

ARTICLE

ESTABLISHING TORT LIABILITY WITH REGULATORY TOOLS?

THE UTILITY OF AIR MODELING AS A SURROGATE FOR MONITORING DATA

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I. INTRODUCTION 2

II. BACKGROUND 3

III. AIR DISPERSION MODELS AND EPA..... 5

 A. Arbitrary and Capricious Standard 5

 B. Rational Relationship Between Model and Behavior
 of Pollutant 7

 C. “Perfect Fit” Not Required 8

 D. Judicial Deference..... 8

 E. Pollutants and Turtles 10

IV. AIR DISPERSION MODELS AND CLASS ACTION
 CERTIFICATIONS 11

 A. Establishing Geographical Boundaries..... 12

 1. Experience in Federal Courts 12

 2. Experience in Louisiana State Courts 15

 B. Establishing Temporal Boundaries..... 18

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2	<i>ENVIRONMENTAL & ENERGY LAW & POLICY J.</i>	[3:1
	C. Workers in Plants	19
	V. AIR DISPERSION MODELS IN THE TORT CONTEXT	21
	A. Dose.....	21
	B. Worst Case Scenario	21
	VI. ESTIMATING THE RATE OF EMISSIONS	25
	VII. AIR DISPERSION MODELS AND CAUSATION	27
	VIII. ACCURACY AND PRECISION OF AIR MODELS	28
	IX. CONCLUSION.....	30

I. INTRODUCTION

The Texas Supreme Court has labored to establish evidentiary requirements to ensure that scientific evidence—epidemiological studies, in particular¹—comports with our legal notions that evidence be admitted only if it is “relevant and reliable.”² Such a goal seems appropriate in the civil toxic tort context given the burden upon plaintiff litigants to prove their case to a jury by a preponderance of the evidence. In the field of epidemiology, the Texas Supreme Court has insisted on the admission of scientific studies only after plaintiffs demonstrate a doubling of the relevant risk, together with statistically significant results to support an association between exposure to substances and development of disease.³ The science of epidemiology has accommodated this exercise, in part, because of the statistical confidence interval, which provides a mathematical means of assuring a basic measure of integrity for the particular result involved.⁴

While air quality concerns continue to expand beyond the employment context to encompass potentially harmful impacts upon larger groups of neighborhood residents, litigants increasingly look for scientific tools to evaluate the relationship between air quality and disease. As regulatory tools become more scientifically sophisticated, greater emphasis will fall upon

1. “Epidemiological studies examine existing populations to attempt to determine if there is an association between a disease or condition and a factor suspected of causing that disease or condition.” *Merrell Dow Pharms., Inc. v. Havner*, 953 S.W.2d 706, 715 (Tex. 1997).

2. *See, e.g., id.* at 720–21; *E.I. du Pont de Nemours & Co. v. Robinson*, 923 S.W.2d 549, 556 (Tex. 1995).

3. *Havner*, 953 S.W.2d at 717, 725.

4. *See id.* at 723.

the use of mathematical predictions to reconstruct past residential or employment exposure in order to determine any patterns of disease, and the technique known as air dispersion modeling resides at the forefront of evidentiary technology. The ultimate question presented is simply whether mathematic computations or predictions constitute acceptable evidence to support a finding of actual dose in the clear absence of individual monitoring data.

This Article reviews selected cases from courts evaluating air dispersion modeling in the regulatory and tort contexts, as well as during the process of class action certification. In doing so, the following discussions focus primarily upon recent efforts to critically evaluate the technique and its evidentiary value.

II. BACKGROUND

An air dispersion model is a computer simulation that uses mathematical equations to describe the way that substances are distributed downwind from an emission source.⁵ In other words, air dispersion models describe the behavior and movement of emissions plumes.⁶ Regulatory agencies have long employed Gaussian models as their basic analytical tool.⁷ The Gaussian

5. James A. Westbrook, *Air Dispersion Models: Tools to Assess Impacts from Pollution Sources*, 13 NATURAL RES. & ENV'T 546, 546 (1999); see also U.S. Env'tl. Prot. Agency, Dispersion Modeling, <http://www.epa.gov/scram001/dispersionindex.htm> (last visited June 4, 2008) (explaining that "[d]ispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind receptor locations").

6. The Sixth Circuit Court of Appeals further described air dispersion modeling in the following manner:

Dispersion modeling studies consist of two steps. First, an approved device is used to monitor the actual effect of the emissions from a given source of the ambient air. Next, a computer calculation is obtained which is a predictor of the effect of emissions from the source in light of known facts and verified assumptions concerning plant design, emission rates, surrounding terrain, atmospheric conditions and other factors which influence the total effect on air quality of the emissions from a given stationary source.

Ohio Env't Council v. U.S. Env'tl. Prot. Agency, 593 F.2d 24, 30 n.4 (6th Cir. 1979). In Texas, the Third District Court of Appeals provided additional helpful guidance in explaining air dispersion computer modeling as follows:

Air dispersion computer modeling is a method commonly used [by regulatory agencies and applicants for permits] to evaluate the possible impacts of emissions on humans and the environment. Air dispersion computer models predict the maximum ground-level concentrations of air contaminants at various off-site locations, as would result from a facility's operations in the event the requested permit were issued.

United Copper Indus., Inc. v. Grissom, 17 S.W.3d 797, 803 n.3 (Tex. App.—Austin 2000, pet. dism'd).

7. Westbrook, *supra* note 5, at 548.

model assumes that the air pollutant dispersion follows a Gaussian distribution, meaning that the distribution reflects a normal probability distribution.⁸ These models are most often used to describe the distribution of continuous, buoyant plumes of air pollution coming from ground level or from elevated sources.⁹

Of course, the source of emission plumes will vary.¹⁰ More specifically, emissions may come from a single point such as a stack or vent, either at ground level or a more elevated position; from a two-dimensional source, such as a parking lot; or from a three-dimensional source, such as fugitive emissions from a building or from a storage pile.¹¹ Additionally, source locations can be classified as either urban or rural and can be continuous or intermittent.¹²

Atmospheric turbulence is one of the most significant factors affecting the dispersion of air pollution plumes.¹³ Turbulence increases the mixing of unpolluted air into the plume—also known as dilution—spreading the plume both horizontally and vertically as it moves downwind¹⁴ and reducing the concentration of pollutants in the plume.¹⁵ Early modelers used Pasquill dispersion coefficients as a means of characterizing the degree of potential turbulence that might affect a plume.¹⁶ Under this method, Pasquill characterized turbulence into six stability classes ranging from very unstable to very stable.¹⁷ As noted by the Environmental Protection Agency (“EPA”), “[t]he Pasquill approach to classifying stability is commonly used in preferred models,” which now include turbulence as a function of daytime convective and mechanical activities in the atmosphere as well as nighttime stagnant conditions.¹⁸

8. Milton R. Beychok, Air Dispersion Modeling Terminology 2 (Aug. 25, 2007) (unpublished manuscript, on file with the Environmental & Energy Law & Policy Journal). For an entertaining description and representation of a Gaussian bell curve or normal distribution, see John H. Lienhard, *Complex Simplicity*, <http://www.uh.edu/engines/epi1939.htm> (last visited June 4, 2008).

9. Beychok, *supra* note 8, at 2. Buoyant plumes are lighter than the ambient air because they are warmer and are less dense than the air around them. *Id.* at 3.

10. *Id.* at 2.

11. *Id.*

12. *Id.* at 2–3.

13. *Id.* at 3.

14. THAD GODISH, AIR QUALITY 74 (Lewis Publishers, 4th ed. 2004).

15. Beychok, *supra* note 8, at 3.

16. *Id.*

17. *Id.* at 3 tbl. 1.

18. See Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions, 70 Fed. Reg. 68,218, 68,239,

Recent air dispersion models also take into account other forces impacting the dispersion of air pollutant plumes, such as building downwash, gravitational settling, and washout due to rain.¹⁹ The effects of building downwash occur as an air plume goes over a building and creates enhanced air eddies on the downwind side of the building.²⁰ This causes the plume and its pollutants to mix and deposit on the ground much sooner than would occur in the absence of the building.²¹ Moreover, through the process of “wet deposition,” rain causes washout of pollutants from a plume, which also impacts the rate at which pollutants are deposited on the ground.²²

The height at which an emissions plume mixes within the atmosphere represents a significant limiting behavior.²³ Atmospheric conditions affecting the temperature of the air above the earth affect the height at which a plume and its contaminants mix within the atmosphere.²⁴ For example, so-called inversion layers in the atmosphere—in which temperatures increase, rather than decrease, with altitude—cause limited mixing and, thus, generally result in higher concentrations of emissions.²⁵

The foregoing description of basic modeling concepts underscores the highly complex nature of plume behavior that air models attempt to simulate mathematically.²⁶ Nevertheless, as described at greater length below, the air dispersion model continues to represent a basic and essential tool in the field of air quality regulation.

