Jeremy V. Farrell 412.594.3938
jfarrell@tuckerlaw.com

Paul Shane Miller 412.594.5503
smiller@tuckerlaw.com

May 11, 2020

Via Electronic Filing

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Keystone Bldg. 2nd Floor W
400 N. Street
Harrisburg, PA 17120

RE: Geoff Day v. Duquesne Light Company
Docket No. C-2018-3003960

Dear Secretary Chiavetta:

Enclosed please find Duquesne Light Company's Reply to Complainant's Exceptions.

A copy of this document has been served upon Complainant in accordance with Commission regulations.

Sincerely,

/s/ Paul Shane Miller

Jeremy V. Farrell
Paul Shane Miller

Attorneys for Duquesne Light Company

Enclosure

c: Geoff Day (with enclosure)
Office of Special Assistants (OSA), via email (with enclosure)

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

GEOFF DAY,	:	
	:	
Complainant,	:	
	:	
vs.	:	No: C-2018-3003960
	:	
DUQUESNE LIGHT COMPANY,	:	
	:	
Respondent.	:	

REPLY TO COMPLAINANT'S EXCEPTIONS

Filed on behalf of Respondent
Duquesne Light Company

Counsel of Record for this Party:

Jeremy V. Farrell, Esquire
PA I.D. No. 316258
(412) 594-3938

Paul Shane Miller, Esquire
PA I.D. No. 319174
(412) 594-5503

1500 One PPG Place
Pittsburgh, PA 15222
Counsel for Respondent

REPLY TO COMPLAINANT'S EXCEPTIONS

Respondent Duquesne Light Company ("Duquesne Light" or the "Company"), by and through its attorneys, Tucker Arensberg, P.C., files the following Reply to Complainant's Exceptions to the Initial Decision of Administrative Law Judge Jeffrey A. Watson dated March 23, 2020:

I. INTRODUCTION

Prior to the hearing in this matter, the parties entered into a stipulation stating that this case only involves one issue: whether Duquesne Light can install a smart meter at Complainant's service address without his consent. Complainant says Duquesne Light *cannot*. Duquesne Light contends it *must*. On March 23, 2020, the Presiding ALJ issued an Initial Decision in favor of Duquesne Light. The Initial Decision correctly ruled that Pennsylvania law does not permit Complainant to opt-out of receiving a smart meter. Further, it held that the Fourth Amendment to the United States Constitution does not prohibit Duquesne Light from installing a smart meter at the service address. Accordingly, the Presiding ALJ dismissed Complainant's Amended Complaint.

On May 1, 2020, Complainant filed one-page Exceptions. Notably, they cite no incorrect findings of fact or conclusions of law in the Initial Decision. Instead, Complainant states that the Initial Decision is "void and unacceptable" and that the Presiding ALJ engaged in "a clear dereliction of his duties." Further, the Presiding ALJ allegedly "vacated his office," violated Complainant's civil and constitutional rights, and committed a federal crime. The Presiding ALJ must "immediately grant…all requested relief" or otherwise resign from office. Complainant offered no evidence to support these claims.

The Commission should deny the Exceptions for four reasons. First, they identify no findings of fact or conclusions of law that are allegedly incorrect. Second, Act 129 does not permit

utility customers like Complainant to opt-out of receiving a smart meter. Third, Duquesne Light's Tariff requires (and permits) the Company to install a smart meter at Complainant's residence. Finally, Duquesne Light is not a "state actor" and thus not subject to the Fourth Amendment. Accordingly, the Commission should deny the Exceptions, adopt the Initial Decision, and dismiss the Amended Formal Complaint.

II. BACKGROUND

A. Act 129 of 2008

On October 15, 2008, then-Pennsylvania Governor Ed Rendell signed Act 129 into law. 66 Pa. C.S.A. § 101 et seq.; Lamagna v. Pa. Elec. Co., Docket No. C-2017-2608014, 2018 WL 6124353, at *11 (Pa. P.U.C. Oct. 30, 2018) (Watson, ALJ). Act 129 amended Section 2807 of the Pennsylvania Public Utility Code. Of relevance here, Act 129 states:

> **(f) Smart meter technology and time of use rates.--**
>
> ***
>
> (2) Electric distribution companies *shall furnish smart meter technology* as follows:
>
> (i) Upon request from a customer that agrees to pay the cost of the smart meter at the time of the request.
>
> (ii) In new building construction.
>
> (iii) *In accordance with a depreciation schedule not to exceed 15 years.*

66 Pa. C.S.A. § 2807(f)(2) (italics added).

Act 129 also required electric distribution companies ("EDCs") with more than 100,000 customers to file smart meter technology procurement and installation plans with the Commission for approval. 66 Pa. C.S. § 2807(f)(1). Each plan had to describe the smart meter technology that the EDC planned to deploy. Id.; Frompovich v. PECO Energy Co., Docket No. C-2015-2474602, 2018 WL 2149249, at *4 (Pa. P.U.C. May 3, 2018). The Commission also issued an Implementation Order establishing guidelines for smart meter technology procurement and

installation. See Smart Meter Procurement and Installation, Docket No. M-2009-2092655 (Implementation Order entered June 24, 2009).

B. Duquesne Light's Smart Meter Plan and Tariff Rule 9B

On June 29, 2012, Duquesne Light filed a smart meter plan with the Commission as required by the Implementation Order ("Smart Meter Plan"). The Commission approved Duquesne Light's Smart Meter Plan the following year. See Docket No. M-2009-2123948, Opinion and Order (May 6, 2013). Duquesne Light later submitted an Amended Smart Meter Plan, which the Commission approved in relevant part on April 7, 2017. See Docket No. P-2015-2497267, Opinion and Order (April 7, 2017). Duquesne Light's Amended Smart Meter Plan states that the Company will install smart meters at all metered service locations within its service territory.

This requirement is also reflected at Rule 9B of Duquesne Light's Tariff. Rule 9B states in relevant part, "[s]mart meters conforming to Company standards must be installed at each metered service premises. Customers may not decline smart meter installation for any reason." Rule 9B further states that if a customer does not want a smart meter at their service address, the customer's sole remedy is to designate an alternative location on the premises for the smart meter.

C. Complainant's Allegations

Complainant owns two residential properties located at 1699 and 1699 ½ Suburban Avenue, Pittsburgh, PA 15216. Amended Complaint, ¶ 1; Stipulation, ¶ 1 (attached as Exhibit A). Duquesne Light has more than 100,000 customers and falls within the scope and jurisdiction of Act 129. Stipulation at ¶ 4. Duquesne Light has not installed a smart meter at 1699 Suburban Avenue; it has installed a smart meter at 1699 ½ Suburban Avenue. Id. at ¶¶ 2, 3.[1]

[1] Complainant placed a lock on the electric meter at 1699 Suburban Avenue to prevent Duquesne Light from exchanging it with a smart meter. Under Rule 22 of Duquesne Light's Tariff, Company representatives who are properly identified shall have full and free access to the customer's premises at all reasonable

On August 13, 2018, Complainant filed a Formal Complaint with the Commission against Duquesne Light. See Complaint (filed on Aug. 13, 2018). He filed an Amended Formal Complaint about six months later. See Amended Complaint (filed on Feb. 21, 2019). The Formal Complaint and Amended Formal Complaint allege that Duquesne Light installed a smart meter at Complainant's residence without his consent. Complaint, ¶ 4; Amended Complaint, ¶ 5. As relief, Complainant seeks an order requiring Duquesne Light to remove the smart meter installed at 1699 ½ Suburban Avenue; he also seeks to prevent the Company from installing a smart meter at 1699 Suburban Avenue. Complaint, ¶ 5; Amended Complaint, ¶ 5. In response, Duquesne Light denied Complainant's allegations and asserted that it is required by Act 129 to install a smart meter at the service addresses of all customers within its service territory, including Complainant. Answer and New Matter to Formal Complaint (filed on Sept. 4, 2018); Answer and New Matter to Amended Formal Complaint (filed on March 14, 2019).

D. Complainant Moves to Withdraw His Complaint

On June 13, 2019, the Presiding ALJ scheduled a telephonic hearing to take place on August 21-22, 2019. See Call-In Telephone Hearing Notice (June 13, 2019) (Watson, ALJ). About two months later, the Presiding ALJ converted the telephonic hearing to an in-person hearing after Complainant requested an in-person hearing. See Interim Order Converting Hearing to In-Person Hearing, Requiring Complainant and Counsel to Appear at In-Person Hearing and Permitting Witnesses Previously Identified by Complainants and Respondent to Appear Telephonically at the Hearing Scheduled For August 21-22, 2019 (Aug. 12, 2019) (Watson, ALJ).

One week before the hearing, Complainant filed a document titled "Withdraw of Formal Complaint." See Withdraw of Formal Complaint (filed on Aug. 14, 2019). He asserted, "[t]he level

---

times for the purpose of reading Company meters, for inspection and repairs, for removal of Company property, or for any other purpose incident to the service. Complainant is violating Rule 22 by placing a lock on Duquesne Light's meter at 1699 Suburban Avenue.

of corruption within the Public Utility Commission makes any good faith attempt for relief absolutely pointless, and a gross waste of time." Id. Thus, Complainant stated that he was withdrawing his formal complaint against Duquesne Light, although he still prohibited the Company from installing a smart meter on his property. Id.

