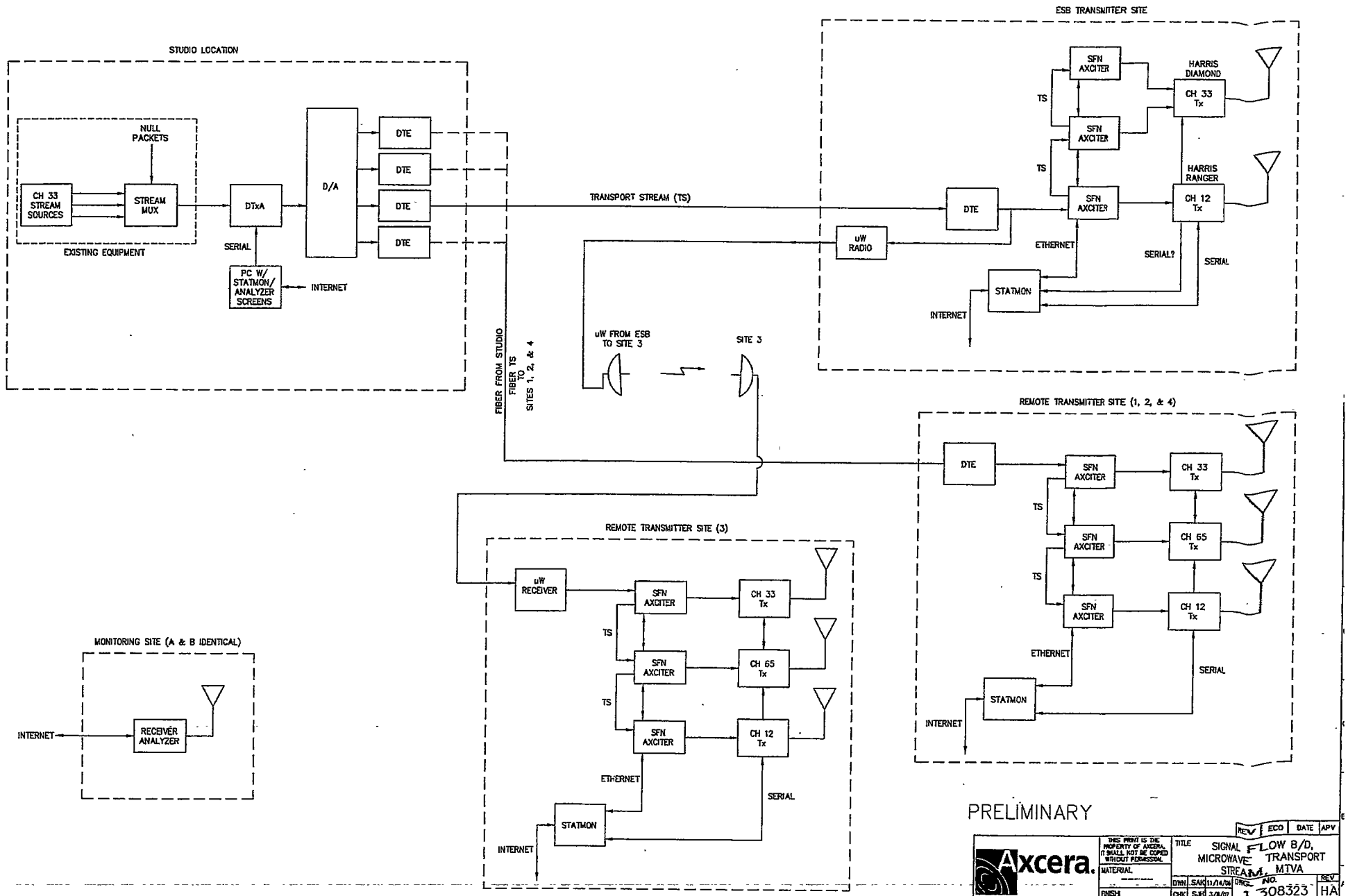
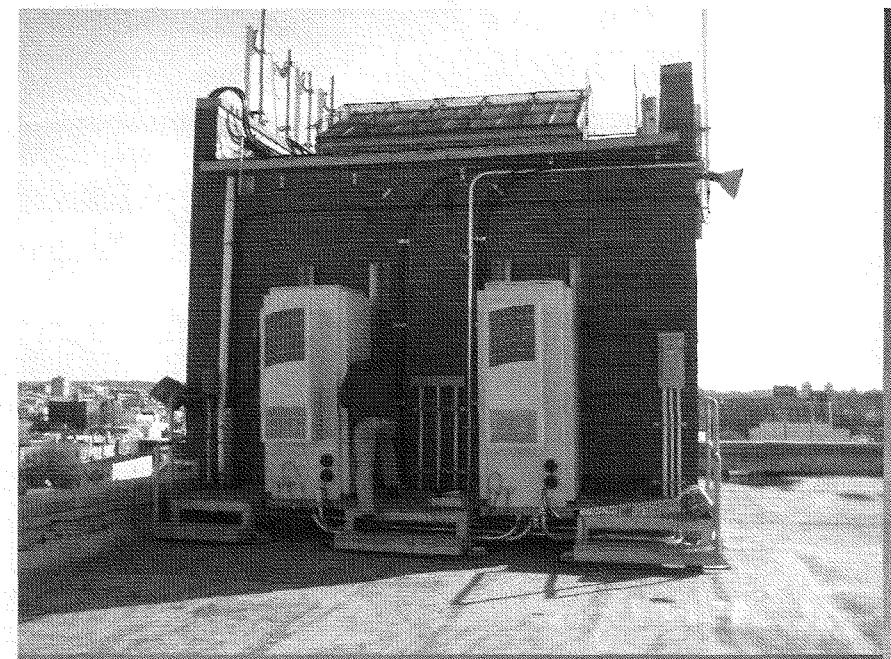
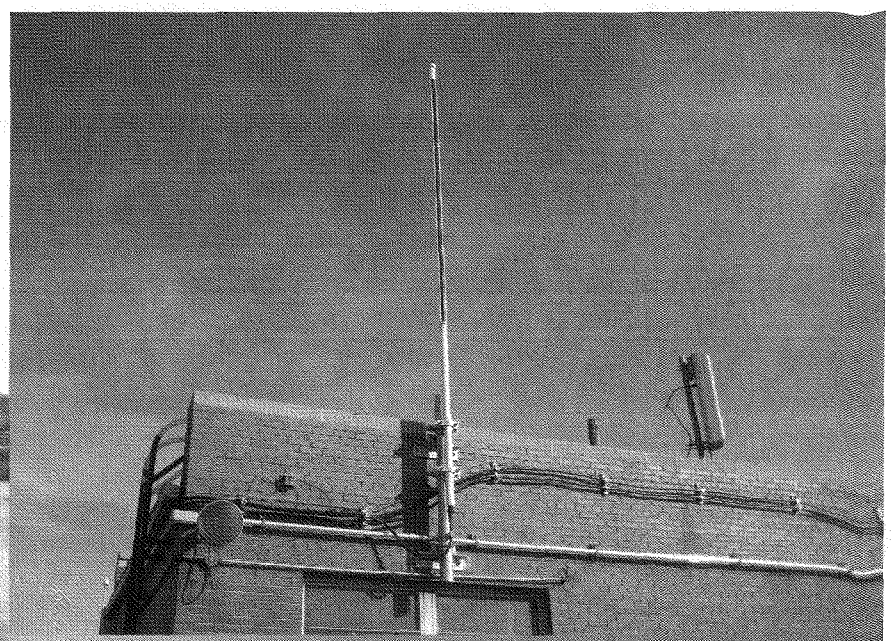
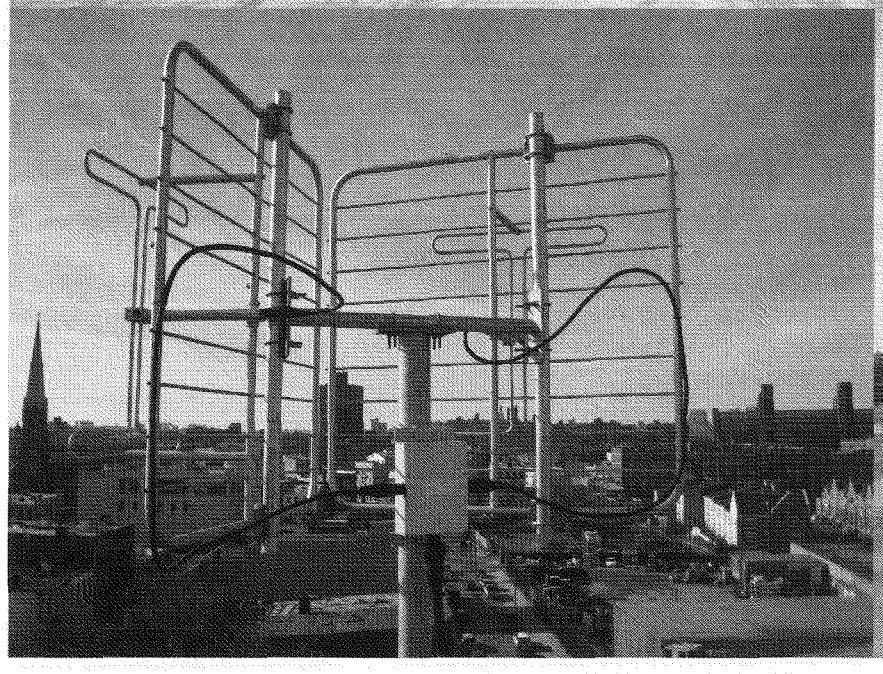
MTVA Prototype DTx System Block Diagram