III. AIR DISPERSION MODELS AND EPA

A. Arbitrary and Capricious Standard

Federal courts have entertained challenges to air dispersion models ever since the original passage of and subsequent

68,245–46 (Nov. 9, 2005).

19. Beychok, *supra* note 8, at 4.

20. *Id.*

21. *Id.*

22. *Id.* “The wet deposition of radionuclides in a pollution plume by a burst of rain often forms so called ‘hot spots’ of radioactivity on the underlying surface.” *Id.*

23. *Id.*

24. Beychok, *supra* note 8, at 4.

25. *Id.*

26. For an additional description of the principles and practice of air modeling, see Andrew C. Wilson, *Tracking Spills and Releases: High-Tech in the Courtroom*, 10 TUL. ENVTL. L. J. 371, 389–92 (1997).

amendments to the Clean Air Act (“CAA”).²⁷ A detailed evaluation describing the application of air dispersion models to cases brought under the CAA is beyond the scope of this Article. However, a limited review of this technique will be useful in order to better understand why regulatory application of air dispersion models by the EPA and other agencies differs from their application within the tort context.²⁸

In 1994, the Circuit Court of Appeals for the District of Columbia (“DC”) considered the evidentiary value of air dispersion models in the case of *Chemical Manufacturers Association v. EPA*.²⁹ The Chemical Manufacturers Association (“CMA”) sought judicial review of the EPA’s decision to designate methylene diphenyl diisocyanate (“MDI”) as a high-risk pollutant under the CAA.³⁰ The CMA challenged as arbitrary and capricious the EPA’s “use of the generic air dispersion model as a rational approximation of the behavior of MDI in a typical facility environment, and the validity of the [inhalation reference concentration (“RfC”)] for MDI as a reasonable approximation of the threshold exposure level for avoiding significant public health effects.”³¹ According to the CMA, the model relied upon by the EPA did not bear a rational relationship to the properties of the chemical under consideration.³² For instance, the CMA noted that the model in question assumed that MDI would be emitted as a gas at 20° C through a single point source.³³ However, the undisputed evidence demonstrated that MDI is a solid at 20° C; that it tends to be a fugitive emission rather than a point source emission; that it does not tend to evaporate; and that it typically disperses as an aerosol—in other words, as fine particles suspended in the air.³⁴ Persuaded by such evidence, the *Chemical Manufacturers* court held that, because the EPA’s generic model did not bear a “rational relationship to the known

27. See Clean Air Act, 42 U.S.C. §§ 7401–7671q (2000).

28. See generally William B. Johnson, Annotation, *Application of air quality modeling to decision making under Clean Air Act (42 U.S.C.A. §§ 7401–7626)*, 84 A.L.R. FED. 710 (1987) (reviewing federal case law interpreting whether the EPA abused its discretion in regard to air quality modeling analyses and decision making under the Clean Air Act).

29. *Chem. Mfrs. Ass’n v. U.S. Env’tl. Prot. Agency*, 28 F.3d 1259 (D.C. Cir. 1994).

30. *Id.* at 1261.

31. *Id.* at 1262.

32. *Id.* at 1264 (noting that “[i]f MDI is to be denominated a high risk based solely upon application of the model to the health effects of the chemical without any validation of the result, the CMA argues, then the model must bear some rational relationship to the known properties of MDI emissions”).

33. *Id.*

34. *Chem. Mfrs. Ass’n*, 28 F.3d at 1264.

properties of MDI emissions . . . MDI was wrongly classified as a pollutant that poses a significant risk to public health.”³⁵

B. Rational Relationship Between Model and Behavior of Pollutant

As a prelude to its opinion, the *Chemical Manufacturers* court noted the broad discretion afforded to the EPA in attempting to fulfill its statutory task.³⁶ The court stated that:

The agency is charged under the Act with evaluating no less than 189 hazardous air pollutants that “span a range of emission release and exposure situations . . . across source categories.” That the Congress gave it the discretion to use a model for that purpose is surely a reasonable reading of the Act.³⁷

The court further reasoned that the “air dispersion model in particular is well-suited . . . to the mandate given to the agency, which is to identify pollutants for which exposure to small quantities ‘may’ be associated with significant adverse human health effects.”³⁸ In the appellate court’s view, Congress contemplated that, in preparing a list of “high risk” pollutants, the EPA would be “overinclusive,” and “because it proceeds from conservative assumptions[,] the model tends to produce that result.”³⁹ Thus, the court held that:

It necessarily follows that in designing the model the agency must have broad discretion to make simplifying assumptions—to model the pollutant as a gas, for example—and to establish parameters or set values for variables, such as choosing ten tons of emissions per facility per year as a conservative output from which to determine a likely exposure level.⁴⁰

Nevertheless, the court understood that EPA’s discretion in using the model was not unlimited and, consequently, restricted the ability of the agency to use models in broader contexts.⁴¹

35. *Id.*

36. *Id.*

37. *Id.* (internal citation omitted).

38. *Id.*

39. *Chem. Mfrs. Ass’n*, 28 F.3d at 1264.

40. *Id.*

41. “If we are to earn our keep, however, judicial deference to the agency’s modeling cannot be utterly boundless; we must reverse the agency’s application of the generic air dispersion model as arbitrary and capricious if there is simply no rational relationship between the model and the known behavior of the hazardous air pollutant to which it is applied.” *Id.* at 1265.

C. “Perfect Fit” Not Required

While the air dispersion model must show a “rational relationship” with respect to the molecule of concern, courts will not require that the model be a “perfect fit.”⁴² According to the court of appeals in *Chemical Manufacturers*:

That the model does not fit every application perfectly is no criticism; a model is meant to simplify reality in order to make it tractable . . . Hence, the normal criterion by which to evaluate a model is not the accuracy of the assumptions from which it proceeds but the utility of the results it produces.⁴³

D. Judicial Deference

Courts have long recognized that decision-making in highly technical areas is the “primary” role of an agency and not of the courts.⁴⁴ Indeed, Congress requires that courts reviewing regulatory decisions of federal agencies set aside only those “action[s], findings, and conclusions found to be arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law.”⁴⁵ In other words, courts cannot substitute their own judgment and must affirm regulatory actions for which a rational basis is demonstrated.⁴⁶ The CAA itself mandates application of this “arbitrary and capricious” standard to the review of emissions standards.⁴⁷

More than a decade before *Chemical Manufacturers*, the Ninth Circuit took the opportunity to review regulatory use of air dispersion models in the case of *Northern Plains Resource Council v. EPA*.⁴⁸ In *Northern Plains*, a coalition of Montana residents (“the Council”) sought review of the EPA’s conditional grant of “prevention of significant deterioration of air quality” (“PSD”) permits for the construction of two new coal-fired electric plants.⁴⁹ Specifically, the Council challenged the “EPA’s refusal

42. *Id.* (noting that “[w]hile the agency must if challenged ‘provide a full analytical defense’ of its model, it need not justify the model on an ad hoc basis for every chemical to which the model is applied, even when faced with data indicating that it is not a perfect fit”) (internal citation omitted).

43. *Id.* at 1264–65.

44. *Vt. Yankee Nuclear Power Corp. v. Natural Res. Defense Council, Inc.*, 435 U.S. 519, 555 (1978).

45. Administrative Procedures Act, 5 U.S.C. § 706(2)(A) (2000).

46. *Citizens to Preserve Overton Park v. Volpe*, 401 U.S. 402, 416 (1971).

47. 42 U.S.C. § 7607 (2006).

48. *N. Plains Res. Council v. U.S. Env'tl. Prot. Agency*, 645 F.2d 1349 (9th Cir. 1981).

49. *Id.* at 1350.

to validate its air dispersion model with monitoring data proffered by the Council.”⁵⁰ In analyzing this issue, the Ninth Circuit began by noting that:

The Council has a heavy burden here, that of demonstrating to this court that EPA action was arbitrary and capricious. If the Council demonstrates that EPA ignored reliable data that so undermined EPA model projections of compliance with PSD increments that reliance on the model was irrational, that burden would be met.⁵¹

The Council argued that the EPA should have validated its model with monitoring data from a site twelve kilometers away that showed sulfur dioxide emissions to be 238% higher than the EPA model predictions for that site.⁵² The court noted that this monitoring data was relevant to only one of the two models used by the EPA⁵³ and that multiplying the model predictions for the area at issue by 238% resulted in a level less than the maximum allowable PSD increment.⁵⁴ Thus, the court ruled that the Council failed to demonstrate “that the EPA irrationally rejected data that would lead to a conclusion that the EPA model was so deficient that the relevant PSD limits would be exceeded.”⁵⁵ The Ninth Circuit’s *Northern Plains* opinion indicates that, in matters relating to “minor discrepancies” of data, there is a clear judicial willingness and practical necessity to defer to agency judgment.