Two days later, the Presiding ALJ issued an order requiring the parties to attend the in-person hearing scheduled for August 21, 2019. See Interim Order Requiring Attendance of Complainant and Counsel for Respondent at In-Person Hearing on August 21, 2019 at 10:00 A.M. (Aug. 16, 2019) (Watson, ALJ). The Presiding ALJ ruled that the parties should appear in-person "in order to explain to Complainant the significance of any ruling by me to grant his request to withdraw the complaint without prejudice, to permit the withdraw [sic] of the complaint with prejudice or to deny Complainants request and to proceed with the in-person evidentiary hearing on August 21, 2019." Id. The Presiding ALJ thus held that Complainant's "request to withdraw the complaint … will be considered after convening the hearing on August 21, 2019 … and after providing each party an opportunity to address this request." Id.

E. The Hearing

On August 21, 2019, the parties appeared for the in-person hearing before the Presiding ALJ. Complainant intended to testify on his own behalf as his only witness. Stipulation at ¶ 5. Duquesne Light planned to call eight witnesses to testify. Id. at ¶ 6. The table below summarizes the planned testimony of each witness for Duquesne Light:

Witness Name	Employer and Job Title	Summary of Planned Testimony
Michael Belanger	Itron, Inc. - Senior Project Line Manager	Mr. Belanger would have testified about the design, manufacture, capabilities, and operation of the smart meters used by Duquesne Light, as well as how the meters comply with various standards and codes relating to radiofrequency exposure.
Steven Wright	Itron, Inc. - Senior Project Manager	Mr. Wright would have testified about the design, manufacture, capabilities, and operation of the smart meters used by Duquesne Light, as well as how the meters comply with various standards and codes relating to radiofrequency exposure.
Dr. Benjamin Cotts	Exponent, Inc. - Senior Managing Engineer	Dr. Cotts would have offered expert testimony and opinion in response to the electromagnetic and radiofrequency exposure concerns raised by Complainant. In particular, Dr. Cotts would have testified that Duquesne Light's smart meters represent a negligible contribution to Complainant's radiofrequency exposure; that radiofrequency exposure from other existing sources is many times greater than from Duquesne Light's smart meters; and that the radiofrequency exposure from a typical Duquesne Light smart meter represents a fraction of the limits set by the Federal Communications Commission and complies with other applicable industry standards and best practices.
Dr. Gabor Mezei	Exponent, Inc. - Senior Managing Scientist	Dr. Mezei would have offered expert testimony in response to Complainant's claims about the alleged adverse health effects of smart meters. Specifically, Dr. Mezei would have testified that there is no causal relationship between environmental exposure to Duquesne Light's smart meters and adverse human health effects. He also would have testified that the estimated radiofrequency exposure from Duquesne Light's smart meters is below scientifically-based exposure guidelines.
Michael Secchiutti	Duquesne Light - Senior Manager of Smart Meter Operations	Mr. Secchiutti would have testified about the Company's smart meter implementation plan; the operational features of Duquesne Light's smart meters; the read schedules utilized by

		Duquesne Light's smart meters; the nature of the information collected by Duquesne Light's smart meters; Duquesne Light's smart meter network; the customer benefits of Duquesne Light's smart meter system; and Duquesne Light's compliance with applicable regulations, standards, and best practices.
Ron Dornin	Duquesne Light - Manager of Metering Systems	Mr. Dornin would have testified about the manner in which Duquesne Light's smart meters are installed at customer premises; the training that the Company provides to its personnel; and related policies and procedures.
Michael Tallent	Duquesne Light - Chief Information Security Officer	Mr. Talent would have testified about the cybersecurity and privacy protections and encryption features that Duquesne Light implements in its information systems.
Roxanne Morris	Duquesne Light - Supervisor of Regulatory Consumer Relations	Ms. Morris would have testified about basic account information relating to Complainant's service address. She also would have authenticated relevant Company records and tariff provisions.

After the parties arrived at the hearing – but before the hearing began – Complainant stated that he was withdrawing all allegations and concerns raised in his Complaint and Amended Complaint, except for one legal issue. Stipulation at ¶ 7. The parties entered into a stipulation in which they agreed to brief "the question of law of whether Duquesne Light has the lawful right to install a smart meter at 1699 and 1699 ½ Suburban Avenue by Act 129 of 2008 and the Pennsylvania Public Utility Commission's Implementation Order, even though Mr. Day does not consent to the installation of the smart meter." Id. at ¶¶ 7, 8.

After the parties entered into this stipulation, the Presiding ALJ cancelled the hearing and set a briefing schedule. Interim Order Setting Briefing Schedule (Aug. 28, 2019) (Watson, ALJ). Specifically, the parties could submit written briefs on the above-mentioned legal issue on or before December 2, 2019. Id. at ¶ 1.

F. The Parties' Briefs

On December 2, 2019, Complainant and Duquesne Light submitted respective briefs to the Presiding ALJ. Complainant argued, in sum, that Act 129 is an "opt-in" bill and that Duquesne Light cannot install a smart meter at his residence without his consent. Complainant's Brief at 1. ("The very fact that Act 129 of 2008 is an "opt-in" bill proves that it is not compulsory for the American people, and an "opt-out" is unnecessary for those who choose simply not to opt-in."). He also averred that the Fourth Amendment prohibits Duquesne Light from installing a smart meter at his residence without his consent. Id. at 26-27 ("The compulsory conveyance of data reflecting intimate details of in-home activities does not--and cannot--extinguish the strong expectation of privacy that Americans reasonably have in smart meter data.").

Conversely, Duquesne Light argued that Act 129's plain text and Commission precedent establish that the Company must install smart meters at all residential addresses throughout its service territory; customers cannot "opt-out." See Duquesne Light Company's Post-Hearing Brief at 6-11. Further, the Fourth Amendment only applies to "state actors." Id. at 11-12. Duquesne Light is not a state actor, so the Fourth Amendment does not apply in this situation. Id.

About two weeks after the parties submitted their briefs, the Presiding ALJ closed the hearing record. Interim Order Closing Hearing Record (Dec. 19, 2019) (Watson, ALJ).

G. The Initial Decision

On March 23, 2020, the Presiding ALJ issued an Initial Decision dismissing the Amended Formal Complaint. The Findings of Fact set forth in the Initial Decision were based on the stipulation entered into by the parties. The Initial Decision rejected Complainant's argument that Act 129 is an "opt-in" bill; instead, it held that Act 129 requires Duquesne Light to install a smart meter at Complainant's service address and that there was no evidence that Duquesne Light's refusal to allow Complainant to opt-out violated any law, regulation, or Commission order. Initial Decision, at 15-17 (Mar. 23, 2020) (Watson, ALJ). The Initial Decision also rejected

Complainant's claim that the installation of a smart at his residence violates his right to privacy under the Fourth Amendment. Id. at 16-17. It held that the United States Constitution only applies to "state action" and thus does not apply to the conduct of a private company like Duquesne Light. Id. at 17. Accordingly, the Presiding ALJ found that Complainant's claims are not supported by the evidence and must be dismissed. Id.

H. Complainant's Exceptions

On May 1, 2020, Complainant filed one-page Exceptions to the Initial Decision. See EXEPTION [sic] to initial decision. The Exceptions do not identify any findings of fact or conclusions of law to which exception is taken. Id. They provide no supporting reasons for the exceptions. Id. They cite no relevant pages of the Initial Decision. Id. Rather, the Exceptions state that the Initial Decision is "void and unacceptable" and violate Complainant's constitutional and civil rights. Id. Moreover, Complainant contends that the Presiding ALJ "vacated his office" by issuing the Initial Decision and committed a federal crime punishable up to a year in prison. Id. The Exceptions demand that the Presiding ALJ "carry out his duties in good faith, and immediately grant complainant all requested relief." Id. Otherwise, the Presiding ALJ must resign. Id.

III. ARGUMENT

The Commission should deny the exceptions for four reasons: (i) they fail to identify any erroneous findings of fact or conclusions of law; (ii) Act 129 does not permit utility customers like Complainant to opt-out of receiving a smart meter; (iii) Duquesne Light's Tariff has the force of law and requires the Company to install a smart meter at Complainant's service addresses; and (iv) the Fourth Amendment does not apply to Duquesne Light because it is not a "state actor."

A. The Commission Should Deny the Exceptions Because They Fail to Identify Any Erroneous Findings of Fact or Conclusions of Law.

The Commission should deny the Exceptions because they fail to identify any erroneous findings of fact or conclusions of law. Under 52 Pa. Code § 5.533(b), "each exception must be numbered and identify the finding of fact or conclusion of law to which exception is taken and cite the relevant pages of the decision." Further, "supporting reasons for the exceptions shall follow each specific exception." 52 Pa. Code § 5.533(b).

The Exceptions satisfy none of these requirements. Most notably, they do not identify any findings of fact or conclusions of law to which exception is taken. They also provide no supporting reasons for the exceptions. The Exceptions merely state that the Initial Decision is "void and unacceptable" and make several unfounded accusations against the Presiding ALJ. Although *pro se* complainants generally receive some latitude in legal proceedings, the Exceptions simply provide no basis for overturning the Initial Decision.[2] They should be denied for this reason alone.

