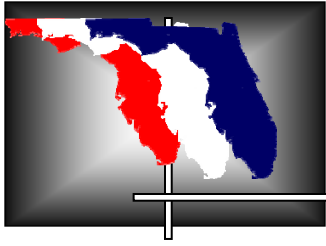


# FDOT *Rail Model*



University of Central Florida

Session 171  
TRB Annual Meeting  
January 11, 2009



# Researchers

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- **Roger L. Wayson**

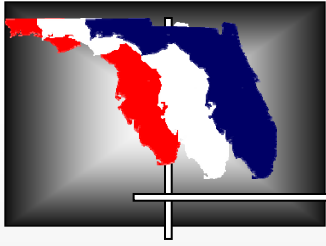
*Volpe National Transportation Systems Center/  
University of Central Florida*

- **John MacDonald**

*University of Central Florida*

- **Mariano Berrios**

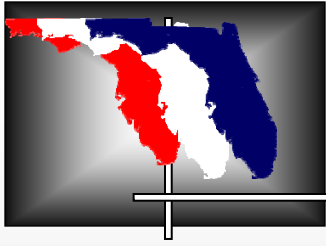
*Florida Department of Transportation*



# Objective of Presentation

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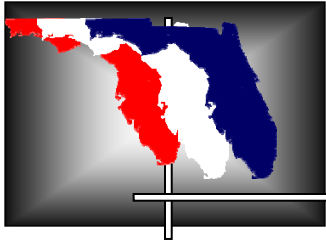
- Purpose of Model Development
- Overview of the FDOT Rail Model
- Presentation of Basic Objects in Model
- Understanding of Model Operation



# Purpose of Model

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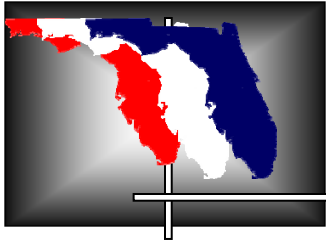
- Noise from railroads are part of the overall soundscape and analysis of noise from this source is needed more and more often by FDOT (FDOT now owns some corridors)
- FDOT uses TNM but model does not account for rail sources and is not easily adaptable for rail sources
- The FDOT Rail Model was developed to permit an easy straight-forward analysis to meet predictive requirements



# Overview: Sources

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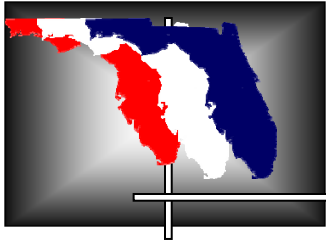
- Windows based, true simulation model
- Object oriented programming
- Drag and drop approach to layout
  - Railways
  - Barriers
  - Receivers
  - Point sources
- Sources modeled as discrete points



# Overview: Propagation

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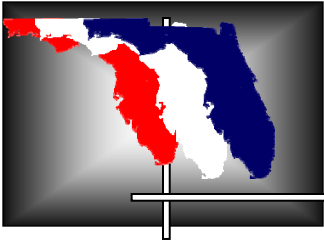
- Propagation prediction accomplished by using ray trace techniques
- Assumed independent corrections can be made
- $L \text{ (dB)} = L_o + A_s + A_m + A_g + A_d + A_{\text{row}}$ 
  - $L$  = sound pressure level at receiver
  - $L_o$  = reference sound pressure level
  - $A_s$  = attenuation due to divergence (geometric spreading)
  - $A_m$  = attenuation due to meteorological effects
  - $A_g$  = attenuation due to interaction with the ground
  - $A_d$  = attenuation due to diffraction effects
  - $A_{\text{row}}$  = attenuation due to building rows



# Overview: Propagation

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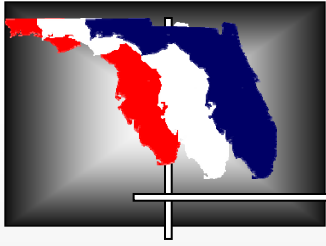
- User selected hard or soft ground surface ground surface prediction using the ISO 9613:2 standard
- Effects of diffracting objects (barrier or terrain line) computed by algorithm based on Kurze and Anderson method
- Multiple diffracting objects ranked using Fresnel number with top two used in a double diffraction algorithm based on Foss method
- Meteorology and building rows included



