CAUSATION'S NUCLEAR FUTURE: APPLYING PROPORTIONAL LIABILITY TO THE PRICE-ANDERSON ACT

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ABSTRACT

For more than a quarter century, public discourse has pushed the nuclear-power industry in the direction of heavier regulation and greater scrutiny, effectively halting construction of new reactors. By focusing on contemporary fear of significant accidents, such discourse begs the question of what the nation's court system would actually do should a major nuclear incident cause radiation-induced cancers.

Congress's attempt to answer that question is the Price-Anderson Act, a broad statute addressing claims by the victims of a major nuclear accident. Lower courts interpreting the Act have repeatedly encountered a major stumbling block: it declares that judges must apply the antediluvian preponderance-of-the-evidence logic of state tort law, even though radiation science insists that the causes of radiation-induced cancers are more complex. After a major nuclear accident, the Act's paradoxically outdated rules for adjudicating "causation" would make post-incident compensation unworkable.

This Note urges that nuclear-power-plant liability should not turn on eighteenth-century tort law. Drawing on modern scientific conclusions regarding the invariably "statistical" nature of cancer, this Note suggests a unitary federal standard for the Price-Anderson Act—that a defendant be deemed to have "caused" a plaintiff's injury in direct proportion to the increased risk of harm the defendant has imposed. This "proportional liability" rule would not only fairly evaluate the costs borne by injured plaintiffs and protect a reawakening nuclear industry from the prospect of bank-breaking litigation, but would prove workable with only minor changes to the Price-Anderson Act's standards of "injury" and "fault."

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INTRODUCTION

For the past several decades, an effective moratorium on building new nuclear-power plants has silenced the nuclear industry.[1] The reasons for the halt in construction have included public outrage over the Three Mile Island meltdown,[2] increasing regulation,[3] and nuclear-power-plant operators' need to insure against a multiplicity of risks.[4] Although the potential harms that the nuclear industry poses to the public are often emphasized, the harmful uncertainty plaguing investment in nuclear power is not. Today, nuclear power is constantly beset by numerous unanticipated risks that it helped to create, including constant media attention[5] and the variable and significant costs of building and maintaining nuclear-power plants.[6] Insuring against such risks has long been an immense cost of participating in the nuclear industry.

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1. Justin Gundlach, Note, *What's the Cost of a New Nuclear Power Plant? The Answer's Gonna Cost You: A Risk-Based Approach to Estimating the Cost of New Nuclear Power Plants*, 18 N.Y.U. ENVTL. L.J. 600, 630 (2011). On February 9, 2012, the Nuclear Regulatory Commission voted to permit construction of two nuclear reactors at the Vogtle nuclear-power plant in Georgia, the first new reactors in more than thirty years. Ayesha Rascoe, *NRC Approves First New Nuclear Plant in a Generation*, REUTERS, Feb. 9, 2012, *available at* http://www.reuters.com/article/2012/02/09/us-usa-nuclear-license-idUSTRE8181T420120209.

2. Peter Behr, *Three Mile Island Still Haunts U.S. Nuclear Industry*, N.Y. TIMES, Mar. 27, 2009, http://www.nytimes.com/gwire/2009/03/27/27greenwire-three-mile-island-still-haunts-us-reactor-indu-10327.html.

3. U.S. NUCLEAR REGULATORY COMM'N, BACKGROUNDER ON THE THREE MILE ISLAND ACCIDENT (Apr. 25, 2014), http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.html.

4. *See* Gundlach, *supra* note 1, at 630–48 (discussing the risks attending plant construction, engineering, fuel costs, staffing, security, safety, decommissioning, licensing, and waste management).

5. *See, e.g.*, Jennifer Weeks, *Nuclear Experts Assess How Well Media Covered Fukushima*, SOC'Y OF ENVTL. JOURNALISTS (July 15, 2011), http://www.sej.org/publications/sejournal/nuclear-experts-assess-how-well-media-covered-fukushima (describing fervent and inaccurate media reporting following the Fukushima incident in early 2011); Nassrine Azimi, Opinion, *Fukushima in America*, N.Y. TIMES, May 10, 2011, http://www.nytimes.com/2011/05/11/opinion/11iht-edazimi11.html (inquiring whether the United States has fallen into "nuclear entrapment" and positing the Fukushima disaster as a moment of reflection for the nuclear industry); Scott Waldman, *Cuomo's Complicated Indian Point Equation*, CAPITAL N.Y. (Apr. 7, 2014, 9:50 AM), http://www.capitalnewyork.com/article/magazine/2014/04/8543109/cuomos-complicated-indian-point-equation (contrasting the Indian Point nuclear-power plant's favorable safety record with resistance to relicensing from prominent environmental groups and the governor of New York).

6. *See* Gundlach, *supra* note 1, at 631–53 (describing uncertain costs incurred as a result of plant engineering, project financing, construction delays, staffing, plant safety and security, and subsequent litigation).

Congress first addressed the complex risks of nuclear power by enacting the 1954 Atomic Energy Act (AEA),[7] creating a licensing regime that permitted civilians to use nuclear fuel for the first time.[8] Congress then amended the AEA in 1957 through the Price-Anderson Act (PAA),[9] mandating that nuclear licensees carry private insurance to hedge against the risk of liability that could result from a major nuclear incident.[10] In recent years, a senescing cadre of nuclear-power plants[11]—which provide 19.4 percent of the country's escalating energy needs[12]—has overshadowed the industry. Reacting through the Energy Policy Act of 2005,[13] Congress has enacted policies to spur further investment in nuclear technologies, providing financial assistance in the form of production tax credits, low-interest federal loans, and insurance insulating many reactors from the costs of regulatory and licensing delays.[14] But as companies seek to site, develop, and maintain these plants over the next half-century, one little-studied threat for the nuclear industry and the public has been glossed over: the risk of civil litigation itself.[15]

Over the years, Congress has somewhat mitigated the cost of litigating claims of radiation-related harm to third parties from nuclear licensees—companies working with nuclear materials—by requiring them to carry significant liability insurance.[16] These

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7. Atomic Energy Act of 1954, Pub. L. No. 83-703, 68 Stat. 919 (codified as amended at scattered sections of 42 U.S.C. (2012)).

8. *See id.* at § 53(a) (permitting the Atomic Energy Commission to issue licenses for domestic possession of "special nuclear material"); John V. Buffington, *Underwriting the Ultimate Tort*, 87 DICK. L. REV. 679, 682 (1983) (observing that private possession of nuclear fuel was prohibited until the 1954 AEA).

9. Atomic Energy Damages Act (Price-Anderson Act), Pub. L. No. 85-256, 71 Stat. 576, 42 U.S.C. § 2210 (2012).

10. 1 PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, REPORT TO THE CONGRESS 13 (1990), *available at* http://www.state.nv.us/nucwaste/news/rpccna.

11. *See* Gundlach, *supra* note 1, at 623 (observing that all nuclear reactors operating in the United States were ordered in the 1960s and 1970s).

12. *US Nuclear Generating Statistics*, NUCLEAR ENERGY INST., http://www.nei.org/Knowledge-Center/Nuclear-Statistics/US-Nuclear-Power-Plants/US-Nuclear-Generating-Statistics (last updated Apr. 14, 2014).

13. Energy Policy Act of 2005, Pub L. No. 109-58, § 638, 119 Stat. 594, 791–94, 42 U.S.C. § 16014 (2012).

14. JAY M. GUTIERREZ & ALEX S. POLONSKY, FUNDAMENTALS OF NUCLEAR REGULATION IN THE UNITED STATES 97–98 (2d ed. 2007).

15. For a discussion of the history of and claims in Price-Anderson Act suits, see *infra* Part I.

16. *See* 42 U.S.C. § 2210(b)(1) (2012) (requiring licensees to hold financial protection in "the amount of liability insurance available from private sources"); 78 Fed. Reg. 41,835, 41,836

requirements compel nuclear licensees to carry liability insurance indemnifying them in any judgment for harms to third parties up to a statutory maximum.[17] Today, administrative remedies are used to address many of the harms caused by radioactive materials to uranium miners, as well as military personnel and civilians near nuclear-test sites.[18] But Congress utilized a separate statutory framework—the PAA—to impose liability for harms to the general public.[19]

Under the PAA, private plaintiffs may sue for physical or economic harms arising from the "hazardous properties of radioactive material" emitted from a nuclear-power plant, a fuel-fabrication operation, a uranium mill, or any similar facility during a "nuclear incident."[20] The PAA's litigation mechanism is the so-called "public liability" lawsuit,[21] a complex,[22] one-way,[23] exclusive ticket to federal court.[24] PAA suits usually take the form of class actions because radioactive materials may disperse widely and affect large

(July 12, 2013) (codified at 10 C.F.R. § 140.11(a)(4) (2014)) (increasing the primary financial-protection layer to $375,000,000 to reflect inflation).

17. *See* 42 U.S.C. § 2210(b) (requiring deferred, retrospective insurance premiums assessed against the nuclear industry in the event of a major nuclear incident).

18. *See infra* notes 204–09 and accompanying text.

19. This Note focuses on the PAA, the exclusive means of remedying claims by third parties arising out of a nuclear incident, rather than the distinct disaster-relief services provided by federal agencies or nongovernmental organizations. For example, the Federal Emergency Management Agency (FEMA) is tasked with executing emergency plans to protect the public from imminent harm. FED. EMERGENCY MGMT. AGENCY, RADIOLOGICAL EMERGENCY PREPAREDNESS PROGRAM, http://www.fema.gov/radiological-emergency-preparedness-program (last updated June 19, 2014). Such agencies would be unlikely to address the cost of compensating injuries or cleaning up the reactor site. *E.g.*, Entergy Nuclear Generation Co., No. 50-293-LR, 2012 WL 1207269, at *3 (N.R.C. Mar. 30, 2012).

20. For a description of the effects of an internal accident at a nuclear-power plant, see generally Lincoln L. Davies, *Beyond Fukushima: Disasters, Nuclear Energy, and Energy Law*, 2011 BYU L. REV. 1937 (2011).

21. Dan M. Berkovitz, *Price-Anderson Act: Model Compensation Legislation? The Sixty-Three Million Dollar Question*, 13 HARV. ENVTL. L. REV. 1, 7 (1989).

22. *See, e.g.*, Richard Goldsmith, *Regulatory Reform and the Revival of Nuclear Power*, 20 HOFSTRA L. REV. 159, 163 n.11 (1991) (describing statutory provisions of the PAA as "complex"); Joel Yellin, *High Technology and the Courts: Nuclear Power and the Need for Institutional Reform*, 94 HARV. L. REV. 498, 517 (1981) (same).

23. *See* 42 U.S.C. § 2210(n)(2) (2012) (permitting the removal of public liability suits from state court to federal court).

24. *See id.* (creating federal jurisdiction for the district in which the "nuclear incident [took] place"); Nieman v. NLO, Inc., 108 F.3d 1546, 1553 (6th Cir. 1997) (noting that members of the general public harmed by radiation from a nuclear-power plant can "sue under the Price-Anderson Act . . . or not at all").

populations in nearby areas.[25] Unlike a car collision or a badly built widget, any physical harms imposed by radiation emissions are impossible to see, slow to materialize, and virtually untraceable to a single identifiable cause. Indeed, litigating a PAA suit is a forensic kabuki dance: all players know that proving "causation" is a matter of probability and not of fact, yet both parties mechanically act out the motions of a tort suit at common law.

This Note tackles the hardship that the PAA's common-law causation rules would create in the wake of a major nuclear incident. Whether the incident should result from an intentional act such as a terrorist attack[26] or as the unintended consequence of a reactor malfunction, such an event might cause damage in excess of $100 billion.[27] Relying on the rich history of smaller radiation-injury suits litigated to date, this Note argues that the PAA's causation rule should impose liability directly in proportion to the statistical chance of increased harm to third parties. Such a rule not only forces the nuclear-power industry to pay directly for negative externalities imposed on the public, but dispels the specter of bank-breaking judgments that could bring a slowly developing industry to its knees.

This Note proceeds in four parts. Part I introduces the provisions of the PAA, explains how defendants pay for and settle public liability lawsuits, and surveys decades of litigation. Part II provides an overview of how radiation harms humans, focusing on the probabilistic effects of low-level radiation exposure. Part III contrasts two methodologies for applying scientific understandings of radiation-induced[28] cancers to the ill-fitting burdens of proof required to demonstrate specific causation in U.S. courts. It shows that combining epidemiological data with the traditional preponderance-of-the-evidence standard would bar the claims of all injured plaintiffs, but that relying on individualized clinical evidence would overdeter defendants. Part IV observes that the all-or-nothing causation rules of state tort law are inapposite to public liability suits because conclusive links between a particular instance of injury and a particular radiation

25. For a summary of major class-action litigation, see *infra* Part I.C.

26. For an overview of the potential aftermath of a terrorist attack on a nuclear reactor, see generally Jason Zorn, Note, *Compensation in the Event of a Terrorist Attack on a Nuclear Power Plant: Will Victims Be Adequately Protected?*, 38 NEW ENG. L. REV. 1087 (2004).

27. *See infra* note 38 and accompanying text.

28. Recognizing the uncertainty inherent in identifying the cause of any incidence of cancer, this Note will use the term "radiation-induced" to refer not only to cancers that were in fact caused by radiation, but those that hypothetically could have been caused by radiation.

source cannot be proven. Part IV further argues that implementing a "proportional liability" standard would benefit all parties by tying recovery directly to the excess risks imposed on plaintiffs. Finally, Part V addresses obstacles to implementing proportional liability, proposing modifications to the PAA's "fault" and "injury" standards that would prevent plaintiffs and defendants from manipulating the effects of current PAA law on a proportional liability regime.

I. A BRIEF SUMMARY OF PUBLIC LIABILITY SUITS UNDER THE PRICE-ANDERSON ACT

> The Price-Anderson Act is one of the most complicated, least understood, and least used laws I have encountered in all my years in the House. Yet its purpose is simple and its role is important. Quite simply, the Price-Anderson Act ensures that adequate funds will be available to compensate the public in the event of a nuclear accident.[29]

Before the AEA's enactment in 1954, the federal government carefully guarded the secrets of nuclear power.[30] In his 1953 speech, "Atoms for Peace," President Dwight D. Eisenhower promised that nuclear power could be harvested "to provide abundant electrical energy in the power-starved areas of the world"[31] through paving the way for private commercial development.[32] Despite Eisenhower's proclamation that the AEA would turn "swords into plowshares" by allowing private peaceful applications for nuclear energy,[33] would-be investors nonetheless voiced concerns that potential profits from

29. 133 CONG. REC. 21,414 (1987) (statement of Rep. Udall).