In *American Coke and Coal Chemicals Institute v. EPA*, an industry group (“the Institute”) challenged an EPA rule “revising certain nationwide limitations on water pollutant discharges from sources in the cokemaking subcategory of the iron and steel industry.”⁵⁶ As in *Northern Plains*, the Institute argued that the

50. *Id.* at 1351. “Validation is a process in which real world ambient readings are compared to theoretical model projections in order to test the predictive accuracy of the model. There is no question that validation by monitoring is a valuable tool in the permitting process.” *Id.* at 1362.

51. *Id.* at 1362–63.

52. *Id.* at 1363.

53. The court observed that:

[T]he EPA employed two models. One was the agency’s Valley Model, used to predict SO₂ concentrations on the elevated terrain of the Northern Cheyenne Reservation. The other model, the PTMPT model (point-multipoint), was used to predict SO₂ concentrations for low lying areas of the reservation The two models thus cover different areas of the Class I reservation, and predict highest SO₂ concentrations at different times and under different conditions.

N. Plains Res. Council, 645 F.2d at 1363.

54. *Id.*

55. *Id.*

56. *Am. Coke & Coal Chems. Inst. v. U.S. Envtl. Prot. Agency*, 452 F.3d 930, 932 (D.C. Cir. 2006).

rule should be rejected as unlawful on “arbitrary and capricious” grounds.⁵⁷ The DC Court of Appeals found that a reasonable and consistent methodology supported the EPA’s rule and, in doing so, analogized the rule to the air dispersion model at issue in *Chemical Manufacturers*.⁵⁸ The court acknowledged that “in both instances, there is a risk that the conceptual tools used to predict the behavior of a range of physical processes might, in a particular instance, fail so significantly that the conceptual tools must be revised in the face of reality.”⁵⁹ Regardless, “deference to EPA’s judgment is appropriate where minor differences between the record data and the agency’s representation of that data may be explained as matters of judgment as to the statistical relevancy of apparently anomalous information.”⁶⁰ Stated differently, because a “perfect fit” was not required, deference to the agency was appropriate. Thus, together with *Northern Plains, American Coke* indicates that the presence of a “rational relationship” between the model and the molecule will enable most EPA rules to withstand challenges based on arbitrary and capricious grounds.⁶¹

E. Pollutants and Turtles

As previously discussed, the *Chemical Manufacturers* court observed that a regulatory agency may use a model despite the lack of a “perfect fit,” and in the vast majority of cases, courts will defer to the judgment of the regulatory body even where minor differences exist in the data.⁶² The DC District Court later applied the *Chemical Manufacturers* rationale when reviewing a model originally developed to determine how protection of turtles at different “life stages” might affect loggerhead sea turtle growth.⁶³ In *Oceana, Inc. v. Evans*, an environmental

57. *Id.*

58. *Id.* at 946.

59. *Id.*

60. *Id.*

61. See *Columbia Falls Aluminum Co. v. U.S. Env’tl. Prot. Agency*, 139 F.3d 914, 923 (D.C. Cir. 1998) (holding that promulgation of Toxicity Characteristic Leaching Procedure for spent potliner was arbitrary and capricious because there was no evidence that the TCLP simulated disposal conditions of the treated residue). The DC Court of Appeals also upheld the EPA’s denial of a request to remove a chemical component of polyurethane from the list of Extremely Hazardous Substances, parenthetically referencing the “rational relationship” discussion in *Chemical Manufacturers* in finding the methodology used to classify the chemical was rationally related to the known behavior of the substance of concern. *Hüls Am. Inc. v. Browner*, 83 F.3d 445, 454 (D.C. Cir. 1996).

62. *Chem. Mfrs. Ass’n*, 28 F.3d at 1256.

63. *Oceana, Inc. v. Evans*, 384 F. Supp.2d 203, 220–21 (D.C. Dist. 2005) [hereinafter

organization challenged the Secretary of Commerce's use of a model suggesting that a scallop fishery would not jeopardize loggerhead sea turtles in violation of the Endangered Species Act.⁶⁴

The court found that the agency did not act irrationally in relying upon a model prepared to determine "shrimp trawl take" estimates or in using mortality data from the 1970s and 1980s.⁶⁵ Moreover, the court indicated that it would "only reject the Secretary's choice of model 'when the model bears no rational relationship to the characteristics of the data to which it was applied'"⁶⁶ and that it is not the court's role "to second-guess agency evaluations of complex scientific data within the agency's expertise."⁶⁷ Because the model at issue "was based on painstaking analysis of the existing literature on the life cycle of loggerhead sea turtles," the *Oceana* court held that:

even if flawed or limited in its application, the model bears a rational relationship to the reality it purports to represent. The model as originally developed was intended to help the agency understand population trends of loggerhead turtles in response to new conservation measures. The [biological order] also relies on the model to understand population trends in a world where those conservation measures have in fact been implemented. Especially since neither plaintiff's expert . . . nor any other expert, has offered a superior—or in fact *any*—alternative for analyzing jeopardy, the Court cannot agree that the agency's use of the model, despite its uncertainties, was inherently irrational.⁶⁸

IV. AIR DISPERSION MODELS AND CLASS ACTION CERTIFICATIONS

A court possesses broad discretion with regard to granting class certifications and, in evaluating certification motions, is not to consider the merits of the plaintiffs' claims.⁶⁹ A number of

Oceana II].

64. *Id.* at 213–14.

65. *Id.* at 224, 227–28 (noting that "[m]ortality rates constructed from data in the 1970s and 1980s may not be perfect proxies for today's loggerhead mortality rates, but especially as these rates are the only viable estimates, the Court cannot conclude that the agency's reliance on them is unreasoned").

66. *Id.* at 221 (citing *Oceanic, Inc. v. Evans*, No. 04-0811, 2005 WL 555416, at *17 (2005)).

67. *Oceana II*, 384 F. Supp.2d at 221 (citing *Conservation Law Foundation v. Mineta*, 131 F. Supp.2d 19, 26 n.15 (D. D.C. 2001)).

68. *Oceana II*, 384 F. Supp.2d at 221.

69. *Duffin v. Exelon Corp.*, No. Civ. A. 06-C-1382, 2007 WL 845336, at *1 (N.D. Ill. Mar. 19, 2007); *Boyd v. Allied Signal, Inc.*, 2003-1840 (La. App. 1 Cir. 12/30/04, writ

courts have considered air dispersion models when ruling upon motions for class certification. The state courts of Louisiana, in particular, have often considered air modeling in relation to a number of class certification motions.⁷⁰ In fact, the Louisiana trial courts certified the classes in each case decided, and the intermediate appellate courts affirmed the certification.⁷¹ However, the appellate courts did amend a few of the trial court rulings, and in one case, the Louisiana Supreme Court reversed a grant of class certification for a case involving air dispersion models.

A. Establishing Geographical Boundaries

1. Experience in Federal Courts

In *Duffin v. Exelon Corporation*, the Northern District of Illinois denied class certification for residents whose homes surrounded a nuclear power plant.⁷² The plaintiffs alleged that spilled tritiated water caused contamination of groundwater and that, as the water evaporated, tritium entered the air for miles surrounding the plant.⁷³ The defendant argued that plaintiffs' evidence, including air dispersion modeling, did not support the

denied); 898 So. 2d 450, 457; *Amerada Hess Corp. v. Garza*, 973 S.W.2d 667, 673, 681 (Tex. App.—Corpus Christi 1996), *writ dismissed w.o.j. sub nom*, *Coastal Corp. v. Garza*, 979 S.W.2d 318 (Tex. 1998).