# Overview: Propagation

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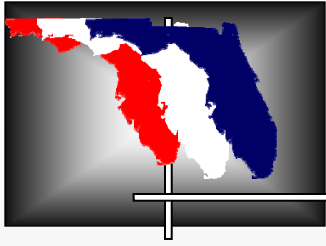
- True simulation in discrete time steps
- Source positions and properties are updated at each time step
- Time step is user selectable but smaller values present less “jumps”
- REMELs computed at each time step for all moving sources since levels are speed dependent.
- Independent propagation terms computed at each time step



# Overview: General

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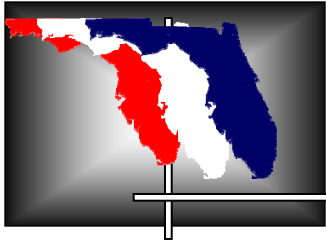
- Model includes algorithms for:
  - Reference emission levels
    - Multiple types
  - Adjustments for:
    - Geometric spreading (distance)
    - Ground effects
    - Diffraction (large objects in path)
    - Meteorological effects
    - Background noise
  - Easy input
    - Spreadsheet
    - Graphically



# Model: Objects and Options

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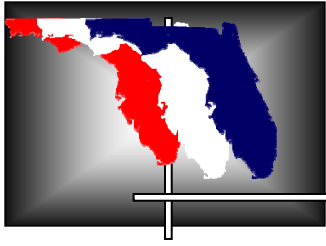
- Units
- Train Sources
- Train Warning Horn Data
- Receivers
- Point Source Area
- Rail Design and Point Sources
- Barriers, Terrain Lines and Building Rows
- Graphic Options
- Zoom to Extents



# Model: Objects

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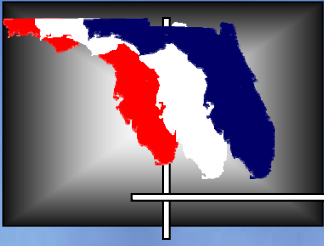
- Example of Object Attributes: The Train Objects
  - Number of locomotives and rail cars
  - Locomotive and car positions
  - Train speed
  - Lengths of each locomotive and rail car
  - Locomotive and rail car type and REMELs
  - Number of day/night operations
    - used by the  $L_{dn}$  feature
  - Properties of warning horn
  - Horn "blast" zone
  - Propagation paths
  - Propagation effects
  
- Note both user input and programmed



# Validation

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- Comparison to values in literature
- Direct comparison to FTA model results
- Comparison to real world measurements conducted for project
- Prediction error = 2.1 dB(A)

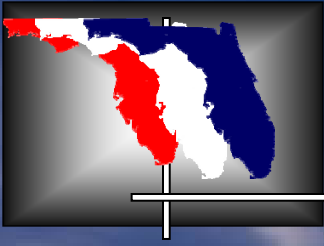


# Input needed



- Railway Coordinates
- Locomotive & Car Details
- Receiver Coordinates
- Details on Loud Point Sources
- Details on Diffraction Objects
- Model Output Desired
  - (Leq or Ldn)





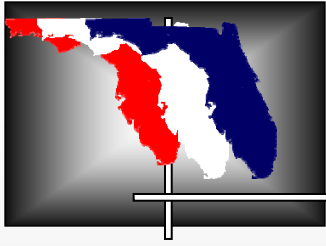
# General Details in FDOTRM

- Order is not important
- Graphical check
- May use toolbars to draw
- Or... enter specific coordinates



Property Inspector		
	Property	Value
1	name	
2	x1	136.7188
3	y1	950.2762
4	z1	0
5	x2	57.8125
6	y2	948.895
7	z2	0
8	height	0
9		
10		
11		
12		

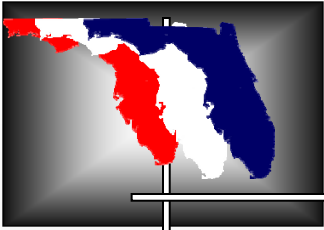




# Menu Bar

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- File
- Model Objects
- Tool
- Calculate



