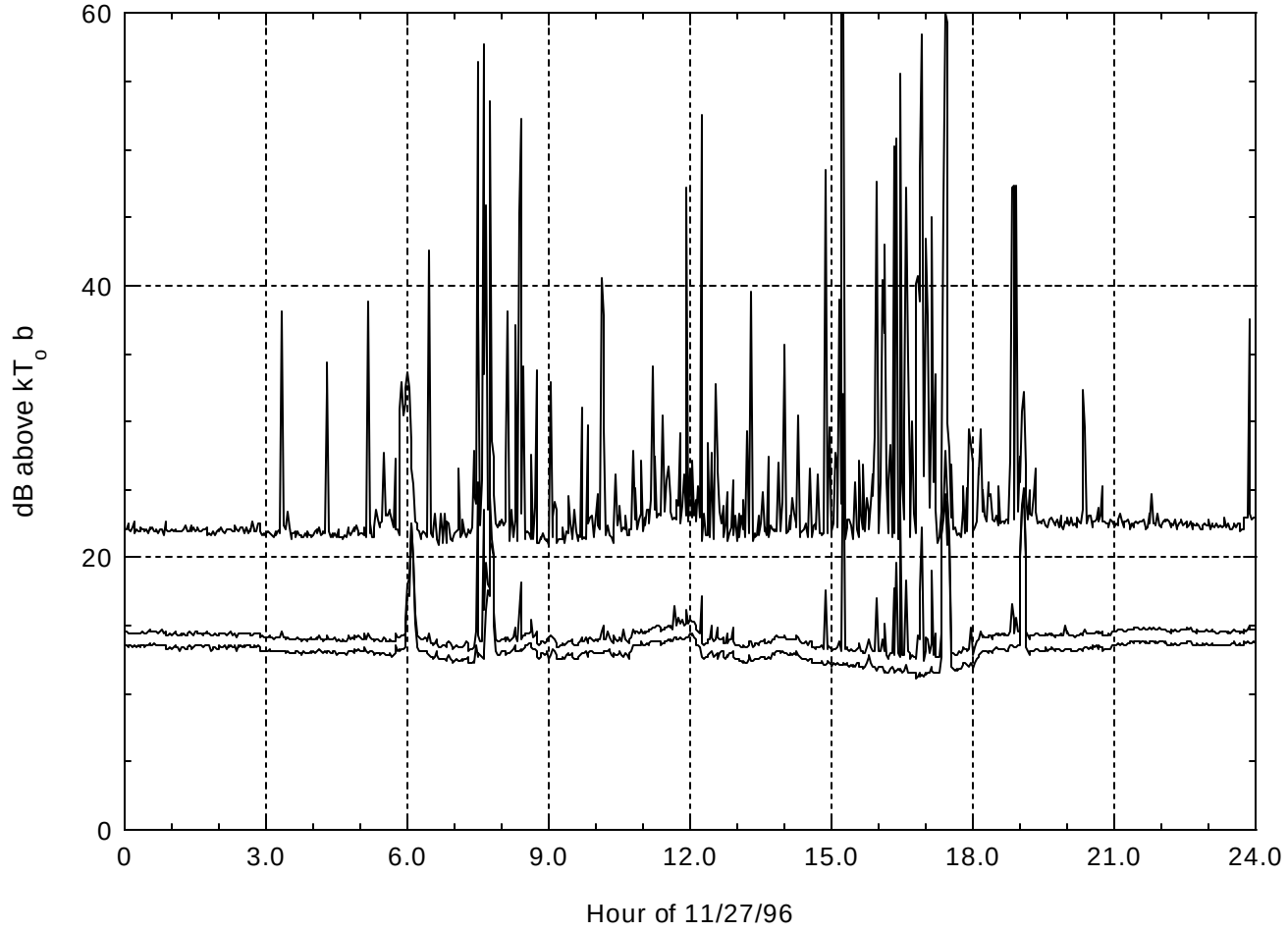
Electrical network near Leyden



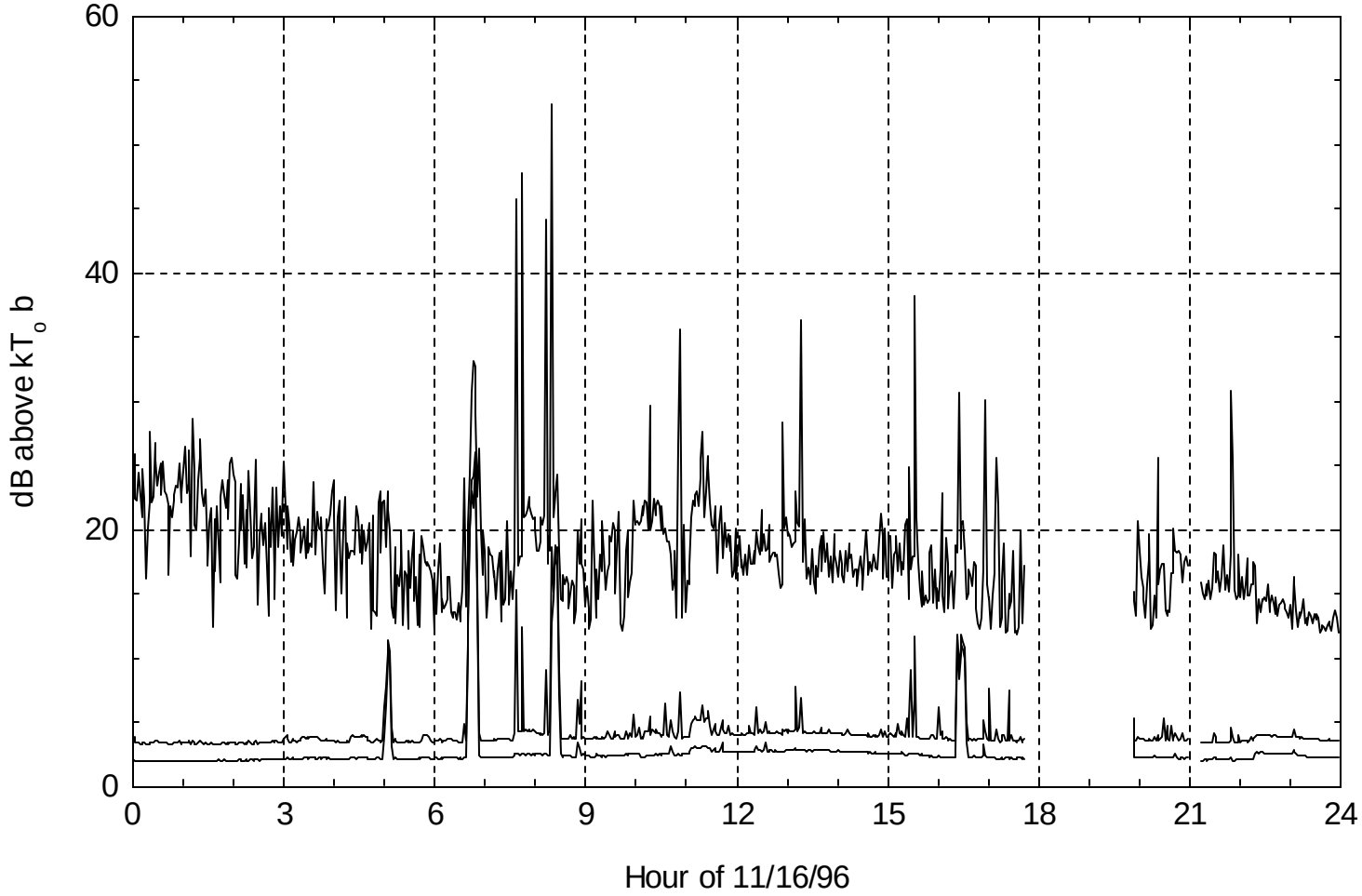