30. *See* Berkovitz, *supra* note 21, at 5 (noting that prior to the enactment of the AEA, the federal government held a "monopoly over nuclear materials and their use").

31. President Dwight D. Eisenhower, Address Before the General Assembly of the United Nations on Peaceful Uses of Atomic Energy, New York City (Dec. 8, 1953), *in* PUB. PAPERS OF THE PRESIDENTS OF THE UNITED STATES: DWIGHT D. EISENHOWER, 1953, at 813, 821 (1954). Notably, contemporary projections suggested no immediate need for nuclear reactors. Rather, "[t]he prevailing sense of urgency . . . reflected instead the fear of falling behind other nations in fostering peaceful atomic progress." J. SAMUEL WALKER & THOMAS R. WELLOCK, A SHORT HISTORY OF NUCLEAR REGULATION, 1946-2009, at 2 (2010), *available at* http://pbadupws.nrc.gov/docs/ML1029/ML102980443.pdf.

32. Buffington, *supra* note 8, at 681–82.

33. Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n, 461 U.S. 190, 193 (1983).

nuclear energy were limited, whereas its potential liabilities were immense.[34]

Congress quelled investors' unease over the risks of nuclear power by enacting the PAA in 1957.[35] The PAA requires reactor licensees to purchase the "maximum amount of liability insurance available" to insure themselves against potential injuries to third parties.[36] Licensees are permitted to use these insurance funds to cover the costs of litigating and settling claims.[37] Recognizing that damages—potentially ranging as high as $100 billion today[38]—might exceed the total available insurance, the Atomic Energy Commission (AEC)[39] indemnified licensees up to another $500 million.[40] Beyond that value, damages were entirely "capped," preventing the public from receiving additional compensation.[41]

A. The Nuclear Industry's Transition from Governmental Indemnity to Private Insurance

Through subsequent amendments, Congress required the nuclear industry to internalize the costs of potential harms to the public. In 1975, just over two decades after the AEA was passed, Congress largely[42] ushered the government out of the nuclear-insurance

34. *See, e.g.*, Harold Green, *Nuclear Power, Risk, Liability, Indemnity*, 71 MICH. L. REV. 479, 480–81 (1973) (recognizing the dual problem for investors of a remote potential for profit "in the relatively remote and uncertain future" and the "major roadblock" of liability to the public).

35. *Id.* at 483–87.

36. 42 U.S.C. § 2210(a)–(b) (2012).

37. Financial Protection Requirements and Indemnity Agreements, 10 C.F.R. § 140.3(d) (2013).

38. Hypothetical scenarios have damages ranging from $10 billion to $100 billion. Michael G. Faure & Tom Vanden Borre, *Compensating Nuclear Damage: A Comparative Economic Analysis of the U.S. and International Liability Schemes*, 33 WM. & MARY ENVTL. L. & POL'Y REV. 219, 266 (2009).

39. The AEC was divided into an energy-research arm and the Nuclear Regulatory Commission in 1974. WALKER & WELLOCK, *supra* note 31, at 49.

40. *Id.* at 15–16.

41. *Id.* The Supreme Court found the liability cap compliant with due-process and equal-protection principles. Duke Power Co. v. Carolina Envtl. Study Grp., Inc., 438 U.S. 59, 87, 93 (1978).

42. Although the United States no longer directly indemnifies private nuclear licensees, limiting the total compensation awardable to the public can still be visualized as an effective subsidy to the industry. For further discussion and explanation, see *infra* note 51.

business, replacing publicly guaranteed indemnity with privately funded insurance pools.[43]

Today, the first layer of compensation available in a public liability suit remains fixed at the maximum insurance available to a single nuclear licensee.[44] This limitation is currently set at $375 million per reactor[45] by the Nuclear Regulatory Commission (NRC) and American Nuclear Insurers (ANI)—a nuclear-insurance pool largely comprised of domestic property-casualty insurance companies.[46] If a nuclear incident caused more than $375 million in damages, a second layer of compensation would activate.[47] At this stage, every other nuclear licensee in the United States would contribute up to $127 million per reactor[48] to finance a large-scale litigation or settlement through additional pro rata charges known as "retrospective premiums," which would be assessed against each nuclear reactor following an accident by any one of them.[49] Accordingly, as more

43. *See* Berkovitz, *supra* note 21, at 14–15 (describing how the 1975 PAA amendments reduced the federal indemnity of $560 million by the amount of funding that nuclear licensees could obtain through private insurance and payment of retrospective premiums). Once the private funding available exceeded $560 million, federal indemnity no longer existed. Thus, although the PAA still addresses indemnification of private licensees in § 2210(c), that section no longer requires governmental indemnity. *See id.* at 15 ("[O]nce the federal indemnity had been eliminated, the liability limit would increase as the number of operating reactors increased. The layer of federal indemnity was eliminated upon the licensing of the 80th reactor in 1982."). Unlike private nuclear-reactor licensees, Department of Energy contractors remain directly indemnified by the federal government. *See* 42 U.S.C. § 2210(d)(2) (2012) ("[T]he Secretary . . . shall indemnify the persons indemnified against such liability above the amount of the financial protection required, in the amount of $10,000,000,000 . . . ."). The activities of such contractors are beyond the scope of this Note.

44. 42 U.S.C. § 2210(b) (2012).

45. *Need for Nuclear Liability Insurance,* AM. NUCLEAR INSURERS 2 (Oct. 2013), http://www.amnucins.com/library/Nuclear%20Liability%20in%20the%20US.pdf.

46. U.S. NUCLEAR REGULATORY COMM'N, NUCLEAR INSURANCE AND DISASTER RELIEF 1 (June 2014), *available at* http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/nuclear-insurance.pdf. As an alternative to the investor-held ANI, nuclear licensees were able to insure through a policyholder-owned mutual-insurance pool. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 13–14. But ANI has been the only nuclear-insurance pool in the United States since 1998. Faure & Vanden Borre, *supra* note 38, at 254. Nuclear operators insure themselves against direct, on-site damage through a separate insurer, Nuclear Electric Insurance Limited. *Id.*

47. *Id.*

48. AM. NUCLEAR INSURERS, *supra* note 45, at 2. Insurance premiums for the primary layer of financial protection are approximately $1.1 million per reactor per year. U.S. NUCLEAR REGULATORY COMM'N, *supra* note 46, at 1.

49. Berkovitz, *supra* note 21, at 6.

reactors are licensed in the United States, each licensee can expect to benefit from a larger pool of secondary liability insurance.[50]

Taking both layers into account, $13.6 billion is currently available for a public liability lawsuit arising out of a major nuclear incident,[51] in addition to a likely congressional backstop.[52] Because the second layer is paid directly by all plant owners, it serves as a deterrent and penalty leveled against nuclear operators, reducing the potential for moral hazard present in many insurance schemes. Furthermore, because the whole industry becomes liable in part for the tortious acts of each participant, the PAA's scheme encourages industry actors to monitor other operators' compliance with regulatory standards.[53]

B. The Price-Anderson Act's Requirement that Federal Courts Apply Exclusively State Law

The first public liability suits hardly differed from common-law tort claims[54] and were litigated in state courts until the Three Mile Island (TMI) incident.[55] At that time, federal jurisdiction was available only if the NRC determined that the case resulted from an

50. *Id.* at 6–7.

51. AM. NUCLEAR INSURERS, *supra* note 45, at 2. The debate over the adequacy of the compensation fund for a major incident has received significant attention. *See generally* Michael Faure & Karine Fiore, *An Economic Analysis of the Nuclear Liability Subsidy*, 26 PACE ENVTL. L. REV. 419 (2009) (deeming the PAA's liability limit "less distorting" than its international counterparts, but nonetheless inadequate); Daniel Meek, Note, *Nuclear Power and the Price-Anderson Act: Promotion over Public Protection*, 30 STAN. L. REV. 393 (1978) (arguing that the fund's then-current compensation scheme, similarly structured but with a liability cap less than one-tenth of today's amount, was "grossly deficient" in the 1970s). *But see generally* Joseph Marrone, *The Price-Anderson Act: The Insurance Industry's View*, 12 FORUM 605 (1977) (considering the 1970s compensation fund adequate); Zorn, *supra* note 26 (finding compensation adequate in a terrorist attack on a nuclear-power plant).

52. *See* 42 U.S.C. § 2210(e)(2) (2012) ("In the event of a nuclear incident involving damages in excess of the amount of aggregate public liability under paragraph (1), the Congress will . . . take whatever action is determined to be necessary . . . to provide full and prompt compensation to the public for all public liability claims resulting from a disaster of such magnitude.").

53. *See* Faure & Vanden Borre, *supra* note 38, at 272 (observing an incentive for reciprocal monitoring because "any low quality operation will lead to increased financial exposure" for other operators).

54. *See* Berkovitz, *supra* note 21, at 4 ("The Act did not create a federal cause of action for damages arising out of a nuclear incident, and it did not alter any of the rules of state law that might apply.").

55. *See, e.g.*, Bennett v. Mallinckrodt, Inc., 698 S.W.2d 854, 863 (Mo. Ct. App. 1985) (holding that common-law tort claims brought in state court against a radiopharmaceutical plant were not barred by federal preemption of nuclear regulation).

"extraordinary nuclear occurrence" (ENO).[56] Because the statute imposed no timeline on deciding whether an incident was an ENO, it relegated plaintiffs to an "unusual jurisdictional limbo" between state and federal courts until the NRC issued a ruling.[57] In the TMI litigation, a district court held that Congress intended federal jurisdiction to cover "borderline" cases as long as an ENO was alleged in good faith.[58] The Third Circuit ultimately reversed this holding.[59]

Following the Third Circuit's ruling, and after over three thousand plaintiffs brought more than one hundred cases in both federal and state courts,[60] representatives from both sides of the litigation testified before Congress that it would be more efficient if all nuclear accidents, regardless of size, were litigated in federal district courts.[61] Congress amended the PAA to so provide in 1988, imbuing all nuclear incidents with federal jurisdiction.[62] The amendments also enacted procedural mechanisms for increasing the efficiency of PAA suits, such as caseload-management panels.[63]

Once a case arrives in federal court, however, the PAA does not provide substantive federal law for adjudicating the suit. As early as the 1960s, Congress considered creating a federal system of nuclear tort law to adjudicate PAA cases with greater certainty and uniformity.[64] But the Joint Committee on Atomic Energy balked at the effort and advised Congress to retain state tort rules in public

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56. *See* Cook v. Rockwell Int'l Corp., 618 F.3d 1127, 1135–36 (10th Cir. 2010) ("Accordingly, unless the diversity statute applied or the action resulted from an 'extraordinary nuclear occurrence,' nuclear-related tort claims typically could not proceed in federal court.").

57. *In re* Three Mile Island Litig., 87 F.R.D. 433, 437 (M.D. Pa. 1980).

58. *See id.* at 435–38 (holding that federal district courts have jurisdiction over "lawsuits seeking damages from a nuclear incident of the magnitude of TMI.").

59. *See* Stibitz v. Gen. Pub. Util. Corp., 746 F.2d 993, 996 n.3, 997 (3d Cir. 1984) (holding that, except for ENOs, the PAA did not provide for federal jurisdiction); Kiick v. Metro. Edison Co., 784 F.2d 490, 493 (3d Cir. 1986) (same).

60. S. REP. NO. 100-218, at 13 (1987), *reprinted in* 1988 U.S.C.C.A.N. 1476, 1488.

61. *Id.*

62. 42 U.S.C. § 2210(n)(2) (2012) (creating federal jurisdiction and allowing removal to federal court for cases "resulting from a nuclear incident"); *id.* § 2014(q) (defining "nuclear incident" as an injury "resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special, nuclear, or byproduct material").

63. *See id.* § 2210(n)(3) (granting the chief judge of the district court with jurisdiction over the case permission to create management panels of other district and appellate judges if the case has an "unusual" impact on the work of the court or if the aggregate public liability is great); *id.* § 2210(n)(3)(C) (permitting management panels to consolidate cases, establish claim priority, and assign cases to judges or special masters).

64. S. REP. NO. 89-1605, at 9 (1966), *reprinted in* 1966 U.S.C.C.A.N. 3201, 3209.

liability cases.[65] The Supreme Court ultimately followed suit, adopting a policy of minimal interference[66] with state law. In *Pacific Gas & Electric Co. v. State Energy Resources Conservation & Development Commission*,[67] the Court acknowledged that many of Congress's actions—such as the creation of the AEC—suggested that the entire field of nuclear safety was preempted. Nonetheless, the Court observed that states remained free to regulate activities such as nuclear-power-plant licensure on economic grounds.[68] The Court then ruled in *Silkwood v. Kerr-McGee Corp.*[69] that federal law permitted punitive-damage awards for radiation-related injuries as long as they were permitted under state law.[70] Today, federal courts ruling on PAA claims continue to apply the substantive law of the state in which the nuclear incident occurred unless doing so would be inconsistent with the PAA.[71]

C. Modern Price-Anderson Act Cases Evincing Rising Costs and Significant Complications

For the first two decades of the PAA's existence, public liability suits were inexpensive and straightforward to litigate, particularly for the nuclear industry. A spreadsheet tracking expected, hypothesized, and settled lawsuits contains just over one page addressing claims resolutions before 1980, and those claimants were indemnified for under $2 million in total.[72] Because of the absence of notable nuclear incidents in the United States for the first two decades of the PAA, nuclear insurers were even able to return much of their required

65. *See id.* ("[T]he committee does not believe it is necessary to go to the length of enacting substantive law . . . to achieve these ends."). The Joint Committee believed that a waiver of defenses at the fault stage was sufficient to resolve legal uncertainties in major incidents, and that new federal law on causation and damages would be excessive. *Id.* at 3209–10.

66. *See, e.g.*, S. REP. NO. 89-1605, at 6 (1966), *reprinted in* U.S.C.C.A.N. 3201, 3206 ("Since its enactment by Congress in 1957 one of the cardinal attributes of the Price-Anderson Act has been its minimal interference with State law.").

67. Pac. Gas & Elec. Co. v. State Energy Res. Conservation & Dev. Comm'n, 461 U.S. 190 (1983).

68. *Id.* at 216.

69. Silkwood v. Kerr-McGee Corp., 464 U.S. 238 (1984).

70. *Id.* at 246–58. The PAA does prohibit punitive-damage awards when the United States must indemnify a defendant such as a government contractor. 42 U.S.C. § 2210(s) (2012).

71. 42 U.S.C. § 2014(hh) (2012).