70. See, e.g., *Howard v. Union Carbide Corp.*, 2004-1035 (La. App. 5 Cir. 2/15/05, writ denied); 897 So. 2d 768; *Boyd v. Allied Signal, Inc.*, 2003-1840 (La. App. 1 Cir. 12/30/04, writ denied); 898 So. 2d 45; *Mayho v. Amoco Pipeline Co.*, 99-620-24 (La. App. 5 Cir. 12/15/99, writ denied); 750 So. 2d 278; *Hollaway v. Gaylord Chem. Corp.*, 98-0828 (La. App. 1 Cir. 12/28/98); 730 So. 2d 952; *Ford v. Murphy Oil U.S.A.*, 94-1218 (La. App. 4 Cir. 8/28/96); 681 So. 2d 401, *aff'd in part and rev'd in part*, 96-2913 (La. 9/9/97); 703 So. 2d 542; *Livingston Parish Police Jury v. Acadiana Shipyards, Inc.*, 598 So. 2d 1177 (La. App. 4 Cir. 1992). Texas courts have also encountered air dispersion models when evaluating class certification issues. For instance, the Twenty-Eighth District Court of Nueces County, Texas certified a class in 1995 against several chemical manufacturers and commercial facility owners in a suit alleging property damage from long-term emissions contamination. See *Citgo Refining & Mktg., Inc. v. Garza*, 187 S.W.3d 45, 51 (Tex. App.—Corpus Christi 2005, pet. abated). The Thirteenth Court of Appeals later affirmed the certification order without discussing the scientific evidence considered by the trial court in defining the boundaries of the class of over 1,500 parcels of real property. *Amerada Hess Corp. v. Garza*, 973 S.W.2d 667 (Tex. App.—Corpus Christi 1996), *writ dismissed w.o.j. sub nom*, *Coastal Corp. v. Garza*, 979 S.W.2d 318 (Tex. 1998). In a 2005 opinion on appeal of the trial court finding that certain defendants had breached a settlement agreement, the Court of Appeals noted that, at the certification hearing, both plaintiffs and defendants presented evidence concerning air dispersion modeling while arguing over the proposed plaintiff class boundaries. *Citgo*, 187 S.W.3d at 72.

71. See *infra* Part III.A.2.

72. *Duffin*, 2007 WL 845336, at *3.

73. *Id.* at *1.

proposed class of over 2,500 properties and 6,500 residents.⁷⁴ The court agreed, noting that the plaintiffs' evidence showed elevated tritium levels only in limited areas near a plume and a blowdown line,⁷⁵ and therefore, the twenty-five square-mile class area drawn as a circle around the plant was unrelated to the evidence.⁷⁶ The models relied upon by the plaintiffs estimated airborne tritium levels that existed shortly after two spills, but the plaintiffs failed to provide any evidence of tritium deposits. According to the court, it was the plaintiffs' burden to demonstrate evidence identifying a "concentration of any tritium that was on the ground or any other surface."⁷⁷ Therefore, the court noted that the "plaintiffs provide[d] no evidence that properties within the class area were actually contaminated by airborne tritium."⁷⁸

Similarly, the federal district court in Kansas denied class certification for a group of plaintiffs alleging property and vehicle damage resulting from sulfuric acid emissions in the case of *Vickers v. General Motors Corp.*⁷⁹ The plaintiffs proposed to define the class as "[t]hose persons owning real property located within a 1000 meter radius of the [defendant's] plant and, in addition thereto, those individuals with confirmed damage to vehicles."⁸⁰ However, air dispersion model data suggested that "the prevailing wind in the area of the plant is from the south."⁸¹ In other words, "the wind in the area surrounding the plant does not blow uniformly from every direction."⁸² Finding it difficult to accept that emissions blown in one consistent direction would somehow disperse in a perfect circle, the court found the plaintiffs' proposed class definition was simply not reasonable.⁸³

In *O'Connor v. Boeing North American, Inc.*, the Central District of California certified a class of past and present residents who lived near nuclear testing facilities.⁸⁴ The court relied upon air dispersion models and other evidence to define

74. *Id.* at *3.

75. The blowdown line is an underground pipe through which the *Duffin* defendant discharged tritiated water into the Kankakee River. See Complaint at para. 19, *Duffin*, 2007 WL 845336 (No. Civ. A. 06-C-1382).

76. *Duffin*, 2007 WL 845336, at *4.

77. *Id.*

78. *Id.*

79. *Vickers v. Gen. Motors Corp.*, 204 F.R.D. 476 (D. Kan. 2001).

80. *Id.* at 477.

81. *Id.* at 479.

82. *Id.*

83. *Id.*

84. *O'Connor v. Boeing N. Am., Inc.*, 184 F.R.D. 311 (C.D. Cal. 1998) (certifying a class after earlier denying motion for certification).

the geographical boundaries of the class. The *O'Connor* court found that the evidence, including toxic dispersion maps based on the models, was sufficient to show that airborne releases of chemicals such as hexavalent chromium traveled throughout the entire area within the defined boundaries.⁸⁵ Defendants objected that the plaintiffs' modeling evidence was "based on assumptions unsupported by the actual data" and argued that the models did not show "any actual contamination of any property or exposure of any individual."⁸⁶ The court stated that such objections were directed to the merits of plaintiffs' claims, which were not before the court and that a *Daubert* analysis would be inappropriate at the class certification stage.⁸⁷ Regardless, after granting summary judgment to defendants on a statute of limitations defense, the court handed down a separate reported decision decertifying one of the original classes at issue—initially defined as those who lived or worked in the area since 1946—because the class no longer met the typicality and adequacy requirements once the court limited recovery to property damage sustained since 1994.⁸⁸

In *Fisher v. Ciba Specialty Chemical Corporation*, the Southern District of Alabama denied class certification for residents who lived in the area surrounding a chemical manufacturing facility that produced dichloro-diphenyl-trichloroethane ("DDT") and benzene hexachloride ("BHC") during the 1950s.⁸⁹ "Plaintiffs argued that vast quantities of DDT and BHC had migrated offsite from the Ciba plant in contaminated process wastes via pathways of airborne dispersion, wastewater emissions into surface and ground waters, and human activity."⁹⁰ In their motion for class certification, the *Fisher* plaintiffs recognized that "neither [the ground nor surface water] pathways is relevant for class certification purposes," due in part to a report of the plaintiffs' own expert finding that water would need to flow "upgradient" in order to contaminate the named plaintiffs' land.⁹¹ Thus, the plaintiffs sought to define the geographic boundaries of the

85. *Id.* at 320.

86. *Id.* at 321.

87. *Id.* at 321 n.7.

88. *O'Connor v. Boeing N. Am., Inc.*, 197 F.R.D. 404 (C.D. Cal. 2000); see Fed. R. Civ. P. 23(a).

89. *Fisher v. Ciba Specialty Chem. Corp.*, 238 F.R.D. 273 (S.D. Ala. 2006). In fact, "[b]ecause of on-site contamination, [the defendant's] facility was designated a Superfund site by the [EPA] in 1983." *Id.* at 277.

90. *Id.*

91. *Id.* at 290.

proposed class on the theory of airborne dispersion, with their expert testifying that variable wind directions blew contaminant particles in all directions from the plant.⁹² However, the plaintiffs' experts did not prepare air dispersion models, and as a result, the *Fisher* court concluded that there was "no evidence in the record as to how far and in what concentrations wind-borne transportation of contaminants . . . might reasonably be expected to travel."⁹³

2. Experience in Louisiana State Courts

In *Boyd v. Allied Signal, Inc.*, the First Circuit Court of Appeals of Louisiana affirmed certification of a class solely to determine the issue of liability, "with the class being defined by the class members' presence within or other relationship to a geographic area defined by named streets which roughly corresponded" to the site where boron trifluoride gas leaked from a tractor-trailer unit.⁹⁴ The trial court in *Boyd* considered testimony from numerous fact witnesses regarding their observation of a visible vapor cloud on the day of incident, as well as testimony from numerous expert witnesses. An expert for the plaintiffs used the SLAB and ALOHA models, which are heavy-gas dispersion models.⁹⁵ On the other hand, the defense experts used two separate models of their own: the CALPUFF model⁹⁶ and the HGSYSTEM model.⁹⁷

The *Boyd* court noted that the results of the plaintiffs' models "differed markedly" with the defense models, which showed a smaller area of dispersion.⁹⁸ However, the appeals court likewise found no manifest error in the trial court's acceptance of the plaintiffs' expert testimony.⁹⁹ The court likewise found no error in the trial court's admitting evidence of tree

92. *Id.* at 291 n.35.

93. *Id.* at 291 n.36.

94. *Boyd v. Allied Signal, Inc.*, 2003-1840 (La. App. 1 Cir. 12/30/04); 898 So. 2d 450, 455.

95. *Id.* at 461. The SLAB model "yielded cigar-shaped 'footprints' or isopleths depicting the plumes of gas dispersed by the wind on an hourly basis for fourteen consecutive hours." *Id.* at 460. The ALOHA model results further "corroborated with the original results obtained from the SLAB model, but with much higher concentrations of [boron trifluoride] and longer plume duration." *Id.* at 461.

