



# ***Air Dispersion Modeling Example***

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# *What is the Project?*

- ✍ New Fiberglass Boat Manufacturing Facility*
- ✍ Location: Hometown, USA (located on Carolina coastline)*
- ✍ Expected Emission Sources*
  - ✍ Boat Manufacturing Area*
  - ✍ Boiler (natural gas-fired)*

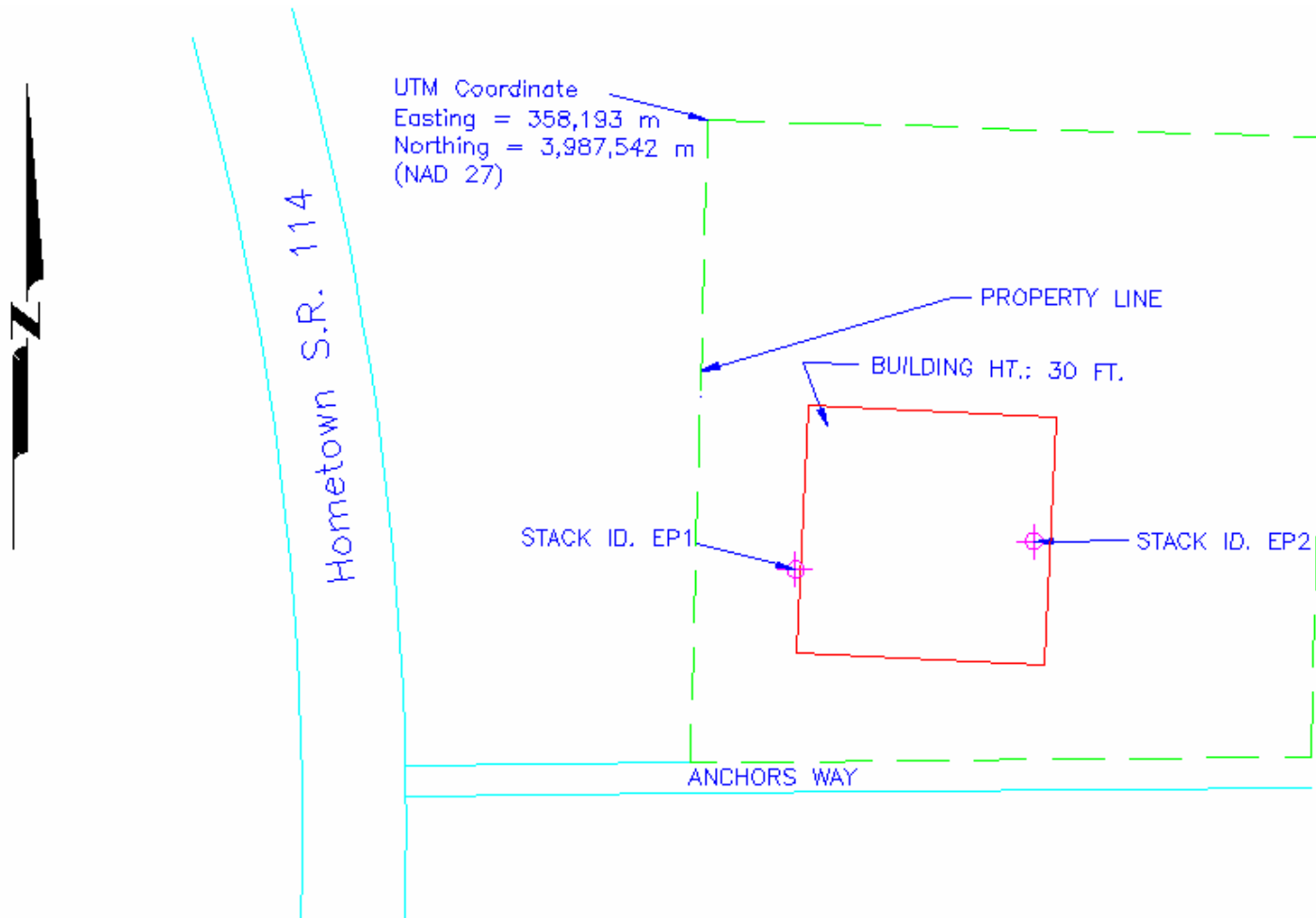


## ***What Details Do We need?***

- ✍ Site plan (including building heights & property line)*
- ✍ Stack parameters*
- ✍ Expected emission rates*
- ✍ Applicable modeling standards*