B. *The Commission Should Deny the Exceptions Because the Presiding ALJ Correctly Ruled That Complainant Cannot Opt-out of Receiving a Smart Meter.*

Next, the Exceptions should be denied because the Presiding ALJ correctly ruled that Act 129 does not permit Complainant to opt-out of receiving a smart meter. Per the parties' stipulation, the sole question before the Presiding ALJ was whether Duquesne Light has a legal right to install a smart meter at Complainant's residence without his consent (assuming that Complainant wants to continue receiving service from Duquesne Light). By holding that Complainant cannot opt out of receiving a smart meter from Duquesne Light, the Presiding ALJ

[2] Duquesne Light also notes that Complainant's Exceptions ignore the procedural protections afforded to him by the Presiding ALJ. Complainant attempted to withdraw his case prior to the hearing, but the Presiding ALJ required that all parties nevertheless appear for the hearing so that the impact of this decision could be discussed with Complainant. After a lengthy discussion with the Presiding ALJ on the record, Complainant decided only to withdraw some of his claims. Therefore, the fact that the parties are even briefing this issue is a result of the protection that the Presiding ALJ gave to Complainant.

correctly interpreted Act 129's plain text and followed the Commission's well-established precedent.

As discussed in Duquesne Light's Post-Hearing Brief, Act 129 states that "[e]lectric distribution companies *shall* furnish smart meter technology…in accordance with a depreciation schedule not to exceed 15 years." Duquesne Light Company's Post-Hearing Brief at 6 (citing 66 Pa. C.S.A. § 2807(f)(2)) (emphasis added). The Commission has repeatedly ruled that the use of the word "shall" in Act 129 indicates the General Assembly's direction that all customers receive a smart meter. Duquesne Light Company's Post-Hearing Brief at 6 (citing Evans v. PECO Energy Co., Docket No. C-2013-2368477, 2013 WL 7019103, at *3 (Pa. P.U.C. Dec. 19, 2013) (Hoyer, ALJ)). The Commission has consistently held that no provision in the Public Utility Code or the Commission's Regulations or Orders allows a customer to "opt out" of receiving a smart meter. Duquesne Light Company's Post-Hearing Brief at 6 (citing Hoffman-Lorah v. PPL Elec. Util. Corp., Docket No. C-2018-2644957, 2019 WL 2325713, at *28 (Pa. P.U.C. May 23, 2019); Paul v. PECO Energy Co., Docket No. C-2015-2475355, 2018 WL 3093596, at *4-5 (Pa. P.U.C. June 14, 2018); Frompovich, 2018 WL at *4; Povacz v. PECO Energy Co., Docket No. C-2012-2317176, 2013 WL 392699, at *6 (Pa. P.U.C. Jan. 24, 2013)). If a customer wants to opt-out of receiving a smart meter, he must lobby the General Assembly to change the law rather than seeking relief from the Commission. Duquesne Light Company's Post-Hearing Brief at 6 (citing Myers v. PPL Elec. Utilities Corp., Docket No. C-2017-2620710, 2018 WL 4185437, at *22 (Pa. P.U.C. Aug. 16, 2018) (Barnes, ALJ); Kline v. PPL Elec. Utilities Corp., Docket No. C-2017-2621072, 2018 WL 4185436, at *15 (Pa. P.U.C. Aug. 16, 2018) (Barnes, ALJ)). Without additional legislation from the General Assembly, the Commission cannot prohibit a utility from installing a smart meter where a customer does not want one. Duquesne Light Company's Post-Hearing Brief at 6-7 (citing Schmukler v. PPL Elec. Utilities Corp., C-2017-2621285, 2018 WL 4185440, at *27 (Pa. P.U.C. Aug. 16, 2018) (Barnes, ALJ)).

Several Commission decisions establish that a customer cannot opt-out of receiving a smart meter, as Complainant seeks to do here. More than six years ago in Povacz, a complainant (like Complainant here) did not consent to receiving a smart meter and requested to opt-out of receiving one from her electric distribution company. Duquesne Light Company's Post-Hearing Brief at 7 (citing 2013 WL at *1). The presiding administrative law judge sustained the company's preliminary objections and dismissed the formal complaint, holding that Act 129 does not allow customers to opt-out of receiving a smart meter. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *4). On exceptions, the Commission ruled "there is no provision in the Code, the Commission's Regulations or Orders that allows a…customer to "opt out" of smart meter installation, as the Complainant desires to do." Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *6). The Commission thus denied the complainant's exceptions. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id.).

The Commission made the same decision about five years later in Frompovich. In that case, the complainant (like Complainant here) requested to opt-out of receiving a smart meter because she believed that Act 129 did not require the universal deployment of smart meters. Duquesne Light Company's Post-Hearing Brief at 7 (citing 2018 WL at *1-2). After a hearing, the presiding administrative law judge dismissed her formal complaint. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *3). On exceptions, the Commission ruled that the utility "is mandated under applicable law to replace all automatic meter reading (AMR) meters owned by it within its service territory with advanced metering infrastructure (AMI) meters, or smart meters." Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *4). The Commission thus denied the complainant's request to opt-out of receiving a smart meter and dismissed her complaint. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *35).

The Commission made the same ruling about a month later in Paul. Duquesne Light Company's Post-Hearing Brief at 7. Like Complainant here, the complainant in Paul filed a formal

complaint against an EDC and requested to opt out of receiving a smart meter. Duquesne Light Company's Post-Hearing Brief at 7 (citing 2018 WL at *1). The presiding administrative law judge held a hearing, then dismissed the complaint. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id. at *3-4). The complainant filed exceptions. Duquesne Light Company's Post-Hearing Brief at 7 (citing Id.). The Commission found that the complainant was not entitled to opt-out of receiving a smart meter and affirmed the dismissal of her complaint. Duquesne Light Company's Post-Hearing Brief at 7-8 (citing Id. at *16-17).

About a year ago, the Commission made the same ruling in Hoffman-Lorah. Duquesne Light Company's Post-Hearing Brief at 8. The complainant there (like Complainant here) contended that Act 129 only required her to receive a smart meter upon request. Duquesne Light Company's Post-Hearing Brief at 8 (citing Hoffman-Lorah, 2019 WL at *8). The presiding administrative law judge rejected this argument, holding that no provision in the Code, the Commission Regulations, or Orders allows a customer to opt-out of receiving a smart meter. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *9). On exceptions, the Commission held that "we do not have the authority, absent directive in the form of legislation, to prohibit the Company from installing a smart meter where a customer does not want one." Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *28). The Commission thus dismissed the complaint. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id.).

In other decisions issued after Hoffman-Lorah, the Commission held that customers cannot opt-out of or refuse the installation of a smart meter. Duquesne Light Company's Post-Hearing Brief at 8 (citing Larson v. PECO Energy Co., Docket No. C-2017-2615206, 2019 WL 4738825, at *3 (Pa. P.U.C. Sept. 19, 2019) (Act 129 does not provide customers with a general opt-out right); Gavin v. PECO Energy Co., Docket No. C-2017-2616249, 2019 WL 3252287, at *21-22 (Pa. P.U.C. July 11, 2019) (customer cannot opt-out of receiving a smart meter)).

The Presiding ALJ has consistently followed the Commission's precedent. For example, in Hanley v. Pa. Power Co., Docket No. C-2016-2557487, 2018 WL 5994765 (Pa. P.U.C. Oct. 24, 2018) (Watson, ALJ), two customers filed a formal complaint to prevent an EDC from replacing their existing electric meter with a smart meter. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *1). At the hearing, the complainants asserted they can receive a smart meter only if they requested one. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *12). Like Duquesne Light here, the EDC claimed that Act 129 required it to install a smart meter at all customer service locations. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *13). The Presiding ALJ dismissed the complaint, holding that the complainants failed to prove that Act 129 does not mandate the universal deployment of smart meters. Duquesne Light Company's Post-Hearing Brief at 8 (citing Id. at *17).

The Presiding ALJ made the same decision in Lamagna. Duquesne Light Company's Post-Hearing Brief at 9. The complainant in that case objected to the installation of a smart meter at her home. Duquesne Light Company's Post-Hearing Brief at 9 (citing 2018 WL at *10). She argued that a smart meter could be deployed only upon her request and consent. Duquesne Light Company's Post-Hearing Brief at 9 (citing Id. at *12). The Presiding ALJ dismissed her complaint, holding "[t]he final version of Act 129 that was signed into law by the Pennsylvania legislature does not contain a specific out-opt provision." Duquesne Light Company's Post-Hearing Brief at 9 (citing Id. at *14-15).