96. The CALPUFF model allowed for more precise use of meteorological data at five-minute intervals in calculating wind direction changes, a fact with which even the plaintiffs' expert agreed. *Id.*

97. According to the defendant's experts, the HGSYSTEM model is a heavy gas dispersion model used for analyzing the behavior of the vapor mist for a period of time until it becomes neutrally buoyant and behaves no differently than normal air. *Id.* at 462.

98. *Id.*

99. *Boyd*, 898 So. 2d at 463.

damage described by witnesses and corroborated by photographs.¹⁰⁰ While such circumstantial evidence of tree damage “may not be sufficient for purposes of proving causation on the merits,” the court found that “it may properly be considered as corroborative evidence supporting the trial court’s decision on the geographic area in the context of determining class certification.”¹⁰¹

In the earlier case of *Hollaway v. Gaylord Chemical Corporation*, the First Circuit Court of Appeals of Louisiana affirmed certification of a class in a suit for damages from a chemical release caused by an explosion of a railroad tank car.¹⁰² Like the *Boyd* court’s decision to admit evidence of tree damage, the *Hollaway* court also approved of the trial judge’s decision to consider evidence other than that provided by expert witnesses. While experts on each side presented air dispersion modeling data, the trial court permitted numerous claimants to testify regarding their experiences and alleged damages, even though some claimants were beyond the geographical boundaries suggested by the plaintiffs’ expert at the time of the incident.¹⁰³ The court of appeals found no manifest error in the lower court’s reliance on such factual, nonexpert testimony in extending the geographical boundaries of the class beyond those suggested by plaintiffs’ expert.¹⁰⁴

Louisiana’s First Circuit Court of Appeals affirmed certification of a class geographically defined as persons within a 2.5-mile radius of the center of a hazardous waste dumpsite in the case of *Livingston Parish Police Jury v. Acadiana Shipyards, Inc.*¹⁰⁵ The trial judge in *Livingston Parish* placed little credibility in the testimony of both plaintiffs’ and defendants’ air dispersion modeling experts and in the mathematical formulas

100. *Id.*

101. *Id.*

102. *Hollaway v. Gaylord Chem. Corp.*, 98-0828 (La. App. 1 Cir. 12/28/98); 730 So. 2d 952.

103. *Id.* at 956.

104. *Id.* As stated by the court:

The expert evidence, combined with the testimony of individuals who were not within the boundaries set forth by Dr. Courtney, but who alleged they were adversely affected, lead us to conclude that the trial court did not abuse its discretion in extending the geographical boundaries beyond those suggested by plaintiffs’ expert. Rather, the evidence supports the factual determinations of the trial court and no abuse of discretion occurred in the setting of the geographical boundaries.

Id.

105. *Livingston Parish Police Jury v. Acadiana Shipyards, Inc.*, 598 So. 2d 1177 (La. App. 1 Cir. 1992).

they used to define the geographical area for the class.¹⁰⁶ Rather, the trial judge visited the site and defined the area based on his own observations.¹⁰⁷

The appeals court in *Livingston Parish* found that the trial judge's lack of confidence in the experts for both sides was justified because the plaintiffs' experts derived their calculations from incorrect data due to a typographical error and because the trial judge's observations indicated that the boundaries asserted by the defendants would not include areas where odor from the dump was present.¹⁰⁸ However, the court did find that the trial judge erred in relying on his own observations to define the geographic boundaries and remanded for the taking of evidence to establish the boundaries, stating that:

In order for the trial court to have technically valid evidence, an expert in air dispersion modeling should recompute the calculations for establishing the geographic class perimeter using the corrected data. If the trial court is dissatisfied with the evidence he might consider appointing his own experts to draw a boundary.¹⁰⁹

In 1996, Louisiana's Fourth Circuit Court of Appeals delivered its opinion in the case of *Ford v. Murphy Oil U.S.A.*¹¹⁰ The *Ford* court affirmed certification of a class against two of four named defendants in a suit in which the plaintiffs alleged a "synergistic accumulation or combination of releases, emissions, disbursements, placement, seepage, drainage, migration or otherwise nonconsensual placing of pollutants on [plaintiffs'] properties or persons."¹¹¹ The *Ford* majority noted that the trial court did not define the geographical area of the class, an observation which prompted the appellate court to formulate the applicable definition by reference to several parish communities and certain streets previously proposed by the plaintiffs.¹¹²

While the majority did not discuss any evidence in the record relating to the class definition, the dissenters in *Ford* found fault with the trial court's failure to conduct a proper evidentiary hearing, along with its failure to make the proper preliminary

106. *Id.* at 1183.

107. *Id.*

108. *Id.*

109. *Id.*

110. *Ford v. Murphy Oil U.S.A.*, 94-1218 (La. App. 4 Cir. 8/28/96); 681 So. 2d 401, *aff'd in part and rev'd in part*, 96-2913 (La. 9/9/97); 703 So. 2d 542.

111. *Id.* at 405.

112. *Id.* at 409.

determination as to the qualifications of expert witnesses.¹¹³ Though no live testimony was given at the hearing, the plaintiffs' expert affidavits apparently relied to some degree on air dispersion models, and thus, the dissenting justices identified discrepancies between the affidavits and the experts' deposition testimony.¹¹⁴

Ultimately, the Louisiana Supreme Court reviewed *Ford*, affirming the lower courts' denial of certification against two defendants and reversing the certification against the other two defendants.¹¹⁵ The court found the element of commonality to be lacking because "each class member will necessarily have to offer different facts to establish that certain defendants' emissions, either individually or in combination, caused them specific damages" and concluded that the novel and untested "synergy" theory was inappropriate for the class action procedure.¹¹⁶

B. Establishing Temporal Boundaries

In *Howard v. Union Carbide Corp.*, the Fifth Circuit Court of Appeals of Louisiana affirmed certification of a class defined as persons living or located between two towns and who were present in those locations during a 17-hour period when naphtha vapor escaped a tank at the defendant's facility.¹¹⁷ The class definition was further restricted to those persons who experienced physical symptoms such as nausea, coughing, choking, gagging, or irritation of eyes, nose or throat.¹¹⁸ The court accepted one of the plaintiffs' witnesses as an expert in the field of air dispersion modeling but noted the presence of conflicting testimony as to both the concentration of naphtha and the level at which individuals would begin to experience

113. *Id.* at 409–10, 418–19.

114. *Id.* at 418.

115. *Ford v. Murphy Oil USA*, 96-2913 (La. 9/9/97); 703 So. 2d 542.

116. *Id.* at 548–49.

117. *Howard v. Union Carbide Corp.*, 2004-1035 (La. App. 5 Cir. 2/15/05); 897 So. 2d 768, 770.

118. More precisely, the *Howard* court defined the class as follows:

those persons living or located between the Union Carbide Plant and the towns of Taft and Killona, including the towns of Taft and Killona, and the residents of the town of Montz, who were present in these locations for some time, from 10:00 p.m. on September 10, 1998 until 3:00 on September 11, 1998, and who experienced the physical symptoms which include any or all of the following—eyes, nose, or throat irritation, coughing, choking or gagging, or nausea, as a result of their exposure to naphtha or other chemical substance release from Union Carbide.

Id.

irritating effects.¹¹⁹ Regardless, the seven class representatives each testified that they were in the defined area during the applicable time-period and experienced symptoms of exposure.¹²⁰ Moreover, the plaintiffs also submitted the names and addresses of several thousand individuals alleged to have experienced similar symptoms.¹²¹ As a result, the appeals court found a reasonable basis for the trial court's finding that joinder of so many claims would be impractical.¹²²

A few years before *Howard*, Louisiana's Fifth Circuit Court of Appeals reviewed the case of *Mayho v. Amoco Pipeline Co.* and affirmed certification of a class defined as persons present at the time of a crude oil spill at defendant's facility within an area bounded by certain streets and the Mississippi River.¹²³ The trial court rejected the defendant's *Daubert* challenge to the plaintiffs' expert testimony estimating concentrations of hydrogen sulfide via air dispersion modeling.¹²⁴ The appeals court found that the defendant failed to prove the expert's analysis lacked any probative value and emphasized that, because *Mayho* was a bench trial rather than a jury trial, the trial judge "was able to give the testimonies their appropriate weight and value them accordingly."¹²⁵

C. Workers in Plants

In *Hoyte v. Stauffer Chemical Company*, a Florida circuit court denied a motion to certify a class of former employees of a phosphorous plant that ceased operations seventeen years before the suit was filed.¹²⁶ The *Hoyte* court found that changes in the plant's equipment, processes, and protective equipment, as well as individual differences in the use of such equipment, supported a worker-by-worker analysis rather than class certification.¹²⁷

The *Hoyte* plaintiffs argued that their air dispersion modeling expert could prove exposures on a class-wide basis by recreating ambient concentrations of various substances at

119. *Id.* at 772–73.