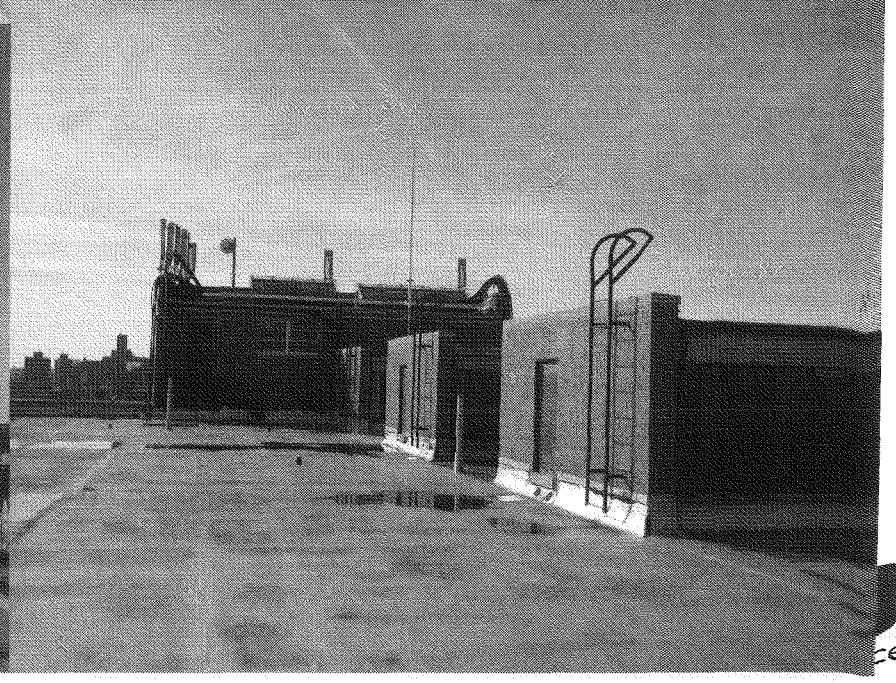


Site # 2 – DTx Transmitter Site









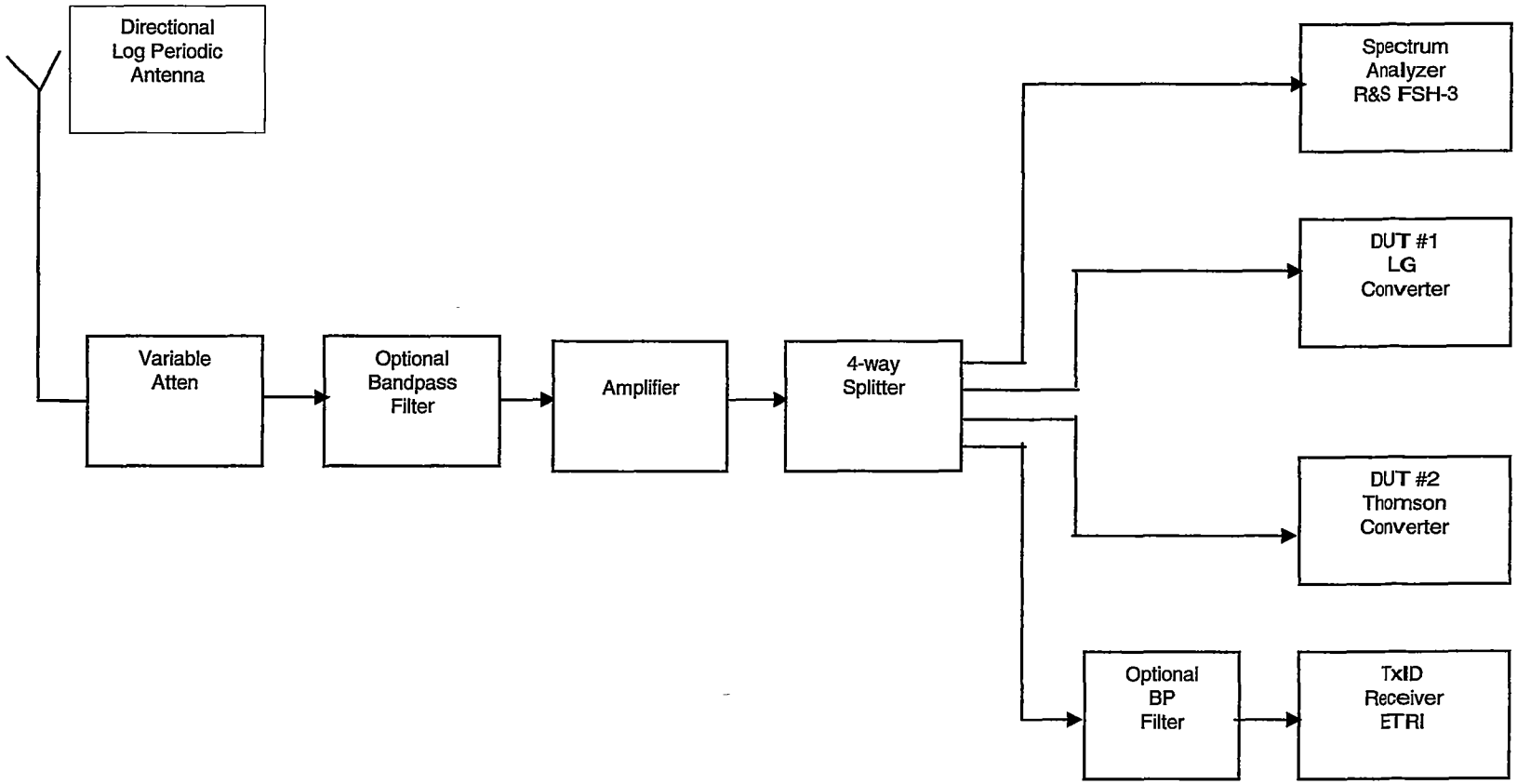
Field Measurements

- Channel 12, 33, & 65
  - Field Strength - 30 Ft. & 15 Ft.
    - ESB Only
    - ESB & DTx
  - Reception Margin - 30 Ft. & 15 Ft.
    - ESB Only
    - ESB & DTx
  - Antenna Ranging - 30 Ft. & 15 Ft.
    - ESB Only
    - ESB & DTx

Field Measurements