# Site Plan – What's Important?





# What are the Expected Stack Parameters?

	<u>Manufacturing Area</u> (EP1)	<u>Boiler</u> (EP2)	
✦ Height	27 ft.	37 ft.	(or higher)
✦ Diameter	2.7 ft.	1.5 ft.	(or less)
✦ Temperature	68°F	257°F	(or greater)
✦ Velocity	55 ft/s	11.21 ft/s	(or greater)
✦ Raincap	Yes (proposed)	Yes (proposed)	
✦ Modeled Velocity	0.00328 ft/s	0.00328 ft/s	



# What are the Expected Emission Rates?

- ✍ *This will typically be the worst-case hourly emission rates for each pollutant*
- ✍ *Can use other averaging periods, depending on the basis for the applicable standard*
  - ✍ *Boat Manufacturing Area (EP1)*
    - » *Styrene – 48.5 lb/hr*
  - ✍ *Boiler (EP2)*
    - » *PM<sub>10</sub>/TSP – 0.1 lb/hr*
    - » *SO<sub>2</sub> – 0.01 lb/hr*
    - » *CO – 0.7 lb/hr*
    - » *NO<sub>x</sub> – 1.3 lb/hr*



# ***What are the applicable South Carolina modeling standards?***

- ✍ ***SC Reg. 61-62.5 Std. 2 – Criteria Pollutants***
  - ✍ *Applicable to criteria pollutants from boiler*
- ✍ ***SC Reg. 61-62.5 Std. 8 – Toxic Air Pollutants***
  - ✍ *Applicable to styrene emissions from boat manufacturing area*
  - ✍ *Toxic air pollutants emitted due to the combustion of a virgin fuel oil are exempt from Standard No. 8*
- ✍ ***SC Reg. 61-62.5 Std. 7 – PSD Increment***
  - ✍ *Not applicable since the PSD baseline date has not been triggered in Hometown, USA.*



## ***What are the applicable North Carolina modeling standards?***

- ✍ NC Reg. 15A NCAC 02D .1100 – Control of Toxic Air Pollutants and NCAC 02O .700 - Toxic Air Pollutant Procedures*
  - ✍ Applicable to styrene emissions from boat manufacturing area*
  - ✍ Toxic air pollutants emitted due to the combustion of unadulterated fossil fuels are exempt.*



## *Where Do We Begin?*

- ✍ Good Engineering Practice (GEP) Analysis*
- ✍ Cavity Analysis*
- ✍ Simple and/or Complex Terrain Analysis*



## *What is a GEP Analysis?*

*GEP stack height is defined as the greater of:*

- 65 meters as measured from the base of the stack, or*
- GEP stack height as determined from the following formula.*

$$HG = HB + 1.5L$$

*where:*

- HG = the GEP stack height,*
- HB = the height of the nearby structure, &*
- L = the lesser dimension (height or projected width) of the nearby structure.*



## ***GEP Analysis Results***

<b>Structure</b>	<b>Height (ft)</b>	<b>Width (ft)</b>	<b>Length (ft)</b>	<b>GEP (ft)</b>	<b>Region of Influence (ft)</b>	<b>Stacks Within 5L</b>
Building	30	240	240	75	150	EP1 & EP2

- $HG = HB + 1.5L$*
- Stack Heights < 65-meters - Dispersion modeling using actual stack heights is in compliance with GEP regulations.*
- Stack Heights < GEP-Formula Height = Potential for aerodynamic downwash of exhaust plumes*



