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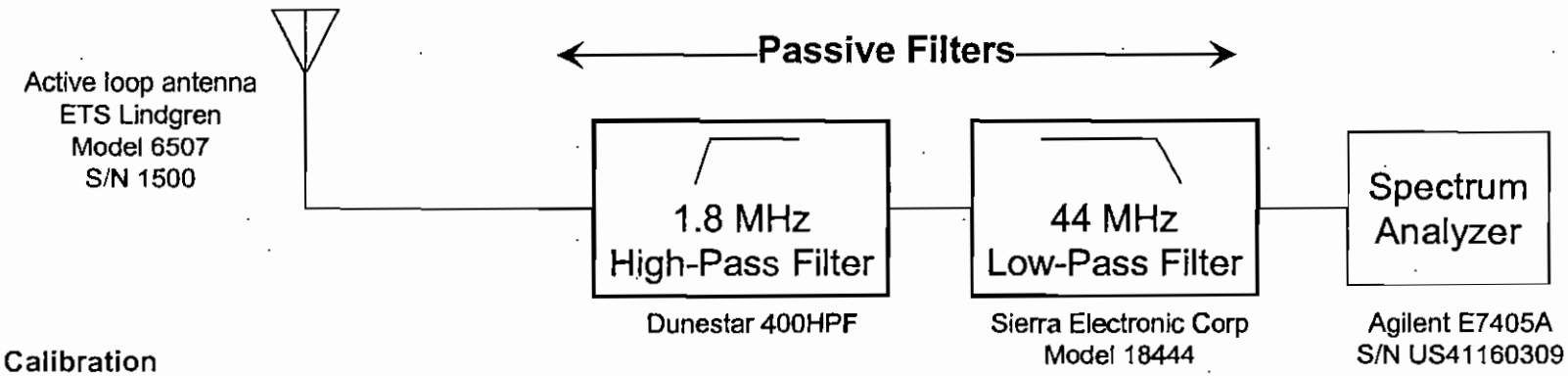
Test Description for Compliance Measurements



- **Calibration**
  - The combination of all cables & filters was calibrated, as a function of frequency, using the spectrum analyzer's tracking generator
- **Measurement locations**
  - Antenna height: 1 meter
  - Horizontal offset from the power line on which the BPL signals were injected: 10-meters (on the tobacco-field side of the power line rather than on the road side, for physical safety)
  - Distance down line from BPL coupler: 0, 0.25, 0.5, 0.75, & 1* wavelength (southwest of coupler at Woodchase; south of coupler at Holland Meadows)
    * - At Woodchase, the final measurement was 0.87 wavelength down line, due to a large mud puddle at one wavelength. Wavelengths were based on the BPL device center frequencies of 23.2 MHz at Woodchase and 19.2 MHz at Holland Meadows.
  - Antenna orientations
    - Two orientations used at both sites: (1) Plane of loop vertical & parallel to power line, (2) plane of loop vertical & perpendicular to power line
    - Third orientation (plane of loop horizontal) was tested at only one Woodchase location and yielded lower field strengths
- **Procedure**
  - Power average spectra were measured at each antenna location & orientation. Antenna was returned to the location exhibiting the maximum field strength and power average spectrum was repeated. CISPR quasi-peak measurement was performed in limited band around frequency of maximum emission
- **Distance extrapolation to 30-meter distance at which emission limit is specified**
  - 40 log of slant range from antenna to power line, based on optically-measured power line heights of 10.9 m at Whitehurst and 10.5 m at Holland Meadows
  - Extrapolation was applied to the emission limit rather than to the measured data, so that the plots indicate actual field strength observed at the antenna location

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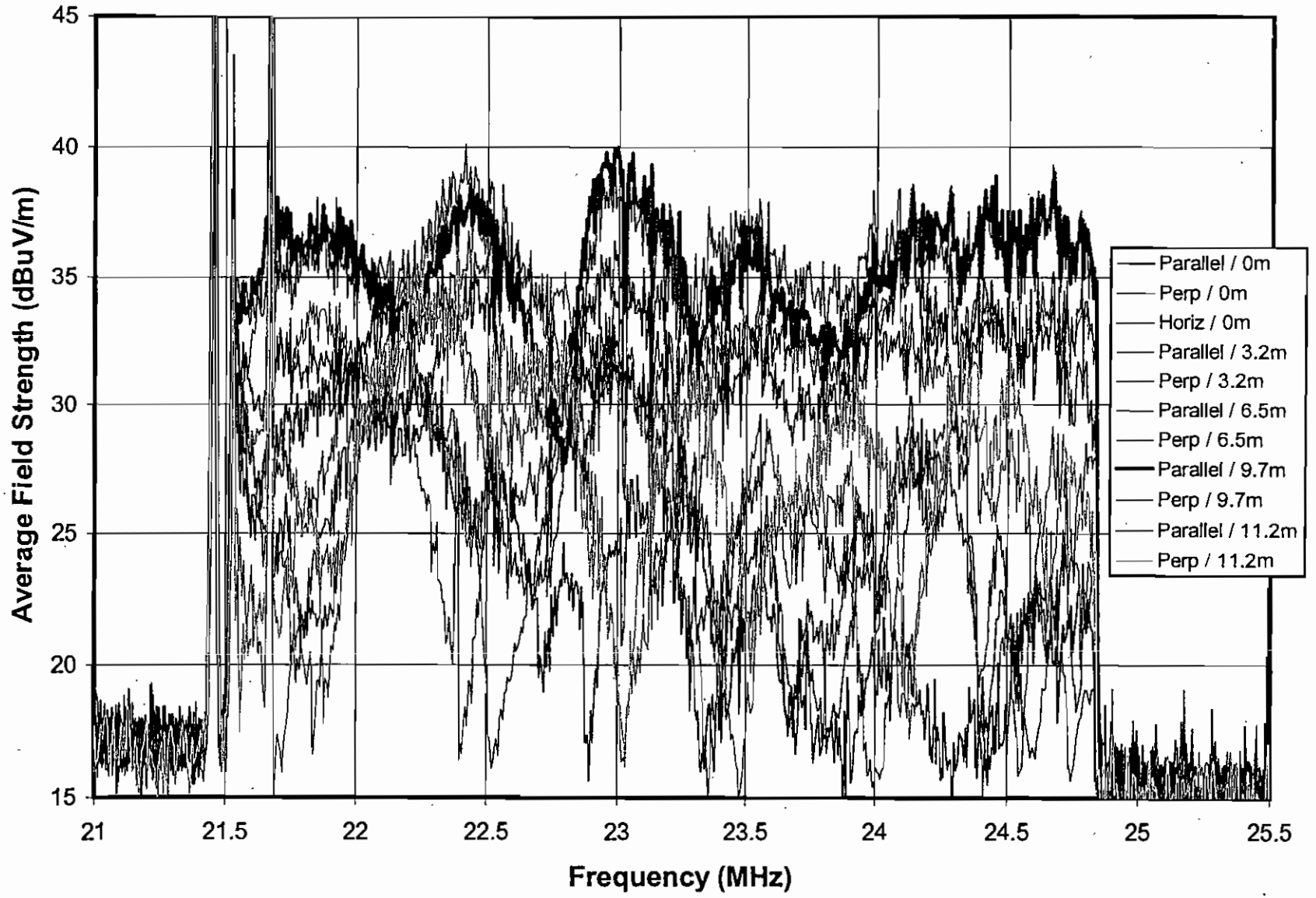
Compliance Tests on Overhead Injector on Slaughter Rd at Woodchase