The Presiding ALJ reached the same conclusion in Tellefsen v. Metropolitan Edison Co., Docket No. C-2018-3005250, 2019 WL 5865110 (Pa. P.U.C. Nov. 1, 2019) (Watson, ALJ). Duquesne Light Company's Post-Hearing Brief at 9. In that case, the complainants filed a formal complaint seeking to prevent the utility from replacing the existing electric meter at their residence with a smart meter. Duquesne Light Company's Post-Hearing Brief at 9 (citing Id. at *1). As in our case, the parties in Tellefsen agreed to forego a hearing and brief the sole issue of whether

or not smart meter installation is mandated by Act 129. Duquesne Light Company's Post-Hearing Brief at 9 (citing Id. at *2). After considering both parties' briefs, the Presiding ALJ ruled that the utility was required by Act 129 to install smart meters at its customers' service locations and thus dismissed the formal complaint. Duquesne Light Company's Post-Hearing Brief at 9 (citing Id. at *9).

These prior decisions by the Commission and the Presiding ALJ must be upheld under the rule of *stare decisis*. Duquesne Light Company's Post-Hearing Brief at 9. This rule states, "[f]or the sake of certainty, a conclusion reached in one case should be applied to those which follow, if the facts are substantially the same, even though the parties may be different." Duquesne Light Company's Post-Hearing Brief at 9 (citing Freed v. Geisinger Med. Ctr., 971 A.2d 1202, 1212 (Pa. 2009)). *Stare decisis* is the preferred legal course because "it promotes the evenhanded, predictable, and consistent development of legal principles, fosters reliance on judicial decisions, and contributes to the actual and perceived integrity of the judicial process." Duquesne Light Company's Post-Hearing Brief at 9 (citing Id.). The Commission has applied *stare decisis* to its prior holdings that Act 129 requires the universal deployment of smart meters. Duquesne Light Company's Post-Hearing Brief at 9-10 (citing Bervinchak v. PPL Elec. Utilities Corp., Docket No. C-2016-2577527 and Docket No. C-2016-2572824, 2018 WL 4185438, at *15 (Pa. P.U.C. Aug. 16, 2018) (Barnes, ALJ) (*stare decisis* precedent at the Commission level requires a finding that Act 129 contains no opt-out); Zimmerman v. PPL Elec. Utilities Corp., Docket No. C-2017-2615038, 2018 WL 4185439, at *15 (Pa. P.U.C. Aug. 16, 2018) (Barnes, ALJ) (same)).

Here, the Presiding ALJ properly applied *stare decisis* by holding that Complainant cannot opt-out of receiving a smart meter. Although the parties here are different than in cases like Povacz, Frompovich, Paul, Hoffman-Lorah, Hanley, Lamagna, and Tellefsen, this case is substantially the same as those cases. Like those complainants, Complainant is attempting to

opt-out of receiving a smart meter because he believes Duquesne Light can only install one at his request or with his consent. But as the Commission repeatedly held in those prior cases, Complainant's interpretation of Act 129 misconstrues its plain text, which states that electric distribution companies with more than 100,000 customers "*shall* furnish smart meter technology…in accordance with a depreciation schedule not to exceed 15 years." 66 Pa. C.S.A. § 2807(f)(2) (emphasis added). Accordingly, the Presiding ALJ correctly ruled that Duquesne Light has the right to install a smart meter at Complainant's residence, regardless of whether he consents to the installation.

Moreover, the Presiding ALJ properly held that the mandatory deployment of smart meters not only complies with Act 129's plain text, but it is also the most plausible interpretation when read in conjunction with the statute's other provisions. Duquesne Light Company's Post-Hearing Brief at 10. Act 129 requires all EDCs with more than 100,000 customers to submit smart meter technology and procurement plans to the Commission for approval. Id. If the General Assembly intended for EDCs to deploy smart meters only upon customer request, it would make little sense to require EDCs to submit detailed smart meter plans without describing the circumstances under which customers would be permitted to opt-out. Id. If customers could opt-out at their discretion, EDCs would not know how many smart meters they would be required to install before submitting their smart meter plans. Id. It thus would be difficult - if not impossible - for an EDC to craft a detailed smart meter plan. Id. Act 129's requirement that EDCs submit detailed smart meter plans to the Commission for approval only makes sense if the General Assembly also intended that smart meters be universally deployed. Id. The Commission said as much in its Implementation Order by stating, "[it] is this system-wide deployment [of smart meters] that will provide the foundation for the EDCs' smart meter installation plans." Id. at 10-11 (citing Smart Meter Procurement and Installation at 14). Accordingly, the Presiding ALJ correctly ruled that

Duquesne Light has the right to install a smart meter at Complainant's service address, despite his objections.

C. *The Commission Should Deny the Exceptions Because Duquesne Light's Tariff Has the Force of Law and Requires the Company To Install a Smart Meter at Complainant's Service Addresses.*

The Commission also should deny the Exceptions because Duquesne Light's Tariff requires the Company to install a smart meter at Complainant's service addresses. Duquesne Light Company's Post-Hearing Brief at 14. Commission-approved tariffs have the force of law. Duquesne Light Company's Post-Hearing Brief at 14 (citing Warren v. Duquesne Light Co., Docket No. F-2014-2399085, 2014 WL 3834561, at *3 (Pa. P.U.C. July 15, 2014) (Long, ALJ)). Several rules in Duquesne Light's Tariff expressly authorize Company personnel to enter Complainant's property to install a smart meter. Duquesne Light Company's Post-Hearing Brief at 14.

First, Rule 9B of Duquesne Light's Tariff provides that smart meters conforming to Duquesne Light's standards *must* be installed at *each* metered service premises:

> **B. Meter Relocation for all Customers**
>
> Pursuant to Act 129 of 2008; the Commission's Smart Meter Procurement and Installation Implementation Order entered June 24, 2009, at Docket No. M-2009-2092655; and Duquesne Light's Smart Meter Procurement and Installation Plan, approved in relevant part by Order entered April 7, 2017, at Docket No. P-2015-2497267; **smart meter(s) conforming to Company standards must be installed at each metered service premises. Customers may not decline smart meter installation for any reason. Instead, as their sole remedy, customers may designate an alternative location on the premises for the smart meter.** The Company shall relocate the smart meter to such alternative location where (i) the relocation (including associated customer service equipment) conforms to the Company's "Electric Service Installation Rules" (see Rule No. 6) and the National Electric Safety Code, as determined by the Company in its sole judgment; (ii) the relocation can be readily, safely, and reliably interconnected to the Company's facilities, as determined by the Company in its sole judgment; (iii) the customer provides any easements, permits, or other governmental or third-party approvals the Company deems necessary to accommodate such relocation; and (iv) the Company receives, in advance, payment for the Company's estimated total direct and indirect costs including the related income tax of such relocation.

Duquesne Light Company's Post-Hearing Brief at 14-15 (emphasis added).

In addition, Rule 22 of Duquesne Light's Tariff authorizes Company representatives to access the Company's equipment as follows:

> 22. ACCESS TO PREMISES Company representatives, who are properly identified, **shall have full and free access to the customer's premises at all reasonable times for the purpose of reading Company meters, for inspection and repairs, for removal of Company property, or for any other purpose incident to the service. The Company shall have the right to access customer owned facilities and equipment at all hours for the purposes of responding to an emergency, restoring electric service, rendering the electric facilities safe and reliable, or for the purpose of reducing the likelihood of damage to the Company's facilities or equipment.** The customer should immediately communicate with the Company in case of any question as to the authority or credentials of Company representatives. A customer's failure to provide access may be grounds for service termination pursuant to Rule No. 33 herein.

Duquesne Light Company's Post-Hearing Brief at 15 (emphasis added).

Finally, Rule 33 of Duquesne Light's Tariff authorizes the Company to terminate service and remove its equipment from the customer's property if the Company is blocked proper access to its equipment:

> 33. INACCESSIBILITY **The Company may terminate electric service and remove its equipment from the premises upon reasonable notice in case meter readers or other authorized representatives of the Company cannot gain admittance or are refused admittance to the premises for the purposes of reading Company meters, inspection and repairs, removal of Company property, responding to an emergency, restoring electric service, rendering the electric facilities safe and reliable, or for any other purpose incident to the service or in case the customer interferes with Company representatives in the performance of their duties.** When a residential customer or a residence is involved, the Company will comply with the provisions of 52 Pa. Code Chapter 56, "Standards and Billing Practices for Residential Utility Service" and 66 Pa.C.S. § 1406, "Termination of Utility Service."

Duquesne Light Company's Post-Hearing Brief at 15 (emphasis added).

These Tariff provisions have the force of law and collectively establish that (i) Duquesne Light must install a Smart Meter at Complainant's service addresses; (ii) Complainant cannot refuse a smart meter installation for any reason; (iii) Duquesne Light's representatives have full

and free access to Complainant's premises at all reasonable times to read Company meters, conduct inspections and repairs, remove Company property, and for any other purpose incident to service; and (iv) Duquesne Light can terminate Complainant's electric service and remove its equipment from his premises upon reasonable notice if he fails to grant proper access to Company representatives. Accordingly, the Presiding ALJ properly ruled that Duquesne Light has the right to enter Complainant's property to install a smart meter (assuming that Complainant wants to continue receiving electric service from the Company).

D. *The Commission Should Deny the Exceptions Because the Presiding ALJ Correctly Ruled That the Fourth Amendment Does Not Prohibit Duquesne Light From Installing a Smart Meter at Complainant's Residence.*

Finally, the Presiding ALJ correctly ruled that the Fourth Amendment does not prohibit Duquesne Light from installing a smart meter at Complainant's residence. The Fourth Amendment states:

> The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

Duquesne Light Company's Post-Hearing Brief at 11 (citing U.S. Const. Amend. IV).