# What is a Cavity Analysis?

- ✦ *Near Wake Effects of Building Downwash*

- ✦ *SCREEN3 Model Inputs*

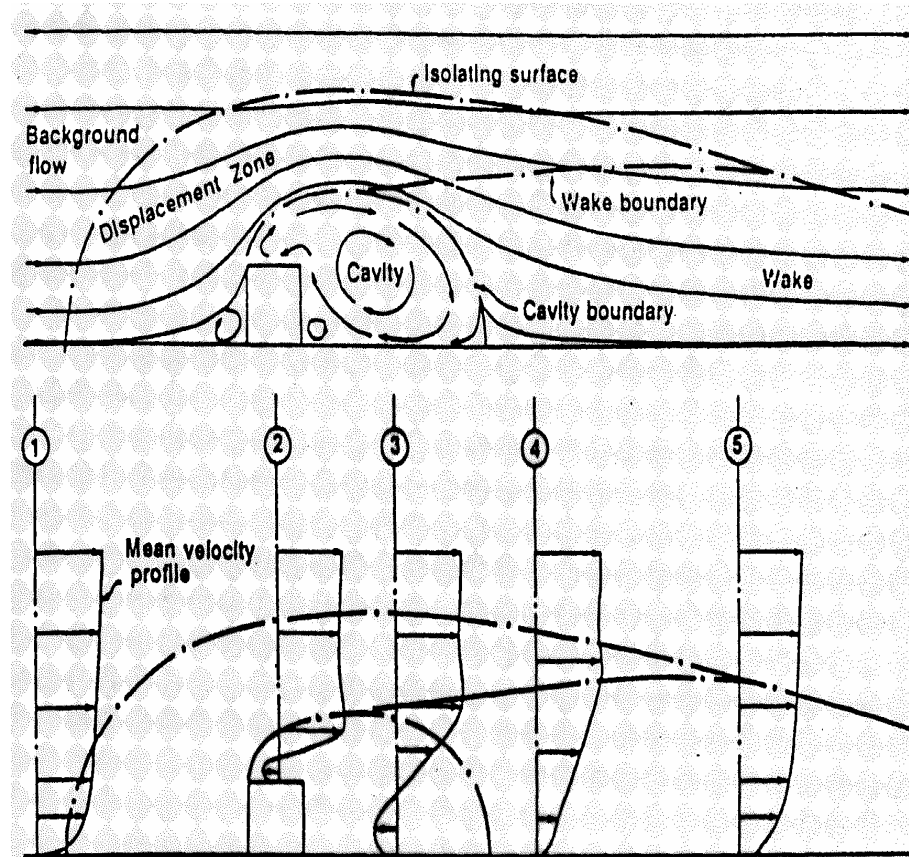
  - ✦ *Building Dimensions*

  - ✦ *Stack Parameters*

- ✦ *SCREEN3 Model Outputs*

  - ✦ *Cavity Lengths*

  - ✦ *Cavity Concentration*





# *Cavity Lengths*

- ✍ *SCREEN3 Cavity Lengths*
  - ✍ *EP1 – Cavity Length = 140 ft*
  - ✍ *EP2 – No Cavity*
- ✍ *Shortest Distance from Building to Property Line = 100 ft.*
- ✍ *Evaluation of Cavity Concentration Required*



# Cavity Concentrations

$$C = E \text{ (lb/hr)} * U \text{ (ug/m}^3\text{)} * F$$

- ✍ C = Concentration to be compared to Standard*
- ✍ E= Emission rate to be presented in permit application*
- ✍ U = Concentration resulting from modeling an emission rate equivalent to 1 lb/hr*
- ✍ F = SCREEN3 predicts cavity impacts on a 1-hour average. Conversion factors are used to facilitate a direct comparison with the standard.*



# Cavity Concentrations for EP1

*Cavity Concentration = Emission rate (lb/hr)\* Unit Concentration (ug/m<sup>3</sup>)\* Conversion Factor*

- ✍ Styrene Emission Rate = 48.5 lb/hr*
- ✍ Unit Concentration = 125.4 ug/m<sup>3</sup>*
- ✍ Conversion Factor*
  - » North Carolina's Styrene Standard is 1-hour standard.  
Conversion factor = 1.*
  - » South Carolina's Styrene Standard is 24-hour standard.  
Conversion factor = 0.4*
- ✍ Styrene Cavity Concentrations*
  - » 1-Hour Concentration = 6,082 ug/m<sup>3</sup>*
  - » 24-Hour Concentration = 2,433 ug/m<sup>3</sup>*