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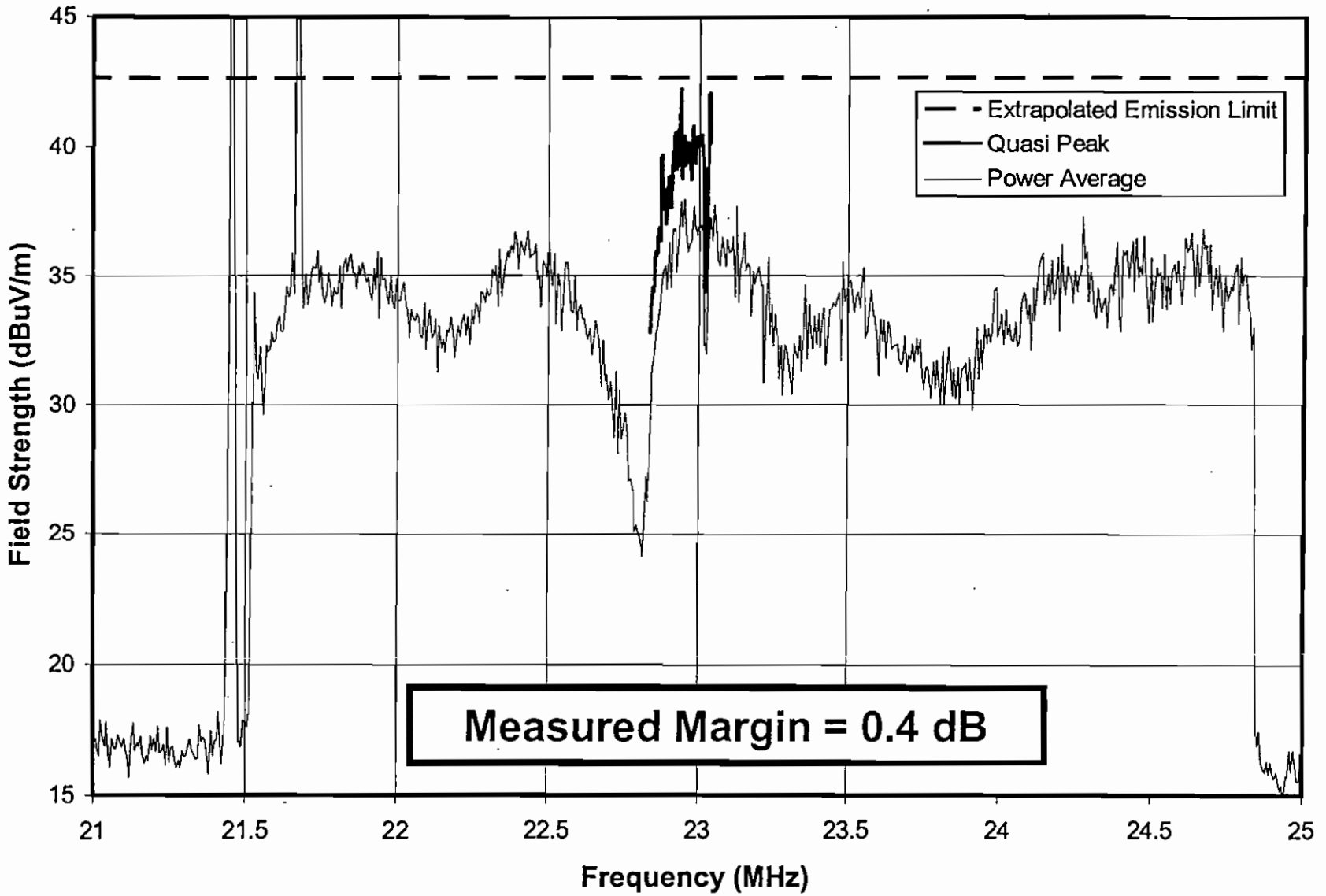
Compliance Tests on Overhead Injector on Slaughter Rd at Woodchase



Compliance Tests on 19.2-MHz Overhead Injector on Holland Church Rd

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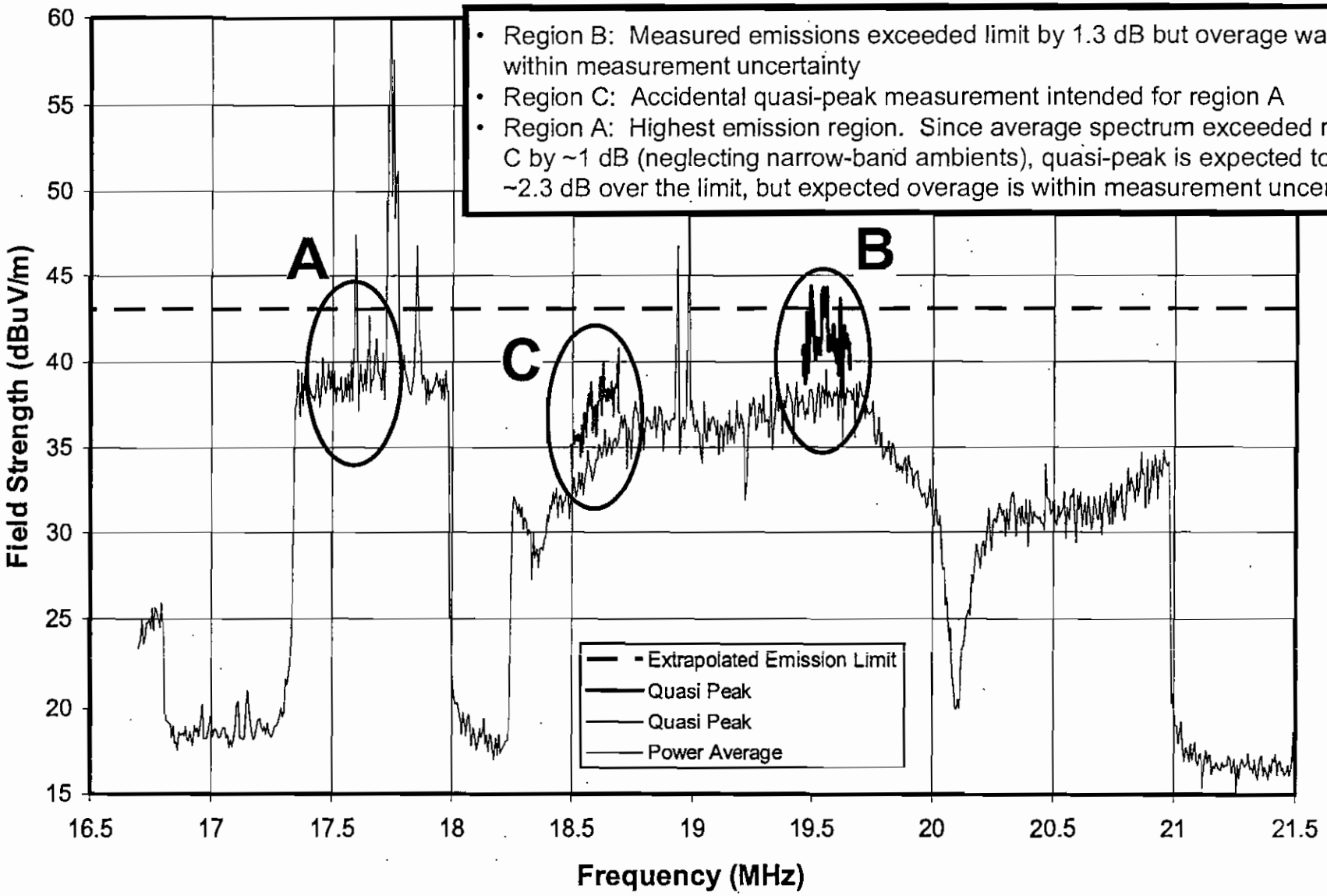
- Region B: Measured emissions exceeded limit by 1.3 dB but overage was within measurement uncertainty
- Region C: Accidental quasi-peak measurement intended for region A
- Region A: Highest emission region. Since average spectrum exceeded region C by ~1 dB (neglecting narrow-band ambients), quasi-peak is expected to be ~2.3 dB over the limit, but expected overage is within measurement uncertainty



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Compliance with Emission Limits

- **Compliance results**
  - BPL devices on overhead power lines
    - Tested two overhead "injectors" (in-band emissions only) – Emission levels are at compliant (within measurement uncertainty) BPL devices on underground power lines
    - Not tested, but compliance expected based on radio tests, which indicated much lower emissions from underground wiring than overhead wiring