# File Menu

Florida DOT Rail Model 1.0 beta

File Model Objects Tools Calculate

ID: Position:

receiver

Place Track

signal/Xing

Source area

Diffraction

zoom out

zoom in

cancel sim

Florida DOT Rail Model 1.0 beta

File Model Objects Tools Calculate

- New
- Open
- Save
- Save As
- View Model Data/Results
- Save Results
- C:\vb6\FdotRailcode\raiTTest.CCN
- Exit

Source area

Diffraction

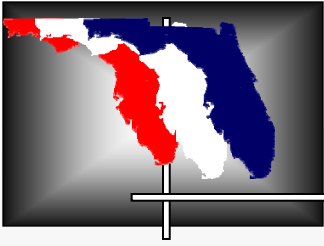
zoom out

zoom in

cancel sim

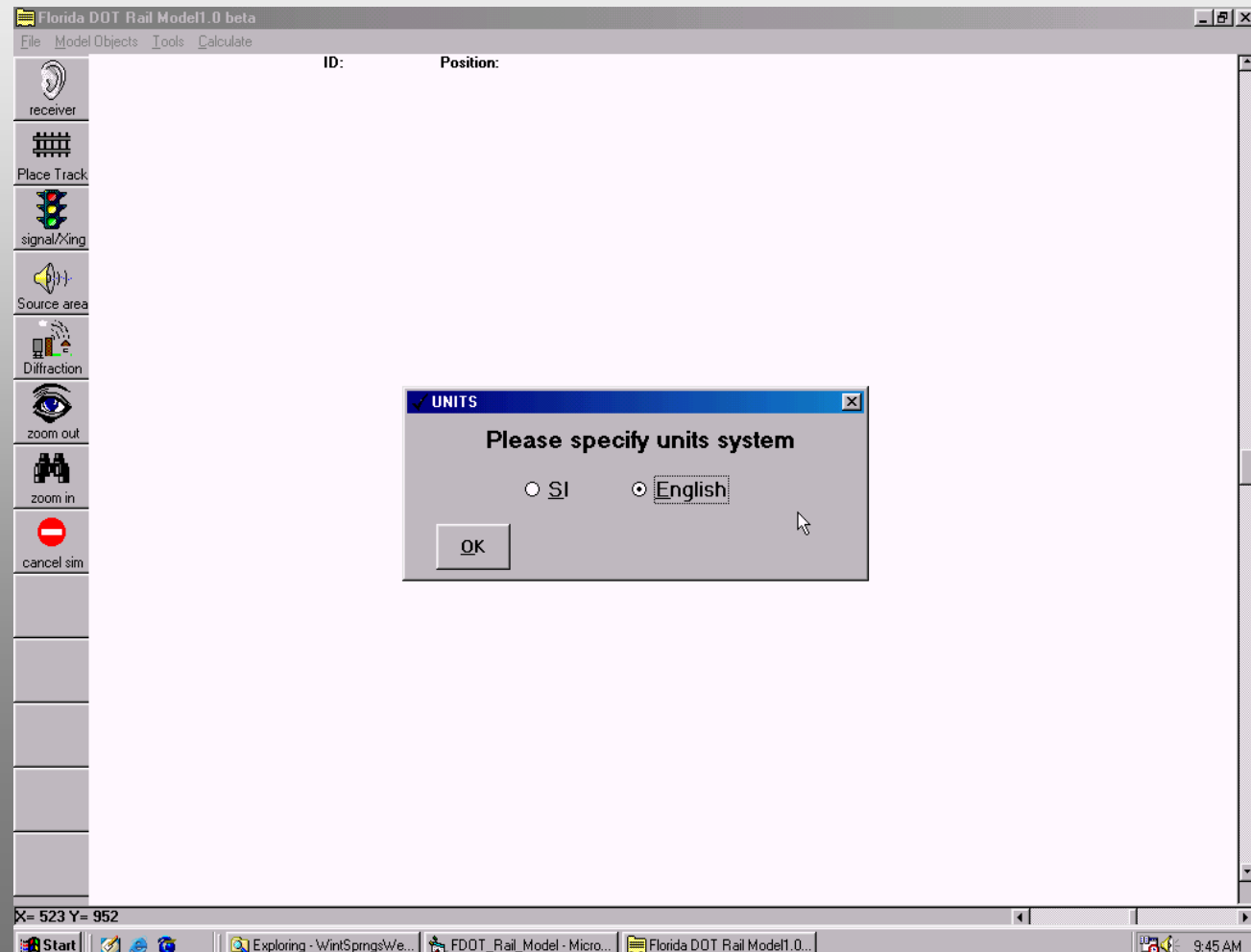
X= 64 Y= 917

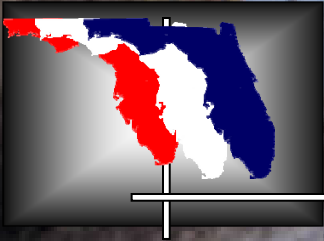
Start | Exploring - WintSprngsWe... | FDOT\_Rail\_Model - Micro... | Florida DOT Rail Mod... | 8:52 AM



# Units

- English or metric





# Railway Coordinates



Florida DOT Rail Model \*.CCN

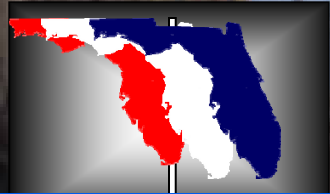
File Model Objects Tools Calculate

ID: track1 Position:

- receiver
- Place Track**
- signal/Xing
- Source area
- Diffraction
- zoom out
- zoom in
- cancel sim



- Model Objects Tools Calculate
- Units
- Train Sources
- Train Warning Horn Data
- Receiver Editor
- Point Source Area
- Rail Design and Point Sources**
- Barriers, Terrain Lines and Building Rows
- Graphics Options
- Zoom to Extents



# Rail Sources



Rail/Point Sources

	Track Name	Entry X ft	Entry Y ft	Entry Z ft	Exit X ft	Exit Y ft	Exit Z ft	Speed mph	Day trains	Night trains	Next Track
1	Track 1	9	82	0	32	82	0	0	0	0	0

Enter Numbers of Locos and Rail cars for each track

	Track Name	#Locos	#Rail Cars	Eng Type	Rail Car Type