72. U.S. NUCLEAR REGULATORY COMM'N, THE PRICE-ANDERSON ACT—CROSSING THE BRIDGE TO THE NEXT CENTURY 85 (1998).

insurance premiums after reserving them for ten-year increments.[73] But on March 28, 1979, the reactor-core meltdown at TMI changed the public's perception of the industry as Americans watched residents within a five-mile radius of the nuclear-power plant evacuate their homes.[74] The President's Commission on the Accident at Three Mile Island[75] as well as private research institutions[76] independently investigated potential health effects experienced by nearby residents. Though a consensus emerged that public exposures were negligible,[77] the TMI incident nonetheless sparked increased distrust of the nuclear industry.[78] The ensuing litigation settled for $71 million.[79] A 1997 Congressional report on the Price-Anderson Act found that TMI accounted for more than half of what ANI had then paid to resolve all lawsuits dating back to 1957.[80]

In courts throughout the country, the claims against the TMI plant and its operators prompted similar litigation against other nuclear-power plants and NRC licensees. In addition to the TMI suits, the Third Circuit decided cases stemming from uranium-processing and waste-disposal activities in western Pennsylvania.[81]

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73. *Id.* at 82. In the 1950s and 1960s, insurers generally returned 95 to 99 percent of reserve premiums. The refund rate for 1969 premiums, which were due to be paid out after the TMI incident in 1979, fell to a historic low of 27.9 percent. The return rate recovered to 70 percent over the next fifteen years. *Id.* at 83.

74. U.S. NUCLEAR REGULATORY COMM'N, *supra* note 3.

75. JOHN G. KEMENY ET AL., STAFF REPORT TO THE PRESIDENT'S COMMISSION ON THE ACCIDENT AT THREE MILE ISLAND 1 (1979).

76. *See* U.S. NUCLEAR REGULATORY COMM'N, *supra* note 3 ("[C]omprehensive assessments by several well respected institutions, such as Columbia University and the University of Pittsburgh, have concluded . . . the actual release had negligible effects on the physical health of individuals or the environment.").

77. *Id.*; U.S. NUCLEAR REGULATORY COMM'N, *supra* note 72, at xvii.

78. U.S. NUCLEAR REGULATORY COMM'N, *supra* note 3.

79. NUCLEAR ENERGY INST., INSURANCE: PRICE-ANDERSON ACT PROVIDES EFFECTIVE LIABILITY INSURANCE AT NO COST TO THE PUBLIC 1 (2012), *available at* http://www.nei.org/corporatesite/media/filefolder/Price_Anderson_Act_Sept_2012.pdf.

80. *See* U.S. NUCLEAR REGULATORY COMM'N, *supra* note 72, at 84 (concluding that ANI had spent approximately $131 million on indemnity and defense costs by 1997, of which $70 million related to the Three Mile Island incident). By 2008, ANI had spent $304 million in indemnity and litigation expenses. Marjorie Berger, *Managing Nuclear Risks in the United States: INLA Inter Jura Congress 2009*, AM. NUCLEAR INSURERS 8 (2014), *available at* http://www.amnucins.com/library/INLA-2009.pdf.

81. Hall v. Babcock & Wilcox Co., 69 F. Supp. 2d 716, 734 (W.D. Pa. 1999) (granting a motion for a new bellwether trial in a several-hundred-plaintiff suit against now-defunct fuel-fabrication facilities); McMunn v. Babcock & Wilcox Power Generation Grp., Inc., 896 F. Supp. 2d 347, 351 (W.D. Pa. 2012) (addressing discovery motions in nine newly filed multi-plaintiff suits by community residents against the same facilities).

The Ninth Circuit ruled on thousands of claims relating to cancers allegedly caused by radioiodine emissions at the Hanford plutonium-production facility in Washington[82] as well as class-action and single-plaintiff suits against rocket-testing facilities in southern California.[83] The Sixth Circuit addressed suits alleging an increased risk of cancer and property damage from emissions at a nuclear-weapons facility in Ohio,[84] culminating in the creation of a settlement fund and lifetime medical monitoring for former employees.[85] In Kentucky, employees at uranium-enrichment facilities and nearby residents sued plant owners, alleging "subcellular" harm and property damage.[86] Finally, claims against uranium mills in Colorado and New Mexico[87] and the *Cook v. Rockwell International Corp.*[88] case against the Rocky Flats nuclear-weapons-production facility near Denver[89] transformed the Tenth Circuit into the primary stomping ground of recent public liability suits.

In such recent public liability suits, the financial threat to the nuclear industry has been significant. By 2009, ANI had paid out $300 million,[90] and an additional $80 million settlement with a former operator was still being litigated.[91] Although ANI has historically

82. *In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 995 (9th Cir. 2007).

83. O'Connor v. Boeing N. Am., Inc., 311 F.3d 1139, 1144–45 (9th Cir. 2002).

84. Day v. NLO, Inc., 864 F. Supp. 40, 41 (S.D. Ohio 1994).

85. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 90; Tim Bonfield, *History Repeats Itself*, CINCINNATI ENQUIRER, Feb. 11, 1996, http://enquirer.com/fernald/stories/021196c_fernald.html.

86. *See* Smith v. Carbide & Chems. Corp., 507 F.3d 372, 374–77 (6th Cir. 2007) (summarizing residents' property claims for water and soil contamination); Rainer v. Union Carbide Corp., 402 F.3d 608, 611, 613 (6th Cir. 2005) (describing allegations of "future harms" that could result from damage to DNA).

87. *See* Wilcox v. Homestake Mining Co., 619 F.3d 1165, 1166 (10th Cir. 2010) (reviewing personal-injury claims against a uranium mill); June v. Union Carbide Co., 577 F.3d 1234, 1236–38 (10th Cir. 2009) (addressing personal-injury and medical-monitoring claims against a uranium- and vanadium-mining company); Dodge v. Cotter Corp., 328 F.3d 1212, 1217–20 (10th Cir. 2003) (ruling on trespass, negligence, nuisance, and emotional-distress claims against a uranium mill); Kerr-McGee Corp. v. Farley, 115 F.3d 1498, 1500–01 (10th Cir. 1997) (reviewing jurisdiction in a suit by Navajo Nation against a nearby uranium mill); Boughton v. Cotter Corp., 65 F.3d 823, 825 (10th Cir. 1995) (addressing medical-monitoring claims against a uranium mill).

88. Cook v. Rockwell Int'l Corp., 618 F.3d 1127 (10th Cir. 2010).

89. *See id.* at 1133 (ruling on property claims brought by nearby residents); Building & Constr. Dept. v. Rockwell Int'l Corp., 7 F.3d 1487, 1490 (10th Cir. 1993) (ruling on medical-monitoring claims by former employees and unions).

90. Berger, *supra* note 80.

91. Babcock & Wilcox Co. v. Am. Nuclear Insurers, 76 A.3d 1, 3–7 (Pa. Super. Ct. 2013).

retained almost $300 million in litigation reserves,[92] the threat of bank-breaking judgments continues to haunt its member operators, particularly in cases with little apparent merit. Epitomizing this threat is the *Cook* case against the Rocky Flats nuclear-weapons-production facility in Denver, in which the jury awarded roughly $1 billion in compensatory and punitive damages for alleged plutonium contamination of the plaintiffs' property.[93] At trial, the linchpin of the plaintiffs' strategy was for experts to explain that any radioactive contamination on their property, no matter how small, could cause an increase in the risk of getting cancer.[94] Ultimately, the lower court instructed the jury that no appreciable health risk needed to be shown in order for plaintiffs to recover.[95] If paid in full, the judgment would have greatly exceeded the plant's first layer of liability, forcing nuclear operators nationwide to contribute more than $600 million.[96] After it was reversed on appeal, the case was remanded, then re-appealed on the issue of whether the PAA inherently preempts state law claims based on the same facts.[97]

Furthermore, the complex legal issues plaguing public liability suits have often caused plaintiffs' claims to languish without any hope of a court reaching a final judgment. Indeed, suits against Washington's Hanford Nuclear Reservation, the "nation's most contaminated area,"[98] were first filed in 1990, and bounced between the district and appellate courts for more than eighteen years.[99] Notwithstanding favorable bellwether verdicts for two thyroid-cancer

92. *See Price-Anderson Act Reauthorization: Hearing Before the Subcomm. on Transp., Infrastructure, and Nuclear Safety of S. Comm. on Env't and Public Works*, 107th Cong. 57 (2003) (statement of John L. Quattrocchi, Senior Vice President for Underwriting, Am. Nuclear Insurers) (noting that ANI then held $282 million in reserve for indemnity and defense of outstanding claims).

93. COOK V. ROCKWELL INT'L CORP., VERDICT PROFILE 1 (2013), *available at* Bloomberg Law.

94. *Cook*, 618 F.3d at 1134.

95. *See id.* ("Plaintiffs are *not* required to show that plutonium is present on the Class Properties at any particular level or concentration, that they suffered any bodily harm because of the plutonium, or that the presence of plutonium on the Class Properties damaged these properties in some other way.").

96. *See supra* notes 41–42.

97. Transcript of Record at 197, Cook v. Rockwell Int'l Corp., No. 14-1112 (10th Cir. Mar. 26, 2014), ECF No. 1.

98. Gerald F. Hess, *Hanford: Cleaning Up the Most Contaminated Place in the United States*, 38 ARIZ. L. REV. 165, 180 (1996).

99. *In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 995 (9th Cir. 2008).

claimants,[100] later settlement offers made to other residents with thyroid disease in the Hanford cases were relative pittances.[101] Overall, little of the money paid by nuclear insurers supports claims settlements. Excluding the payouts from TMI, twenty-three times as much has been expended on legal fees as on compensation.[102]

As discussed further in Part III, the cost, duration, and perceived unfairness of adjudicating public liability suits under the PAA partly results from the difficulty of deciding whether a nuclear-power plant's radiation releases have "caused" a particular injury.[103] Indeed, in 1990, the Presidential Commission on Catastrophic Nuclear Accidents (the Presidential Commission), which was tasked with suggesting potential changes to the PAA, found that the "principal problem" with compensating public liability claims is "the difficulty of proving or defending such claims on the issue of causation in fact."[104] Individualized causation issues in public liability suits are extensively litigated through "prediscovery" orders,[105] through summary-judgment motions,[106] and through *Daubert* hearings[107] at which competing experts vie for the judge's ear on the causes of radiation-induced cancers. These experts disagree over the factual

100. *See id.* at 1000, 1017 (affirming judgments totaling approximately $550,000 in favor of thyroid-cancer plaintiffs).

101. *See Hanford Down-Winder Pursues a Settlement for Exposure to Radioactive Fallout*, ASSOCIATED PRESS, June 8, 2013, http://www.oregonlive.com/environment/index.ssf/2013/06/hanford_down-winder_pursues_a.html (reporting thyroid-cancer settlements ranging from $10,000 to $15,000); *Hanford Offers Sent to Hundreds*, THE SPOKESMAN-REVIEW, Apr. 1, 2012, http://www.spokesman.com/stories/2012/apr/01/hanford-offers-sent-out (reporting eighty-six hypothyroid-disease-settlement offers totaling $524,600).

102. U.S. NUCLEAR REGULATORY COMM'N, *supra* note 72, at 92. In comparison, administrative costs in the much-maligned asbestos litigation only exceeded compensation paid to plaintiffs by a two-to-one ratio. Robert L. Rabin, *Some Thoughts on the Efficacy of a Mass Toxics Administrative Compensation Scheme*, 52 MD. L. REV. 951, 953 (1993).

103. *See, e.g.*, Marcie Rosenthal, *How the Price-Anderson Act Failed the Nuclear Industry*, 15 COLUM. J. ENVTL. L. 119, 127 (1990) ("Victims of a nuclear accident have the burden of proving causation. This poses a difficult, if not impossible challenge to plaintiffs seeking compensation from radiation-induced injuries.").

104. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 101.

105. *See infra* notes 167–68 and accompanying text.

106. *E.g.*, Cotroneo v. Shaw Envtl. & Infrastructure, Inc., 639 F.3d 186, 192–93 (5th Cir. 2011) (granting summary judgment for lack of a causal nexus between radiation exposure and injury); Golden v. CH2M Hill Hanford Grp., 528 F.3d 681, 683 (9th Cir. 2008) (same).

107. For a paradigmatic and methodical analysis of radiation dose experts in a public liability suit, see *In re* TMI Litig., 193 F.3d 613, 666–722 (3d Cir. 1999).

circumstances of radiation exposure,[108] the rates at which radiation exposure causes cancer,[109] and whether certain radionuclides can cause cancer at all.[110] To date, the federal courts of appeals have been unable to agree on issues of specific causation because, as discussed previously, the PAA paradoxically defers these substantive questions to state tort law.[111]

II. RADIATION AS SCIENTIFIC CAUSE

A brief primer on radiation's health effects on humans is essential to understand how scientific theories of causation diverge from their legal counterparts. Radiation consists of the emission of alpha particles, beta particles, or gamma rays[112] from unstable nuclei as they decay.[113] Such emissions—called ionizing radiation—cause "ionization" by knocking electrons from their orbits, creating additional charged particles.[114] These emissions can directly and indirectly damage structures within the human body as cells are disrupted or killed by the ionizing radiation itself, and as energy is transferred to cells triggering second-order chemical changes.[115]

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108. *See, e.g.*, *id.* at 659–61 (contrasting studies by defendants and the Pennsylvania Department of Health showing no exposures above NRC limits with the plaintiffs' experts' theory of a "blowout" plume of radioactive gases that evaded nearby radiation monitors).

109. *See, e.g.*, *In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 998–99 (9th Cir. 2008) (assessing differing testimony from plaintiffs and defendants as to whether thyroid cancer can be caused by less than forty rads of radiation exposure).

110. *See, e.g.*, McMunn v. Babcock & Wilcox Power Generation Grp., Inc., 896 F. Supp. 2d 347, 356–57 (W.D. Pa. 2012) (addressing defendants' objections that there is insufficient evidence to demonstrate that unenriched uranium is a human carcinogen).

111. 42 U.S.C. § 2014(hh) (2012). In the words of one commentator, "Price-Anderson simply works to defer responsibility and resolution of important issues." Rosenthal, *supra* note 103, at 127.

112. An alpha particle consists of two protons and two neutrons, JAMES E. TURNER, ATOMS, RADIATION, AND RADIATION PROTECTION 61 n.3 (3d ed. 2007), whereas beta particles are electrons emitted from the nucleus of an atom, *id.* at 65. Gamma rays are electromagnetic radiation emitted as photons from nuclei after radioactive decay. *Id.* at 68.

113. *Id*. at 58–71.