The United States Constitution only applies to "state action." Duquesne Light Company's Post-Hearing Brief at 11. It does not apply to conduct by a private company like Duquesne Light, even if the company is regulated by the state. Duquesne Light Company's Post-Hearing Brief at 11 (citing Jackson v. Metropolitan Edison Co., 419 U.S. 345, 349-350 (1974); Schutz v. PPL Elec. Utilities Corp., No. C-2018-3005659, 2019 WL 2744430, at *12 (Pa. P.U.C. June 11, 2019)).

In Jackson, a customer sued a privately owned and operated utility company, alleging that it violated her due process rights under the Fourteenth Amendment to the United States Constitution by terminating her electric service. Duquesne Light Company's Post-Hearing Brief at 11 (citing 419 U.S. at 348-49). The U.S. District Court for the Middle District of Pennsylvania

dismissed her complaint. Duquesne Light Company's Post-Hearing Brief at 11 (citing Id. at 349). The United States Court of Appeals for the Third Circuit affirmed. Duquesne Light Company's Post-Hearing Brief at 11 (citing Id.). The Supreme Court of the United States ruled that although the utility company was heavily regulated by the Commonwealth of Pennsylvania, state regulation did not convert the utility's decision to terminate the complainant's electric service into "state action." Duquesne Light Company's Post-Hearing Brief at 11 (citing Id. at 358-59).

The Commission recently reached the same conclusion in Schutz. Duquesne Light Company's Post-Hearing Brief at 12. In that case, a residential customer filed a complaint seeking to prevent a utility company from installing a smart meter at her residence. Duquesne Light Company's Post-Hearing Brief at 12 (citing 2019 WL at *1). She argued that the installation of a smart meter violated her right against unreasonable searches and seizures under the Fourth and Fourteenth Amendments to the United States Constitution. Duquesne Light Company's Post-Hearing Brief at 12 (citing Id. at *12). In response, the utility (like Duquesne Light here) asserted that it was not a state actor and thus not subject to the Fourth and Fourteenth Amendments. Duquesne Light Company's Post-Hearing Brief at 12 (citing Id.) The presiding administrative law judge held that the utility was not a "state actor"; rather, "it is a private, regulated utility company not constrained by the Fourth Amendment." Duquesne Light Company's Post-Hearing Brief at 12 (citing Id.) Accordingly, the presiding administrative law judge dismissed the complaint. Duquesne Light Company's Post-Hearing Brief at 12 (citing Id. at *14).

Although Duquesne Light is regulated by the Commission, it is a private company, not a "state actor." Accordingly, the Presiding ALJ correctly ruled that the United States Constitution (including the Fourth Amendment) does not apply here.

In addition, the Presiding ALJ and the Commission lack jurisdiction to rule on any claims arising under the United States Constitution. Duquesne Light Company's Post-Hearing Brief at 12. The Commission is a creature of statute and may exercise only those powers that are

expressly conferred upon it by the legislature. Duquesne Light Company's Post-Hearing Brief at 12 (citing Feingold v. Bell of Pa., 383 A.2d 791, 794 (Pa. 1978)). The Commission must act within its jurisdiction. Duquesne Light Company's Post-Hearing Brief at 12 (citing City of Pittsburgh v. Pa. Pub. Util. Comm'n., 43 A.2d 348, 348 (Pa. Super. 1945)). Subject matter jurisdiction is a prerequisite to the exercise of power to decide a controversy. Duquesne Light Company's Post-Hearing Brief at 12 (citing Hughes v. Pa. State Police, 619 A.2d 390, 393 (Pa. Cmwlth. 1992)). The Commission is only authorized to hear complaints regarding the Code, Commission Regulations, or a Commission order. Duquesne Light Company's Post-Hearing Brief at 12-13 (citing 66 Pa. C.S. § 701; Haleema B. Alkhatib v. PECO Energy Co., C-2011-2242125, 2012 WL 641672, at *5 (Pa. P.U.C. Jan. 12, 2012)). The Commission does not have jurisdiction over claims arising under the United States Constitution. Duquesne Light Company's Post-Hearing Brief at 13 (citing White v. PPL Elec. Utilities Corp., Docket No. C-2018-3003468, 2019 WL 2250756 (Pa. P.U.C. May 6, 2019) (Barnes, ALJ) (Commission has no jurisdiction to determine if the installation of a smart meter violates a complainant's constitutional rights); Alice Ann Belmonte-Gates v. PECO Energy Co., F-2012-2332583, 2013 WL 596066, at *7 (Pa. P.U.C. Jan. 24, 2013) (Commission does not have jurisdiction over matters involving federal civil rights) (Cheskis, ALJ); James Coppedge v. PECO Energy Co., F-2009-2135893, 2010 WL 3183815, at *5-6 (Pa. P.U.C. July 29, 2010) (Commission does not have jurisdiction over issues arising under the United States Constitution)).

In Coppedge, a complainant alleged that an EDC violated his rights under the United States Constitution by placing incorrect charges on his bill. Duquesne Light Company's Post-Hearing Brief at 13 (citing James Coppedge v. PECO Energy Co., F-2009-2135893, 2010 WL 3183815, at *1 (Pa. P.U.C. July 29, 2010)). The EDC filed preliminary objections, asserting that the Commission had no authority to grant the requested relief. Duquesne Light Company's Post-Hearing Brief at 13 (citing Id. at *2). The presiding administrative law judge sustained the EDC's

preliminary objections. Duquesne Light Company's Post-Hearing Brief at 13 (citing Id.). After the complainant filed exceptions, the Commission held that his claims relating to violations of the United States Constitution were beyond the Commission's subject matter jurisdiction. Duquesne Light Company's Post-Hearing Brief at 13 (citing Id. at *5).

Similarly in White, a customer filed a complaint to prevent an EDC from installing a smart meter at her residence. Duquesne Light Company's Post-Hearing Brief at 13 (citing White v. PPL Elec. Utilities Corp., Docket No. C-2018-3003468, 2019 WL 2250756, at *1 (Pa. P.U.C. May 6, 2019) (Barnes, ALJ)). She argued that she should be permitted to opt-out of receiving a smart meter because it violated her right to religious freedom under the United States Constitution. Duquesne Light Company's Post-Hearing Brief at 13 (citing Id. at *10). The presiding administrative law judge ruled that the Commission had no jurisdiction to rule upon this issue; instead, the Commission could only determine if the EDC violated the Public Utility Code, a Commission order or regulation, or the utility's tariff. Duquesne Light Company's Post-Hearing Brief at 13 (citing Id. at *11).

In this case, as in Coppedge and White, the Commission and Presiding ALJ do not have jurisdiction over claims arising under the United States Constitution. Thus, the Presiding ALJ correctly rejected Complainant's claim that Duquesne Light violated his constitutional rights by seeking to install a smart meter at his service address.

IV. CONCLUSION

Duquesne Light respectfully requests that the Commission deny the Exceptions, adopt the Initial Decision, and dismiss the Amended Formal Complaint. The Exceptions provide no basis to overturn the Initial Decision because they identify no finding of fact or conclusion of law that is allegedly incorrect. Further, the Commission has repeatedly held that Act 129 does not permit customers to opt-out of receiving a smart meter, which is what Complainant seeks to do here. Moreover, Duquesne Light's Tariff - which has the force of law - requires the Company to install

a smart meter at Complainant's service addresses. Finally, the Fourth Amendment to the United States Constitution (or any other constitutional provision) does not apply to this situation. For these reasons, the Initial Decision is correct and should be adopted by the Commission.

Respectfully submitted,

TUCKER ARENSBERG, P.C.

/s/ Paul Shane Miller

Jeremy V. Farrell, Esquire
PA I.D. No. 316258
Paul Shane Miller, Esquire
PA I.D. No. 319174
1500 One PPG Place
Pittsburgh, PA 15222
Counsel for Respondent, Duquesne Light Company

EXHIBIT "A"

1. Geoffrey Day is the ~~estate~~ owner of 1699 and 1699 ½ Suburban Avenue, Pittsburgh, PA, ~~15216.~~

2. 1699 Suburban Avenue does not presently have a smart meter installed at that property.

3. Duquesne Light has installed a smart meter at 1699 ½ Suburban Avenue.

4. ~~The~~ Duquesne Light is an electric distribution company with more than 100,000 customers that falls within the scope and jurisdiction of Act 129 of 2008.

5. At the hearing scheduled for August 21 + 22, 2019, Mr. Day appeared to testify on his own behalf. He does not plan to present additional witnesses.

6. At the hearing ~~on~~ scheduled for August 21, and 22, 2019, Duquesne Light planned to call eight witnesses ① Michael Belanger, ② Steven Wright, ③ Ben Cotts, ④ Gabor Mezei, ⑤ Michael Secchuitti, ⑥ Ron Dorrin, ⑦ Michael Tullient, and ⑧ Roxanne Morris. These witnesses were prepared to testify about the subjects identified in Duquesne Light's List of Potential Witnesses dated

6 (cont). February 1, 2019. Drs. Lotts + Mezei would also testify as expert witnesses on the subjects covered in their ~~respe~~ expert reports dated August 13, 2019, and August 12, 2019, respectively. ~~Copies of~~ ~~said~~ ~~Those reports~~ Duq. Light's witness list, Dr. Lotts' report, + Dr. Mezei's reports are attached as Ex. A, B, + C respectively.