- Spectrum Analyzer – Power Measurements & Spectrum Plot
- TXID Analyzer RF Watermark Measurement & Plot
- Two 5th Generation STB Receivers
  - CECB Eligible Receivers
- Receive Antennas
  - Outdoor Log Periodic
  - Indoor Dipole & Consumer Antenna

Field Test Vehicle Block Diagram



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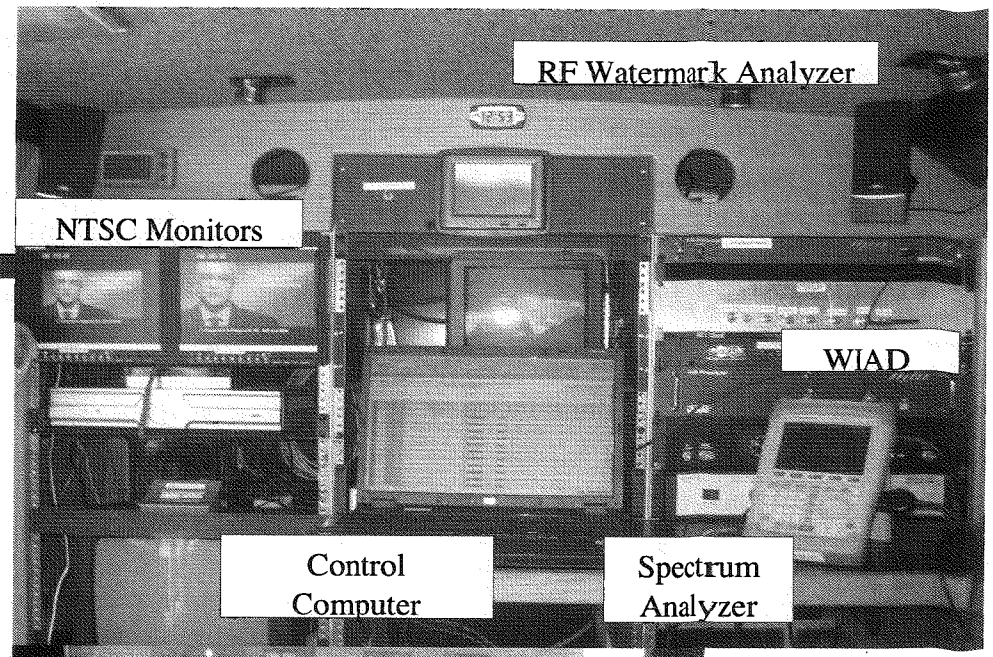
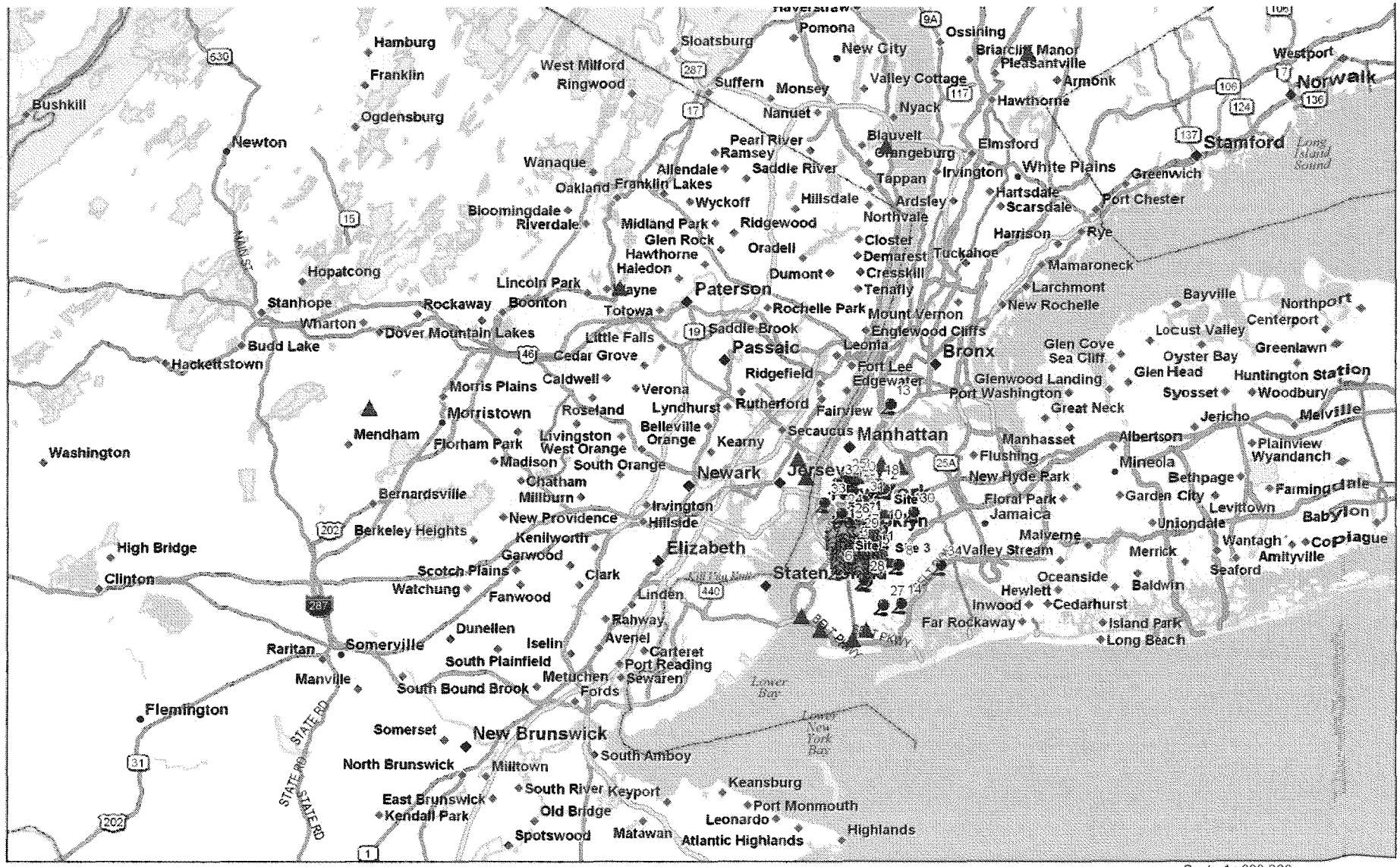