Denver West Office Park near residential area



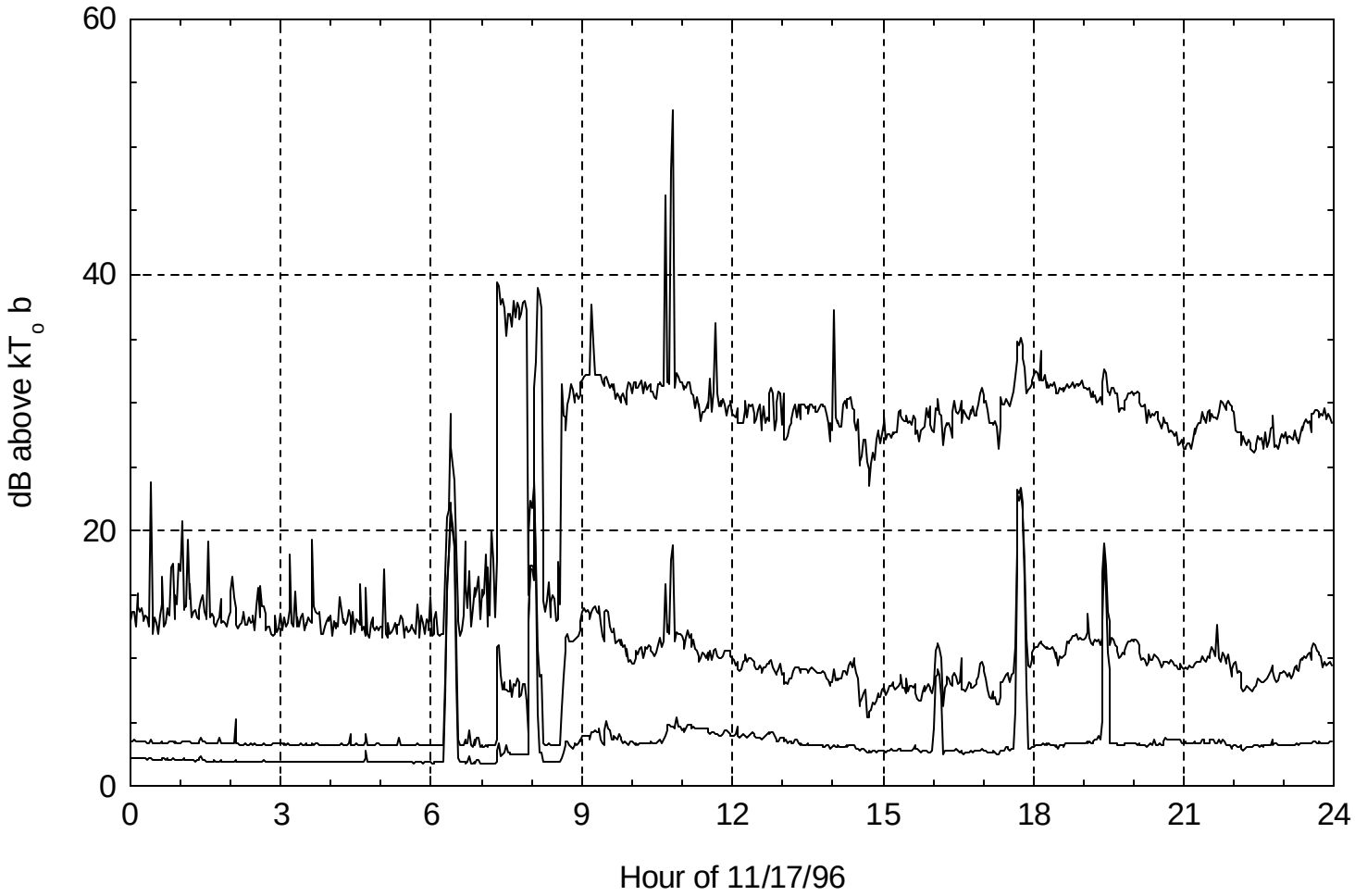