Interference Potential Outside of Notches

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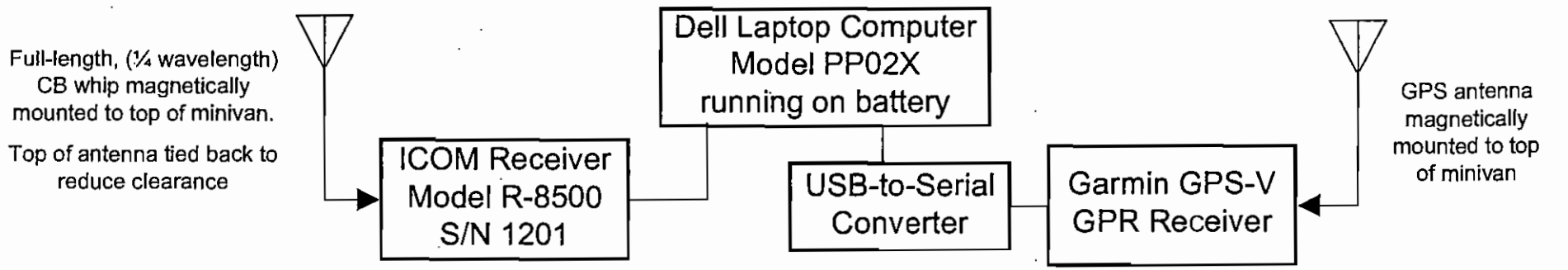
Test Description for Mobile Radio Measurements



- **Signal strength and position logging and mapping for driving tests**
  - Signal strength and GPS coordinates were logged at 2-second intervals to comma-delimited .CSV files.
  - When necessary to prevent excessive overlap of data points on maps, logged data was thinned by combining data points within a fixed distance of each other into a single point having a signal strength equal to maximum signal strength of the combined points.
- **Signal strength**
  - Signal strength monitored using the serial port of the receiver. Output has a lower bound of -114 dBm, even when actual signal strength is lower. During much of the testing outside of BPL areas, the S-meter was at ~s0, which should nominally correspond to -127 dBm; hence the lowest amplitude range on all map plots is shown as -127 to -114 dBm.
  - Antenna and receiver are uncalibrated, and antenna is not tuned to specific frequencies used in tests. Intent of tests are to show relative signal strengths.
- **Receiver mode**
  - AM with 5.5 kHz bandwidth
- **Frequency selection**
  - Receiver was tuned while away from the BPL area to a frequency having no active transmissions
  - Frequency was selected within the intended injection band of an overhead injector

ORIGINAL UNREDACTED

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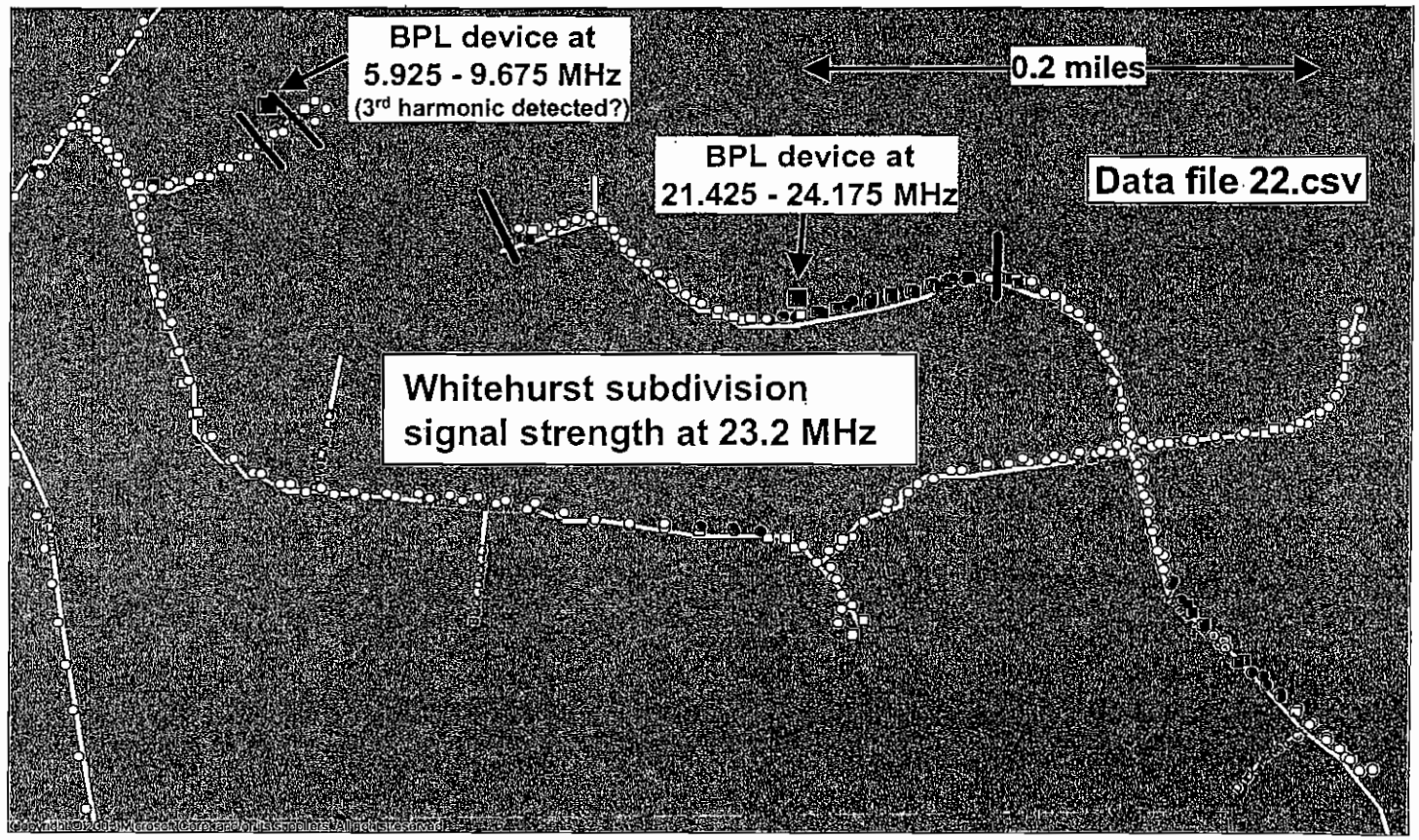
BPL on Underground Wiring

Geographic Extent of Emissions at One Frequency in Whitehurst

Signal Strength in 5.5kHz band at 23.2 MHz (dBm)

- -85 to -76
- -90 to -86
- -95 to -91
- -100 to -96
- -105 to -101
- -110 to -106
- -113 to -111
- -127 to -114



- **Underground BPL emissions are audible for short distances; e.g, at 23.2 MHz,**
  - Fundamental emissions were audible along 320 m (0.2 mi) of road around a BPL device
  - Emissions attributed to 3rd harmonic from another device were audible along 25 m of road

(Black lines mark edges of audibility)