# Cavity Compliance Demonstration

<i>Averaging Period</i>	<u><i>1-hr</i></u>	<u><i>24-hr</i></u>
<i>Styrene Cavity Concentration</i>	<i>6,082 µg/m<sup>3</sup></i>	<i>2,433 µg/m<sup>3</sup></i>
<i>Maximum Allowable Concentration</i>	<i>10,600 µg/m<sup>3</sup></i>	<i>5,325 µg/m<sup>3</sup></i>
<i>Underlying Standard</i>	<i>15A NCAC 02D.1100</i>	<i>SC Reg. 61-62.5 Std. 8</i>



# *Simple/Complex Terrain Analysis*

- ✍ Model Selection Review: ISCST3 Model*
- ✍ Input Data Required*
  - ✍ Stack Parameters (including UTM coordinates)*
  - ✍ Building Coordinates and Height*
  - ✍ Fenceline Coordinates*
  - ✍ Receptor Grid with Elevations (from DEM data)*
  - ✍ Meteorological Data (5 years)*
    - » Wilmington, NC Surface Station and Charleston, SC Upper Air Station*



# ISCST3 Model Results – Criteria Pollutants

- ✦ *PM<sub>10</sub>/TSP*
  - ✦ *24-Hour Concentration = 4.4 ug/m<sup>3</sup>*
  - ✦ *Annual Concentration = 0.6 ug/m<sup>3</sup>*
- ✦ *Nitrogen Oxide*
  - ✦ *Annual Concentration = 7.8 ug/m<sup>3</sup>*
- ✦ *Sulfur Dioxide*
  - ✦ *3-Hour Concentration = 1.8 ug/m<sup>3</sup>*
  - ✦ *24-Hour Concentration = 0.4 ug/m<sup>3</sup>*
  - ✦ *Annual Concentration = 0.06 ug/m<sup>3</sup>*
- ✦ *Carbon Monoxide*
  - ✦ *1-Hour Concentration = 295 ug/m<sup>3</sup>*
  - ✦ *8- Hour Concentration = 79 ug/m<sup>3</sup>*



# Background Concentrations for Criteria Pollutants

- ✧ *PM<sub>10</sub>*
  - ✧ *24-Hour Concentration = 53 ug/m<sup>3</sup>*
  - ✧ *Annual Concentration = 22 ug/m<sup>3</sup>*
- ✧ *TSP*
  - ✧ *Annual Concentration = 37 ug/m<sup>3</sup>*
- ✧ *Nitrogen Oxide*
  - ✧ *Annual Concentration = 18.8 ug/m<sup>3</sup>*
- ✧ *Sulfur Dioxide*
  - ✧ *3-Hour Concentration = 97 ug/m<sup>3</sup>*
  - ✧ *24-Hour Concentration = 34 ug/m<sup>3</sup>*
  - ✧ *Annual Concentration = 8 ug/m<sup>3</sup>*
- ✧ *Carbon Monoxide*
  - ✧ *1-Hour Concentration = 5843 ug/m<sup>3</sup>*
  - ✧ *8- Hour Concentration = 3322 ug/m<sup>3</sup>*



## Compliance with SC Reg. 61-62.5 Std. 2 – Criteria Pollutants

Pollutant	Averaging Period	Modeled Concentration (ug/m <sup>3</sup> )	Background Concentration (ug/m <sup>3</sup> )	Total Concentration (ug/m <sup>3</sup> )	Standard No. 2 (ug/m <sup>3</sup> )	Compliance (Yes or No)
PM	24-Hour	4.4	53	57.4	150	Yes
PM	Annual	0.6	22	22.6	50	Yes
TSP	Annual	0.6	37	37.6	75	Yes
NO <sub>x</sub>	Annual	7.8	18.8	26.6	100	Yes
SO <sub>2</sub>	3-Hour	1.8	97	98.8	1300	Yes
SO <sub>2</sub>	24-Hour	0.4	34	34.4	365	Yes
SO <sub>2</sub>	Annual	0.06	8	8.06	80	Yes
CO	1-Hour	295	5,843	6,138	40,000	Yes
CO	8-Hour	79	3,322	3,401	10,000	Yes