120. *Id.* at 773.

121. *Id.*

122. *Howard*, 897 So. 2d at 773.

123. *Mayho v. Amoco Pipeline Co.*, 99-620 to 624 (La. App. 5 Cir. 12/15/99); 750 So.2d 278, 280–81.

124. *Id.* at 281–82.

125. *Id.* at 282.

126. *Hoyte v. Stauffer Chem. Co.*, No. 98-3024-CI-7, 2002 WL 31892830 (Fla. Cir. Ct. Nov. 6, 2002).

127. *Id.* at *16.

different locations on the plant site for any given day and year during the life of the plant.¹²⁸ The court rejected this argument, pointing out that the plaintiff's modeling expert admitted to not knowing whether sufficient information existed about changes in equipment and emissions over the life of the plant and about periods of shutdown.¹²⁹ The expert also conceded that, although a model requires a variety of data for surface air and for upper air—such as wind speed and direction, temperature, and precipitation—the closest source of surface air data was twenty miles away, while the closest source for upper air data was even farther away.¹³⁰ Moreover, the expert indicated that the model could not be used to estimate concentrations inside buildings, which was where many of the plaintiffs worked.¹³¹ In rejecting the plaintiffs' certification request, the court held that:

[E]ven with complete information, the model can only predict ambient air concentrations and thus *potential* exposures to workers—to determine what a worker's *actual* exposures were while working at the Plant requires knowledge of where in the Plant he or she was over the course of their employment and when he or she worked at the Plant.¹³²

Further underlying the *Hoyte* court's decision, the plaintiffs sought class certification as a vehicle for seeking medical monitoring damages, arguing at the certification hearing that the alleged plant exposures caused the putative class members to suffer increased risks of developing latent diseases.¹³³ Unfortunately for the plaintiffs, the court held that disease risk is dose-dependant and, thus, could not be assessed on a class-wide basis.¹³⁴ Instead, the *Hoyte* court found that, in order to justify medical monitoring damages, the increased risk of developing long-latency diseases must be determined specifically for each substance and each worker.¹³⁵

128. *Id.*

129. *Id.* at *17.

130. *Id.*

131. *Hoyte*, 2002 WL 31892830, at *17.

132. *Id.* (emphasis in original).

133. *Id.* at *2.

134. *Id.* at *17.

135. *Id.*

V. AIR DISPERSION MODELS IN THE TORT CONTEXT

A. *Dose*

The value of air dispersion models as an evidentiary tool in toxic tort litigation is likely to increase due to the enhanced burdens now put upon plaintiffs to not only prove exposure to certain toxic agents but also to introduce evidence of the “dose” to which the toxic tort plaintiff was exposed. Indeed, the Texas Supreme Court recently recognized that “dose” is the most important factor to determining whether exposures to allegedly harmful substances cause adverse health impacts.¹³⁶

The cases reviewed below demonstrate efforts to adapt air dispersion models in order to address this important concern for tort litigants and to determine the level of harmful pollutants subject to inhalation in the ambient air. While most models have not faced serious challenges, the cases below demonstrate the courts’ increasing attention to the reliability of their conceptual and factual bases.

B. *Worst Case Scenario*

In *Walls v. Olin Corp.*, three construction workers brought a personal injury action against a plant owner in connection with the release of phosgene gas.¹³⁷ Phosgene can cause pulmonary edema and is potentially lethal.¹³⁸ Additionally, phosgene has a well-known inflammatory effect on moist surfaces of tissue and can burn human lungs upon inhalation.¹³⁹ In reviewing a jury verdict in favor of the defense, the *Walls* court evaluated the evidence and noted that, shortly after the alleged incident, the plaintiffs received medical evaluations in the emergency room of a local hospital, though not one plaintiff showed any immediate effects as a result of exposure.¹⁴⁰ Further, none of the injuries associated with inhalation of phosgene gas appeared within the first twenty-four hours of the event. In spite of this lack of immediate severe injuries, the plaintiffs claimed a variety of adverse physiological impacts, ranging from headaches to aggravation of emphysema.¹⁴¹

136. *Borg-Warner Corp. v. Flores*, 232 S.W.3d 765, 770 (Tex. 2007).

137. *Walls v. Olin Corp.*, 87-835 (La. App. 3 Cir. 11/9/88); 533 So. 2d 1375.

138. *Id.* at 1376.

139. *Id.* at 1378.

140. *Id.* at 1377.

141. *Id.* at 1377.

The *Walls* court's analysis suggests that the quality of the testimony concerning the typical physical injuries from phosgene exposure likely influenced its decision. Specifically, the court quoted the testimony from one of the treating doctors who stated that "[t]here is nothing magic about phosgene and injuring the lung. It's like heat causing a burn; if it occurs, you know it."¹⁴² The testimony also noted that, just as one may be exposed to heat and not suffer burns, a person may be exposed to phosgene and not suffer lung injury.¹⁴³ However, the defense also presented what the court called "a second line of defense": that the plaintiffs could not have been injured because the "dose was not strong enough."¹⁴⁴ The model assumed the worst-case scenario and calculated the maximum dose to which the plaintiffs had been exposed. In addressing this argument, the court did not discuss any evidentiary objection to the use of the model.¹⁴⁵ The parties made no objections to the assumptions or the particular data underlying the mathematical predictions. The model itself simply calculated how a quantity of gas released from an emission point would get to the place where the plaintiffs were working.¹⁴⁶

According to the defense experts in *Walls*, the maximum exposure to the plaintiffs was insufficient to cause injury, even using the "worst case" calculations. In the absence of any evidence of exposure to a level known to cause injury to a person, the defense experts indicated that the exposure in question would not require treatment, much less cause injury.¹⁴⁷ Thus, the model in this case effectively highlighted the absence of any actual exposure evidence.

In *Molden v. Georgia Gulf Corporation*, defendants seeking summary judgment used air dispersion modeling to establish a low level of exposure insufficient to support a finding of physical injury.¹⁴⁸ Over 3,500 plaintiffs in nine consolidated lawsuits alleged exposure to phenol as a result of a fire at a Georgia Gulf Company phenol plant.¹⁴⁹ Numerous plaintiffs alleged that they suffered "transient health effects."¹⁵⁰ The plaintiffs presented an expert report stating that the calculated level of phenol was well

142. *Walls*, 533 So. 2d at 1378.

143. *Id.*

144. *Id.*

145. *Id.*

146. *Id.* at 1379.

147. *Walls*, 533 So. 2d at 1379.

148. *Molden v. Ga. Gulf Corp.*, 465 F. Supp. 2d 606 (M.D. La. 2006).

149. *Id.* at 610.

150. *Id.*

below any of the levels recognized in the scientific literature as capable of causing physical injury to humans. Indeed, the phenol level concentration of 0.30 parts per million (“ppm”) was not exceeded anywhere within about a ten-mile radius of the source.¹⁵¹

The defendants objected to the plaintiffs’ method on the basis of the time interval selected for the calculations, but the court never considered this point, due to the defendants’ acceptance of the plaintiffs’ numbers showing an absence of any levels sufficient to cause injury.¹⁵² On this record, the court granted summary judgment in favor of defendants. The absence of a concrete injury or illness coupled with admitted exposure to levels of phenol below any known harmful level demonstrated the absence of any scientific evidence to support causation.¹⁵³ The model’s results again demonstrated that the worst-case scenario calculated by the plaintiffs was insufficient to exceed the relevant health effects levels.¹⁵⁴

In *Harris v. Peridot Chemical (New Jersey), Inc.*, the defense unsuccessfully attempted to demonstrate the absence of exposure sufficient to cause injury.¹⁵⁵ The plaintiffs filed an action claiming injury caused by exposure to hydrogen sulfide. The

151. *Id.* at 610–11. The odor threshold for phenol (.04 ppm) is much lower than any health effect level. In this case, it appears that the parties calculated the area for an odor threshold and then determined that the calculated phenol concentration of .30 ppm was never exceeded in the “10-mile odor threshold.” *Id.*

152. *Id.* at 611.

153. *Molden*, 465 F. Supp. 2d at 611.