RF Watermark Analyzer
NTSC Monitors
WIAD
Control
Computer
Spectrum
Analyzer

Field Measurement Locations

- Outdoor Measurements
  - Total 109 Outdoor Locations
    - 80 "Grid" Measurements in "Box"
    - 23 Driveway of Indoor Sites
    - 6 Interference Locations
- Indoor Measurements
  - 23 Indoor Locations
    - 10 In the "Box"
    - 13 Out of "Box"

Tx and Test Site Map



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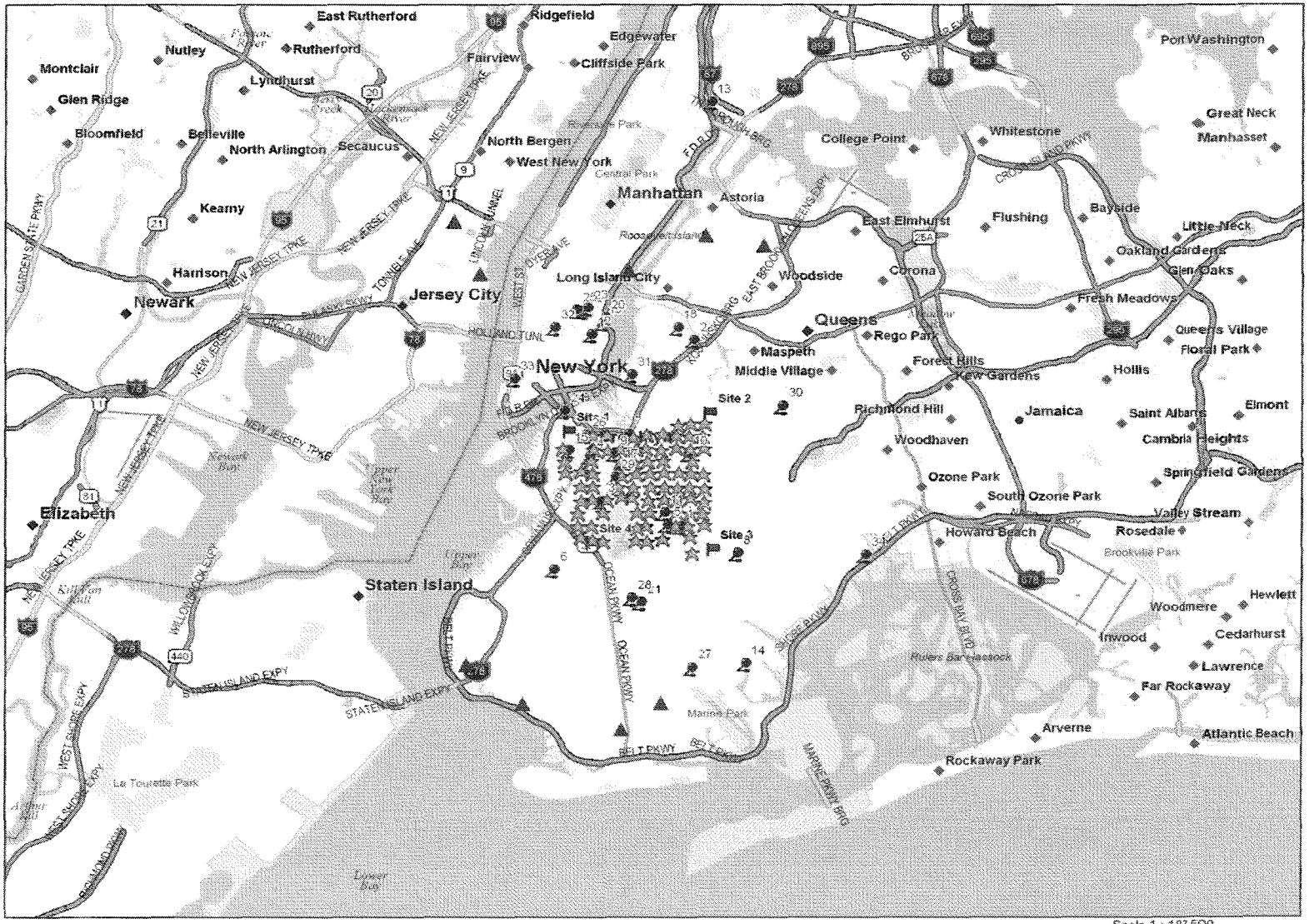
Tx and Test Site Map