Denver West Office Park near highway



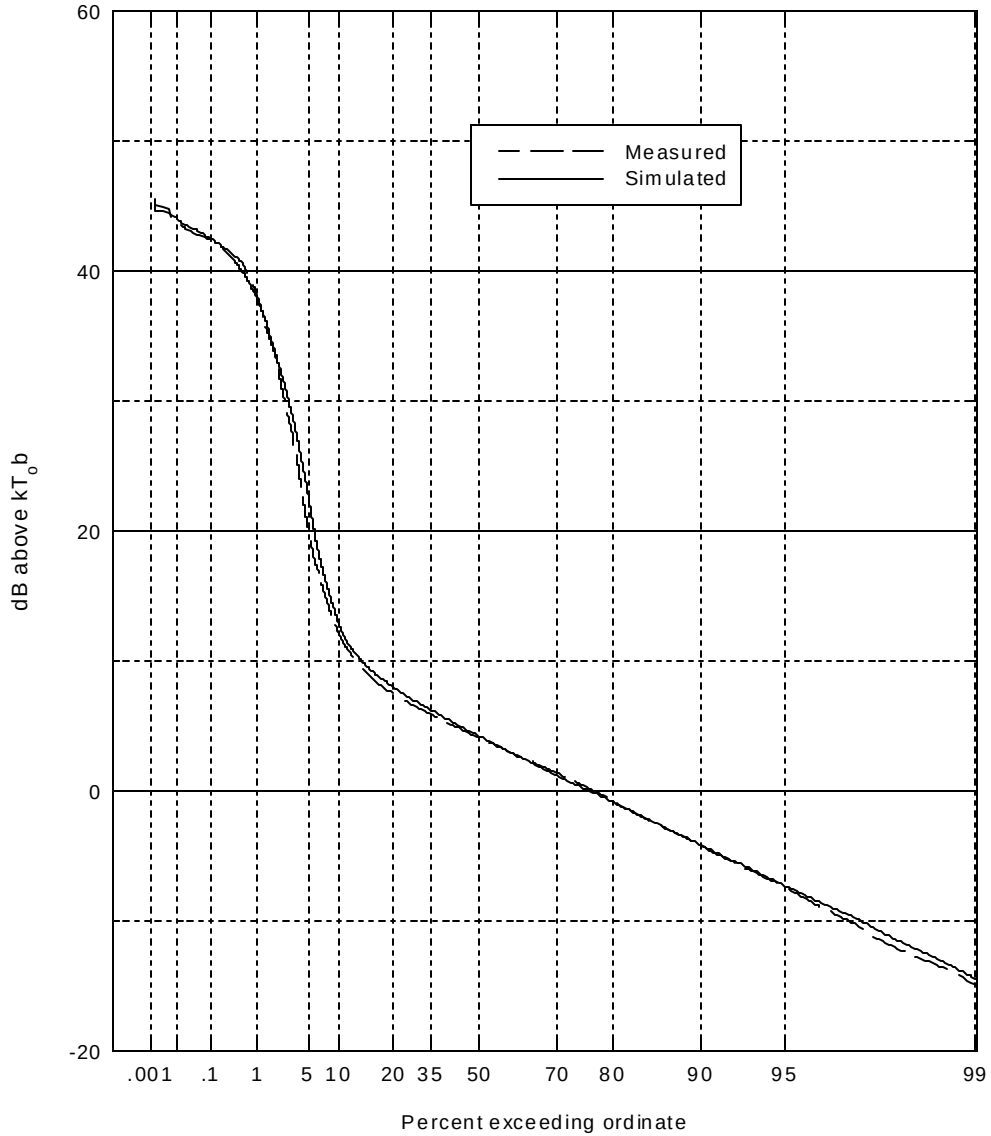
Denver West Office Park