1	Track 1	0	0		

Select Loco type and Rail Car type

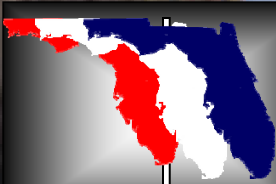
Locos

RailCars

- FTA Diesel-Elect.
- FTA Elect.
- Hvy. Diesel
- GE-60CP Loco
- UK diesel
- US diesel
- ASEA RC4 loco

- FTA Commuter
- AGT Steel Wheel
- AGT Rubber Wheel
- Monorail
- Maglev
- Hi-speed rail
- Pass. car, iron brakes
- Pass. car, disk brakes

OK Cancel Add Object Delete Row Set Xing



# Crossing Information

Rail/Point Sources

	Track Name	Entry X ft	Entry Y ft	Entry Z ft	Exit X ft	Exit Y ft	Exit Z ft	Speed mph	Day trains	Night trains	Next Track
1	Track 1									0	0

Enter Numbers of Loco and Rail Car type

	Track Name
1	Track 1

OK

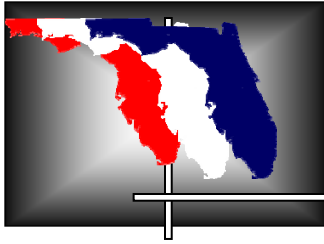
OK Cancel Add Object Delete Row Set Xing

Track Crossing Locations

	Track	Xing position ft
1	Track 1	No Xing
2		
3		
4		
5		
6		
7		
8		
9		

OK





# Setting Train Horn

**Horn Settings**

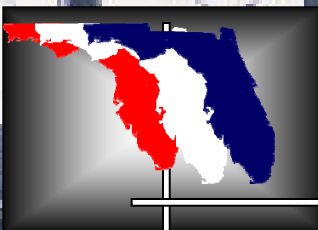
Enter the Horn Level at 50 ft reference distance and the height of the horn above the track. This setting will apply to all locomotives.

<b>Horn Reference Level at 50 ft dB(A)</b>	<input type="text" value="105"/>
<b>Horn Height above Track (ft)</b>	<input type="text" value="4.5717"/>
<b>Distance from crossing that horn is activated (ft)</b>	<input type="text" value="304.78"/>
<b>Number of horn blasts as train approaches Xing</b>	<input type="text" value="0"/>

Disable Horn Sound File

Show Blast Zone

Train Horn Interface.