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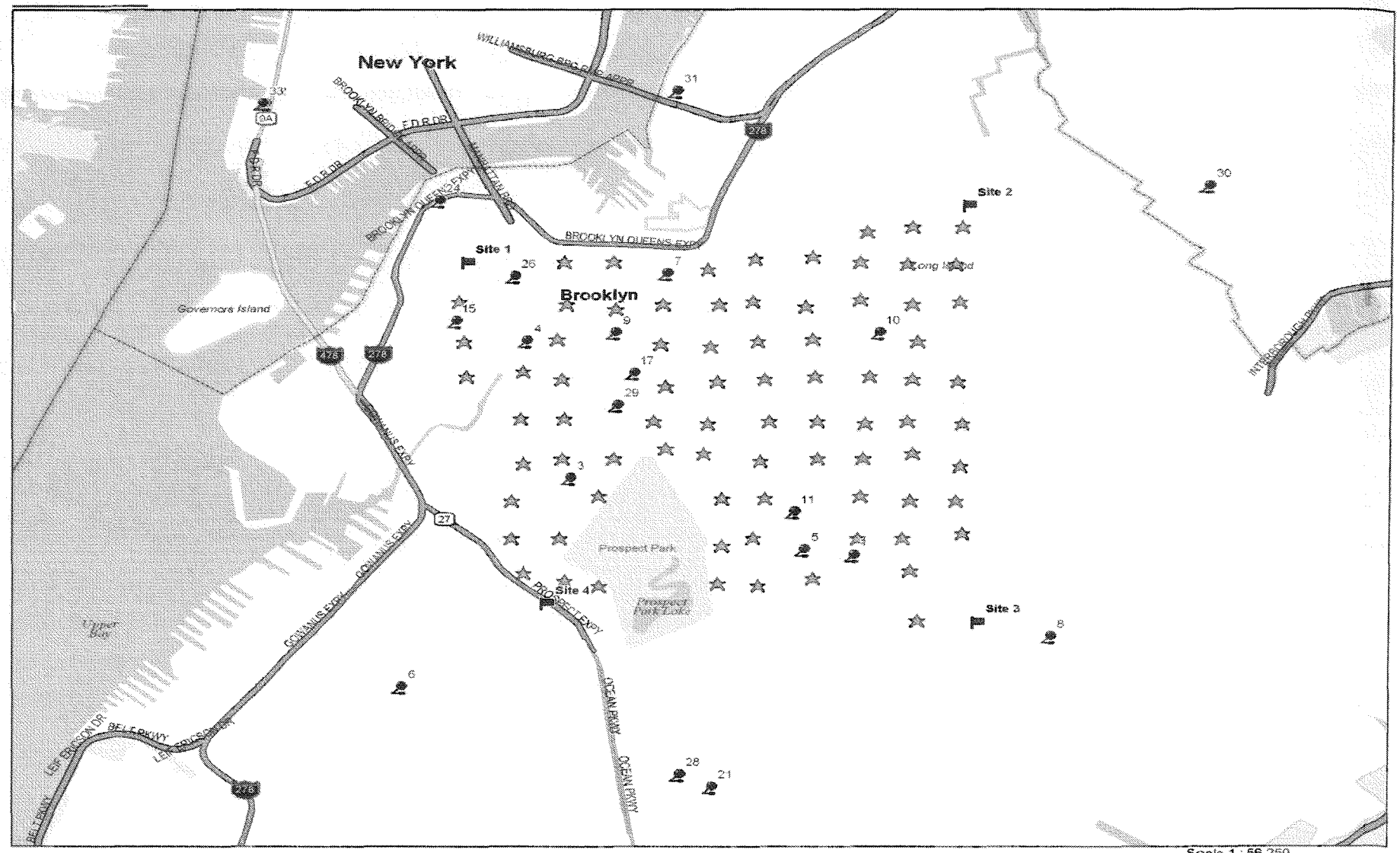
DTx Transmitter and Test Site Map



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Scale 1 : 56,250
1 cm = 562.5 m Data Zoom 11-7

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Data Analysis & Report

- ☐ Field Strength PDF, CDF, & Median
- ☐ DTV Service Availability
- ☐ DTV Margin Median & Improvement
- ☐ Failure Analysis
- ☐ Antenna Adjustment Range
- ☐ Indoor/Outdoor Attenuation Factor

Field Test Results – Outdoor Field Strength

DTx Status	CH 33		CH 12		CH 65		Units
	30'	15'	30'	15'	30'	15'	
DTx OFF	72.7	69.9	58.9	56.7	N.A.	N.A.	dBμV/m (ave)
	73.7	70.3	58.0	56.7	N.A.	N.A.	dBμV/m (med)
	9.6	8.9	8.5	7.9	N.A.	N.A.	dBμV/m (std dev)
DTx ON	80.2	77.1	69.7	66.7	76.0	73.8	dBμV/m (ave)
	79.3	77.6	70.6	66.2	75.7	73.2	dBμV/m (med)
	7.8	7.6	8.7	8.8	8.9	8.2	dBμV/m (std dev)
Field Strength Increase	**7.5**	**7.2**	**10.8**	**10.0**	N.A.	N.A.	dBμV/m (ave)
	4.0	**4.4**	**8.2**	**8.4**	N.A.	N.A.	dBμV/m (med)
	9.0	**8.5**	**10.2**	**10.0**	N.A.	N.A.	dBμV/m (std dev)

Table 6 Inside the "box" *peaked* DTV field strength site statistics.

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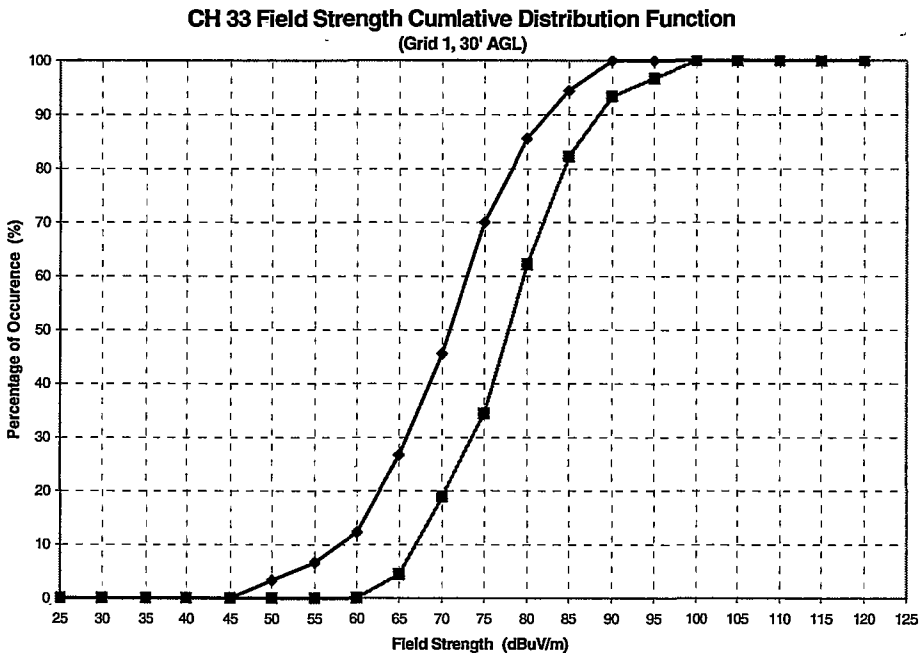
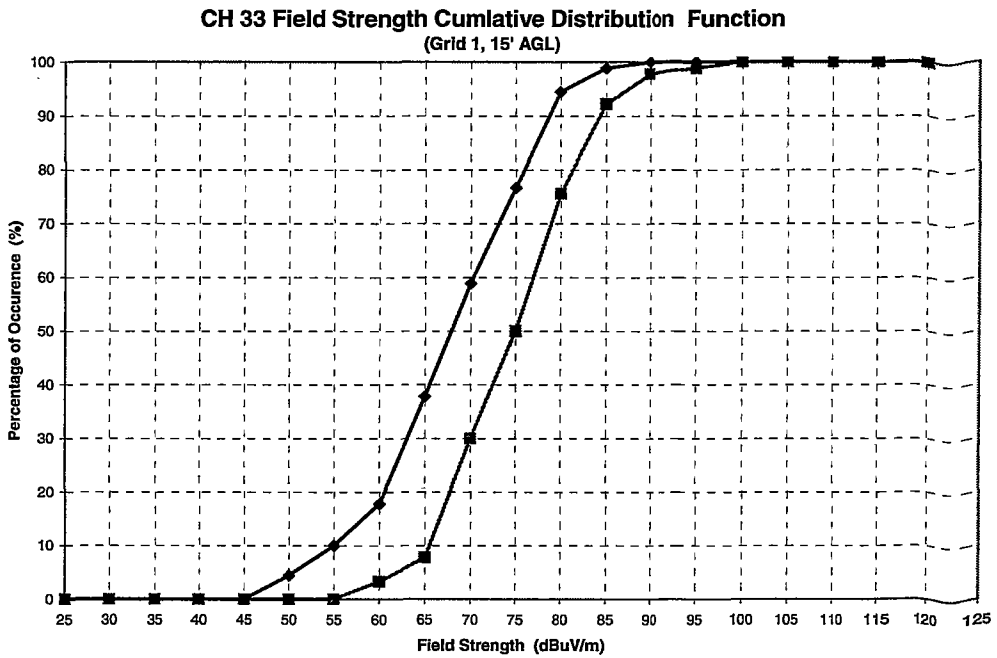
Field Test Results – Outdoor Field Strength 30ft/15ft