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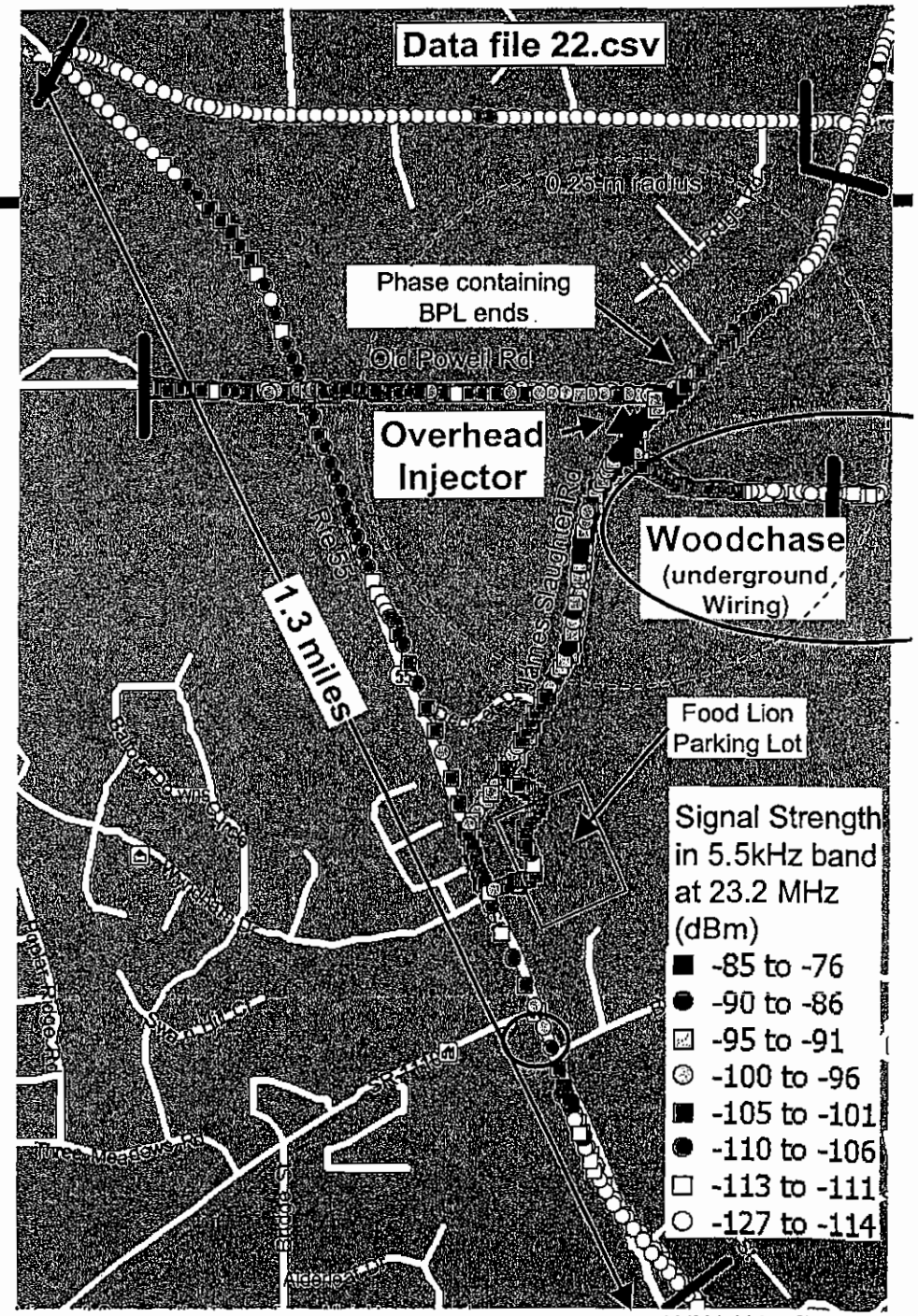
Un-Notched Overhead BPL

(Geographic extent of emissions at 23.2 MHz from overhead injector)

- **Effect of Single BPL Overhead Injector**
  - BPL audible (AM detector) between black lines
    - 3.5 miles of roadway outside of the subdivision served
    - 0.9 mi downline from coupler
    - 0.8 mi straight line distance from coupler
    - 0.19 mi (300m) from power line near coupler
  - Interference distance < audible distance
    - Distance depends on strength of desired signal, type of modulation, and margin required by listener or detector



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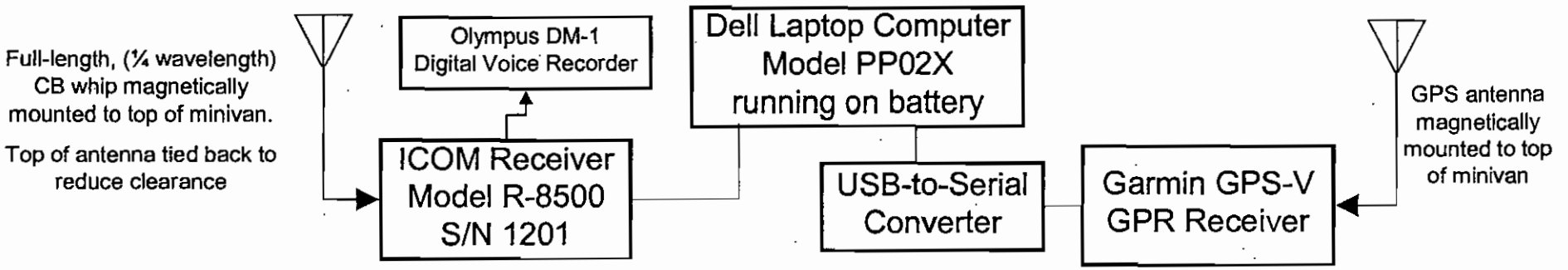
Test Description for Audio/Video Collection of Mobile Radio Measurements



- **Receiver mode**
  - AM with 5.5 kHz bandwidth except where SSB is specified
- **Recording**
  - Audio was recorded on a Olympus DM-1 pocket-sized digital voice recorder by direct connection to the receiver audio output
  - Video was recorded through the windshield using a Canon Model ES75A Hi8 camcorder; audio from the receiver's speaker was recorded through the built-in microphone of the camcorder
- **Frequency selection**
  - For both tests, the receiver was tuned to an un-notched frequency within the injection band of the overhead BPL injector
  - For the audio-only test, the receiver was tuned to 23.185 MHz, a frequency having no obvious transmissions (except for BPL)
  - For the video test, the radio was tuned to 21.639 MHz, where a foreign language broadcast station was received
- **Signal strength and position logging and mapping for driving tests**
  - As described previously
  - The cable between the ICOM receiver and the laptop computer was inadvertently disconnected throughout the video listening test. Signal strength data plotted on the map is from a subsequent test run while tuned off of the shortwave station to a frequency of 21.718 MHz

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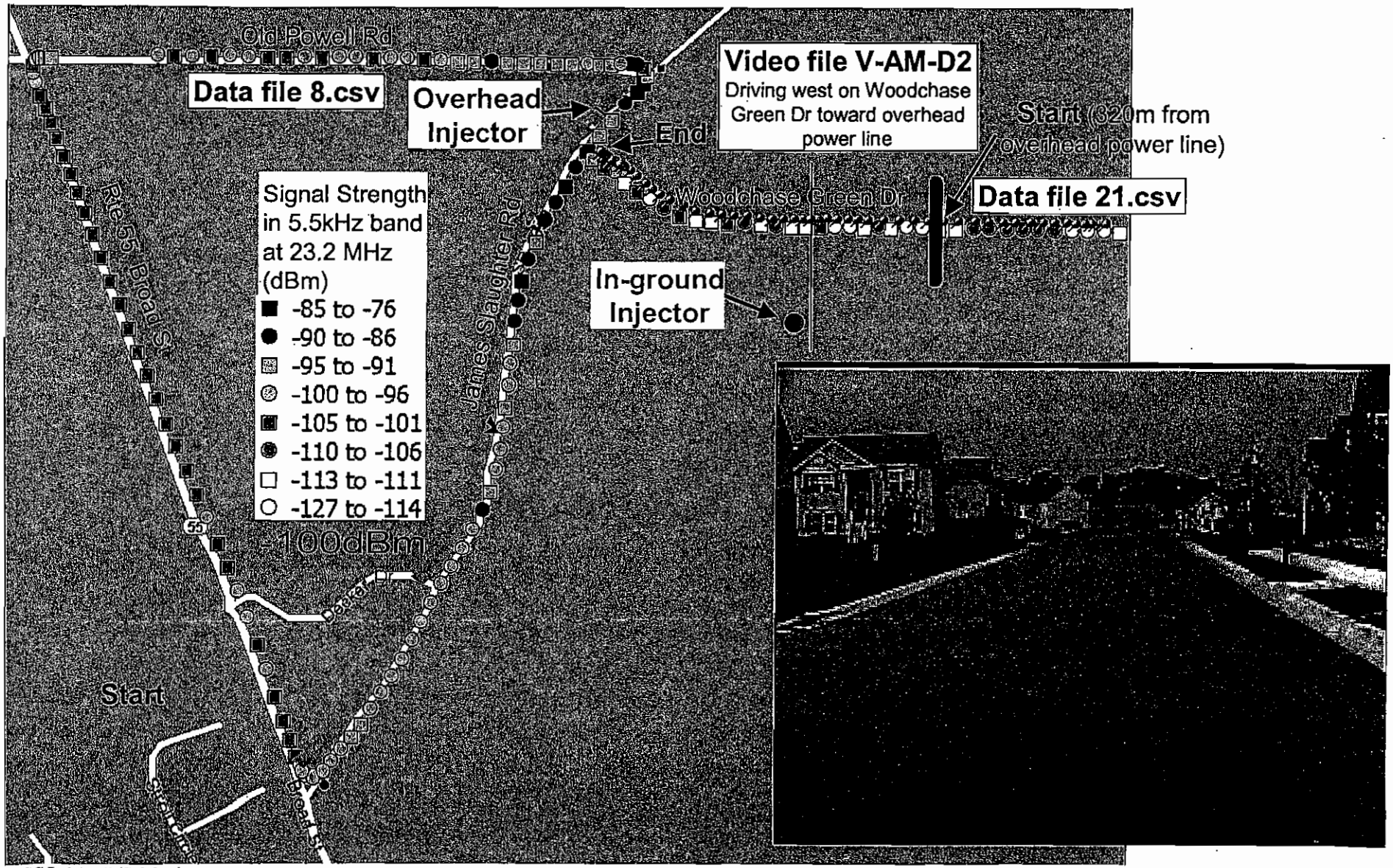
Video Example