114. *Id.* at 109, 139. Non-ionizing radiation produced by microwaves and radios is not thought to cause long-term health effects because it lacks sufficient energy to do so. *Microwaves, Radio Waves, and Other Types of Radiofrequency Radiation*, AM. CANCER SOC'Y, http://www.cancer.org/cancer/cancercauses/radiationexposureandcancer/radiofrequency-radiation (last visited Oct. 16, 2014). Most studies show that radiofrequency waves from cell phones cannot cause DNA damage, and are therefore not a cancer risk. *Cellular Phones*, AM. CANCER SOC'Y, http://www.cancer.org/cancer/cancercauses/othercarcinogens/athome/cellular-phones (last visited Oct. 16, 2014).

115. TURNER, *supra* note 112, at 408.

Acute radiation syndrome may kill or damage enough cells to cause lasting harm to bodily tissues and organs, and can be lethal when critical organs are exposed to sufficiently high doses.[116] Doses of one to three gray[117] may lead to "[m]ild to severe nausea, malaise, anorexia, [or] infection." Exposures of three to six gray can result in "hemorrhaging, infection, diarrhea, epilation, [and] temporary sterility,"[118] and exposures in the range of 3.5 gray or more can be fatal.[119] Receiving more than six gray impairs the nervous system, and more than ten gray incapacitates the exposed individual, generally resulting in death.[120] The symptoms of the resultant "acute radiation syndrome" are deterministic: whether or not they will occur can be assessed based on dosage and conditions of exposure, although their manifestations may vary somewhat from person to person.[121]

Exposure to lower doses of ionizing radiation leads to so-called "delayed somatic effects."[122] Such effects are stochastic, rather than deterministic—there is a chance, but not a certainty, that injury will develop based on the level of exposure.[123] Most notable is the potential damage to the controls regulating cellular division in human DNA, resulting in uncontrolled cellular growths.[124] After a latency period—often ranging between two and ten years—such growths may manifest as cancer.[125] The prevailing analysis of this process for solid cancers, embraced by major health-physics societies,[126] is the "linear no-threshold" (LNT) model, which states that even de minimis

116. *Id.* at 419.

117. The gray, the "international system (SI) unit of radiation dose expressed in terms of absorbed energy per unit mass of tissue," is equivalent to 100 rads. *Gray (Gy)*, HEALTH PHYSICS SOC'Y, http://hps.org/publicinformation/radterms/radfact79.html (last updated Aug. 13, 2014).

118. TURNER, *supra* note 112, at 421.

119. *Id.*

120. *Id.*

121. *Id.* at 410, 419–21.

122. *Id.* at 421–23.

123. *Id.* at 421–22.

124. *Id.* at 429.

125. *Id.* at 421–22.

126. Underlying the LNT model are the findings of the United Nations Scientific Committee on the Effects of Atomic Radiation, the National Council on Radiation Protection and Measurements, and the National Academy of Sciences that DNA damage is strictly proportional to dosage at "reasonably low" doses of radiation. ENVTL. PROT. AGENCY, EPA RADIOGENIC CANCER RISK MODELS AND PROJECTIONS FOR THE U.S. POPULATION 6 (2011), *available at* http://epa.gov/rpdweb00/docs/bluebook/bbfinalversion.pdf.

exposure has the potential to cause cancer.[127] Although "the probability that cancer will result from [a given exposure] increases proportionally with [the] dose,"[128] not all forms of cancer are alike. Some cancers, like red-blood-cell and bone-marrow leukemias, and lung, skin, thyroid, breast, or stomach cancers, are more strongly linked to radiation exposure.[129]

Although some radiation-induced cancers may be attributable to nuclear-power production, most result from a variety of mundane sources of radiation.[130] Each year, the public is exposed to radiation from radon, cosmic rays, medical devices,[131] and even banana consumption.[132] Unlike a chemical product, which may be traceable to a particular manufacturer, different sources of radiation are not distinguishable, nor is there any noticeable difference between cancers caused by nuclear-power production and those caused by other sources of radiation.[133]

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127. *Id.* The National Research Council's BEIR VII Committee employed a linear-quadratic model for leukemia, TURNER, *supra* note 112, at 422, although epidemiological data are also consistent with the linear model at low doses, ENVTL. PROT. AGENCY, *supra* note 126, at 10–15. In contrast to the LNT model, "adaptive response" theories suggest that exposure to very low levels of radiation may actually trigger bodily defense mechanisms that fight cancerous and precancerous mutations. *See* TURNER, *supra* note 112, at 429 ("In some systems, a small dose of radiation (e.g., several mGy) triggers a cellular response that protects the cells from a large dose of the radiation given subsequently."); ENVTL. PROT. AGENCY, *supra* note 126, at 11 ("[L]ow-dose radiation may stimulate defense mechanisms, which could be beneficial in preventing cancer or other diseases."). Furthermore, some courts have rejected the LNT model because it is an extrapolation from cancer risks experienced at higher levels of exposure. *See* Cano v. Everest Minerals Corp., 362 F. Supp. 2d 814, 849 (W.D. Tex. 2005) (summarizing district-court cases rejecting the LNT theory).

128. *In re* TMI Litig., 193 F.3d 613, 642 (3d Cir. 1999).

129. *Radiation Exposure and Cancer*, AM. CANCER SOC'Y, http://www.cancer.org/cancer/cancercauses/othercarcinogens/medicaltreatments/radiation-exposure-and-cancer (last visited Oct. 22, 2014).

130. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 101.

131. ENVTL. PROT. AGENCY, *supra* note 126, at 13–14.

132. *See Doses in Our Daily Lives*, U.S. NUCLEAR REGULATORY COMM'N, http://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html (last visited Oct. 16, 2014) (describing average radiation doses from medical procedures and ingested food).

133. *See* TURNER, *supra* note 112, at 468 ("[I]t is difficult, if not impossible, to attribute a given malignancy in a person to his or her past radiation history. Diseases induced by radiation, from either natural or man-made sources, also occur spontaneously."); *id.* at 410 ("Although we might be able to predict the magnitude of the increased incidence, we cannot say which particular individuals in the population will contract the disease and which will not.").

III. RADIATION AS LEGAL CAUSE

In public liability suits, plaintiffs must prove causation under the tort laws of the state in which the incident occurred.[134] Under most states' common law, toxic-tort plaintiffs must show "generally" that exposure to a substance can cause their injury and "specifically" that exposure in fact did cause the injury.[135] General causation is satisfied by showing that a form of cancer may be attributable to radiation.[136] Specific causation is more problematic because it requires showing that the defendant's emissions were the most likely cause of the plaintiff's injury.[137] Some courts have interpreted this standard to mean that a plaintiff must show a preponderance of the evidence—at least a 50 percent likelihood that the defendant's emissions caused the plaintiff's injury.[138]

A. The Preponderance-of-the-Evidence Rule

For some substances that were the subject of previous toxic-tort litigation, plaintiffs could feasibly prove causation above the 50 percent threshold—by a preponderance of the evidence—if the plaintiffs suffered "signature injuries" sufficiently rare that a jury merely needed to know that the injury existed to pair it with its cause. For example, women exposed *in utero* to the morning-sickness medication diethylstilbestrol (DES) were significantly more likely to develop a very rare form of cancer.[139] Because studies estimated that

134. 42 U.S.C. § 2014(hh) (2012).

135. RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 26 cmt. g (2010).

136. *See, e.g.*, June v. Union Carbide Corp., 577 F.3d 1234, 1245 (10th Cir. 2009) (observing in a PAA case that general causation requires the plaintiffs to show that radiation had the "capacity" to cause their cancers).

137. *See, e.g.*, Golden v. CH2M Hill Hanford Grp., Inc., 528 F.3d 681, 683 (noting that a PAA plaintiff must show that exposure to radiation "in fact" caused his injuries). Showing specific causation is problematic because it is "highly individualistic, and depends on the characteristics of individual plaintiffs (*e.g.* state of health, lifestyle) and the nature of their exposure." *In re* Agent Orange Prod. Liab. Litig., 818 F.2d 145, 165 (2d Cir. 1987).

138. *See* Cano v. Everest Minerals Corp., 362 F. Supp. 2d 814, 820 (W.D. Tex. 2005) ("Courts adopting such a requirement [to show "doubled risk"] have found that the requirement of a more than 50% probability means that epidemiological evidence must show that the incidence of an injury or condition . . . was more than double the incidence in the unexposed or control population.").

139. Glen O. Robinson, *Multiple Causation in Tort Law: Reflections on the DES Cases*, 68 VA. L. REV. 713, 718 (1982). Interestingly, men exposed to DES *in utero* do not appear to bear a noticeable increase in cancer risk. *See* William H. Strohsnitter, Kenneth L. Noller, Robert N. Hoover, Stanley J. Robboy, Julie R. Palmer, Linda Titus-Ernstoff, Raymond H. Kaufman,

DES caused seven out of every eight such cancers in young women, defendants could be said to have caused the injury in the overwhelming majority of instances.[140] Similarly, in the long-running asbestos litigation, proving causation is less difficult because of the relative rareness of mesothelioma.[141] By contrast, given that radiation-induced cancers have no "signature" origin, the simple preponderance standard has proven problematic to implement and difficult to meet.

As discussed below, courts have taken two approaches to implementing the preponderance standard in public liability suits. Accepting that the process of attributing causes to cancer is purely statistical, some courts apply what mass-torts scholars call the "weak" preponderance rule, requiring plaintiffs to rely on epidemiological studies showing that it is more than 50 percent likely that the plaintiffs contracted cancer from a particular source.[142] Others apply a "strong" preponderance rule, focusing on individualized assessments of a plaintiff's lifestyle and exposure to other substances to decide whether the plaintiff's cancer is connected to the alleged exposure.[143]

B. The Preponderance Rule and Epidemiological Evidence

In cases in which courts apply a preponderance rule relying purely on the incidence of disease in the general population, mass-tort plaintiffs cannot prevail unless the defendant exposed them to a so-called "doubled dose," which doubled their risk of injury.[144] Ruling on remand in the infamous Bendectin litigation, Judge Alex Kozinski explained:

Ervin Adam, Arthur L. Herbst & Elizabeth E. Hatch, *Cancer Risk in Men Exposed* In Utero *to Diethylstilbestrol*, 93 J. NAT'L CANCER INST. 545, 549–50 (2001) (finding no increased prevalence of many cancers, but unclear results for testicular cancer).

140. Chemicals; Toxic Chemical Release Reporting; Community Right-to-Know; Proposed Significant New Use Rule, 57 Fed. Reg. 41,020, 41,026 (Sept. 8, 1992) (to be codified at 40 C.F.R. pt. 372 & 721). For the DES plaintiffs, the infamous problem was not proving that DES caused their cancers, but proving *which particular defendant* sold the product that harmed them. Robinson, *supra* note 139, at 719.

141. *See, e.g.*, Tragarz v. Keene Corp., 980 F.2d 411, 417–18 (7th Cir. 1992) (rejecting the argument that the asbestos manufacturer did not cause the plaintiff's injury because "mesothelioma is extremely rare among persons not exposed to asbestos").

142. *See infra* Part III.B.

143. *See infra* Part III.C.

144. McMunn v. Babcock & Wilcox Power Generation Grp., Inc., No. 10-cv-143, 2014 WL 814878, at *1 (W.D. Pa. Feb. 27, 2014) (noting the Third Circuit requirement that exposure levels "exceeded the normal background level").

> [T]ort law requires plaintiffs to show not merely that Bendectin increased the likelihood of injury, but that it more likely than not caused *their* injuries. . . . Because the background rate of limb reduction defects is one per thousand births, plaintiffs must show that among children of mothers who took Bendectin the incidence of such defects was more than two per thousand.[145]

Judge Kozinski concluded that because the plaintiffs' causation experts could not provide evidence that Bendectin was the most likely cause of the plaintiffs' injuries, summary judgment was appropriate.[146] The plaintiffs fared only slightly better in the Agent Orange litigation, in which Judge Jack Weinstein found a settlement appropriate because, in part, no individual plaintiff could have proved at trial that his or her chances of developing cancer from the defoliant exceeded 50 percent.[147]

Two recent Tenth Circuit decisions ruling on public liability suits illustrate the ongoing problems associated with equating a preponderance standard with a 50 percent threshold. In *June v. Union Carbide Corp.*,[148] residents of a uranium- and vanadium-mining town in Colorado sued the former mill operators, alleging that the mills' operations caused their cancers and that the plaintiffs were likely to develop cancers in the future.[149] The plaintiffs relied on specific-causation experts who opined that airborne uranium and vanadium tailings would be "substantial factors" in the cancers if the tailings constituted at least 5 to 10 percent of the plaintiffs' total radiation exposure.[150] However, Colorado tort law, in line with the *Restatement (Second) of Torts*,[151] requires a "substantial factor" to be sufficient *on*

145. Daubert v. Merrell Dow Pharms., Inc., 43 F.3d 1311, 1320 (9th Cir. 1995) (citation omitted).

146. *Id.* at 1322.

147. *In re* Agent Orange Prod. Liab. Litig., 597 F. Supp. 740, 834 (E.D.N.Y. 1984) ("It is likely, however, that even if plaintiffs as a class could prove that they were injured by Agent Orange, no individual class member would be able to prove that his or her injuries were caused by Agent Orange. . . . The probability of specific cause would necessarily be less than 50% based upon the evidence submitted.").

148. June v. Union Carbide Corp., 577 F.3d 1234 (10th Cir. 2009).

149. *Id.* at 1236–37.

150. *Id.* at 1246.

151. RESTATEMENT (SECOND) OF TORTS § 432(2) (1965) ("If two forces are actively operating, one because of the actor's negligence . . . and each of itself sufficient to bring about harm to another, the actor's negligence may be found to be a substantial factor in bringing it about.").

its own to cause the injury.[152] Accordingly, the Tenth Circuit concluded that no individual in the class could demonstrate that the defendant's radiation specifically caused the individual's cancer.[153]

One year later, in an analogous uranium-mining case, *Wilcox v. Homestake Mining Co.*,[154] the plaintiffs' specific-causation expert alleged more substantial "assigned share" figures, stating that there was up to a 45 percent probability that the defendants' uranium mining caused the plaintiffs' cancers.[155] The Tenth Circuit, employing similar reasoning as in its *June* decision,[156] held that New Mexico law's "substantial factor" causation also required that the defendant's conduct be sufficient to cause plaintiffs' cancers on its own.[157] As in *June*, a 45 percent probability that the defendant caused the plaintiffs' injuries still fell short of satisfying the preponderance rule.[158]

Applying the preponderance rule in cases relying on epidemiological studies creates great difficulties for plaintiffs, who usually cannot prove that they were exposed to a "doubled dose" of radiation.[159] Even in heavily exposed populations, such as survivors who were within twenty-five-hundred meters of the Hiroshima and Nagasaki atomic-bomb blasts, the increased chance of developing solid tumors[160] was no more than 10 percent on average.[161] In contrast,

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152. *June*, 577 F.3d at 1244–45. The *Restatement (Third)* abandoned the "substantial factor" test because it tended to conflate the distinct factual-causation and proximate-causation analyses. RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM § 26 cmt. j (2000). But the *Restatement (Third)* still requires a factual cause of injury to be a "but-for" cause of the harm standing "alone." *Id.* at § 27; *June*, 577 F.3d at 1239 ("[T]he ultimate legal standards in the two Restatements are essentially identical for our purposes.").