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Field Test Results – Outdoor DTV Received Margin

DTx Status	CH 33				CH 12				CH 65				Units
	30'		15'		30'		15'		30'		15'		
	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	
DTx OFF	23.6	23.1	20.0	19.9	20.1	20.1	16.9	17.0	N.A.	N.A.	N.A.	N.A.	dB (ave)
	24.5	24.0	20.0	20.5	20.0	20.0	18.0	17.0	N.A.	N.A.	N.A.	N.A.	dB (med)
	11.8	12.5	10.5	11.3	10.0	10.2	9.6	9.6	N.A.	N.A.	N.A.	N.A.	dB (std dev)
DTx ON	30.9	30.3	25.8	24.3	29.7	28.9	26.4	25.1	22.5	21.6	19.7	18.8	dB (ave)
	32.0	31.5	26.5	26.0	32.0	32.0	26.0	26.0	23.0	22.0	20.0	20.0	dB (med)
	9.8	11.3	11.1	13.0	11.2	12.5	10.7	12.7	10.8	12.0	10.0	11.5	dB (std dev)
Change in Margin with DTx	7.3	7.2	5.8	4.4	9.6	8.8	9.5	8.1	N.A.	N.A.	N.A.	N.A.	dB (ave)
	2.5	3.0	2.0	0.0	8.0	8.0	8.0	7.0	N.A.	N.A.	N.A.	N.A.	dB (med)
	13.0	14.1	11.1	13.1	12.4	13.6	13.4	14.6	N.A.	N.A.	N.A.	N.A.	dB (std dev)

Table 12 Inside the "box" DTV margin statistics with antenna adjusted for peak signal strength.

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Field Test Results – Outdoor Antenna Rotation Range

DTx Status	CH 33				CH 12				CH 65				Units
	30'		15'		30'		15'		30'		15'		
	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	
DTx OFF	300.4	256.4	290.0	240.5	266.4	254.2	242.6	228.3	N.A.	N.A.	N.A.	N.A.	deg (ave)
	360.0	307.5	360.0	296.0	305.0	273.0	270.0	236.0	N.A.	N.A.	N.A.	N.A.	deg (med)
	107.9	124.3	115.1	134.5	107.8	110.7	121.6	119.1	N.A.	N.A.	N.A.	N.A.	deg (std dev)
DTx ON	337.0	259.0	313.5	231.9	350.1	289.5	344.6	267.8	289.8	224.1	275.8	207.0	deg (ave)
	360.0	360.0	360.0	294.0	360.0	360.0	360.0	360.0	360.0	261.0	340.0	235.0	deg (med)
	65.3	130.5	104.9	139.9	49.1	109.7	54.1	122.8	109.4	138.4	112.7	142.7	deg (std dev)
Change in ROR with DTx	36.5	2.6	23.5	-8.5	83.7	35.3	102.0	39.5	N.A.	N.A.	N.A.	N.A.	deg (ave)
	0.0	0.0	0.0	0.0	41.0	17.0	72.0	8.0	N.A.	N.A.	N.A.	N.A.	deg (med)
	118.0	171.8	132.4	169.9	106.6	130.3	116.2	162.0	N.A.	N.A.	N.A.	N.A.	deg (std dev)

Table 14 Inside the "box" DTV range of rotation statistics with antenna adjusted for *peak* signal strength.

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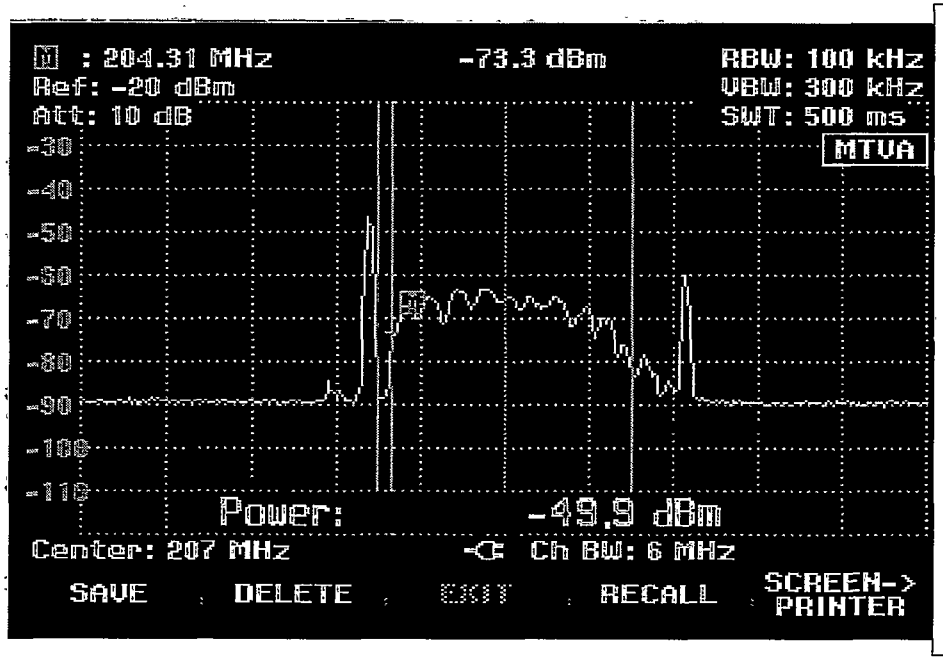
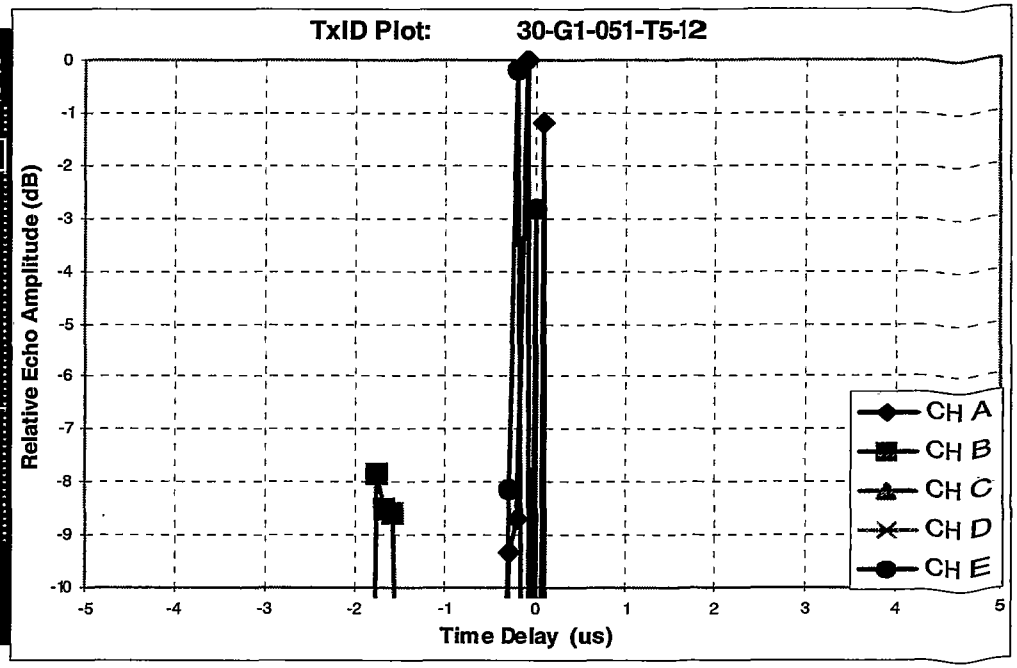
Outdoor Reception- Example Good Reception with Multiple Echoes