# Receiver Information

Florida DOT Rail Model

File Model Objects Tools Calculate

receiver ID: Position: 0.0 dB(A)

Place Track

signal/Xing

Source area

Diffraction

zoom out

zoom in

cancel sim

Receivers Editor

All receivers soft  Include all

	Name	X feet	Y feet	Elev feet	ht. above grnd	Surface type	Include?	Backgrnd dB(A)
1	Rec 1	13.6	142.3	0.0	5.0	<input type="checkbox"/> soft grnd	<input checked="" type="checkbox"/> Include	0
2	Rec 2	19.1	206.0	0.0	5.0	<input type="checkbox"/> soft grnd	<input checked="" type="checkbox"/> Include	0

Receiver Input Data

OK Cancel Delete Add Rec. Set Background Level


Background Noise Level

Default Background Levels

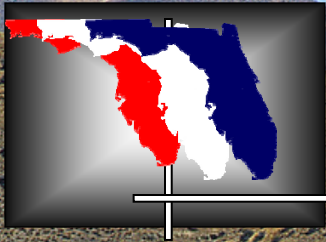
- Rural
- Quiet Residential
- Noisy Residential
- Downtown

Enter Background Level dB(A) if other than shown above

OK



Set Background Level



# Moving Point Source (Areas)

**Point Source Areas**

Indicate the four coordinates of the point source areas. Also indicate the number of sources in the area and mean reference level information. Or choose from the defined point sources available.

	Area 1	Area 2
X1	168	568
Y1	478	789
X2	360	664
Y2	245	709
elev	0	0
height	12	1
sources	2	1
Mean	92	87
Ref. Dist	50	50
stdev	1	1
One time?	<input type="checkbox"/> one time	<input type="checkbox"/> one time
Moving?	<input checked="" type="checkbox"/> moving	<input checked="" type="checkbox"/> moving
Desc.	Dump Truc	wheel scre
type	rect	rect
speed	25	20
op. time secs/min	30	15

Default Sources

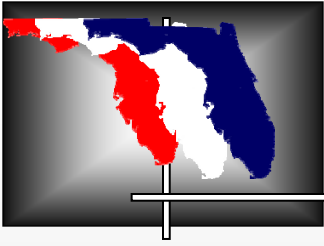
- loco horn
- shaker/pit
- shaker only
- Dump Truck horn
- F.end loader alarm
- F. end loader
- wheel screech
- loco moving
- weigh sta.
- rock falling
- Dump truck
- weigh sta. shld

Area Type

- Rectangle
- Line

OK Cancel Add Area Delete Area Help! More Rail Sources





# Stationary Point Sources

Rail Sources

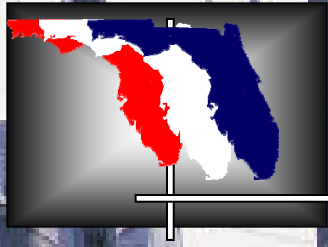
Rail Point Sources

	name	p1x	p1y	p1z	Level	refDist	op. time secs/min
P1	Generator	1372	2568	4.5	67	50	60
P2	compressor	4625	1524	2	65	50	30

OK Cancel Add Object Delete Row



# Diffraction Objects



Add Diffraction Object

Select type of diffraction object

- Barrier
- Terrain
- Building Row

OK

Barriers, Terrain Lines and Building Rows

Barriers | Terrain Lines | Building Rows

SSedit

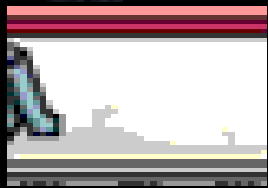
	Name	x1 feet	y1 feet	z1 feet	x2 feet	y2 feet	z2 feet	ht feet
1	Barr 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