153. *See June*, 577 F.3d at 1247 ("Plaintiffs . . . have never (not even in this court) contended that they have produced evidence that Uravan radiation was a necessary component of a causal set that probably would have caused the Plaintiffs' ailments.").

154. Wilcox v. Homestake Mining Co., 619 F.3d 1165 (10th Cir. 2010).

155. *Id.* at 1171 (Lucero, J., concurring in part).

156. *See id.* at 1170 n.2 (majority opinion) ("Although our opinion in *June* was based on Colorado law and we are applying New Mexico law in the instant case, we interpret New Mexico law to require the same showing of but-for causation that was required in *June*.").

157. *Id.* at 1170.

158. *Id.*

159. *See* PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 110 (noting that the chance that a cancer was caused by a fixed radiation exposure is "well below 50 percent even for exposures in the tens of rads range"); *cf.* David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 HARV. L. REV. 849, 858 (1983) ("The excess risk caused by exposure to a toxic agent frequently does not exceed the background risk . . . .").

160. A solid tumor, or solid cancer, is an "abnormal mass of tissue that usually does not contain cysts or liquid areas," as with sarcomas, carcinomas, or lymphomas. *Solid Tumor*, NAT'L

the maximum annual dose of radiation that a facility is permitted to discharge to a member of the public is extremely low.[162] Even at a one-time dose one hundred times the regulatory limit, the chance that a later-developed cancer is attributable to the event may be approximately one in forty-two.[163]

In single-plaintiff cases, a simple preponderance rule for radiation-related injuries can be justified. After all, if a line must be drawn somewhere, the 50 percent mark seems like a reasonable place to draw it: such a rule prevents recovery when the claimant's injury likely came from another source.[164] In a *class-action* suit for radiation-related injury, however, the preponderance rule no longer holds water. Assuming that the defendants have exposed the public to some degree of risk, the judge must decide not merely whether a plaintiff was harmed or not, but *how many* plaintiffs were harmed, and *who* those plaintiffs are. Given enough plaintiffs and a notable increase in cancer risk, it becomes virtually certain that some plaintiffs were harmed, though no particular plaintiff would ever prevail. Compare Judge Jack Weinstein's hypothetical in the Agent Orange Litigation:

CANCER INST., http://www.cancer.gov/dictionary?cdrid=45301 (last visited Oct. 16, 2014). Such cancers are contrasted with blood cancers like leukemia, which do not result in solid tumors.

161. *See Solid Cancer Risks Among Atomic-Bomb Survivors*, RADIATION EFFECTS RESEARCH FOUND., http://www.rerf.jp/radefx/late_e/cancrisk.html (last visited Oct. 16, 2014) ("For the average radiation exposure of survivors within 2,500 meters (about 0.2 Gy), the increase is about 10 percent above normal age-specific rates.").

162. *See* Dose Limits for Individual Members of the Public, 10 C.F.R. § 20.1301 (2013) (fixing the maximum annual radiation dose from a nuclear facility to a member of the public at 0.1 rem).

163. NAT'L RESEARCH COUNCIL, HEALTH RISKS FROM EXPOSURE TO LOW LEVELS OF IONIZING RADIATION, BEIR VII PHASE 2, at 7 (2006) (predicting that forty-two out of every one hundred people will be diagnosed with cancer, but that only one such cancer would result from a one-time exposure to 0.1 sievert of radiation above background levels). 0.1 sievert is one hundred times the accepted dose limit for members of the public in the United States. *See Radiation Term: Sievert (Sv)*, HEALTH PHYSICS SOC'Y, http://hps.org/publicinformation/radterms/radfact137.html (last updated Aug. 13, 2014) ("One sievert is equivalent to 100 rem.").

164. For example, the Energy Employees Occupational Illness Compensation Program creates a federal compensation fund that employs a 50 percent causation threshold for former DOE employees at nuclear-weapons-manufacturing and nuclear-weapons-testing facilities. *NIOSH Radiation Dose Reconstruction Program: Frequently Asked Questions*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/niosh/ocas/ocasfaqs.html (last updated Sept. 26, 2014). But members of "special exposure cohorts" with radiation-induced cancers at designated facilities receive compensation irrespective of the probability that the facility caused their cancers. *NIOSH Radiation Dose Reconstruction Program: Special Exposure Cohort,* CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/niosh/ocas/ocassec.html (last updated Sept. 26, 2014).

> Let us assume that there are 10 manufacturers and a population of 10 million persons exposed to their product. Assume that among this population 1,000 cancers of a certain type could be expected, but that 1,100 exist, and that this increase is "statistically significant," permitting a reasonable conclusion that 100 cancers are due to the product of the manufacturers. In the absence of other evidence, it might be argued that as to any one of the 1100 there is only a chance of about 9% (100/1100) that the product caused the cancer. Under traditional tort principles no plaintiff could recover.[165]

For torts on the scale of nuclear-reactor malfunctions—where the harm is inherently generic, lacks a signature, and bears a long latency period—the preponderance rule will generally severely undercompensate claimants.[166]

In the past, defendants have taken particular advantage of the low likelihood that any plaintiff's cancer has been caused by non-background sources. One defense strategy, adopted from similar mass-tort suits, has been to seek specific "pre-discovery" disclosures explaining each individual's theory of exposure.[167] These *Lone Pine* orders[168] may require plaintiffs to identify the precise radionuclides that caused their injuries, the biological pathways of exposure, individualized dose estimates, and scientific and medical evidence supporting the plaintiffs' exposure theory.[169] Plaintiffs argue that *Lone*

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165. *In re* Agent Orange Prod. Liab. Litig., 597 F. Supp. 740, 837 (E.D.N.Y. 1984).

166. *See* Rosenberg, *supra* note 159, at 881 ("In cases in which the probability of causation does not exceed fifty percent, the strong and weak versions of the rule both deny victims all recovery and thus unjustly enrich defendants. When the probability of causation exceeds fifty percent, the rule simply reverses the burden of inequity."). Of course, if the probability that the plaintiffs' cancers were caused by the defendant is just over 50 percent, the inequity is reversed: the defendant has caused only half of the plaintiffs' injuries, but will pay for all of them.

167. *See, e.g.*, Steering Comm. v. Exxon Mobil Corp., 461 F.3d 598, 604 n.2 (5th Cir. 2006) ("*Lone Pine* orders . . . are pre-discovery orders designed to handle the complex issues and potential burdens on defendants and the court in mass tort litigation by requiring plaintiffs to produce some evidence to support a credible claim."). In *Exxon Mobil*, the court affirmed a denial of class certification in a suit involving a chemical-plant fire because the plaintiffs' affidavits failed to show that formulaic calculations could be applied broadly enough to satisfy Federal Rule of Civil Procedure 23(b)(3)'s predominance and superiority requirements. *Id.* at 604–05.

168. The technique is named for its use in *Lore v. Lone Pine Corp.*, No. L-33606-85, 1986 WL 637507 (N.J. Super. Ct. Law. Div. Nov. 18, 1986). Such orders may require plaintiffs to present expert affidavits estimating the severity of their injuries. *Steering Comm.*, 461 F.3d at 604 n.2.

169. McMunn v. Babcock & Wilcox Power Generation Grp., Inc., 896 F. Supp. 2d 347, 350 (W.D. Pa. 2012); *see also* Acuna v. Brown & Root, Inc., 200 F.3d 335, 340–41 (5th Cir. 2000) (affirming a grant of summary judgment because 1600 plaintiffs in a PAA suit failed to present

Pine orders force them to proffer information reserved for discovery at the pleading stage,[170] whereas defendants claim that detailed exposure information should be considered essential to bringing a PAA claim in the first place.[171]

C. The Preponderance Rule and Individualistic Evidence

Rather than relying solely on statistical evidence, some courts appear to operate under the belief that jurors, endowed with an ability approaching divination, can identify whether and which individuals were harmed by their exposures to the defendants' radioactive emissions. In such suits, Plaintiff A might be able to prove causation by a preponderance of the evidence with a doctor's testimony that a "differential diagnosis" eliminates all alternative sources of cancer.[172] That is, Plaintiff A could prevail by demonstrating to the jury that he *was* the improbable individual whose cancer was caused by the defendant.[173] For example, in the Hanford Nuclear Reservation cases, in which the Ninth Circuit addressed whether Washington residents were exposed to radionuclides emitted from the world's first large-scale plutonium-manufacturing facility,[174] the court concluded that it was inappropriate for the trial court to require statistical proof of a greater-than-50-percent probability of causation because certain "individualized factors, such as heredity . . . might raise the likelihood of contraction of cancer at lower levels of exposure."[175] The court suggested that although epidemiological statistics from exposed populations might

adequate, individualized information regarding the nature, circumstances, and attribution of their injuries).

170. *See, e.g.*, *Acuna*, 200 F.3d at 340 ("Plaintiffs contend that the pre-discovery orders requiring expert support for the details of each plaintiff's claim imposed too high a burden for that stage of litigation.").

171. *See id.* at 340–41 ("The scheduling orders issued below essentially required that information which plaintiffs should have had before filing their claims pursuant to Fed. R. Civ. P. 11(b)(3).").

172. *See* Hall v. Babcock & Wilcox Co., 69 F. Supp. 2d 716, 721 (W.D. Pa. 1999) ("Differential diagnosis is a methodology used to determine causation of a disease suffered by an individual, based on efforts to consider and exclude all possible alternate causes.").

173. *See, e.g.*, *id.* (permitting plaintiffs' experts to prove specific causation by ruling out alternate causes through differential diagnosis in spite of defendants' objections that no specific radiation doses were alleged).

174. *In re* Hanford Nuclear Reservation Litig., 292 F.3d 1124, 1126–28 (9th Cir. 2002).

175. *Id.* at 1137. The Ninth Circuit also ruled that the lower court had erred by addressing the question of epidemiology statistics at the general-causation phase rather than at the specific-causation phase. *Id.* at 1134–35.

be insufficient to demonstrate that the defendants caused plaintiffs' cancers, individualized forms of proof could conclusively demonstrate that the defendants caused certain instances of plaintiffs' cancers but not others.[176]

Arguably, some jurors may find a doctor's specific testimony about the source of a plaintiff's cancer to be persuasive. Furthermore, they may have greater confidence in the resulting judicial decision because they perceive that the judicial system's role is to determine conclusively whether a defendant is the legal cause of a plaintiff's injury.[177] Expectations of certainty from simpler tort cases, such as car accidents, may carry over into the mass-tort realm, particularly when ensconced in the confidence of a medical professional.[178] The notion that a doctor can conclusively attribute a cancer to a particular cause through differential diagnosis, however, has been soundly debunked.[179] In public liability suits, clinical assessments are helpful only in the sense that they inform the statistical likelihood that plaintiffs contracted cancer from a particular source. As the Third Circuit observed in the TMI cases:

> [M]edical evaluation, by itself, can neither prove nor disprove that a specific malignancy was caused by a specific radiation exposure. Therefore, the primary basis to link specific cancers with specific radiation exposures is data that has been collected regarding the increased frequency of malignancies following exposure to ionizing radiation. In other words, causation can only be established (if at all)

176. *See In re* Berg Litig., 293 F.3d 1127, 1130 (9th Cir. 2002) (citing cases from various circuits employing non-epidemiological evidence to establish causation). *Berg* was decided the same day as *Hanford*, and consisted of claims by plaintiffs severed from its companion case. *Id.* at 1129.

177. *See* Rosenberg, *supra* note 159, at 873 (hypothesizing that courts' demands for particularized evidence might "buttress the system's legitimacy by promoting a public perception that verdicts are based on more than probabilities" and "reinforce the image of a neutral, nonpolitical, and nonredistributional system").

178. *See id.* at 872 (suggesting that the preference for individualized rather than broader statistical evidence indicates courts' "desire that judgments in mass tort cases rest upon a higher degree of certainty about the causal connection than they normally do in sporadic accident cases").

179. *See id.* at 869 ("The short answer to the demand for 'particularistic' evidence of causation in mass exposure cases is that no such evidence can be produced."); *id.* at 870 ("The concept of 'particularistic' evidence suggests that there exists a form of proof that can provide direct and actual knowledge of the causal relationship between the defendant's tortious conduct and the plaintiff's injury. 'Particularistic' evidence, however, is in fact no less probabilistic than is the statistical evidence that courts purport to shun . . . .").

> from epidemiological studies of populations exposed to ionizing radiation.[180]

Radiation-protection scientists are in agreement that differential diagnosis cannot confidently identify the ultimate source of a plaintiff's cancer. For example, the National Council on Radiation Protection and Measurements (NCRP)[181] has concluded that

> [i]n the absence of biological markers of radiation it is generally not possible to make [a causation] determination with a high level of confidence since cancers may, and do, occur in the absence of exposure to a particular carcinogen of interest, including ionizing radiation, and, conversely, may and do fail to occur in the presence of exposure.[182]

The Committee on Biological Effects of Ionizing Radiation (BEIR)[183] similarly recommends the use of purely statistical, probability-of-causation assessments.[184] Combined publications of the International Atomic Energy Agency (IAEA)[185] and the World Health Organization (WHO) recommend probabilistic models for identifying causes of radiation exposure.[186] The probability-of-causation approach is also consistent with the Federal Judicial Center's *Reference Manual on Scientific Evidence*,[187] subject to certain

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180. *In re* TMI Litig., 193 F.3d 613, 643 (3d Cir. 1999) (citations omitted).

181. The NCRP is a private radiation-protection and health-science organization chartered by Congress in 1964. *About NCRP*, NAT'L COUNCIL ON RADIATION PROT. & MEASUREMENTS, http://www.ncrponline.org/AboutNCRP/About_NCRP.html (last visited Oct. 16, 2014).

182. NAT'L COUNCIL ON RADIATION PROT. & MEASUREMENTS, NCRP REPORT NO. 171: UNCERTAINTIES IN THE ESTIMATION OF RADIATION RISKS AND PROBABILITY OF DISEASE CAUSATION 194 (2012).