- Site G1-50 – 30 Ft. Channel 12
  - 63 dBuV/m Signal Level
- Largest Signal TX A (ESB)
- TX A (Naturally Occurring Multipath)
  - 1 Very Strong Short Post-Echo
  - 1 Weak Short Pre-Echo
- TX E (DTx Induced)
  - 1 Very Strong Pre-Echo
  - 1 Moderate Post-Echo
  - 1 Weak Pre-Echo
- TX B (DTx Induced)
  - 2 Strong Pre-Echoes
- Both Receivers were able to receive
  - RX1 Good Reception with 14dB of Margin
  - RX2 Good Reception with 12dB of Margin

Outdoor Reception- Example Good Reception with Multiple Echoes



Spectrum



TXID Channel Impulse Response

Meintel, Sgrignoli, & Wallace

Field Test Results – Indoor Field Strength

DTx Status	Primary Antenna			Secondary Antenna			Units
	CH 33	CH 12	CH 65	CH 33	CH 12	CH 65	
DTx OFF (all) (All **23 sites**)	68.8	51.4	N.A.	65.0	49.5	N.A.	dBμV/m (ave)
	67.7	50.2	N.A.	64.0	47.4	N.A.	dBμV/m (med)
	9.4	7.0	N.A.	9.4	7.4	N.A.	dBμV/m (std dev)
DTx ON (All **23 sites**)	72.4	56.0	61.6	68.7	53.9	57.8	dBμV/m (ave)
	70.4	55.5	58.4	66.7	52.5	53.8	dBμV/m (med)
	8.6	9.7	10.2	8.6	9.7	10.9	dBμV/m (std dev)
DTx OFF (Inside the Box) (**10 sites**)	66.2	51.1	N.A.	62.1	49.0	N.A.	dBμV/m (ave)
	66.6	49.7	N.A.	61.0	46.9	N.A.	dBμV/m (med)
	8.6	6.5	N.A.	7.5	6.5	N.A.	dBμV/m (std dev)
DTx ON (Inside the Box) (**10 sites**)	72.7	60.4	68.0	70.0	58.1	65.0	dBμV/m (ave)
	70.4	58.0	64.3	66.9	56.4	65.4	dBμV/m (med)
	7.5	10.2	7.7	7.0	9.7	7.5	dBμV/m (std dev)

Table 16 Indoor field strength statistics.

Field Test Results – Indoor/Outdoor Signal Attenuation

DTx Status	30' AGL to Primary Antenna			15' AGL to Primary Antenna			Units
	CH 33	CH 12	CH 65	CH 33	CH 12	CH 65	
DTx OFF (All **23 sites**)	5.6	7.8	N.A.	5.0	5.5	N.A.	dB (ave)
	6.6	6.3	N.A.	5.8	5.0	N.A.	dB (med)
	6.5	10.4	N.A.	7.0	8.4	N.A.	dB (std dev)
DTx ON (All **23 sites**)	6.4	8.9	5.6	4.3	6.2	4.4	dB (ave)
	8.3	6.5	4.9	5.1	4.1	4.2	dB (med)
	8.8	10.0	10.3	7.9	8.7	9.2	dB (std dev)

Table 17 Outdoor-to-indoor field strength attenuation statistics.

Field Test Results- Indoor DTV Service/Margin/ROR

DTx Status	Test Parameter	CH 33		CH 12		CH 65		Units
		Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	
DTx OFF (10 sites)	DTV Service	70.0	60.0	20.0	10.0	N.A.	N.A.	%
	Margin	12.5	11.9	3.6	2.2	N.A.	N.A.	dB (ave)
	Range of Rotation	179.5	170.0	36.0	36.0	N.A.	N.A.	deg (ave)
DTx ON (10 sites)	DTV Service	90.0	80.0	30.0	30.0	90.0	90.0	%
	Margin	18.2	16.6	9.0	8.8	16.6	16.4	dB (ave)
	Range of Rotation	288.0	261.0	92.0	92.0	251.5	233.5	deg (ave)

Table 19 *Primary* antenna test results for the **10** "in-the-box" DTV indoor test sites

DTx Status	Test Parameter	CH 33		CH 12		CH 65		Units
		Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	
DTx OFF (10 sites)	DTV Service	60.0	50.0	20.0	20.0	N.A.	N.A.	%
	Margin	10.1	9.4	3.9	3.8	N.A.	N.A.	dB (ave)
	Range of Rotation	144.5	138.0	30.0	30.0	N.A.	N.A.	deg (ave)
DTx ON (10 sites)	DTV Service	80.0	80.0	30.0	30.0	80.0	80.0	%
	Margin	18.6	18.3	8.6	8.1	16.1	15.8	dB (ave)
	Range of Rotation	208.5	208.5	58.0	54.0	265.5	265.5	deg (ave)

Table 20 *Secondary* antenna test results for the **10** "in-the-box" DTV indoor test sites

Field Test Results-Indoor Measurements "Metric" Comparisons

Parameter	Comparison (**10** sites)	**Primary Antenna**				**Secondary Antenna**				Units
		CH 33		CH 12		CH 33		CH 12		
		Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	Rx1	Rx2	
Service	Better	30	40	20	20	30	40	20	20	%
Service	Same	60	40	70	80	60	50	70	70	%
Service	Worse	10	20	10	0	10	10	10	10	%
Margin	Better	60	50	20	20	60	60	30	20	%
Margin	Same	0	10	60	70	10	10	60	60	%
Margin	Worse	40	40	20	10	30	30	10	20	%
Margin	Worse, but OK	30	20	10	10	20	20	0	10	%
ROR	Better	50	50	20	20	40	40	20	20	%
ROR	Same	30	30	80	80	30	30	60	60	%
ROR	Worse	20	20	0	0	30	30	20	20	%
ROR	Worse, but OK	0	0	0	0	0	0	0	0	%

Table 21 Comparison test results for the **10** "inside the box" indoor test sites for CH 33 and CH 12.