BPL Notching

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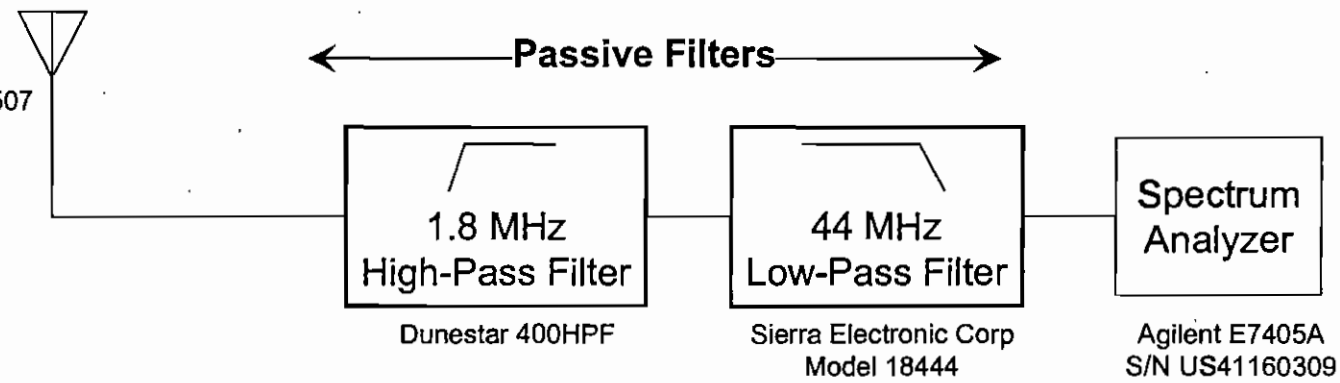
Equipment Setup for Notch-Depth Measurements

- Active loop antenna: ETS Lindgren Model 6507 S/N 1500
- Biconical antenna: Singer Model 94455-1 S/N 0366)



- **Calibration**
  - The combination of all cables and filters was calibrated, as a function of frequency, using the tracking generator in the spectrum analyzer
  - Biconical antenna data is uncalibrated below 20 MHz
- **Device under test**
  - Overhead Injector centered at 19.2 MHz at Holland Meadows
- **Measurement location**
  - Antenna placed directly under power line, 7.7 meters down line (south) from BPL coupler
  - Antenna height: 4.36 meters (active loop); 4.05 meters (biconical antenna)

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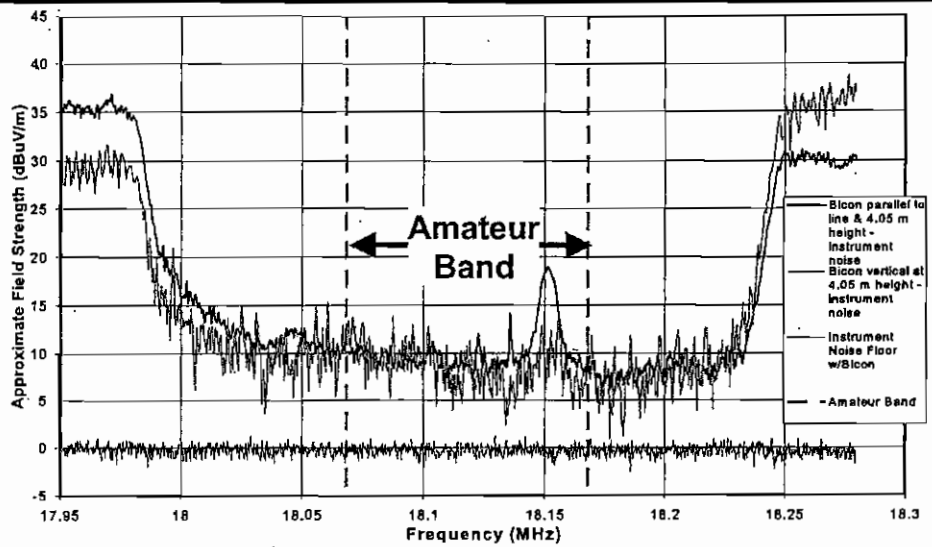
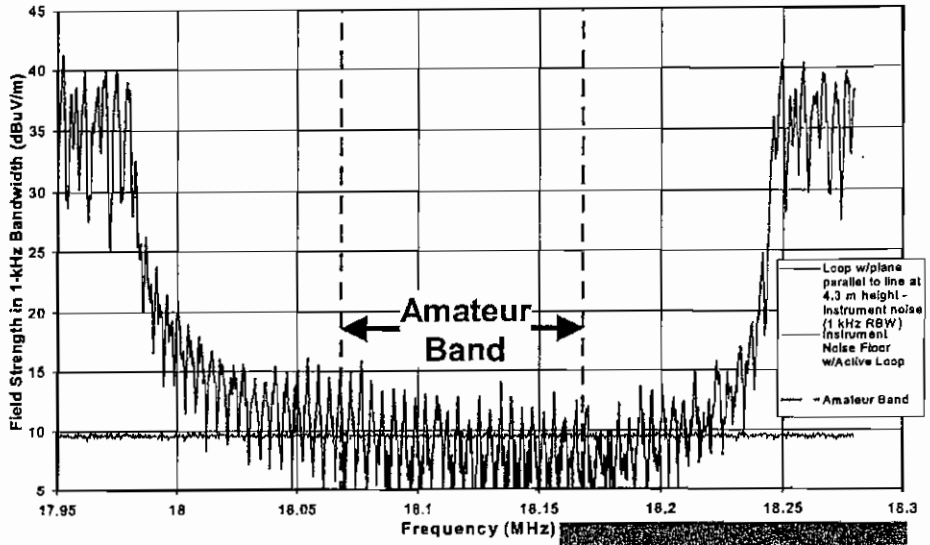
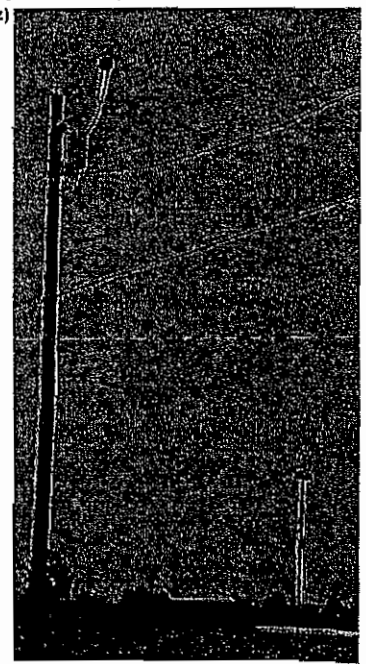
Notch Depth





- **Notch depth of only unit with complete notch (19.2 MHz injector on Holland Church Rd) was measured in two ways**
  - Evaluated spectrum band averages in two moderate-resolution (9 kHz) spectra from bicon antenna
  - Evaluated OFDM peaks in high resolution (1-kHz) spectra from loop antenna
  - Results ranged from 23.4 to 25.0 dB, with an average of 24 dB
- **Carrier structure indicates that bottom of notch was filled in by BPL signal—not by ambients or general power line noise.**