7. Mr. Day is withdrawing all ~~compone~~ allegations and concerns raised in the Complaint + Amended Complaint filed at Docket No. C-2018-3003960, with the exception of the ~~legal issue~~ question of law of whether Duquesne Light ~~is required~~ has the lawful right to install a smart meter at 1699 + 1699 ½ Suburban Avenue by Act 129 of 2008 and the ~~associ~~ Pennsylvania Public Utility Commission's Implementation Order, even though Mr. Day does not consent to the installation of the smart meter.

8. The parties have agreed to brief the sole question of law referenced in para. 7, above, in accordance with the schedule ~~e~~ established by the presiding ALJ.

Geoffrey Day,
Complainant

Jeremy V. Farrell,
Counsel for Duquesne Light

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

GEOFF DAY,

Complainant,

v.

DUQUESNE LIGHT COMPANY,

Respondent.

No: C-2018-3003960

RESPONDENT'S LIST OF POTENTIAL WITNESSES

Served on Behalf of Respondent
Duquesne Light Company

Counsel of Record for this Party:

Jeremy V. Farrell, Esquire
Pa. I.D. No. 316258

Paul Shane Miller, Esquire
Pa. I.D. No. 319174

Tucker Arensberg, P.C.
1500 One PPG Place
Pittsburgh PA 15222
(412) 566-1212

Ex. A

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

GEOFF DAY,	:	
Complainants,	:	
vs.	:	No: C-2018-3003960
DUQUESNE LIGHT COMPANY,	:	
Respondent.	:	

RESPONDENT'S LIST OF POTENTIAL WITNESSES

In accordance with the Interim Order Establishing Initial Litigation Schedule dated December 14, 2018, Respondent Duquesne Light Company identifies the following individuals who it may call as fact or expert witnesses at the hearing of this matter.

Duquesne Light identifies the following individuals based on the allegations Complainant raised in the Formal Complaint. Because (1) Complainant has not yet provided full and complete responses to Respondent's discovery requests, (2) discovery remains open until April 1, 2019, and (3) Complainant has not yet identified any expert witnesses or produced any expert reports, Duquesne Light reserves the right to modify or supplement the information provided below in order to respond to information and/or allegations subsequently made by Complainant.

EXPERT WITNESSES

1. Benjamin Cotts, Ph.D., P.E.
   Senior Managing Engineer
   Exponent Failure Analysis Associates
   17000 Science Drive Suite 200
   Bowie, MD 20715

   Dr. Cotts is a Senior Managing Engineer in the Electrical Engineering and Computer Science Practice at Exponent, Inc., who would offer expert testimony and opinion in response to the electromagnetic and radiofrequency (RF) exposure concerns raised by Complainant and/or any expert witnesses offered by Complainant. Based on the

current record (and subject to the reservations noted above), Duquesne Light expects that Dr. Cotts will testify about the RF signal technology used by smart meters to communicate as well as the relative levels of RF that are expected during smart meter transmissions. Dr. Cotts will describe the RF exposure from Duquesne Light's smart meters and compare the emissions from Duquesne Light's smart meters to Complainant's exposure from other RF sources, both natural and anthropogenic, to demonstrate that Duquesne Light's smart meters will represent a negligible contribution to Complainant's overall RF exposure, that the RF exposure from other existing sources are many times greater than from the typical Duquesne Light smart meter, and that the RF exposure from the typical Duquesne Light meter represents a fraction of the allowable FCC limit and complies with applicable industry standards and best practices.

All of Dr. Cotts' opinions will be offered within a reasonable degree of scientific and engineering certainty.

2. Gabor Mezei, M.D., Ph.D.
Senior Managing Scientist - Health Sciences
Exponent
149 Commonwealth Drive
Menlo Park, CA 94025

Dr. Mezei is a medical doctor and epidemiologist with Exponent Inc., who would offer expert opinion and testimony in response to Complainant's allegations about the adverse health effects that would allegedly stem from the installation of a smart meter at the service address. Based on the current record (and subject to the reservations noted above), Duquesne Light anticipates that Dr. Mezei will conduct a weight-of-the-evidence review of the relevant scientific and medical literature and research and opine that there is no causal relationship between environmental exposure to RF fields, including those from smart meters being operated by Duquesne Light, and adverse human health effects. He will also explain that the estimated exposure to RF from the smart meters being operated by Duquesne Light is below internally-accepted, scientifically-based exposure guidelines like those set by the FCC and ICNIRP.

All of Dr. Mezei's opinions will be offered within a reasonable degree of medical and scientific certainty. Duquesne Light reserves Dr. Mezei's right to testify on Complainant's medical issues to the extent he raises them.

FACTUAL WITNESSES

1. Michael Secchiutti Michael Secchiutti (Senior Manager, Smart Meter Operations) and/or Yvonne Phillips (Director, Meter Operations)
Duquesne Light Company
411 Seventh Avenue
Pittsburgh, PA 15219

These witnesses will testify about Duquesne Light's smart meter implementation plan, operational features of Duquesne Light smart meters, the read schedule utilized by

Duquesne Light's smart meters, the nature of information collected by Duquesne Light's smart meters, the network within which Duquesne Light's smart meters operate (including security features thereof), and the benefits the smart meter system provides to Duquesne Light's customers, and Duquesne Light's compliance with applicable regulations, standards, and best practices.

2. Kevin Baden (Supervisor - AMI Field Services) and/or David Defide (Manager, Customer Programs)
   Duquesne Light Company
   411 Seventh Avenue
   Pittsburgh, PA 15219

   These witnesses will testify about the notices/information Duquesne Light provides to its customers relating to smart meters as well as other customer service issues relating to the installation and operation of Duquesne Light's smart meters, including the notice of anticipated smart meter installation provided to Complainants.

3. Karen Skovran (Manager, Meter Operations)
   Duquesne Light Company
   1800 Seymour Street
   Pittsburgh, PA 15233

   Ms. Skovran will testify about the manner in which Duquesne Light's smart meters are installed at customer premises and the related policies and procedures.

4. Ron Dornin (Manager, Metering Systems), and/or John Pawling (Meter Support Specialist)
   Duquesne Light Company
   2645 New Beaver Ave.
   Pittsburgh, PA 15233

   These witnesses will testify about the manner in which Duquesne Light's smart meters are installed at customer premises, training provided to Company personnel, and the related policies and procedures.

5. Michael Tallent (Chief Information Security Officer)
   Duquesne Light Company
   411 Seventh Avenue
   Pittsburgh, PA 15219

   Mr. Tallent will testify about the cybersecurity and privacy protections and other encryption features that have been implemented with respect to Duquesne Light's information systems.

6. Roxanne Morris (Supervisor of Regulatory Consumer Relations) and/or Duquesne Light Records Custodian

Duquesne Light Company
411 Seventh Avenue
Pittsburgh, PA 15219

Ms. Morris, or another records custodian employed by Duquesne Light, would offer basic account information relating to the service address and authenticate relevant company records and tariff provisions.

7. Mike Belanger (Senior Project Line Manager) and/or Steve White (Senior Project Manager)
313 N. Highway 11
West Union, South Carolina 29696

These witnesses will testify about the design, manufacture, capabilities, and operation of the smart meters used by Duquesne Light, as well as the compliance of such devices with various codes and standards, including, but not those limited to, those that relate to RF exposure and/or those set by the FCC, ANSI, IEEE, and UL.

8. Charles Rush (Field Technician)

Mr. Rush will testify regarding the pictures taken of Complainant's meter.

Duquesne Light reserves the right to call additional witnesses to respond to any additional matters raised by Complainant at the hearing, including Duquesne Light representatives who have spoken with Complainant on the subject of smart meters and their communications with Complainant.