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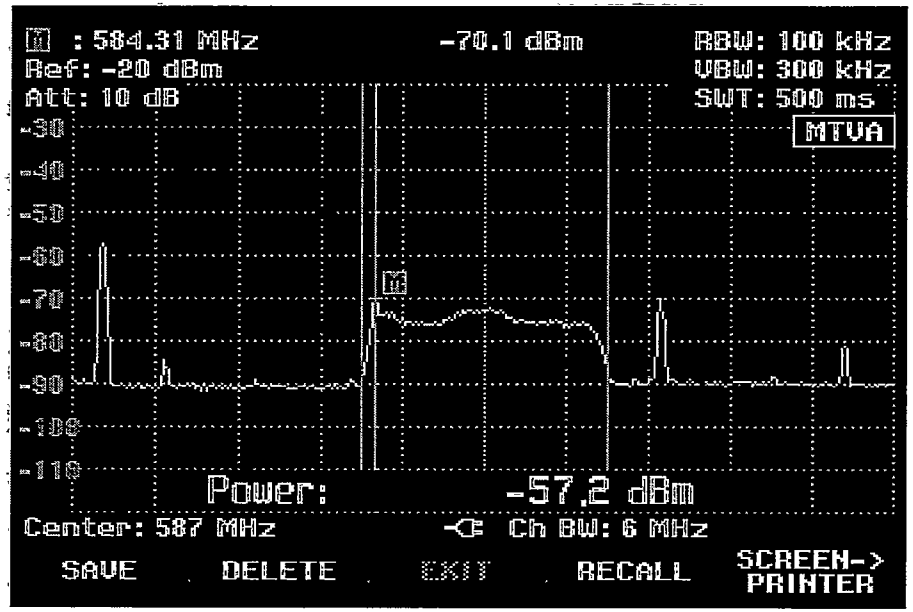
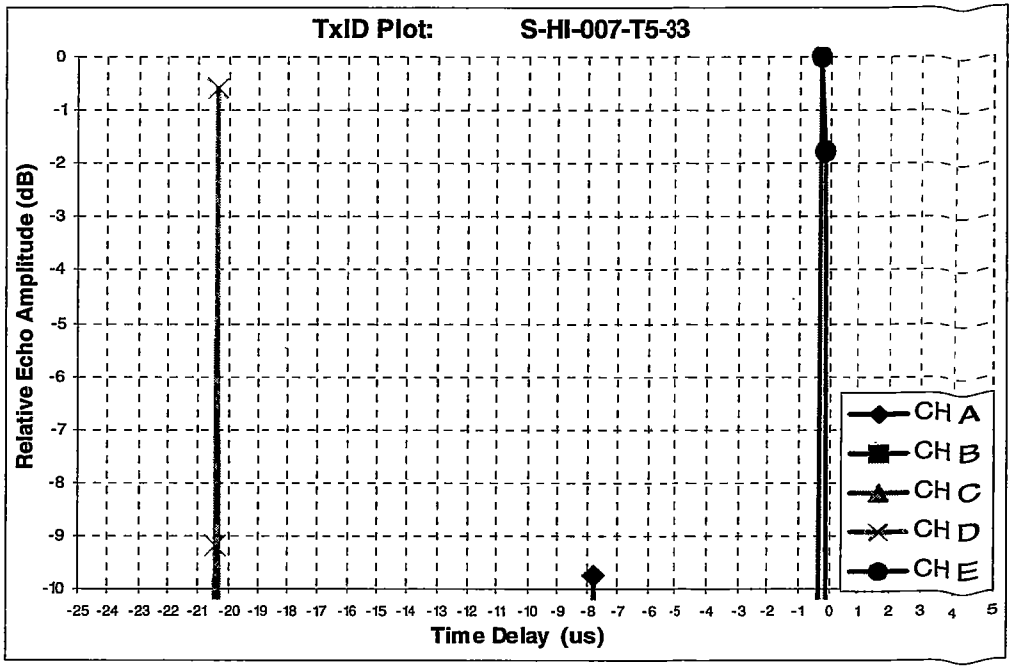
Indoor Testing – Example DTx Induced Echoes – No Reception

- Site IH-7 Channel 33
  - 59.1dBuV/m Signal Level
- Largest Signal TX E (DTx Site 4)
- TX E (Naturally Occurring Multipath)
  - 1 Very Strong Short Post-Echo (-2dB @ +0.2uSec)
- TX D (DTx Induced)
  - 1 Very Strong Pre-Echo (-0.5dB @ -20.5uSec)
  - 1 Weak Pre-Echo
- TX A (DTx Induced)
  - 1 Strong Pre-Echoes (-9.8dB @ -7.8uSec)
- Both Receivers were NOT able to receive
  - RX1 NO Reception
  - RX2 NO Reception

Indoor Testing – Example DTx Induced Echoes – No Reception



Spectrum



TXID Channel Impulse Response

Meintel, Sgrignoli, & Wallace

Outdoor Testing Summary

- DTx System (A-110B) works in major urban area. (On-Channel System Channels 12 & 33).
- Off-Channel System on Ch.65 also worked well.
- DTX does provide increased field strength in the area of interest – In NYC an average increase of 7dB
- Margin Generally increased same 7dB average value
- Self-Induced Interference seems to be within receiver's ability to equalize – Few Failures attributed to self-induced multipath.
- Increases in antenna range of rotation for Rx1 were about +20 to +100degrees
- Changes in antenna range of rotation for Rx2 were -10 to +40 degrees.
- Rx2 was generally more susceptible to multipath impairments.
- Very Good Reception (High Field Strength around 73 dBuV/m) from the single ESB transmitter made differences in reception with DTx minimal.

Indoor Testing Summary

- DTx System (A-110B) works in major urban area. (On-Channel System Channels 12 & 33).
- Off-Channel System on Ch.65 also worked well.
- DTX does provide increased field strength inside the home within the area of interest – In "Box" an average increase of 7dB
- Margin Generally increased same 7dB average value
- Self-Induced Interference seems to be within receiver's ability to equalize – Few Failures attributed to self-induced multipath.
- Increases in antenna range of rotation for Rx1 averaged +108 degrees
- Changes in antenna range of rotation for Rx2 averaged +56 degrees
- Rx2 was generally more susceptible to multipath impairments.
- Very Good Reception (Field Strength averaged 66 dBuV/m) from the single ESB transmitter made differences in reception with DTx minimal. (73dBuV/m with DTx Active)