154. *See also* *Galloway v. Empire Fire & Marine*, No. 03-113, 2007 WL 1199502 (W.D. La. Apr. 20, 2007) (providing another “worst case scenario” analysis). The *Galloway* plaintiffs claimed exposure to HCL fumes when three canisters—known as “totes”—developed a crack and began to leak HCL as a semi-trailer was proceeding down an interstate highway. The driver was advised about the leak by another truck driver and stopped to inspect his cargo. The plaintiffs claimed that they had been exposed to the HCL fumes as they drove behind the truck before being directed off the highway by the state police. Initially, the court noted the burden upon personal injury plaintiffs in toxic tort cases to show the harmful level of substances to which they were exposed. The court then went on to evaluate the use of the ALOHA model, which had been validated by the EPA, which was used by first responders to predict the dispersion of chemicals in an emergency, and was submitted by defendants in support of their motion for summary judgment. The defendants’ experts argued that the plaintiffs could not have been exposed to harmful levels of HCL based on their reported position, wind direction, and amount of material released. In their “worst case scenario” evaluation, the expert for the defense concluded that plaintiffs could not have been exposed to any HCL. Although plaintiffs themselves testified to establish exposure to HCL vapors, they failed to present any medical or scientific evidence in support of their claims. In the absence of any contradicting medical or scientific evidence, the court granted summary judgment to the defendants.

155. *Harris v. Peridot Chem. (N.J.), Inc.*, 712 A.2d 1181 (N.J. Super. Ct. App. Div. 1998).

evidence demonstrated that, shortly after the incident, both plaintiffs were taken to a hospital where they were evaluated. Both plaintiffs reported experiencing the “rotten egg” smell associated with hydrogen sulfide.¹⁵⁶ Doctors placed one plaintiff on a respirator, while pulmonary studies disclosed “marked airway obstruction and impaired diffusing capacity.”¹⁵⁷ Lung examinations revealed “inspiratory crackles,” and doctors diagnosed the plaintiff with sulfur dioxide inhalation and released him nine days later.¹⁵⁸

The other *Harris* plaintiff was admitted, treated for severe fume inhalation, and released seven days later, after treatment with oxygen, steroids and bronchodilators.¹⁵⁹ Much of the evidence presented dealt with the identification of the source of the release and the conditions leading to the release of material. The defense expert presented testimony about several air dispersion models that accounted for different wind directions and asserted that the amount of material reaching the plaintiffs’ work location was “minuscule.”¹⁶⁰

One of the defense expert’s models also indicated that the material released would “touchdown” at a distance well beyond the point where plaintiffs worked.¹⁶¹ While it did not discuss any evidentiary objections, the court did note the criticisms offered by the plaintiffs’ experts, emphasizing that a “Gaussian plume” describes “possible movement” of pollution in the atmosphere and does not reflect the air dispersion of pollutants in the “near field.”¹⁶² According to the court, the defense model simply could not rule out exposures 300 feet from the source of the emission.¹⁶³ Therefore, the *Harris* defendant was unable to use the worst-case scenario to demonstrate the absence of exposure to a harmful level of material. Rather, the court was persuaded by the reliance of the plaintiffs’ experts on adverse physical effects to determine the level of exposure.¹⁶⁴

156. *Id.* at 1184.

157. *Id.*

158. *Id.*

159. *Id.* at 1185.

160. *Harris*, 717 A.2d at 1190.

161. *Id.*

162. *Id.*

163. *Id.* at 1188.

164. Plaintiffs’ expert testified that plaintiff Smith was probably exposed to 500 to 1000 ppm of hydrogen sulfide for five to ten minutes because it takes only 8.5 minutes to kill humans at 500 to 600 ppm. *Harris*, 717 A.2d at 1189. The expert opined that plaintiff Harris was exposed from three to five minutes at the same level on the basis of serious neurological effects. *Id.*

VI. ESTIMATING THE RATE OF EMISSIONS

Occasionally, courts do engage in a detailed review of the data used to support opinions derived from air dispersion models. In *In re Voluntary Purchasing Groups, Inc.*, the Northern District of Texas, mindful of its role as a gatekeeper, found that a Gaussian dispersion algorithm represented an “accepted scientific methodology” for calculating past emissions from industrial sources.¹⁶⁵ Courts generally accept that air dispersion models are typically used by regulatory agencies to calculate a “worst case” scenario to help agencies set emissions limits for permitting purposes.¹⁶⁶ In the nonregulatory context, the “modeler’s inputs and assumptions must be accurate” for the results to be “methodologically sound and scientifically valid.”¹⁶⁷ After all, “propagation of seemingly small errors in the Gaussian model parameters can cause very large variations in the model’s predictions.”¹⁶⁸

Before addressing the air dispersion model, the *Voluntary Purchasing* court focused upon the methodology used to estimate the rate of particulate emissions from various sources at the facility. The court indicated that “calculation errors and faulty assumptions” were matters that went to “weight and credibility” and, thus, beyond a *Daubert* “threshold” inquiry.¹⁶⁹ However, the court found that the methodology employed by the plaintiffs’ expert did not meet the threshold reliability standard.¹⁷⁰ The expert’s methodology incorporated information from other facilities to analogize and extrapolate an estimate of the rate of arsenic acid emissions from a scrubber flare system that recovered arsenic acid from a production unit.¹⁷¹ Furthermore, the plaintiffs’ expert did not show that the other facilities were sufficiently similar to the facility in question.¹⁷² Thus, the court noted that there was no way to test the reliability of the emissions estimate.¹⁷³

The *Voluntary Purchasing* court also found that the expert’s

165. *In re Voluntary Purchasing Groups, Inc.*, No. Civ. A. 3:94CV2477H, 2000 WL 1842779, at *2 (N.D. Tex. Dec. 14, 2000).

166. *Avance v. Kerr-McGee Chem., L.L.C.*, No. 5:04CV209, 2006 WL 3912471, at *3 (E.D. Tex. Dec. 26, 2006).

167. *Id.* at *4.

168. Milton R. Beychok, *Error Propagation in Air Dispersion Modeling*, <http://www.air-dispersion.com/feature.html> (last visited June 4, 2008).

169. *In re Voluntary Purchasing Groups, Inc.*, 2000 WL 1842779, at *2.

170. *Id.* at *3.

171. *Id.*

172. *Id.*

173. *Id.*

selection of a percentage factor used by the EPA to estimate industrial emissions from the dry handling of arsenic acid was not sufficiently reliable because the factor was simply based on a “survey of manufacturers” and not supported by engineering calculations.¹⁷⁴ The plaintiffs’ expert also suggested that certain exposures might have resulted from “airborne particulate matter from the arsenic dust deposited on and around the stretch of industry railroad track used to transport raw material into the facility.”¹⁷⁵ In arriving at this conclusion, the expert relied upon an EPA-approved equation for estimating topsoil erosion from open areas.¹⁷⁶ However, the court determined that the plaintiffs’ expert did not select or reliably apply “a sound scientific methodology appropriate to the facts of this case.”¹⁷⁷ Given the absence of a methodology designed exclusively for the required emissions estimates, the court found “too great an analytical gap” between the expert’s analysis and the facts of the case.¹⁷⁸

Finally, the *Voluntary Purchasing* court decided to strike any testimony based on the air dispersion model results because the model was based on faulty estimates of the emission rate.¹⁷⁹ Moreover, the court noted that the meteorological data used to run the model was not sufficiently complete.¹⁸⁰ The model proponents “could point to no source that indicates a minimum threshold of data sufficiency for the long-term, retroactive application of the model required by this case.”¹⁸¹ While the model used by the plaintiffs’ expert—the Industrial Source Complex Short Term Model (“ISCST3”) model¹⁸²—was found to be “generally accepted” by the EPA and had been subjected to peer-review and testing for “short-term modeling in the regulatory context,” the court found that the plaintiffs still failed to show that this model was “even minimally reliable for modeling atmospheric dispersion of particulate matter over a long term, and long past, period of time.”¹⁸³

174. *In re Voluntary Purchasing Groups, Inc.*, 2000 WL 1842779, at *3.

175. *Id.*

176. *Id.*

177. *Id.*

178. *Id.* at *4.

179. *In re Voluntary Purchasing Groups, Inc.*, 2000 WL 1842779, at *5.

180. *Id.*

181. *Id.*

182. *Id.* at *5 n.15.

183. *Id.* at *4.