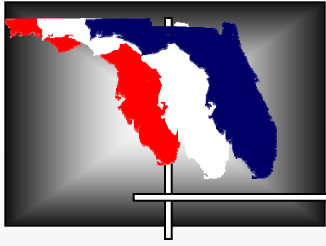
OK

Cancel

Add  
Object

Delete



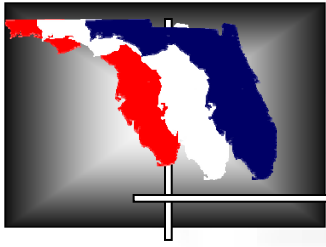


# Other Options in Model Objects

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- Graphic Options
  - Display coordinates can be entered manually if so desired
- Zoom to Extents
  - This is similar to the TNM feature where the program zooms out to a point where all objects in the viewing area

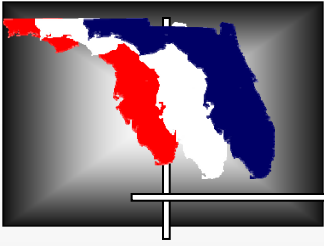




# Run FDOTRM

- Leq mode
- Ldn mode
- View Results
- Save to file
- Compare to available data to check for errors



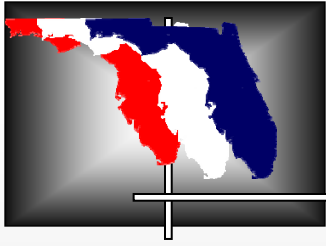


# Calculate Options

The screenshot displays the 'Florida DOT Rail Model1.0 beta' software interface. The main window has a menu bar with 'File', 'Model Objects', 'Tools', and 'Calculate'. Below the menu bar, it shows 'ID: Track 1' and 'Position:'. A vertical toolbar on the left contains icons for 'receiver', 'Place Track', 'signal/king', 'Source area', 'Diffraction', 'zoom out', 'zoom in', and 'cancel sim'. A 'Calculate Sound Levels' dialog box is open in the center, featuring the following fields and options:

- Update Receiver Level (seconds): 20
- Simulation time (seconds): 3600
- Simulation Time Step (seconds): 1
- Run 24 Ldn? (radio button)
- 24 hr Ldn (radio button)
- Go (button)
- Cancel (button)

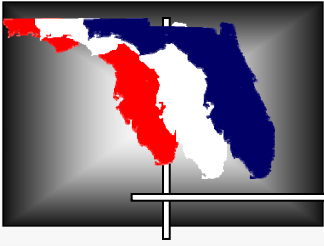
The Windows taskbar at the bottom shows the Start button, several open applications including 'Exploring - Printers', 'FDOT\_Rail\_Model - Micro...', and 'Florida DOT Rail Model1.0...', and the system clock showing '11:24 AM'.



## Ldn Mode

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- FDOTRM runs a 20 minute simulation of existing model conditions and applies persistence factors to a 24 hour period to calculate Ldn



# Simulation Results

Florida DOT Rail Model C:\vb6\FdotRailcode\railTest.CCN

File Model Objects Tools Calculate

receiver

Place Track

signal/cxing

Source area

Diffraction

zoom out

zoom in

cancel sim

X= 914 Y= 725

Start Exploring - Removable Dis... FDOT\_Rail\_Model - Micro... Florida DOT Rail Model C...

11:36 AM

**Text Viewer**

Rec. Results Rail Results Ground effects Diff. Effects Input Data Spreadsheet View