Respectfully submitted,

Jeremy V. Farrell, Esquire
PA I.D. No. 316258
jfarrell@tuckerlaw.com
Paul Shane Miller, Esquire
PA I.D. No. 319174
smiller@tuckerlaw.com
1500 One PPG Place
Pittsburgh, PA 15222
(412) 566-1212
(412) 594-5619 (fax)
Counsel for Respondent

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

GEOFF DAY,	:	
	:	
Complainant,	:	
	:	
vs.	:	No: C-2018-3003960
	:	
DUQUESNE LIGHT COMPANY,	:	
	:	
Respondent.	:	

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a true copy of the foregoing Respondent's potential witness list upon the participant listed below in accordance with the requirements of 52 Pa. Code § 1.54 (relating to service by a participant):

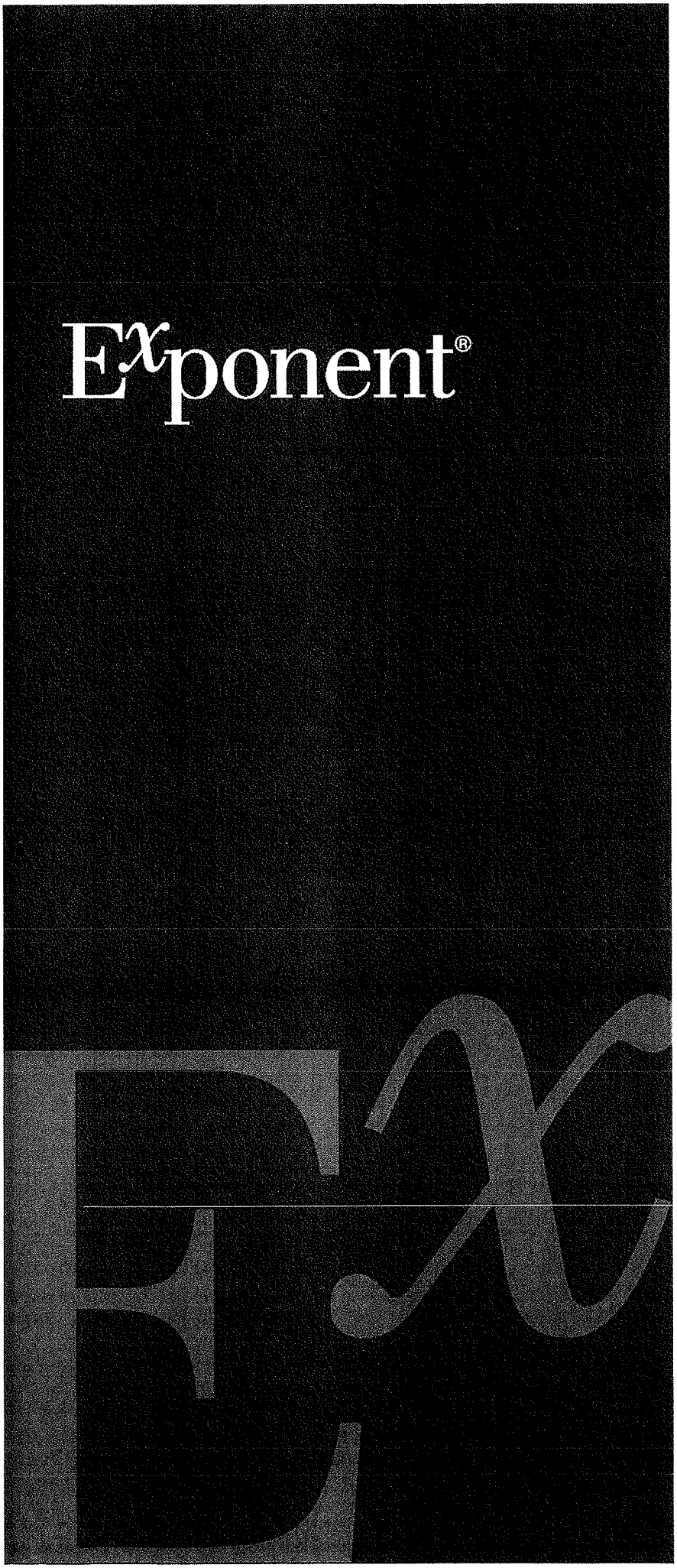
Geoff Day
1699 Suburban Avenue
Pittsburgh, PA 15216
Ceros78@gmail.com
Via Email and Mail

Administrative Law Judge Jeffrey Watson
Pennsylvania Public Utility Commission
Office of Administrative Law Judge
Piatt Place, Suite 220
301 Fifth Avenue
Pittsburgh, PA 15222

Dated this 1st day of February, 2019

Jeremy V. Farrell, Esquire
PA I.D. No. 316258
jfarrell@tuckerlaw.com
Paul Shane Miller, Esquire
PA I.D. No. 319174
smiller@tuckerlaw.com
1500 One PPG Place
Pittsburgh, PA 15222
(412) 566-1212
(412) 594-5619 (fax)
Counsel for Respondent

TADMS:5091649-1 014657-158498



Electrical Engineering & Computer Science Practice

Report of Benjamin Cotts, Ph.D., P.E.

Re: Geoff Day v. Duquesne Light Company, Pennsylvania Public Utility Commission Docket No. C-2018-3003960

Ex. B

Report of Benjamin Cotts, Ph.D., P.E.

Re: Geoff Day v. Duquesne Light Company, Pennsylvania Public Utility Commission Docket No. C-2018-3003960

Prepared for

Duquesne Light Company
411 7th Avenue
Pittsburgh, PA 15219

Prepared by

Benjamin Cotts, Ph.D., P.E.
Exponent, Inc.
17000 Science Drive, Suite 200
Bowie, MD 20715

August 13, 2019

EXHIBIT N2

Contents

List of Figures

List of Tables

Acronyms and Abbreviations

AC	Alternating Current
AM	Amplitude modulated
cm	Centimeter
DC	Direct Current
DLC	Duquesne Light Company
FM	Frequency modulated
FCC	Federal Communications Commission
GHz	Gigahertz
HAN	Home area network
ICNIRP	International Commission on Non-Ionizing Radiation Protection
Itron, Inc.	Itron
IEEE	Institute of Electrical and Electronics Engineers
LAN	Local area network
MHz	Megahertz
mW/cm^2	Milliwatts per square centimeter
OET	Office of Engineering and Technology
RF	Radiofrequency
SAR	Specific absorption rate
W/cm^2	Watts per square centimeter
W/kg	Watts per kilogram
W/m^2	Watts per square meter

Executive Summary

Electric power utilities throughout the United States are in the process of modernizing their infrastructure in what has come to be known as a "smart grid." In Pennsylvania, Act 129 of 2008 required the deployment of smart meters, and Duquesne Light Company (DLC) selected OpenWay Centron smart meters provided by Itron, Inc. (Itron) for their network.

I have been retained in this matter by DLC in the matter of Geoff Day v. Duquesne Light Company, before the Pennsylvania Public Utility Commission No: C-2018-3003960. My services have been requested in order to provide context on radiofrequency (RF) exposures that are the focus of concerns raised by the Complainant in this matter.

My report describes the RF signal technology that smart meters use to communicate and the relative levels of RF fields that are expected during transmissions. This provides a basis for describing the RF exposure from DLC smart meters and explaining how this exposure compares to the Complainant's exposures from other RF sources, both natural and anthropogenic.

Through my investigation of the DLC Itron smart meters as well as existing RF sources near the Complainant's home, I have determined that the contribution of a typical smart meter to the RF exposure indoors would be about 0.00013% (1/780,000th) of the Federal Communications Commission's (FCC) health-based exposure limit. Furthermore, potential exposures from DLC smart meters are substantially less than the RF exposures from common natural and manmade sources.

Based on my review of the facts in this case, the available material, my background, experience and training, and my work completed to date, the following opinions are submitted within a reasonable degree of engineering and scientific certainty:

1) The Itron smart meters operated by DLC will represent a negligible contribution to the overall RF exposure of the Complainant.
2) The RF exposures from other common sources are many times greater than from a typical DLC smart meter.

3) The RF exposure from a typical DLC smart meter, whether evaluated inside or outside the Complainant's residence, represents a fraction of the allowable FCC limit and complies with applicable industry standards.

I reserve the right to revise or amend these opinions and conclusions if additional information becomes available or if further analysis is performed.

Introduction

Electric power utilities throughout the United States are in the process of modernizing their infrastructure in what has come to be known as a "smart grid." One component of this modernization is termed advanced metering infrastructure, also known as a "smart meter." A hallmark feature of smart meters that sets them apart from their predecessors is the capability of using radiofrequency (RF) signals for two-way wireless radio communication. Two-way wireless radio communication is supported by miniature radio transceivers that communicate electricity consumption back to the utility and receive signals from the utility.

Pennsylvania's Act 129 of 2008 required the deployment of smart meters and Duquesne Light Company (DLC) selected OpenWay Centron smart meters provided by Itron, Inc. (Itron) for their network. Similar to many other smart meter mesh networks, the DLC network operates in the license-free 902-928 megahertz (MHz) portion of the electromagnetic spectrum.

DLC has requested that I provide the scientific background underlying the nature of electromagnetic fields, their natural and manmade sources, and standards relating to human exposure to these fields.

My educational background, qualifications, and Curriculum Vitae are summarized in Appendix A. Appendix B includes a figure from the Federal Communications Commission (FCC) that depicts the various portions of the RF spectrum. The figure illustrates the uses and applications of the many hundreds of RF communication frequency bands licensed in the United States. Appendix C summarizes the methods and results of calculations of exposure to RF from a smart meter at the Complainant's residence.

1. Basic Physics of Electromagnetics

Though not widely recognized, the most common electromagnetic field to which we are exposed every day is naturally-occurring visible light. There are other natural sources as well as man-made sources. There are extremely low frequency sources such as the fields from power transmission and distribution lines and higher frequency sources that are associated with transmission of radio and television broadcast signals as well as from various wireless personal communication devices used daily in modern society.