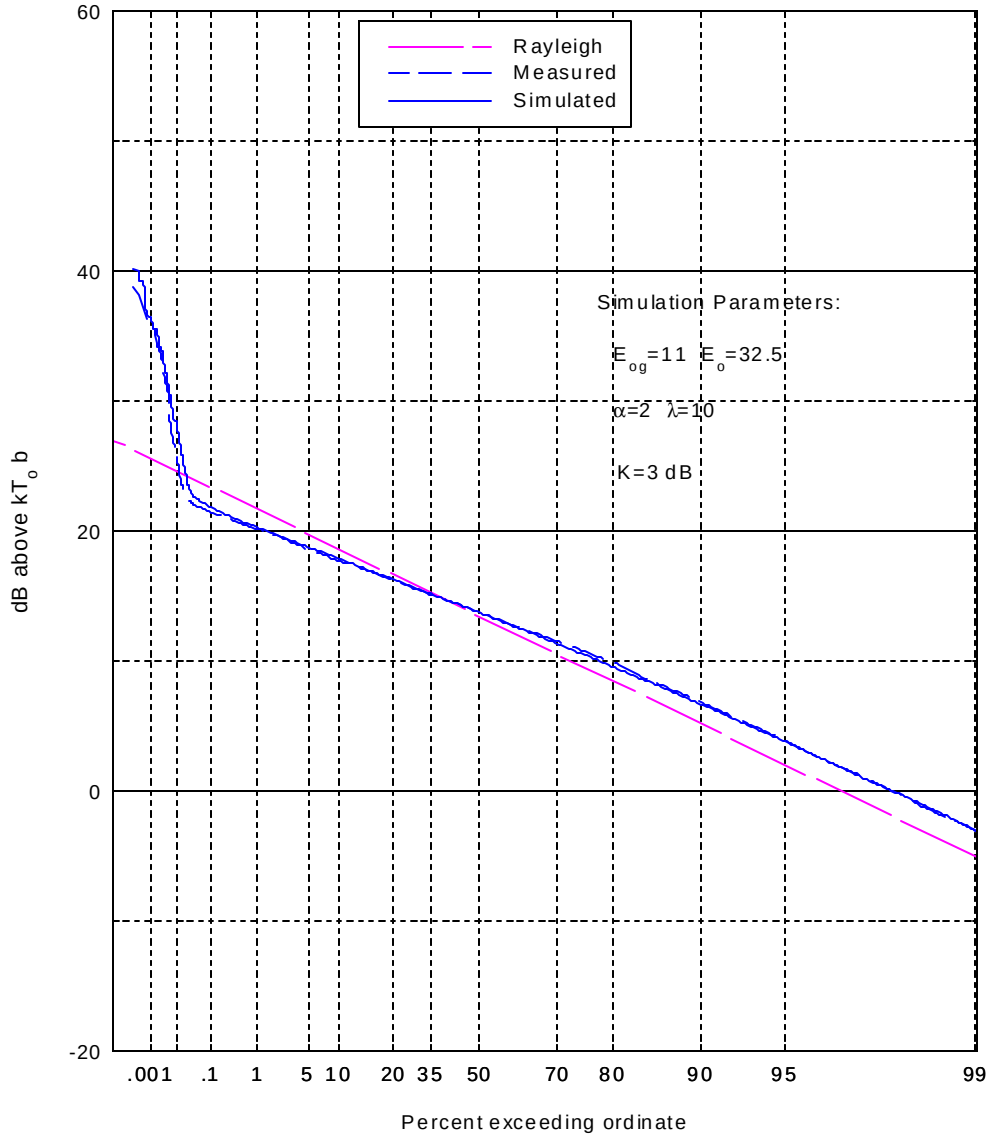
RAD residence



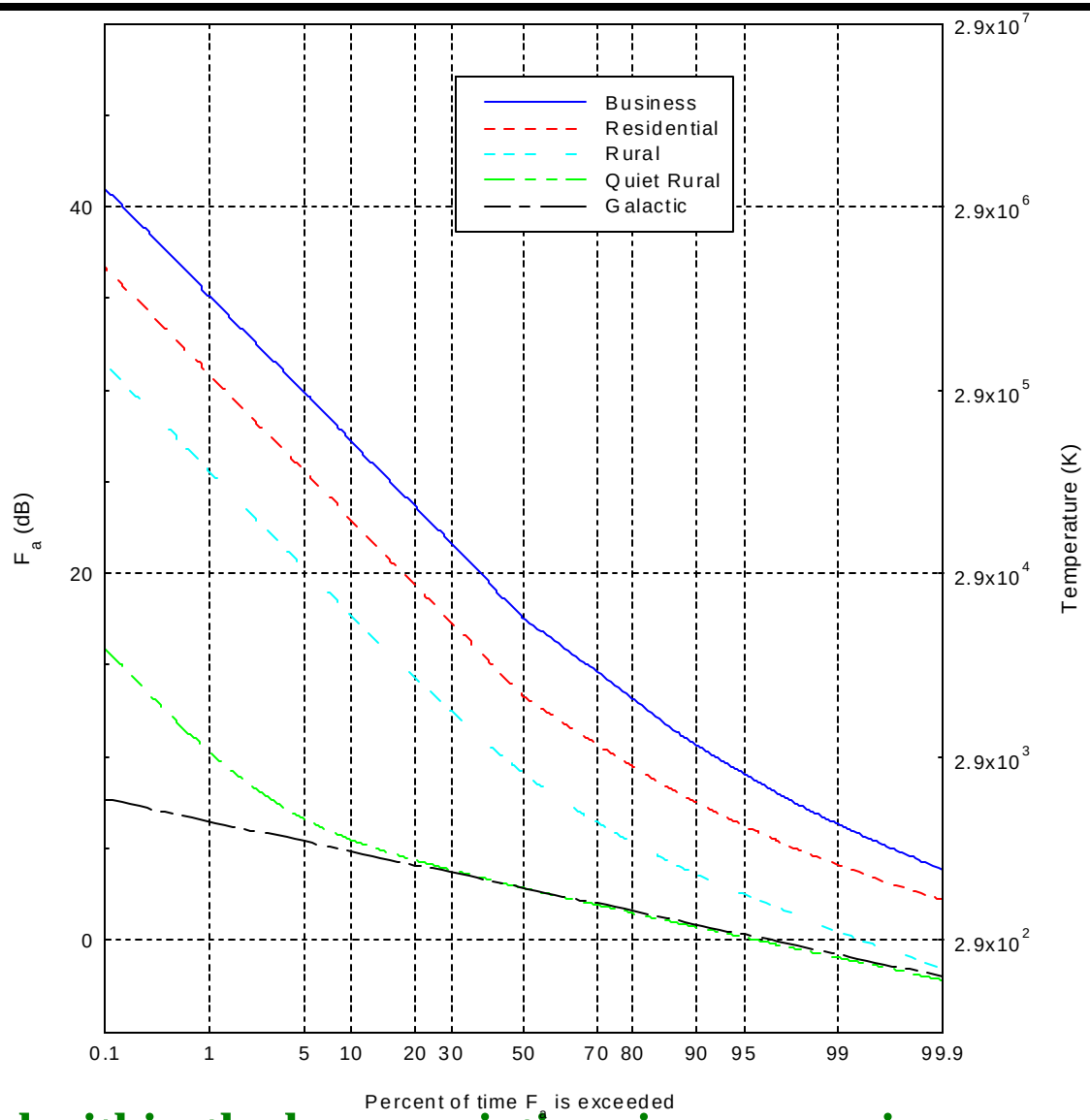