# ***ISCST3 Model Results – Toxic Air Pollutants***

## *✍ Styrene*

*✍ 1-Hour Concentration = 37,061 ug/m<sup>3</sup>*

*✍ 24-Hour Concentration = 5,114 ug/m<sup>3</sup>*



# Styrene Compliance Evaluation

<i>Averaging Period</i>	<u>1-hr</u>	<u>24-hr</u>
<i>Styrene Concentration from ISCST3 Model</i>	<b>37,061</b> $\mu\text{g}/\text{m}^3$	5,114 $\mu\text{g}/\text{m}^3$
<i>Maximum Allowable Concentration</i>	<b>10,600</b> $\mu\text{g}/\text{m}^3$	5,325 $\mu\text{g}/\text{m}^3$
<i>Underlying Standard</i>	15A NCAC 02D.1100	SC Reg. 61-62.5 Std. 8



# What Do You Do Now?

- ✍ *Possible Stack Design Changes for EP1*
  - ✍ *Remove raincap*
  - ✍ *Raise the stack height*
- ✍ *Possible Process Design Changes*
  - ✍ *Lower Styrene Resin*
  - ✍ *Control Device*
- ✍ *Operational Restrictions*





# Stack Design Change for EP1

	<u>Original Values</u>	<u>New Values</u>
✧ Height	27 ft.	27 ft.
✧ Diameter	2.7 ft.	2.7 ft.
✧ Temperature	68°F	68°F
✧ Velocity	55 ft/s	55 ft/s
✧ Raincap	<b>Yes (proposed)</b>	<b>No</b>
✧ Modeled Velocity	<b>0.00328 ft/s</b>	<b>55 ft/s</b>



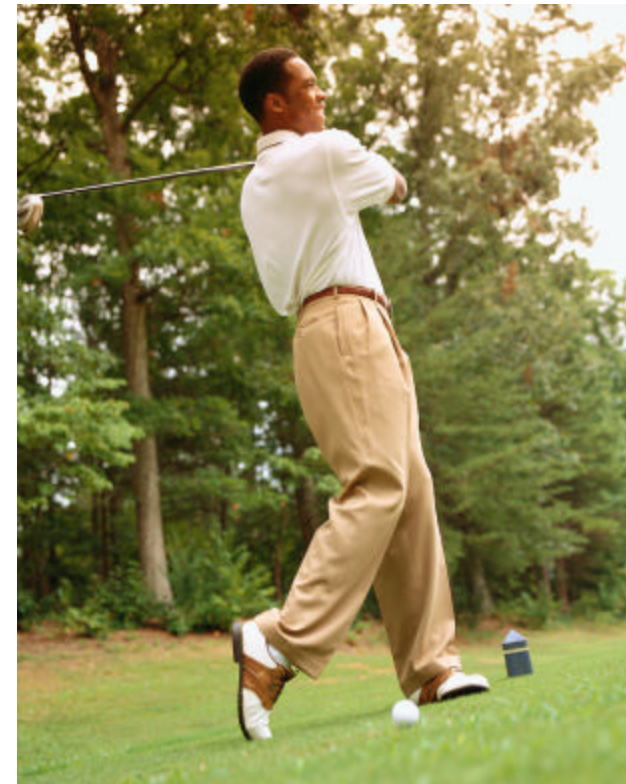
# Revised Styrene Compliance Evaluation

<i>Averaging Period</i>	<u><i>1-hr</i></u>	<u><i>24-hr</i></u>
<i>Styrene Cavity Concentration</i>	<i>723 <math>\mu\text{g}/\text{m}^3</math></i>	<i>289 <math>\mu\text{g}/\text{m}^3</math></i>
<i>Styrene Concentration from ISCST3 Model</i>	<i>7,223 <math>\mu\text{g}/\text{m}^3</math></i>	<i>1,901 <math>\mu\text{g}/\text{m}^3</math></i>
<i>Maximum Allowable Concentration</i>	<i>10,600 <math>\mu\text{g}/\text{m}^3</math></i>	<i>5,325 <math>\mu\text{g}/\text{m}^3</math></i>
<i>Underlying Standard</i>	<i>15A NCAC 02D.1100</i>	<i>SC Reg. 61-62.5 Std. 8</i>



# What Do You Do Now?

- ✍ *Prepare Modeling Report*
  - ✍ *Modeling Procedures*
  - ✍ *Modeling Input*
  - ✍ *Assumptions*
  - ✍ *Results*
- ✍ *Submit Modeling Report for Agency Review*





*Questions?*