183. BEIR is a committee of the United States National Research Council that provides information to the government regarding the effects of ionizing radiation. NAT'L RESEARCH COUNCIL, *supra* note 163, at vii.

184. *Id.* at 265.

185. The IAEA is an independent international organization affiliated with the United Nations that fosters cooperation in the nuclear field. *About the IAEA: The "Atoms for Peace Agency*," INT'L ATOMIC ENERGY AGENCY, http://www.iaea.org/About/about-iaea.html (last visited Oct. 16, 2014).

186. INT'L ATOMIC ENERGY AGENCY, APPROACHES TO ATTRIBUTION OF DETRIMENTAL HEALTH EFFECTS TO OCCUPATIONAL IONIZING RADIATION EXPOSURE AND THEIR APPLICATION IN COMPENSATION PROGRAMMES FOR CANCER 11 (2010).

187. *See* Michael D. Green, D. Michal Freedman & Leon Gordis, Reference Guide on Epidemiology, *in* REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 549, 611–16 (3d ed. 2011) (describing the role of epidemiological evidence in the courtroom).

caveats.[188] The Presidential Commission on Catastrophic Nuclear Accidents, established to make recommendations for improving the PAA's compensation methodology for a large-scale nuclear event,[189] considered the probability-of-causation approach "the best available proxy for direct proof of . . . causation."[190]

Ultimately, permitting reliance on differential diagnoses artificially strengthens those cases in which plaintiffs lack the epidemiological evidence necessary to demonstrate that the defendant's emissions created a measurably increased risk of harm. For example, in the TMI litigation, the cost of adjudicating and settling plaintiffs' claims for economic and physical injuries exceeded $70 million,[191] though the President's Commission on the Accident at Three Mile Island concluded that no civilian radiation exposures were expected to have any health effects.[192] In *Cook v. Rockwell International Corp.*,[193] a jury awarded nearly $1 billion in punitive and compensatory damages[194] on the basis of evidence that radionuclide releases from a government-operated nuclear-weapons plant posed a "small and unquantifiable" risk of harm.[195] Overall, permitting public liability suits under the PAA to proceed on the theory that a jury can identify who has and who has not been harmed is not only unscientific, but poses a serious danger to the viability of the nuclear-power industry after a significant incident.

IV. MODERNIZING CAUSATION IN PUBLIC LIABILITY SUITS

This Note proposes that the failings of traditional preponderance rules require changes to the substantive law governing radiation-injury torts under the PAA. Although other proposals may be imagined, torts scholars and governmental agencies addressing

188. The use of epidemiological evidence is subject to factors such as the validity of the study, similarity between the studied group and the plaintiff, whether exposure accelerates pre-existing conditions, and whether the toxic agent operates independently of other causes. *Id.* at 612–15.

189. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 1.

190. *Id.* at 101.

191. *The Price-Anderson Act: Background Information*, AM. NUCLEAR SOC'Y 3 (2005), *available at* http://www.ans.org/pi/ps/docs/ps54-bi.pdf.

192. *See* KEMENY ET AL., *supra* note 75, at 12, 34 (finding that the expected increase in cancer rates will be either zero or undetectable).

193. Cook v. Rockwell Int'l Corp., 618 F.3d 1127 (10th Cir. 2010).

194. COOK V. ROCKWELL INT'L CORP., *supra* note 93, at 1.

195. *Cook*, 618 F.3d at 1134.

analogous issues in the context of other mass torts have often focused on one of two potential solutions: subsuming the tort claims into an administrative framework or modifying the burden of proof required for an actionable injury.

A. Conversion to an Administrative Process

To resolve the cost, complexity, and unfairness of using traditional tort principles in mass-tort cases, some scholars advocate a transition to administrative compensation regimes.[196] Given that the court-applied law of causation is more amenable to simple, two-party torts, proposals to shift to administrative compensation regimes suggest that mass torts would benefit from the simplicity and speed associated with successful twentieth-century policies such as workers' compensation and no-fault insurance.[197] Such an approach is especially applicable to judges and juries hard-pressed for the time and understanding necessary to absorb scientific doctrines regarding the cause of an injury[198] or the intricacies of nuclear-power regulation.[199] In theory, cases that require comprehension of complex radiological principles might be better resolved by an administrative system than by a legal factfinder.[200]

In the past, administrative schemes created for compensating the victims of the September 11 attacks, children harmed by defective

196. *See generally* Betsy J. Grey, *Homeland Security and Federal Relief: A Proposal for a Permanent Compensation System for Domestic Terrorist Victims*, 9 N.Y.U. J. LEGIS. & PUB. POL'Y 663 (2006) (proposing a permanent, no-fault compensation scheme for domestic victims of terrorist attacks); Jon D. Hanson, Kyle D. Logue & Michael S. Zamore, *Smokers' Compensation: Toward a Blueprint for Federal Regulation of Cigarette Manufacturers*, 22 S. ILL. U. L.J. 519 (1998) (suggesting a national "Smokers' Compensation" fund); Linda S. Mullenix & Kristen B. Stewart, *The September 11th Victim Compensation Fund: Fund Approaches to Resolving Mass Tort Litigation*, 9 CONN. INS. L.J. 121 (2002) (contrasting the idiosyncrasies of the September 11th fund with those of other major administrative regimes and suggesting that effective compensation systems are highly tort-specific); Rabin, *supra* note 102 (addressing issues that would arise in creating an administrative compensation scheme for all mass torts).

197. Rabin, *supra* note 102, at 970.

198. *See* Rosenberg, *supra* note 159, at 926 ("Given that judges usually lack expertise in using and evaluating scientific information, their retention of the preponderance rule . . . in mass exposure cases raising complex medical and epidemiological issues may be a subtle admission of institutional incompetence.").

199. *Cf.* Yellin, *supra* note 22, at 494–97 (arguing for scientific experts to review nuclear-power regulations because "[n]uclear power cases . . . involve risks flowing from a technology whose environmental implications are not yet fully understood, thus raising matters of technological and scientific prediction with which the judiciary has generally been uncomfortable").

200. *Id.*

vaccines, and injured dockworkers have successfully accelerated recovery for nationwide incidents that might otherwise have languished in the court system for years.[201] The mass torts that would most benefit from an administrative compensation regime tend to share characteristics making them amenable to nonjudicial resolution. Often, such mass torts result from a single discrete, compensable event, involve a large number of plaintiffs who bear a similar injury, and are easily traceable to the defendant in question.[202]

Another argument in favor of an administrative compensation regime for injuries sustained as the result of nuclear-power production is that Congress has already evinced a preference for supporting employees at nuclear facilities through similar compensation funds. For example, the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)[203] created a no-fault compensation fund for DOE employees engaged in weapons production and testing.[204] Former employees receive $150,000 and medical benefits if the National Institute for Occupational Safety and Health (NIOSH) determines that their cancers are "at least as likely as not" due to the employee's occupational exposure.[205] For "[s]pecial [e]xposure [c]ohort[s]" at certain facilities, it is unnecessary to prove causation at all.[206] Similarly, the Radiation Exposure Compensation Act of 1990 (RECA)[207] establishes an administrative process for compensating those formerly employed in uranium mines and those present onsite or downwind of nuclear-test sites.[208] RECA provides a cheap and efficient alternative to litigation, rendering proof of causation

201. Mullenix, *supra* note 196, at 123–38, 141–43.

202. Rabin, *supra* note 102, at 964–65.

203. Energy Employees Occupational Illness Compensation Act of 2000, Pub. L. No. 106-398, 114 Stat. 1654 (codified at 42 U.S.C. §§ 7384–7385s-15).

204. *Radiation Dose Reconstruction: Frequently Asked Questions (FAQs), The Act (EEOICPA)*, NAT'L INST. FOR OCCUPATIONAL SAFETY & HEALTH, http://www.cdc.gov/niosh/ocas/faqsact.html (last updated May 11, 2010).

205. *Id.*

206. JOSEPH FALCO, ENERGY EMPLOYEES OCCUPATIONAL ILLNESS COMPENSATION PROGRAM (EEOICPA) 7 (2011), *available at* http://www.bnl.gov/community/cac/docs/CAC_11_11_Falco.pdf.

207. Radiation Exposure Compensation Act of 1990, 42 U.S.C. § 2210 note (2012).

208. *Id.* § 2210 note (establishing a trust fund as well as an administrative-claims-submission process with judicial review in the district courts); *see* U.S. GEN. ACCOUNTING OFFICE, RADIATION EXPOSURE COMPENSATION: ACCOUNT OF JUSTICE'S PROGRAM ADMINISTRATION, at 4 (2001), *available at* http://www.gao.gov/assets/240/232669.pdf.

unnecessary, and requiring instead that an individual be shown to have worked or resided in a designated area.[209]

In 1990, the Presidential Commission explicitly considered whether administrative procedures might be superior to judicial processes in compensating claimants in the event of a major nuclear incident.[210] The committee found several benefits to adopting administrative procedures, including that an agency-administered scheme would accelerate compensation, conserve judicial resources, and limit the use of experts to resolving technical questions of nuclear science and medicine.[211] This approach would avoid repeated deliberations over the same scientific questions across jurisdictions, and its scope could be expanded or constricted as necessary.[212] Indeed, the PAA already bears certain characteristics of such an administrative mechanism,[213] permitting a no-fault approach in the event of an ENO,[214] and distributing compensation from a shared, but limited, insurance pool.[215]

However, in line with the findings of the Presidential Commission, it is difficult to conclude that enacting a rigid administrative compensation scheme under the PAA would be wise. Concerned citizens, a nuclear-industry lobbyist, a prominent torts scholar, and a major judicial figure in the history of mass-tort litigation all advised the Presidential Commission that the lack of public accountability and visibility inherent in any administrative mechanism would strain its credibility in the event of a major nuclear incident.[216] In contrast, judicial procedures endow litigants with their "day in court," and can be flexibly adapted to the unique

209. *Radiation Exposure Compensation Act (RECA)*, U.S. DEP'T OF JUSTICE, http://www.justice.gov/civil/common/reca.html (last visited Oct. 16, 2014).

210. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 34.

211. *Id.* at 34–35.

212. *Id.* at 35.

213. Rabin, *supra* note 102, at 955–58.

214. *See* 42 U.S.C. § 2210(n)(1) (2006) (authorizing indemnity agreements requiring nuclear operators to waive "any issue or defense" relating to their conduct or fault in the event of an "extraordinary nuclear occurrence").

215. *See id.* § 2210(a) (requiring the purchase of primary and secondary financial protection from a nuclear insurer).

216. *See* PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 35 nn.9–10 (recording the testimony of Public Citizen Congress Watch representative Pamela Gilbert, lobbyist Daniel Berger, Professor Robert Rabin, and Judge Jack Weinstein).

circumstances giving rise to a nuclear incident.[217] Even if an administrative mechanism would be appropriate, it is unclear whether it would be constitutional[218]—for example, it might violate injured plaintiffs' Seventh Amendment right to a jury trial.[219] Ultimately, the characteristics that render certain mass torts suitable for administrative compensation are absent from radiation-related injuries, which vary significantly in form, may derive from non-tortious sources, and are difficult to trace to a particular defendant.[220]

B. Judicial Procedures Utilizing "Risk-Based" Causation

Recognizing the distorting effect of traditional notions of causation, some scholars recommend continued judicial involvement in mass-tort suits, but suggest that the preponderance rule should be replaced with a "proportional liability" approach.[221] Rather than fully compensating all plaintiffs with a greater-than-50-percent chance of proving causation and offering no compensation below that threshold, a proportional liability rule compensates plaintiffs in direct proportion to the excess risk of injury imposed by the defendant's activities.[222] Such a rule appears particularly well suited for public liability cases, in which the ultimate "identity" of an injury is

217. *Id.* at 36.

218. The PAA previously survived due-process and equal-protection challenges when its compensation limits were found not to be arbitrary or irrational, but rather a "classic example of an economic regulation" designed to incentivize growth in the nuclear industry. Duke Power Co. v. Carolina Envtl. Study Grp., Inc., 438 U.S. 59, 83 (1978).

219. *See* Granfinanciera, S.A. v. Nordberg, 492 U.S. 33, 51 (1989) ("Congress' power to block application of the Seventh Amendment to a cause of action has limits. Congress may only deny trials by jury in actions at law, we said, in cases where 'public rights' are litigated: . . . *e.g.*, where the Government is involved in its sovereign capacity under an otherwise valid statute creating enforceable public rights.").

220. *See supra* note 202 and accompanying text.

221. *See, e.g.*, Samuel D. Estep, *Radiation Injuries and Statistics: The Need for a New Approach to Injury Litigation*, 59 MICH. L. REV. 259, 281 (1960) (proposing a contribution to a "contingent injury fund" in proportion to the increased risk of latent diseases from radiation exposure); Rosenberg, *supra* note 159, at 859 (advocating the use of aggregative judicial procedures and proportional liability in mass-tort cases); Steven Shavell, *Uncertainty over Causation and the Determination of Civil Liability*, 28 J.L. & ECON. 587, 589 (1985) (arguing that imposing liability in proportion to the probability of causation encourages desirable social behavior).

222. Rosenberg, *supra* note 159, at 859.

biologically inseparable from the increased risk caused by the defendant.[223]

The aims of the tort system are better served by tying damages in public liability suits to the proportional-liability standard. From a rights-based perspective, compensation should seek to provide "corrective justice" to plaintiffs by protecting their entitlements from violations by others.[224] Because the tort system normally provides only retrospective compensation, monetary damages are equivalent to a forced sale of the claimants' entitlements.[225] By contrast, tying recovery to an individual's increased risk of harm provides a *contemporary* measurement of the damage imposed by defendants, and would even permit courts to intervene before a claimant suffers bodily injury.[226] In terms of maximizing utility, the proportional-liability rule deters defendants to the degree of increased risk of harm they impose on the public.[227] Although the proportional-liability rule breaks with tradition by compensating for *risk* rather than *injury*, the approach not only parallels the total damages imposed on plaintiffs by increased cancer incidence, but lowers the defendant's risk of a disproportionately large judgment by preventing plaintiffs from being overcompensated—as they may be under the current system of all-or-nothing judgments.[228]

A proportional-liability rule would address plaintiffs' chances of developing cancer by imposing costs based on their total increase in risk, even in the absence of conclusive proof of specific causation.[229] Although such an approach provides a more accurate assessment of the defendant's fault,[230] any implementation that compensates

223. *See* Estep, *supra* note 221, at 269 (observing that radiation is not amenable to "normal proof rules" because it "only increases the incidence of such injuries in an exposed group"); *id.* at 281 (proposing proportional liability for radiation-related injuries).