Notch Depth is 24 dB

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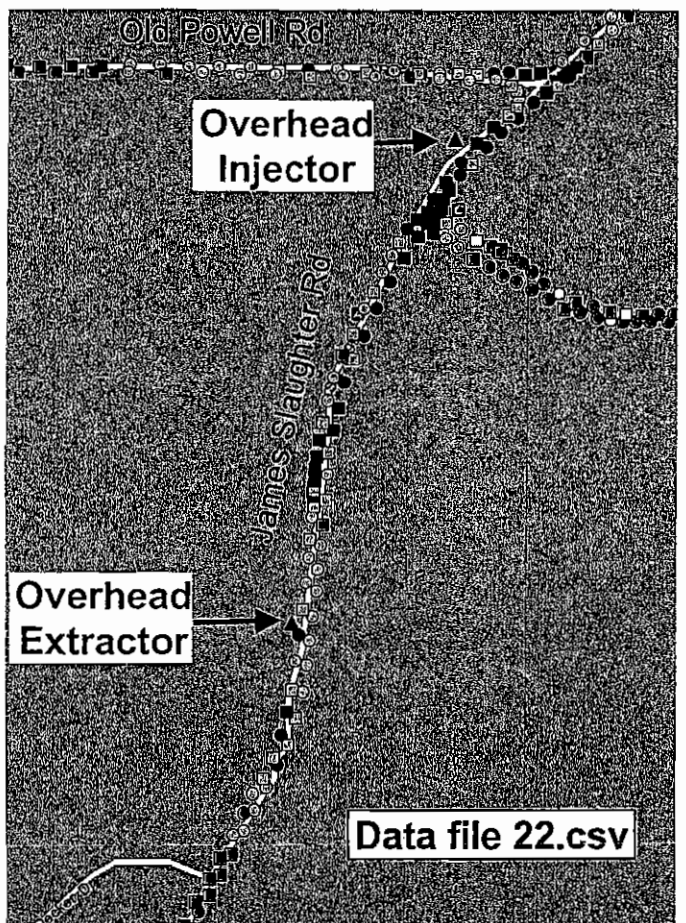
Predicted Effect of Notch

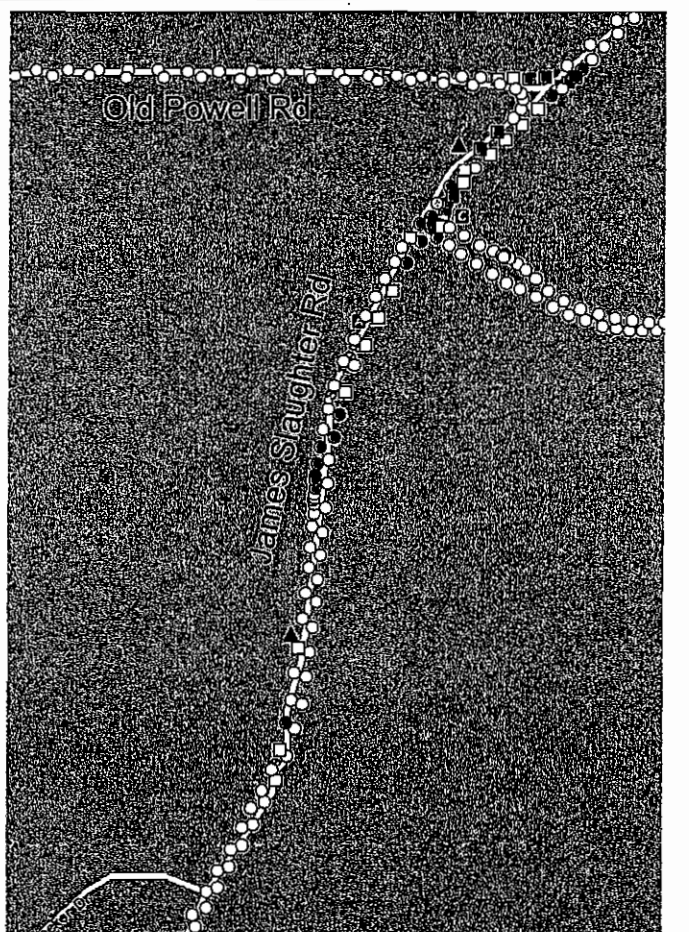
Overhead Injector at Woodchase



Signal Strength in 5.5kHz band at 19.2 MHz (dBm)

- -85 to -76
- -90 to -86
- -95 to -91
- -100 to -96
- -105 to -101
- -110 to -106
- -113 to -111
- -127 to -114

Computed Effect of 24-dB Reduction Due to Notch



Highest emission from BPL is reduced to -100 dBm, 4-dB lower than the maximum seen in driving past the substation and 14 to 27 dB above ambient.

Interference distances are greatly reduced; >= 110 dBm (blue) occurs for only ~120 m of road

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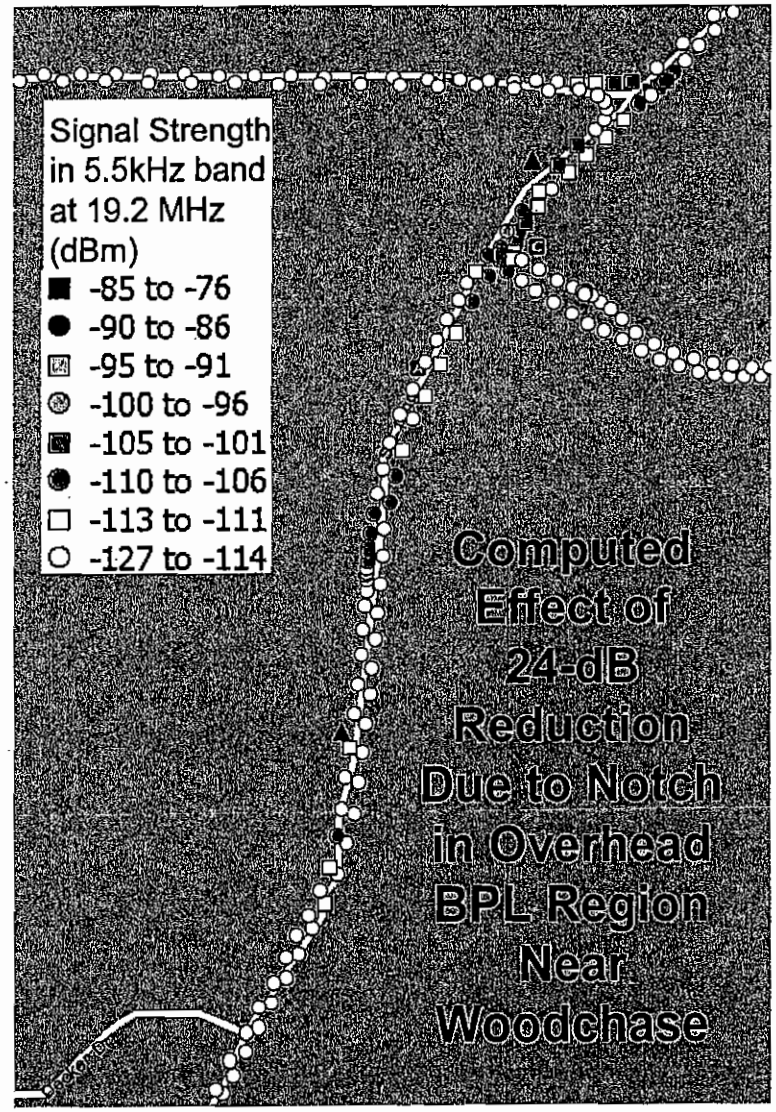
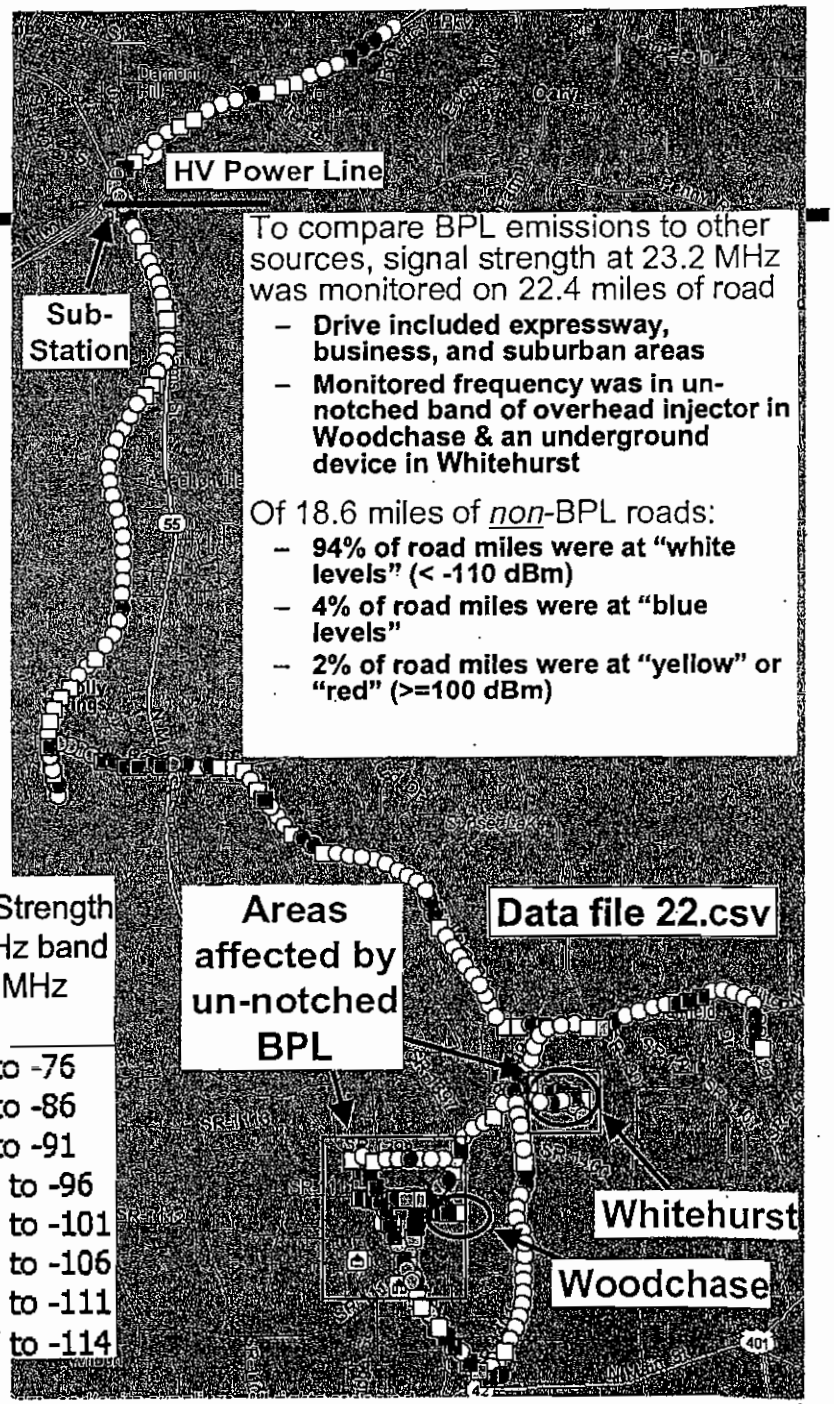
Comparison of Notched BPL Signal Strength with Signal Strength in Non-BPL Regions