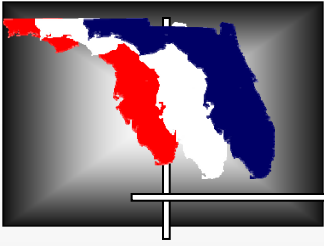
C:\vb6\FdotRailcode\railTest.CCN

Units are SI  
Timestep = 1 seconds

TOTAL SIMULATION RESULTS FOR EACH RECEIVER, Ldn and OTHER METRICS

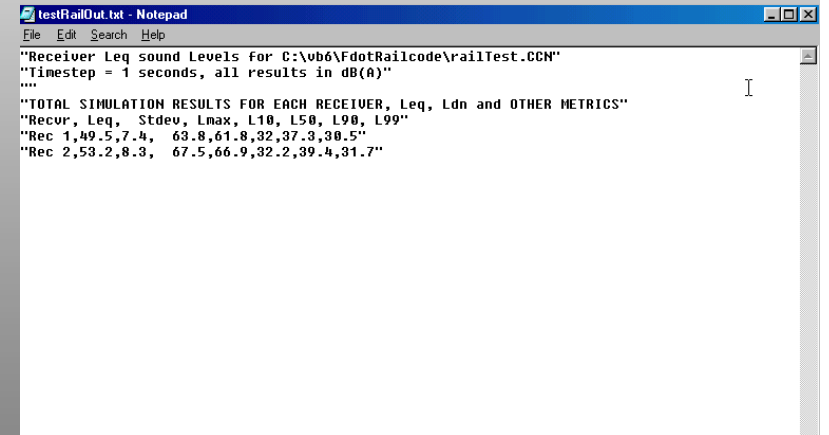
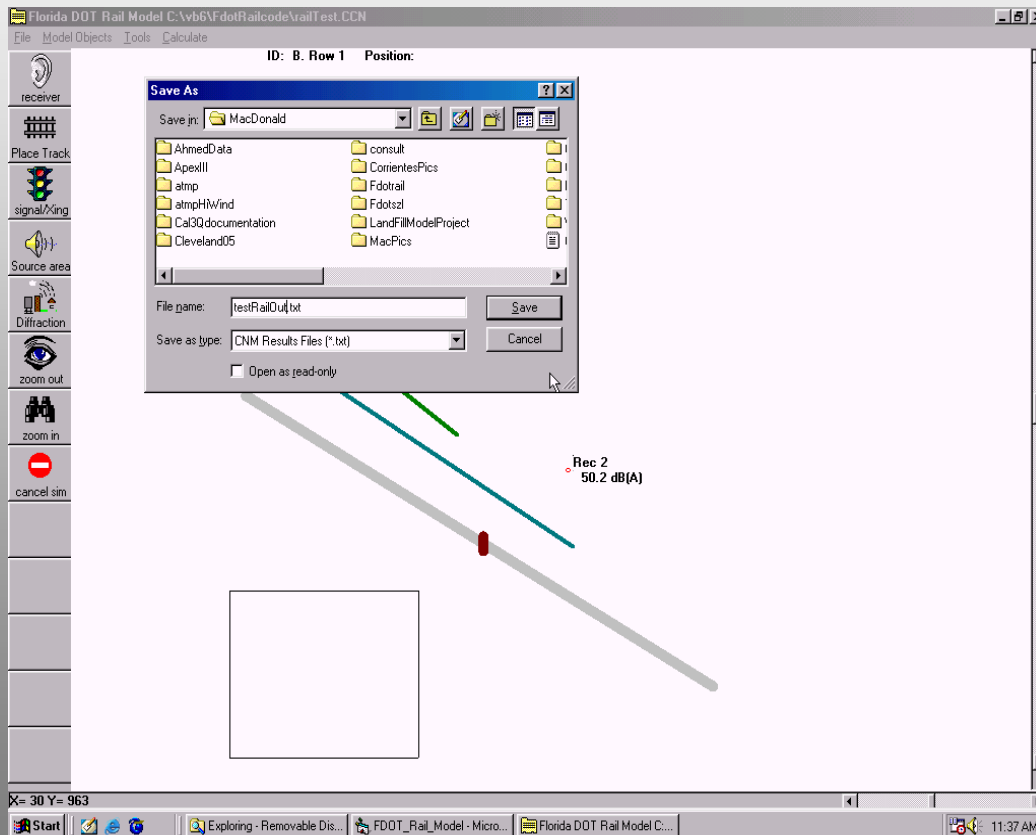
Recvr	Leq dB(A)	Stdev dB(A)	Lmax dB(A)	L10 dB(A)	L50 dB(A)	L90 dB(A)	L99 dB(A)
Rec 1	46.6	5.3	63.8	30	31	30	30
Rec 2	50.2	6	67.5	30	31.1	30	30

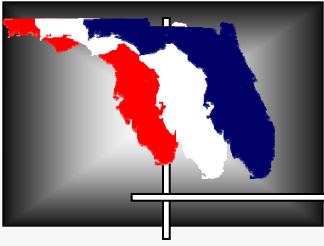
OK Copy to Clipboard



# Save to File Option

- Save Simulation results to a file





# Questions?

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**Any requests for model  
should be directed to  
Mariano Berrios, FDOT**