RAD residence



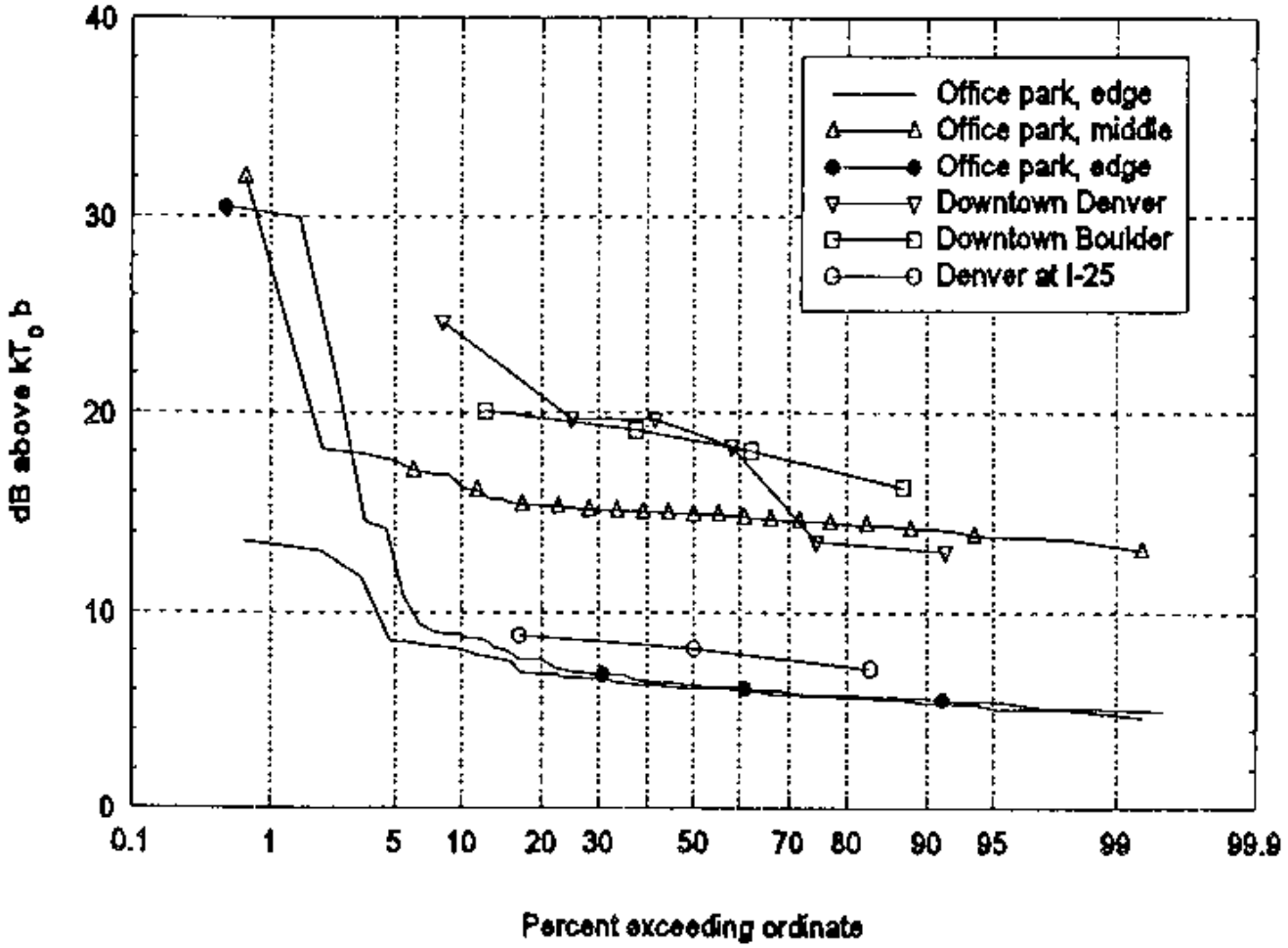
Class B noise measurements near from a noisy rural power line West of Denver on 11/12/96 at 2:02 p.m., average power = 22.6 dB/kT$_o$b.