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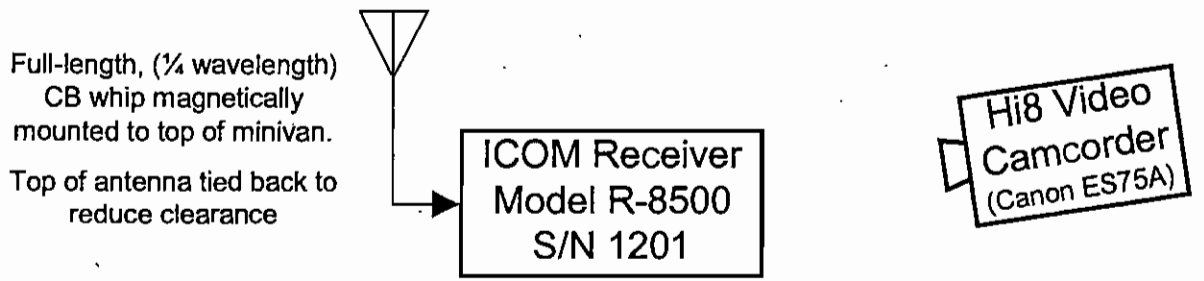
Radio Tests of Notch Effectiveness



- **Procedure**
  - Receiver was manually tuned from the 15-meter amateur band through the 10-meter amateur band while recording sound and video of receiver
  - Test was performed at two sites
- **Receiver mode**
  - AM with 5.5 kHz bandwidth
  - SSB upper sideband with 2.2 kHz bandwidth

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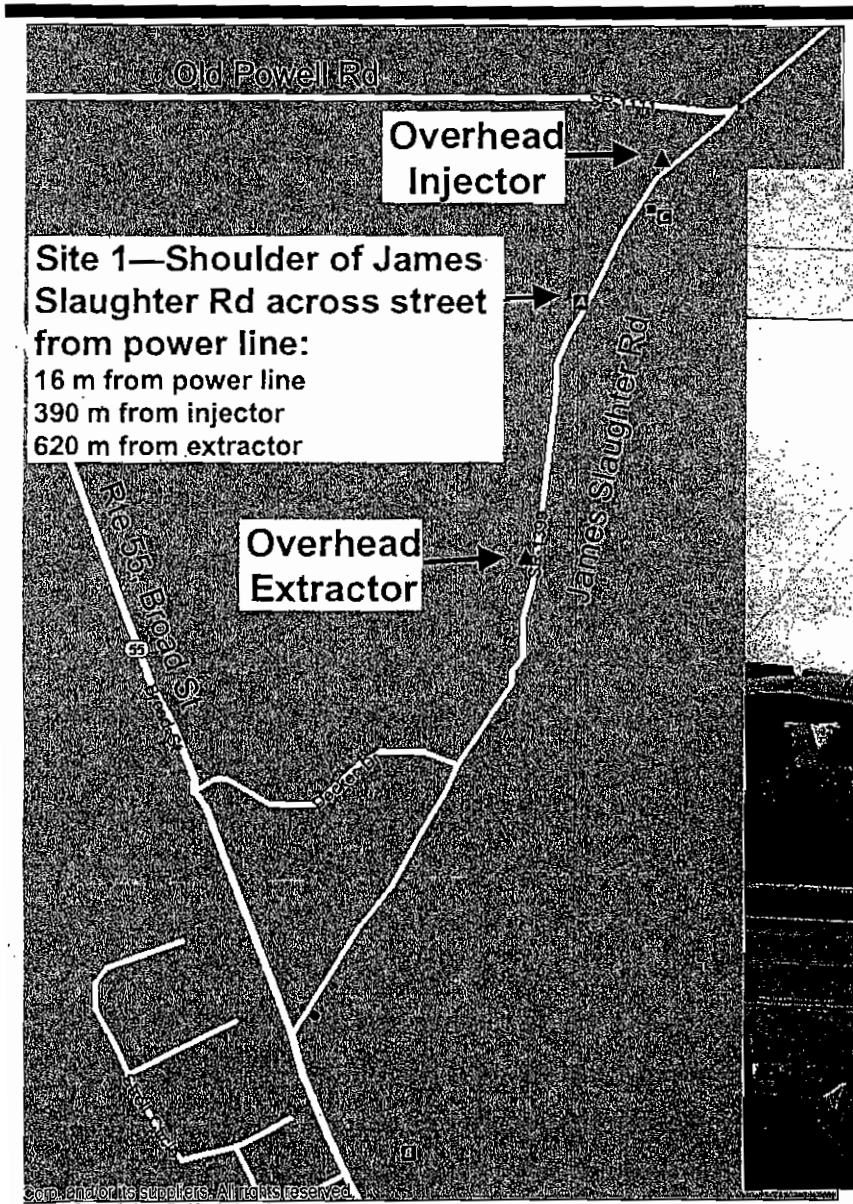
Radio Tests of Notch Effectiveness