224. Rosenberg, *supra* note 159, at 877.

225. *Id.* at 878.

226. For a discussion of measures that might eliminate or mitigate harm to plaintiffs' entitlements before cancer develops, see *infra* notes 262–64 and accompanying text.

227. *See* Rosenberg, *supra* note 159, at 883–84 ("Unlike the preponderance rule, proportional liability never holds a defendant responsible for more or less than the loss the defendant wrongfully caused.").

228. Because proportional-liability regimes may hold a defendant liable for all degrees of increased risk, other limitations—such as a minimum risk-of-injury threshold or fault standard—are necessary to prevent suit by all individuals with a marginally increased chance of being harmed. *See infra* Part V.

229. *In re* Agent Orange Prod. Liab. Litig., 597 F. Supp. 740, 837 (E.D.N.Y. 1984).

230. *See* Rosenberg, *supra* note 159, at 884 ("Because it represents an actuarial average, the excess risk accurately expresses the peril to the entire population . . . .").

individual plaintiffs for increased risk could also increase the attendant transaction costs of litigation by incentivizing suits that would otherwise not be brought, awarding compensation to parties exposed to negligibly increased risks of harm.[231] To prevent low-risk plaintiffs from receiving a windfall, practical implementations of proportional liability would require reducing a plaintiff's total recovery as the probability that the defendant caused his cancer decreases and possibly aggregating his recovery with that of other plaintiffs to fund socially beneficial programs.[232]

Moreover, proportional liability is not merely a theoretical construct, but a causation methodology with existing support from the judiciary and the Presidential Commission. For example, in assessing the fairness of the famous Agent Orange Settlement, Judge Jack Weinstein recommended applying proportional liability to avoid denying recovery class wide when statistical evidence indicated that some of the plaintiffs' injuries must have been caused by the defendants.[233] In 1990, the Presidential Commission specifically recommended that Congress amend the PAA to implement proportional liability.[234] The Presidential Commission proposed that public liability suits would first trigger offsite assessments of the estimated radiation doses to which the public was allegedly exposed.[235] Plaintiffs would then be fully compensated if the

231. *See id.* at 866 n.65 ("As long as liability remains an all-or-nothing proposition, lowering the threshold can only exacerbate the danger of overdeterrence.").

232. *See Agent Orange*, 597 F. Supp. at 837 (suggesting 9 percent of the amount of full compensation is owed for a 9 percent increase in the risk of injury); PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 107–08 (rejecting a proposal to provide some compensation to all cancer claimants in favor of compensating only those claims with sufficiently high likelihoods of causation, and paying lesser amounts to claims with relatively lower likelihoods of causation). For a discussion of the purpose of cumulating plaintiffs' recoveries, see *infra* notes 262–66.

233. *See Agent Orange*, 597 F. Supp. at 837–38, 842 (offering a solution in a class action to try all of the plaintiffs' claims together and hold the defendant "liable to each exposed plaintiff for a pro rata share of that plaintiff's injuries").

234. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 101.

235. *Id.* at 103. Because "dose reconstruction" assessments occur during discovery, they are generally factual contests between plaintiffs' and defendants' experts regarding each claimant's total exposure. *See, e.g.*, McMunn v. Babcock & Wilcox Power Generation Grp., Inc., 896 F. Supp. 2d 347, 365 (W.D. Pa. 2012) (granting a *Daubert* motion to exclude plaintiffs' dose-reconstruction expert); *In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 997–98, 1014 (9th Cir. 2008) (noting that the DOE's "Dose Reconstruction Project" to assess the total radiation exposure surrounding Hanford might have been "biased" by the litigation, but that plaintiffs stipulated to its accuracy). A better approach might be to require both parties to

probability that their cancers were caused by the incident exceeded 50 percent, and compensated at diminishing amounts down to a floor of 20 percent, below which no compensation would be due.[236] Among other reasons, the Presidential Commission considered a proportional-liability rule appealing because it had already funded epidemiological "summary tables" used to assess the excess risk attributable to specific levels of radiation exposure.[237] Today, NIOSH still maintains web-based variants of these tables to calculate the likely increased risk of developing cancer for DOE employees and contractors exposed to varying levels of radiation.[238]

Although recovery in direct proportion to increased risk provides a more accurate measure of a defendant's liability than the preponderance rule, the effectiveness of compensating for "risk" rather than "injury" can be reduced by two opposing litigation strategies.[239] First, if fewer than all exposed plaintiffs sue, proportional liability will not adequately deter nuclear licensees.[240] Defendants pay no more in damages when unmeritorious plaintiffs bring claims, yet

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comply with the assessment of a neutral third party, subject to independent oversight. *See* COMM. ON AN ASSESSMENT OF CDC RADIATION STUDIES, NAT'L RESEARCH COUNCIL, A REVIEW OF THE RADIOLOGICAL ASSESSMENTS CORPORATION'S FERNALD DOSE RECONSTRUCTION REPORT (1997) (disclosing the National Research Council's review of dose assessments performed by a private third-party corporation pursuant to a memorandum of understanding signed by the defendant DOE).

236. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 108. Although the Commission also advanced a proposal to fully compensate nearby cancer claimants who could show an increased risk of injury of 20 percent or more, it felt that the proposal suffered from the same flaws as the undesirable alternative of full compensation to all nearby cancer claimants. *Id.* at 107–08.

237. *Id.* at 109.

238. *See Interactive Radioepidemiological Computer Program (ICRP)*, NAT'L CANCER INST., http://dceg.cancer.gov/tools/analysis/ircp (last visited Oct. 16, 2014).

239. *See, e.g.*, Rosenberg, *supra* note 159, at 881 (observing that proportional liability radically alters traditional causation rules and may confer windfalls on uninjured plaintiffs). For a criticism of the proportional-liability approach from the era of the Presidential Commission's proposal, see generally Louis A. Cox, Jr. & Joseph R. Fiksel, *A Critical Review of the Probability of Causation Method*, *in* THE PRICE-ANDERSON LAW: REPORTS ON PRICE-ANDERSON ISSUES (ANI/MAELU ed., 1985).

240. *See* Rosenberg, *supra* note 159, at 919 (emphasizing that the long latency period from exposure to injury leads disease victims to sue at different times, which may "substantially frustrate the system's deterrence and compensation objectives"). Deterrence could also be achieved by plaintiffs seeking punitive damages, which are permitted by the PAA if authorized by state law, Silkwood v. Kerr-McGee Corp., 464 U.S. 238, 258–59 (1984), as long as the government is not required to indemnify the defendant, 42 U.S.C. § 2210(s) (2012). But punitive damages, aimed exclusively at "retribution and deterrence," may—subject to due-process limitations—exceed and therefore overcompensate plaintiffs for merely potential injuries. State Farm Mut. Auto. Ins. Co. v. Campbell, 538 U.S. 408, 416–17 (2003).

they inevitably pay *less* in damages if some class of exposed claimants—such as those who have not yet developed cancer—fails to sue.[241] Second, without some minimum standard of exposure below which plaintiffs cannot sue, enterprising attorneys may be incentivized to bring large class actions consisting of plaintiffs with de minimis exposure in order to vex defendants or extract a settlement.[242] Thus, although proportional-liability theory is sound, one important consideration is whether the PAA can accommodate any changes necessary to ensure its success in practice.

V. IMPLEMENTING PROPORTIONAL LIABILITY: ROADBLOCKS AND SOLUTIONS

Since their inception, public liability suits have relied on the traditional preponderance rule of causation taken from state tort law.[243] Because the PAA was enacted and amended with this limitation in mind, two changes may be required to address the practical success of a proportional-liability rule. First, in order to impose sufficient deterrence costs on defendants, plaintiffs must be able to sue for their increased risk of injury *before* they develop cancer. Consistent application of this rule would require resolution of an ongoing dispute in the federal courts of appeals regarding the availability in public liability suits of medical-monitoring claims, which can be cast as "future" injuries. Second, in order to avoid excessive costs to defendants, a minimum exposure threshold must be set below which plaintiffs cannot sue. Although such a threshold currently exists in the form of NRC-created exposure regulations for the public, such regulations are not always binding in PAA suits, and in any event, are set significantly below levels at which increased cancer rates would be expected.

241. *See* Rosenberg, *supra* note 159, at 884–85 ("The proportionality rule simply holds the defendant liable for no more (and no less) than the disease losses it has caused in the 'body' of the exposed population. The defendant never overpays, and the population as a whole gains no windfall."). For a discussion of how courts might permit each party subjected to excess risk to sue by allowing claims for "future" injuries, see *infra* Part V.A.

242. *See id.* at 892 (raising, but rejecting, concerns that endorsing a proportional-liability rule "would enable mass exposure suits to enter the system in far greater numbers and flood the courts with petty and spurious claims"). For a discussion of how to prevent overdeterring defendants in suits for low-level emissions, see *infra* Part V.B.

243. *See supra* Part I.B.

A. *Imposing Sufficient Deterrence Costs on Defendants: Permitting Suit for Future Injuries*

Compensating only those plaintiffs who have developed cancer does not address the risk that others in the community will develop cancer in the future.[244] To prevent public liability cases from systematically undercompensating those harmed by the nuclear-power-production industry, it must be possible for all individuals likely to be harmed to be able to sue before their harms are realized. In previous cases, public liability claimants have explored the possibility of recovering for their increased risk of contracting cancer by classifying their injuries as subcellular damage,[245] emotional distress,[246] or an ongoing need for medical monitoring.[247]

At the moment, federal courts diverge on whether public liability suits permit awards for radiation exposure alone. Although Congress did not use phrases such as "medical monitoring" or "cellular damage," the PAA appears to limit plaintiffs to suing for property damage and "bodily injury."[248] Generally, claims for increased risks of harm were not compensated at common law,[249] and courts have tended to interpret the PAA's "bodily injury" language as a sign that Congress also intended to prohibit suits for personal injury until the onset of cancers.[250] Although other courts have concluded that

244. *See supra* note 240 and accompanying text.

245. *Compare* Dumontier v. Schlumberger Tech. Corp., 543 F.3d 567, 569–71 (9th Cir. 2008) (denying that subcellular damage is a redressable harm under the PAA), *with* Rainer v. Union Carbide Corp., 402 F.3d 608, 618, 622 (6th Cir. 2005) (concluding that the PAA defers the issue of recovery for subcellular damage to state law, and that Kentucky law precludes recovery).

246. *Compare* Golden v. CH2M Hill Hanford Grp., Inc., 528 F.3d 681, 683–84 (9th Cir. 2008) (holding that recovery for emotional-distress claims in the absence of physical injury is inconsistent with the PAA), *with* Wilcox v. Homestake Mining Co., 401 F. Supp. 2d 1196, 1200 (D.N.M. 2005) (holding that recovery for emotional-distress claims is not inconsistent with the PAA).

247. *Compare In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 1009–10 (9th Cir. 2008) (holding that recovery for medical-monitoring claims in the absence of physical injury is inconsistent with the PAA), *with* Dodge v. Cotter Corp., 328 F.3d 1212, 1218 (10th Cir. 2003) (implicitly permitting medical-monitoring claims to proceed).

248. *See* 42 U.S.C. § 2014(q) (2012) (defining a "nuclear incident" as an event that causes "bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property" as a result of radioactive materials).

249. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 88.

250. *See, e.g.*, *In re* Berg Litig., 293 F.3d 1127, 1132–33 (9th Cir. 2002) (holding that, in terms of recovery for increased risk of harm, medical-monitoring claims are equivalent to noncompensable claims for "emotional distress"); June v. Union Carbide Corp., 577 F.3d 1234,

radiation exposure itself can constitute an injury under the PAA,[251] substantive state law often bars recovery. For example, in *Rainer v. Union Carbide Corp.*,[252] the Sixth Circuit held that the PAA's "bodily injury" requirement did not preclude recovery for increased risk of harm, but observed that Kentucky state law precludes plaintiffs' claims absent a showing of present physical injury.[253] Accordingly, any proportional-liability regime that relies on claimants to sue for increased risk of injury would, at the moment, be subject to two-fold uncertainty: fractured opinions interpreting the PAA in the federal judiciary,[254] accompanied by wide divergence in tort law across the states.[255]

To surmount this legal uncertainty, the PAA should be amended to permit broader recovery for radiation-related increases in cancer risk.[256] Permitting suit by all parties exposed to increased risk of harm

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1248 (10th Cir. 2009) (dismissing medical-monitoring claims "because they do not assert a 'bodily injury,' as required for jurisdiction under the Price-Anderson Act").

251. *See, e.g.*, Day v. NLO, Inc., 851 F. Supp. 869, 881 (S.D. Ohio 1994) (deeming medical-monitoring claims appropriate with an adequate showing of increased risk of injury); *cf.* Dodge v. Cotter Corp., 203 F.3d 1190, 1192 (10th Cir. 2000) (implicitly permitting medical-monitoring claims to proceed). The Fifth Circuit recently found that because the "bodily injury" language is used to define a "nuclear incident," the PAA should not be read to prohibit recovery for other injuries once an underlying nuclear incident has been demonstrated. Cotroneo v. Shaw Env't & Infrastructure, Inc., 639 F.3d 186, 198 (5th Cir. 2011). The court "respectfully disagree[d]" that nonlisted harms like medical monitoring were necessarily excluded. *Id.* at 199 n.15.

252. Rainer v. Union Carbide Corp., 402 F.3d 608 (6th Cir. 2005).

253. *Id.* at 618–22. By contrast, the Ninth Circuit does not consider the meaning of the "bodily injury" requirement to be fodder for state law. *See* Dumontier v. Schlumberger Tech. Corp., 543 F.3d 567, 570 (9th Cir. 2008) ("Unlike the Sixth Circuit, we have never relied on state law to interpret bodily injury. . . . The Act doesn't call for us to apply state law in its *interpretation* . . . .").

254. *See* Nathan White, Note, *Arguments Not Raised: How the Plaintiffs' Missed Opportunity Led to the Tenth Circuit's Decision in* June v. Union Carbide Corp., 2011 BYU L. REV. 245, 250–57 (detailing the circuit split over recovery for medical-monitoring claims under the PAA). Judges also disagree over whether the "bodily injury" requirement is substantive or merely jurisdictional. *Compare Cotroneo*, 639 F.3d at 200 (Dennis, J., dissenting in part) (noting that the "bodily injury" requirement is a threshold jurisdictional question), *with In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 1009–10 (9th Cir. 2008) (holding that personal-injury claims in the absence of bodily injury necessarily fail to state a claim).