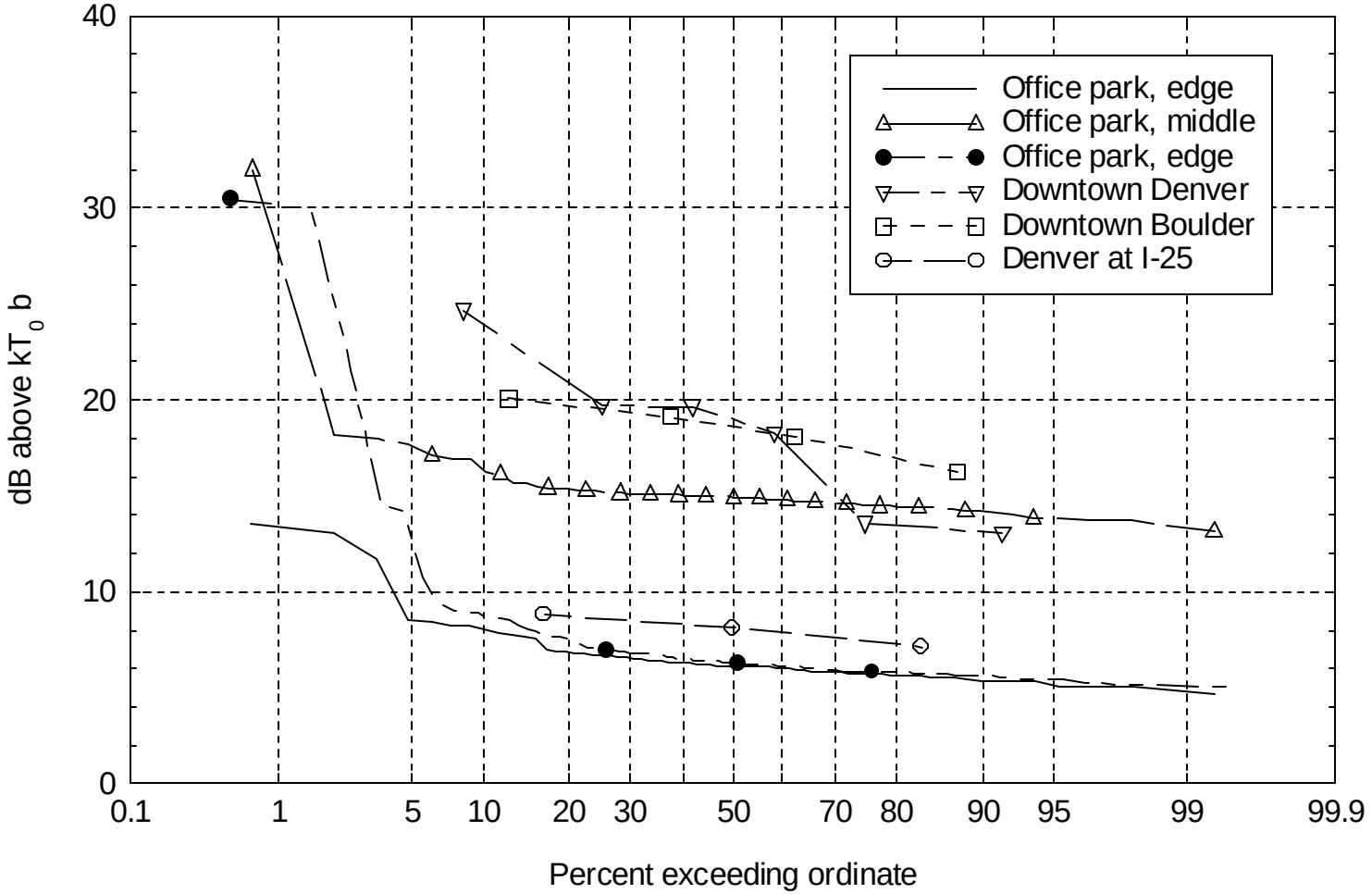
Class B noise measurements in Denver West Park on 11/27/96 at 11:15 to 11:45 a.m., average power = 14.7 dB/$kT_o b$. A constant narrowband noise source yields the characteristic Nakagami-Rice behavior for lower powers.