VII. AIR DISPERSION MODELS AND CAUSATION

Few courts have dealt squarely with the issue of whether air dispersion modeling is suitable as a reliable scientific technique to support causation. Under current Texas tort law, the plaintiff must show both general and specific causation.¹⁸⁴ “General causation” requires legally sufficient epidemiological proof that a particular harmful level and duration of exposure to the substance is capable of causing the illness in question.¹⁸⁵ However, plaintiffs must do more than make a general showing that exposure to a substance can cause a disease. Indeed, the plaintiffs must also show “specific causation” by demonstrating that exposure to a harmful amount of the substance in question caused their actual injury.¹⁸⁶ As previously noted, the Texas Supreme Court recently held in *Borg-Warner Corp. v. Flores* that evidence of “dose” is the “single most important factor to consider in evaluating whether an alleged exposure caused a specific adverse effect.”¹⁸⁷

In the absence of individualized personal monitoring data, toxic tort litigants are attempting to use air-modeling techniques as evidence of a plaintiff’s actual exposure. In *Castellow v. Chevron USA*, the decedent developed acute myelogenous leukemia (“AML”) after working as a service station attendant for more than thirty years.¹⁸⁸ The *Castellow* plaintiffs claimed that exposure to benzene-containing products, including gasoline, caused the decedent’s disease and subsequent death.¹⁸⁹ The evidence of exposure was derived in part from anecdotal evidence from co-workers describing exposure to pure benzene and later demonstrating that the vast majority of the exposures occurred during the decedent’s work around gasoline.¹⁹⁰ Plaintiffs’ experts also presented a series of “exposure assessments” that relied on a

184. *Havner*, 953 S.W.2d at 720–21. “It is fundamental that a plaintiff in a toxic tort case must prove the levels of exposure that are dangerous to humans generally and must also prove the actual level of exposure of the injured party to the defendant’s toxic substances.” *Austin v. Kerr McGee Refining Corp.*, 25 S.W.3d 280, 292 (Tex. App.—Texarkana 2000, no pet.); *see also* *Allen v. Pa. Eng’g Corp.*, 102 F.3d 194, 199 (5th Cir. 1999) (“Scientific knowledge of the harmful level of exposure to a chemical, plus knowledge that the Plaintiff was exposed to such quantities, are minimal facts necessary to sustain the Plaintiff’s burden in a toxic case.”).

185. *Havner*, 953 S.W.2d at 714–15.

186. *Id.*

187. *Borg-Warner Corp.*, 232 S.W.3d at 770 (quoting David L. Eaton, *Scientific Judgment and Toxic Torts—A Primer in Toxicology for Judges and Lawyers*, 12 J.L. & POLY 5, 11 (2003)).

188. *Castellow v. Chevron USA*, 97 F. Supp.2d 780, 781–82 (S.D. Tex. 2000).

189. *Id.* at 782.

190. *Id.* at 784–85.

“modeling formula.”¹⁹¹ While the plaintiffs insisted that the technique was an acceptable scientific methodology well-suited to personal injury cases, the court was “not persuaded that the record supports that assertion when modeling is used to justify causation opinions as a tort claim.”¹⁹²

The court relied on several observations from an air dispersion modeling article by Michael A. Jayjock, Ph.D. to support its conclusion that modeling could not justify causation opinions.¹⁹³ The court noted that “the thrust of the [Jayjock] article appears to herald the importance of a modeling approach to risk assessment, not to causation factors in the legal context” and quoted with approval the maxim that “all models are wrong, but some are useful.”¹⁹⁴ The court agreed with Dr. Jayjock’s statements that “predictions from physical-chemical inhalation models can be extremely valuable; however, at this point these models are far from being considered elegant or complete” and that “inhalation models do not estimate human exposure ‘directly,’ but instead estimate the concentration of toxicants in the air, and then assume that the person is breathing the same air with this concentration.”¹⁹⁵

While the cases discussed have addressed the various applications and limits of air dispersion models, one case in particular identified the essential shortcoming of this technique with respect to the issue of causation.¹⁹⁶ While primarily concerning itself with the class certification issue, the *Hoyte* court pointed out that an air dispersion model simply fails to address the individualized need for information about the person’s actual exposure in a given setting.¹⁹⁷

VIII. ACCURACY AND PRECISION OF AIR MODELS

The EPA’s discussion of its newest air model, AERMOD, can be found in the Federal Register.¹⁹⁸ In addressing various aspects of AERMOD, the EPA acknowledges that air models tend

191. *Id.* at 785–86.

192. *Id.* at 789.

193. *Castellow*, 97 F. Supp.2d at 789–90 (discussing Michael A. Jayjock, *Modeling Inhalation Exposure*, in *THE OCCUPATIONAL ENVIRONMENT—ITS EVALUATION AND CONTROL* 313 (Salvatore R. DiNardi, ed., 1997)).

194. *Castellow*, 97 F. Supp.2d at 789.

195. *Id.*

196. *Hoyte*, 2002 WL 31892830, at *17.

197. *Id.*

198. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions, 70 Fed. Reg. at 68,218. AERMOD is the EPA’s recommended model. *Id.* at 68,218.

to characterize an event by “known” conditions such as “wind speed, mixed layer height, surface heat flux, [and] emissions characteristics” but that unknown or unmeasured conditions such as “unresolved details of the atmospheric flow such as the turbulent velocity field” will also cause variations in the conditions of an event.¹⁹⁹ Variations in such unknown conditions result in “inherent uncertainty,” and the EPA indicates that this source of uncertainty alone may result in a variation of concentrations of plus or minus fifty percent.²⁰⁰

Models also reflect “reducible uncertainties,” which are caused by unknown input values of emissions and meteorological data.²⁰¹ In spite of these unknowns, the EPA suggests that models are “reasonably reliable for estimating the magnitude of highest concentrations occurring sometime, somewhere within an area.”²⁰² For example, the EPA notes that “errors in highest estimated concentrations of [plus or minus] 10 to 40 percent are found to be typical, *i.e.*, certainly well within the often quoted factor-of-two accuracy that has long been recognized for these models.”²⁰³ On the other hand, “estimates of concentration that occur at a specific time and site[] are poorly correlated with actually observed concentrations and are much less reliable.”²⁰⁴ These poor correlations may be due in part to reducible uncertainties. According to the EPA, an error of five to ten degrees in wind direction can result in a concentration error of twenty to seventy percent for a particular time and location.²⁰⁵ Thus, while models are most reliable for estimating the *highest* concentration occurring within an area, they lack the fundamental capacity to show actual exposure to an individual at a precise location. Indeed, the EPA recognizes that model predictions as to a specific time and site are “poorly” correlated with “observed concentrations.”²⁰⁶

Much progress has been made in developing the “elegance” of air dispersion models. Today the EPA uses the AERMOD Model as the tool of choice in carrying out its regulatory functions.²⁰⁷ While models can now address more technologically

199. *Id.* at 68,246.

200. *Id.*

201. *Id.*

202. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions, 70 Fed. Reg. at 68,246.

203. *Id.*

204. *Id.*

205. *Id.*

206. *Id.*

207. Revision to the Guideline on Air Quality Models: Adoption of a Preferred

advanced concerns such as the terrain features and building downwash, they continue to perform essentially the same function as in the past. In other words, air dispersion models continue to describe the movement of contaminants in a plume through the atmosphere from an emission point at a certain elevation. These models provide valuable emissions estimates and account for single or multiple point sources; continuous or intermittent emissions; and varying meteorological conditions impacting the plume's direction, rate of dispersion, and deposition.

More advanced models include mathematical simulations to estimate the rate at which emissions combine with other substances in the atmosphere, as well as effects caused by photochemical reactions related to sunlight and temperature.²⁰⁸ In fact, the sheer complexity of these mathematical computations suggests that those looking to air modeling data should proceed with caution, especially when applying models to ambient individual exposures. However, in the absence of any actual data, air modeling will continue to fulfill valuable evidentiary needs, so long as those parties and experts utilizing this technique meet the stringent proof requirements mandated by Texas law.

IX. CONCLUSION

Air dispersion models will continue to be the tool of choice for dealing with regulatory permitting issues. Emissions standards grow out of legislative mandates addressing concerns of environmental policy. Complex causation inquiries in the tort context incorporate additional factors, born of the need to address the elements of proof necessary to establish liability. At present, air dispersion models maintain their vitality in estimating the "worst case scenarios" but lack the ability to accurately demonstrate individualized exposure. Unless fundamental changes in the residential and work environments can ultimately provide more control over the inherent uncertainties in emissions, emissions sources, and the natural forces around worksites and communities, air dispersion modeling will continue to encounter conceptual challenges to its application in the tort context.

General Purpose Dispersion Model and Other Revisions, 70 Fed. Reg. at 68,246.

208. *Id.*