255. *See supra* note 253. A Sixth Circuit PAA plaintiff may sue for medical monitoring in the absence of physical injury in Ohio, but not in Michigan or Kentucky. *See* D. Scott Aberson, Note, *A Fifty-State Survey of Medical Monitoring and the Approach the Minnesota Supreme Court Should Take when Confronted with the Issue*, 32 WM. MITCHELL L. REV. 1095, 1114–16 (2012) (undertaking a fifty-state survey of medical-monitoring law).

256. *See* PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 57 (recommending that the Presidential Commission's changes to the PAA be enacted into law because judicial application of the same principles could be unconstitutional or inconsistent).

would not only provide a more precise and more predictable means of addressing the social harm caused by the nuclear industry,[257] but would reduce the costs incurred by all parties. Under current law, public liability suits are purely ex post remedies, forcing defendants to wait through an unpredictable latency period before plaintiffs may bring suit.[258] In the meantime, the responsibility for seeking cancer screening or treatment is left to unidentifiable and unaware claimants, who may suffer much greater injuries as a result. But if an entire community exposed to radiation has standing to sue, plaintiffs can secure, ex ante, the benefits of prepaid cancer screenings and prophylactic care.[259] Nuclear insurers might also benefit from this approach, as early diagnoses could reduce the total compensation to claimants who ultimately develop cancer.[260]

Although proportional liability deters defendants more accurately with respect to the total amount of harm caused regardless of who receives the compensation, making up-front payouts to each community member may also be viewed as undercompensating plaintiffs who develop cancer for their actual damages and overcompensating those who never develop cancer.[261] Accordingly, proportional-liability proponents recommend that once a community's increased risk of injury has been shown, a rainy-day fund—corresponding in size to the degree of increased risk—should be established and conserved to compensate future cancer victims.[262] Payouts could be made periodically as individuals developed radiation-induced cancers,[263] and in the meantime, smaller portions of the fund could be used to pay for cancer screenings[264] and other

257. *See supra* note 241 and accompanying text.

258. *See* PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 88 (identifying "the problem of whether to make payments shortly after the accident because of the possibility of latent illnesses emerging later" as one issue of the current legal regime).

259. *See id.* at 108 (recommending the approach of permitting plaintiffs to sue for their increased risk of developing cancer).

260. *Id.* at 91.

261. *Id.* at 102.

262. *See* Estep, *supra* note 221, at 281 (arguing for a "contingent injury fund" in radiation-related injury cases proportionate in size to the increased risk of latent disease in the community); Rosenberg, *supra* note 159, at 919–20 (proposing the creation of insurance funds in mass-tort cases to insure against increased risks of disease).

263. *See* Rosenberg, *supra* note 159, at 920 (describing gradual insurance payouts).

264. PRESIDENTIAL COMM'N ON CATASTROPHIC NUCLEAR ACCIDENTS, *supra* note 10, at 114. Interim medical screenings might include complete physicals for detecting various forms of cancer and follow-up appointments for abnormalities known to be sensitive to radiation exposure, such as thyroid nodules. *Id.* at 114 n.41.

prophylactic measures, ultimately reducing the defendant's total liability. The funds could even provide for corrective measures to account for deviations from expected cancer rates, with courts extracting additional amounts from the nuclear-insurance pools when the incidence of cancer is higher than expected or returning excess compensation to the industry after a fixed period when fewer injuries materialize than were anticipated.[265] Creating community-based compensation funds is a particularly attractive solution for radiation-related injuries because the PAA has already established a large mutual-insurance pool from which compensation can be withdrawn and into which it can be deposited as necessary.[266]

B. Avoiding Excessive Costs to Defendants: Addressing Low-Level Emissions

Some concerns remain that implementing proportional liability in mass-tort cases might open the litigation floodgates to claims previously dammed up by the preponderance rule.[267] Proportional liability discourages needless litigation because plaintiffs would recover little for a marginally increased risk of developing cancer, but the possibility remains that a potential class of sufficient size might nonetheless tempt unscrupulous plaintiffs' attorneys to bring unmeritorious or weak claims to extract a settlement.[268] In this scenario, proportional liability could be used to make the nuclear industry's litigation costs more—rather than less—uncertain, permitting baseless claims to deplete insurance funds and deter investment in nuclear-power production. To eliminate this risk of overdeterrence, nuclear operators should not be held liable for minimal radiation releases.

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265. *See id.* at 91 ("Moreover, because less harm will be sustained when disease is detected . . . and treated at an early stage, such a program will likely reduce the future losses suffered by individuals as the result of latent injury."); Rosenberg, *supra* note 159, at 920 ("The firm could endow the reserve through periodic contributions and might vary the amount of the reserve as more accurate information about the incidence of disease became available over time.").

266. *See* 42 U.S.C. § 2210(a)–(b) (2012) (requiring nuclear operators to participate in primary and secondary financial-protection insurance pools). ANI might ultimately return unused funds to its operators, as it does with its litigation reserves. *See supra* note 73 and accompanying text.

267. Rosenberg, *supra* note 159, at 894.

268. *See id.* at 894–95 (noting that a potential increase in litigation under proportional liability is only feasible if previously unmarketable claims are aggregated in sufficient number to yield a positive return on investment).

The "fault" standard for nuclear operators has received substantial attention in Congress.[269] Although the hazardous nature of nuclear materials would have made the nuclear industry a prime candidate for strict liability, the federal government's longstanding monopoly over nuclear power prevented states from creating coherent strict-liability doctrines as applied to nuclear activities.[270] Instead, Congress required defendants to waive all fault-based defenses for any event deemed to be an ENO.[271] In practice, however, questions of fault are still commonly litigated because no nuclear event has been declared an ENO[272]—the Three Mile Island incident included.[273] Although there is no question that strict liability applies in major nuclear incidents, the PAA's fault standard is subject to state-by-state variation[274] in smaller cases that, taken together, might strain nuclear-insurance pools under a proportional-liability regime.

After years without a unitary fault standard, every federal *appellate* court considering the question of the "standard of care" owed under the PAA has found that public liability claimants must plead a radioactive release in excess of NRC guidelines.[275] Conceding that the PAA demands the use of substantive state tort law for fault,

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269. *See* AM. ENTER. INST., RENEWAL OF THE PRICE-ANDERSON ACT (1985) (describing the debates over whether the ENO provision was too high of a threshold to trigger strict liability, and whether the distinction was irrelevant because applicable state law would require strict liability anyway).

270. *See Price-Anderson Act Amendments of 1985: Hearing Before the Subcomm. on Energy Research and Dev. of the S. Comm. on Energy and Natural Resources on S. 1225*, 99th Cong. 232–33 (1985) (statement of Ms. Van Heijenoort) ("Because of the existence of the Atomic Energy Act, I don't think most States have developed law specifically on strict liability with respect to nuclear incidents in the nontechnical term. It may be that one could successfully argue that dealing with nuclear material is ultrahazardous and get a State court or a Federal court in applying State law to apply strict liability, but I don't think we can assume the courts necessarily do that right now.").

271. For further discussion of the ENO standard, *see supra* Part I.B.

272. O'Connor v. Boeing N. Am., Inc. No. 97-CV-1554 DT, 2005 WL 6035255, at *37 n.46 (C.D. Cal. Aug. 18, 2005) ("No ENO has been declared by the NRC or the United States to date . . . .").

273. Three Mile Island, 45 Fed. Reg. 27,590, 27,591 (Nuclear Regulatory Comm'n Apr. 23, 1980).

274. 42 U.S.C. § 2014(hh) (2012) (deferring the PAA's "substantive rules for decision" to state law).

275. *E.g.*, *In re* Hanford Nuclear Reservation Litig., 534 F.3d 986, 1003 (9th Cir. 2008); Roberts v. Fla. Power & Light Co., 146 F.3d 1305, 1308 (11th Cir. 1998); O'Conner v. Commonwealth Edison Co., 13 F.3d 1090, 1100 (7th Cir. 1994); *In re* TMI Litig. Cases Consol. II, 940 F.2d 832, 859 (3d Cir. 1991). Some district courts in other circuits have come to the same conclusion. *E.g.*, Bohrmann v. Me. Yankee Atomic Power Co., 926 F. Supp. 211, 220 (D. Me. 1996); Corcoran v. N.Y. Power Auth., 935 F. Supp. 376, 386 (S.D.N.Y. 1996).

these courts[276] concluded, relying on the AEA's preemption of nuclear-safety regulation, that state judges would look to federal regulations to decide the standard of care anyway.[277] Accordingly, plaintiffs must show that the defendant's conduct could have exposed them to some level of radiation at which defendants could be sanctioned by the NRC.[278]

Although the consistency achieved among most circuits is heartening, it is not clear that tacking the fault standard to NRC emissions guidelines would be an adequate bar to frivolous suits under a proportional-liability regime. Indeed, merely requiring a radiation emission to exceed "federal guidelines" may impose a punitively low threshold for civil liability:

> [T]he various limits in present NRC regulations . . . have been set at a level which is conservatively arrived at by incorporating a significant safety factor . . . . [A] discharge or dispersal which exceeds the limits in NRC regulations . . . is not one which would be expected to cause substantial injury or damage unless it exceeds by some significant multiple the appropriate regulatory limit.[279]

The standards set for emissions from nuclear facilities are designed to allow the NRC to identify deviations from normal industry practices, not to assess whether any individual could be harmed as a result of that deviation.[280]

Even more concerning, some district courts have held that the standard of care imposed by NRC guidelines is a regulatory aspiration[281] for doses that are "as low as reasonably achievable"

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276. Noting that the PAA provides that a state's duty of care might not be "inconsistent" with the terms of the PAA, the Tenth Circuit questioned whether Colorado tort law was necessarily preempted by federal safety standards at the time of the allegedly tortious conduct. Cook v. Rockwell Int'l Corp., 618 F.3d 1127, 1144 (10th Cir. 2010). On remand, the court found that state tort-law claims for radiation-related injuries are implicitly preempted by the PAA's statutory framework. *See* Cook v. Rockwell Int'l Corp., No. 90-cv-001818-JLK, Nuclear Reg. Rep. (CCH) ¶ 20,747, at *2 (D. Colo. Jan. 28, 2014) ("A failed PAA claim based on an alleged nuclear incident is simply a failed claim, not a state-law claim in waiting.").

277. *See supra* note 275.

278. *See, e.g.*, *O'Conner*, 13 F.3d at 1105 (refusing to create inconsistent standards for federal nuclear-safety regulations and tort liability).

279. Dumontier v. Schlumberger Tech. Corp., 543 F.3d 567, 570–71 (9th Cir. 2008) (quoting 10 C.F.R. § 140.81(b)(1) (2007)).

280. *See* 10 C.F.R. § 140.81(b)(1) (2014) ("It should be clearly understood that [these] criteria in no way establish or indicate that there is a specific threshold of exposure at which biological damage from radiation will take place.").

281. Radiation Protection Programs, 10 C.F.R. § 20.1101(a) (2014).

(ALARA).[282] As the Third Circuit has observed, lowering the fault standard to such a degree effectively gives the jury broad discretion over the question of the applicable standard of care, permitting a finding that exposing members of the public to *any* degree of radiation may be a breach of duty in tort.[283] Certainly, the linear no-threshold model suggests that even minimal radiation exposure may be the cause of an individual's cancer.[284] But if the infinitesimal radiation releases incident to a defendant's normal operations can serve as a basis for imposing liability on nuclear-power plants, then no such facility could ever be considered to operate safely.[285]

Even today, the low fault threshold enforced by most courts does not help prevent frivolous litigation. This failure at the fault threshold misses an opportunity to screen out such litigation because claims that cannot surmount the barrier of the NRC's radiation-protection standards would also be unable to show causation.[286] Although applying proportional liability would more accurately internalize the nuclear industry's cost to society, permitting recovery for an increased risk of harm without a minimum-exposure standard might transform the PAA from a reasoned limitation on nuclear liability into an "unlocked cash register."[287] A unitary federal fault threshold would help assure the nuclear industry that the benefits of proportional

282. *See* McCafferty v. Centerior Serv. Co., 983 F. Supp. 715, 719 (N.D. Ohio 1997) (holding that the defendant had a duty to keep radiation releases "as low as reasonably achievable"); Tang v. S. Cal. Edison Co., No. 93-1308 GT, 1993 WL 839708, at *1, (S.D. Cal. Dec. 28, 1993) (finding that defendants' standard of care includes ALARA); Crawford v. Nat'l Lead Co., 784 F. Supp. 439, 447 (S.D. Ohio 1989) (finding that defendants "exceeded the dose limits" set by applicable regulations by "violating the 'as low as reasonably achievable' (ALARA) requirement"); *In re* Fernald, No. C-1-85-149, 1989 WL 267040, at *3 (S.D. Ohio Apr. 5, 1989) ("We remain unpersuaded by defendants' argument that ALARA is merely an 'approach' to radiation emissions, and sets no quantifiable legal standard. Rather, we conclude that defendants violated ALARA when and if they exposed the public . . . ."); *cf.* Cook v. Rockwell Int'l Corp., 580 F. Supp. 2d 1071, 1151 (D. Colo. 2006) (admitting expert testimony based on the ALARA standard). *But cf.* Cano v. Everest Minerals Corp., 362 F. Supp. 2d 814, 858–59 (W.D. Tex. 2005) (excluding expert testimony incorporating the ALARA standard).

283. *See In re* TMI, 67 F.3d 1103, 1115–16 (3d Cir. 1995) ("Adoption of a standard as vague as ALARA would give no real guidance to operators and would allow juries to fix the standard case by case and plant by plant. An operator acting in the utmost good faith and diligence could still find itself liable for failing to meet such an elusive and undeterminable standard.").

284. *See supra* notes 115–29 and accompanying text.

285. *See supra* Part II.

286. *See supra* Part II.

287. Dumontier v. Schlumberger Tech. Corp., 543 F.3d 567, 571 (9th Cir. 2008). Judge Kozinski expressed concern that the PAA's existing fault standards would be an inadequate bar to liability if plaintiffs could recover for radiation exposure alone. *Id.* at 570–71.

liability would not be washed away by waves of unmeritorious litigation.

CONCLUSION

The science of nuclear causation—like the modern nuclear industry—is better measured by the risks involved than by a smattering of anecdotal tales, news reports, and hearsay. Just as no expert, judge, or jury can definitively know who has been harmed by radiation from the nuclear industry and who has not, so too is it impossible to know what the future holds for the legal regime governing nuclear operators in the United States. What can be said with certainty is that failing to take any risks, whether in building new power sources, spurring investments in new technology, or developing new legal doctrines, poses the even greater threat of failing to address rules that are widely acknowledged to be obsolete and inefficient. Although the proportional-liability approach to nuclear causation remains untested, its benefits cannot be realized until the country is prepared to take that necessary first step into the novel.