Predicted within-the hour variations in mean noise power for four environments, based on CCIR methods.

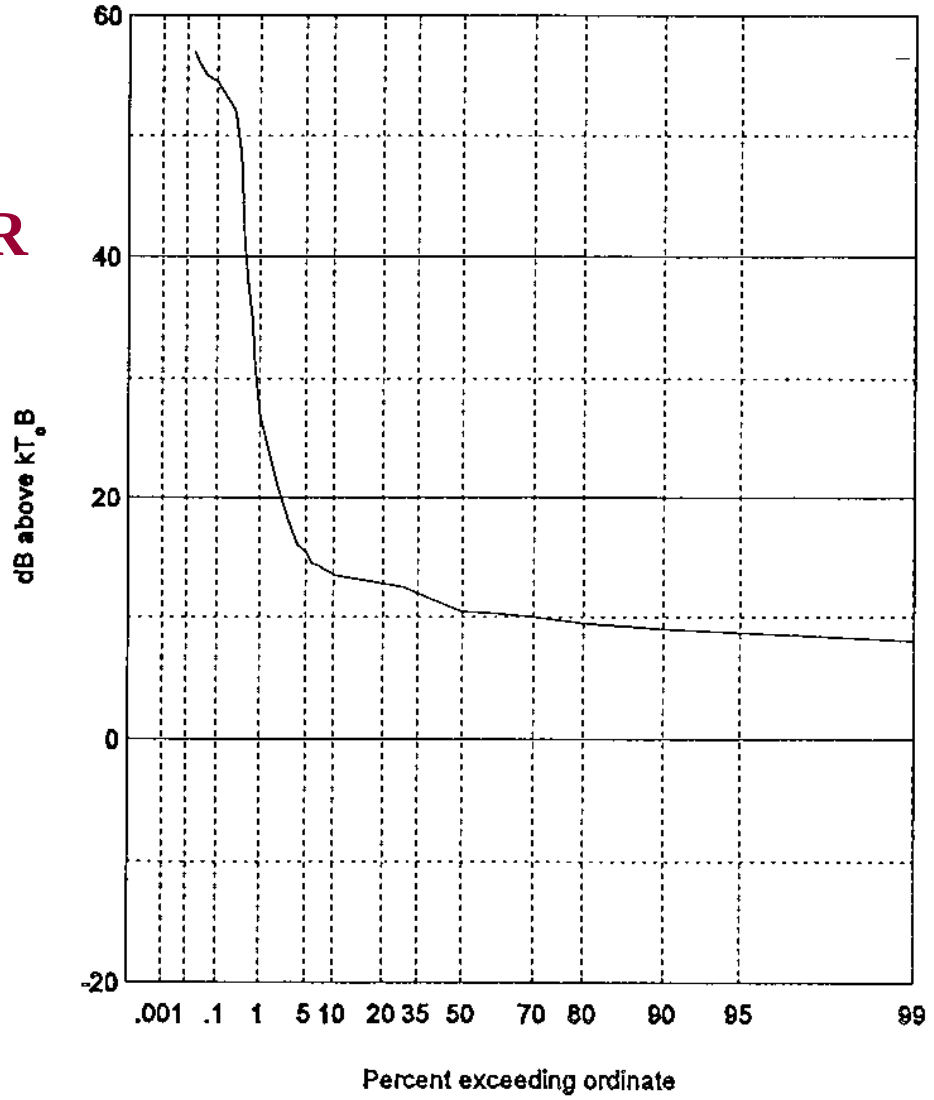


Power averaged from measurements at six urban sites.



Power averaged from measurements at six urban sites.

ISM BAND EMISSION MEASURED IN DOWNTOWN DENVER (2460 MHz)



- **SIGNIFICANT CHANGES IN MAN-MADE NOISE AT 137 MHz**
- **MEAN POWER LEVELS OVERALL ARE LESS**
- **TIME VARIABILITY CHANGED**
- **SIGNIFICANT VARIATION WITHIN ENVIRONMENT CLASSIFICATIONS - PARTICULARLY *BUSINESS***
  - **Automotive emissions reduced**
  - **Power lines appear to be variable and can have significant emissions - density of power line has increased**
  - **Many *new* sources of man-made noise (computers, switching devices, efficient electric motors, microwave ovens, etc.)**
- **MORE VHF AND UHF MEASUREMENTS NEEDED**