Site 1 – Shoulder of James Slaughter Rd



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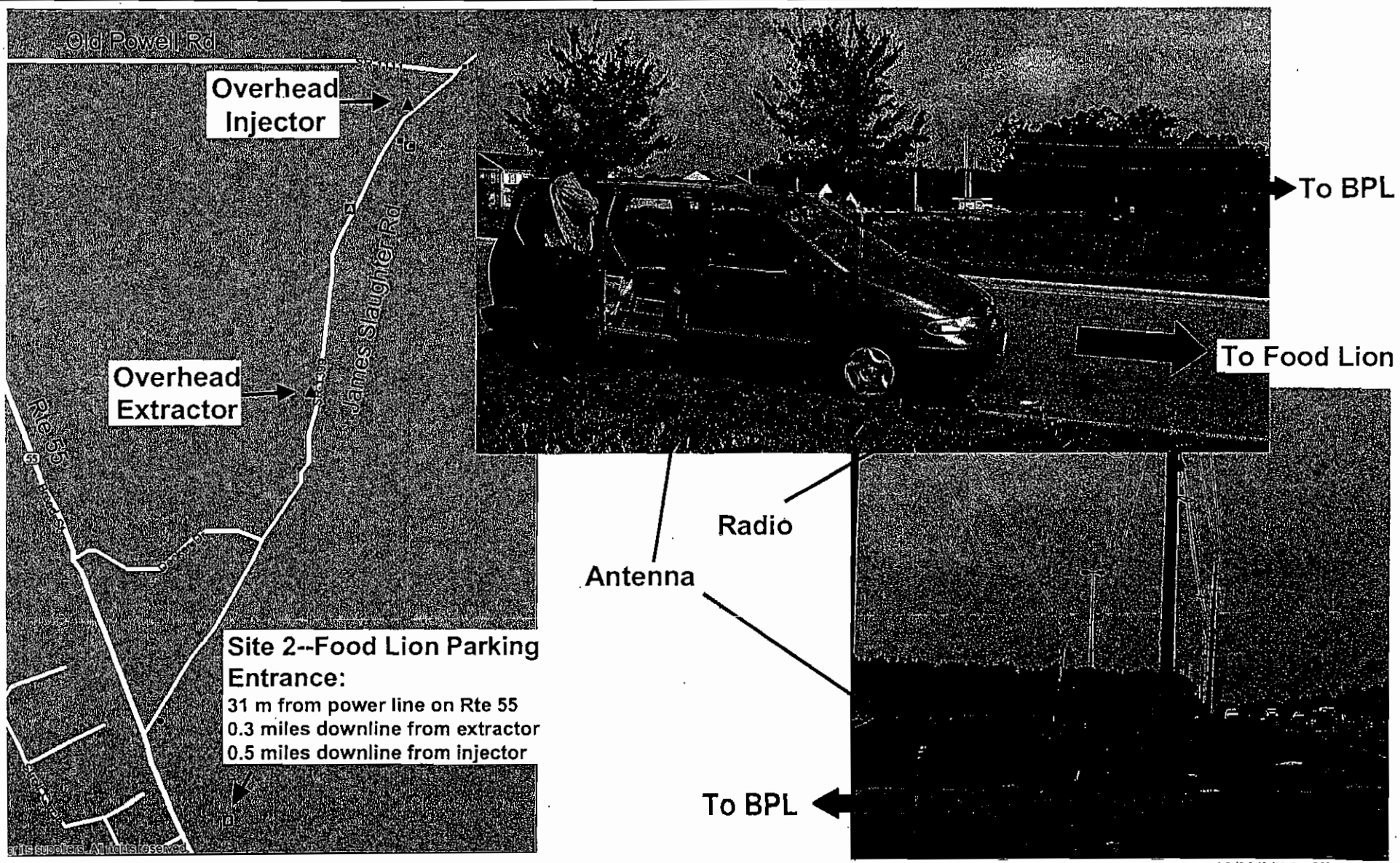
Radio Tests of Notch Effectiveness

Site 2 – Food Lion Parking Entrance



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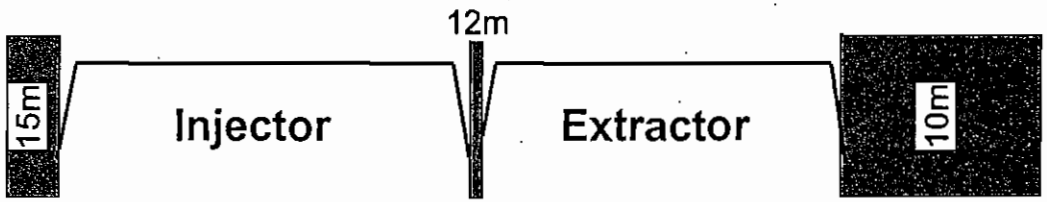
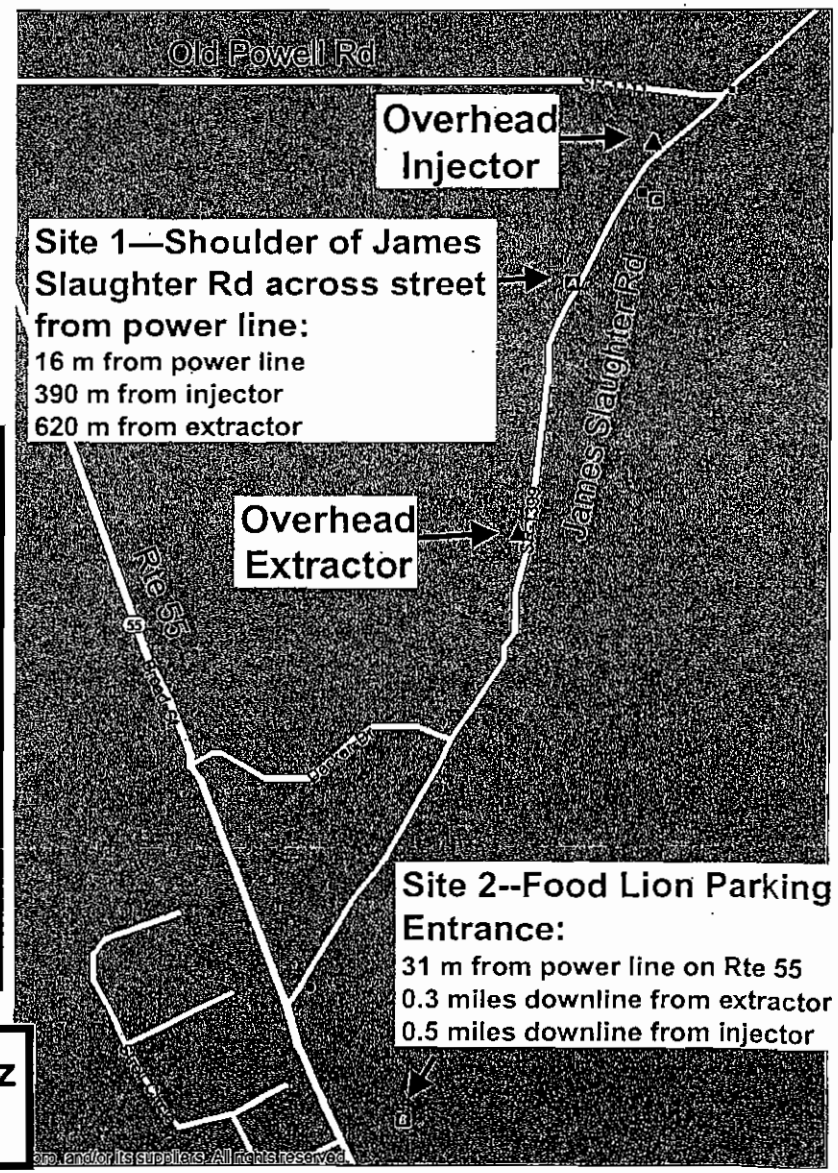
Effectiveness of BPL Notches

Results



Qualitative observations of BPL signal encroachment on amateur bands based on listening in SSB mode

Band	SITE 1 (Video files V-AM-S1 & V-SSB-S1)	SITE 2 (Video files V-AM-S2 & V-SSB-S2)
15 m	Moderate in upper 15kHz; Weak elsewhere	NONE
12 m	Moderate in lower half; Weak in upper half	NONE
10 m	Strong in lower 130kHz; Weak elsewhere	Moderate in lower 100kHz; Weak in next 30kHz; None elsewhere



Recommendation: Increase notch width by 100 kHz at low end of 10m band (28 MHz)

Fixed Amateur Sites

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Fixed Amateurs

- Fixed amateur locations included in complaint
  - 1 5813 Heathill Ct.
  - 2 509 Wyndham Dr
  - 3 201 Wilbon Rd 301B
- Interference not audible w/mobile antenna at 1 & 2, even outside of notches
- 3 not visited due to a mapping error. Location uncertain, but may be close enough to overhead lines on Rte 55 to detect un-notched BPL signals on mobile unit.
- No testing was performed with the fixed HF amateur antennas at any of the locations