The primary defining characteristic of electromagnetic fields is their frequency. The frequency of an electromagnetic field is determined by the number of times it oscillates (i.e., changes direction) each second, and frequency is what governs how these fields interact with humans in their daily lives.[1]

Electromagnetic Waves

It is difficult to intuitively understand electromagnetic waves because not only are most invisible to the human eye, but they cannot be heard, tasted, touched, or smelled. Other types of waves such as sound waves or water waves on the other hand are quite familiar and can be used through analogy to illustrate some of the relevant properties of electromagnetic waves. For instance, when one drops a rock in a pond, the rock creates a water wave, which expands outward from the source. The wave propagating on the surface of the pond does not actually carry water molecules with it, rather the wave spreads to adjacent water molecules (propagates) when adjacent water molecules move up-and-down. The wave that has the highest amplitude (height above the pond's surface) is at the source and as it spreads outward the height of the waves gets successively smaller. Figure 1, taken with a high-speed camera, illustrates how the up and down motion of the wave is largest at the source and diminishes as it expands outward.

[1] Both electromagnetic fields and electromagnetic waves are used concurrently in this report depending on which is more intuitive and more readily understandable, but in all instances, their meaning is the same.

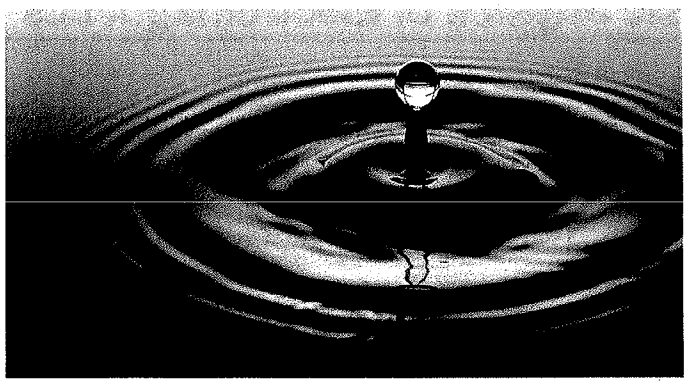


Figure 1. Illustration of the concept of wave energy movement from a source.

Electromagnetic waves are made up of individual electric fields and magnetic fields and, similar to water waves, as electromagnetic waves propagate away from the source, the amplitude (i.e., the strength of the constituent electric and magnetic fields) decreases.

The Electromagnetic Spectrum

Though often assumed to include only RF fields, the electromagnetic spectrum in fact includes all forms of electromagnetic fields. As shown in Figure 2 electromagnetic fields are broadly classified as either *non-ionizing radiation* or *ionizing radiation*.[2] *Non-ionizing radiation* includes well-known RF broadcast signals such as those from amplitude-modulated (AM) and frequency-modulated (FM) radio stations as well as television broadcasts, while light from the sun or from a flashlight are common examples of electromagnetic fields in the visible portion of the electromagnetic spectrum. Between these portions of the spectrum are the microwave (sometimes included in the definition of RF) and infrared portions of the electromagnetic spectrum. Each of these types of fields is too weak to break the bonds within atoms or molecules. In contrast, *ionizing radiation* such as from X-rays or gamma rays is strong enough to break molecular or atomic bonds.[3]

---

[2] The term radiation simply means "energy propagated through space." It is used to describe energy emitted from any particular source such as heat from a campfire, light from a flashlight, acoustic energy from a stereo system, or the broadcast signal from an FM radio antenna (http://er.jsc.nasa.gov/seh/e.html#electromagnetic radiation and http://er.jsc.nasa.gov/seh/r.html#radiation).

[3] http://www.who.int/ionizing_radiation/about/what_is_ir/en/

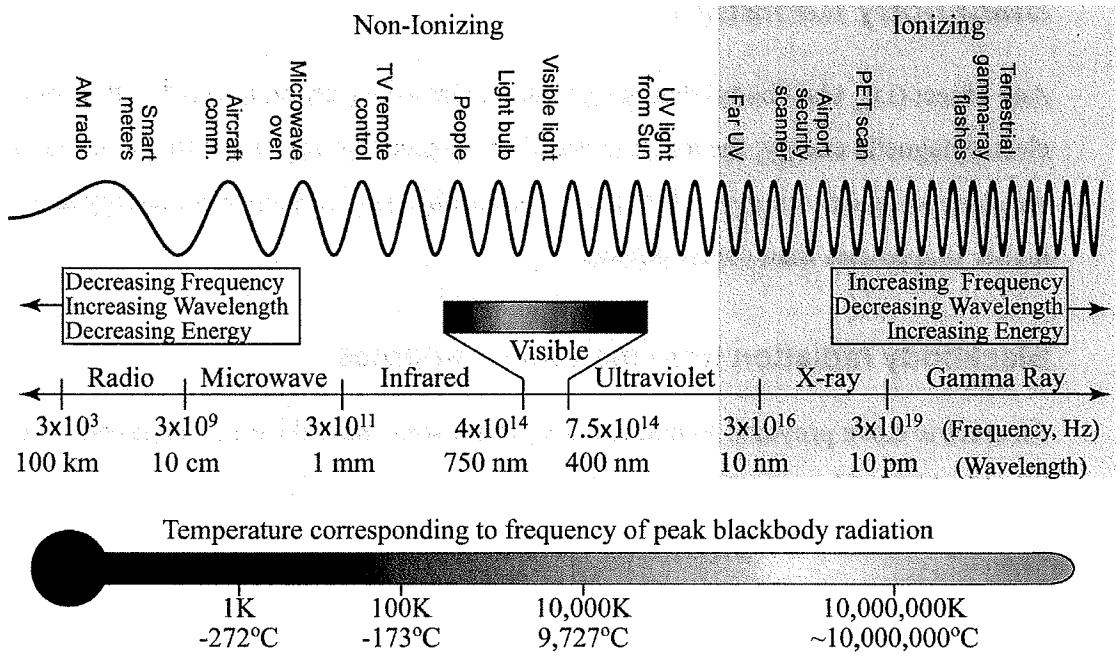


Figure 2. The electromagnetic spectrum and the relationship between frequency, wavelength, energy, and temperature.

Common Sources of Electromagnetic Fields

Modern technologies such as broadcast transmissions, radar, cellular phones, and Wi-Fi are some of the most common man-made sources of electromagnetic fields, but in fact natural sources of RF are far more common and include lightning, the earth itself, and even other organisms, including humans.

Although it is a common phenomenon, the concept that the earth and humans, as well as virtually all objects, are sources of electromagnetic fields warrants additional attention. Extremely hot objects such as the sun produce electromagnetic fields primarily in the visible and ultraviolet portions of the spectrum, while colder objects such as the earth produce fields primarily in the infrared portion of the spectrum. This phenomenon is called thermal radiation or heat radiation, while scientists refer to it as blackbody radiation.

Blackbody Radiation

Any object (i.e., blackbody) that has a temperature above absolute zero[4] will radiate electromagnetic energy; the temperature of the object determines the frequency at which most of the electromagnetic energy will radiate. Hotter objects emit both more energy and energy at higher frequencies than colder objects.

Blackbody radiation from man-made sources

An electric stove provides a good example to illustrate how the electromagnetic energy emitted by a blackbody changes at colder and hotter temperatures. When the stove burner is first turned on it begins to heat up and produces stronger electromagnetic fields in the infrared portion of the spectrum than in the visual portion. This means that the burner still appears the same (black) but the electromagnetic energy can be felt by placing a hand nearby and feeling the infrared heat. Once the burner gets hot enough it begins to glow reddish-orange, which is electromagnetic energy in the lower part of the visible spectrum. Household burners cannot heat beyond this point; however if the temperature did increase further it would begin to glow a yellowish-white color (in the higher portion of the visible spectrum). At still hotter temperatures such as from a welder's torch, the light would become bluish (the highest part of the visible spectrum), and at even higher temperatures, the light from the welder's torch would be in the ultraviolet range.[5]

Blackbody radiation from natural sources

As noted above, any object that has a temperature above absolute zero radiates electromagnetic energy and it does so at all frequencies (although very small amounts at very low or very high frequencies). Since humans and the earth both have a temperature of ~300 Kelvin, they emit the most electromagnetic energy in the infrared portion of the electromagnetic spectrum (i.e., it can be seen with the use of infrared imagers), but a very small portion of that energy is also emitted

---

[4] Absolute zero is the temperature at which the motion of molecules theoretically stops, which is 0 on the Kelvin scale and equivalent to about -273 degrees Celsius or about -460 degrees Fahrenheit.

[5] The emission of this intense heat and ultraviolet light are among the reasons that welders need to wear protective glasses when performing their work.

in the radio and microwave portions of the electromagnetic spectrum. Humans and the earth are therefore sources of RF energy (albeit very small sources).

Radiofrequency Communications

RF fields are an integral part of modern technology; they are used in emergency beacon services, air traffic control systems, cell phones, and smart meters, to name a few. RF fields are also widely used in scientific research and many more industrial, commercial, medical, and personal applications. In addition to frequency discussed above, **power, duty cycle, reflection, and attenuation** are concepts that are common to most RF communication; these concepts are particularly important to understand how much RF energy a person may be exposed to from a variety of RF sources including smart meters.

Power

The importance of power is obvious, as higher output power leads to higher RF signal levels and thus higher potential RF exposure. The other factors are discussed in greater detail below.

Duty Cycle

One of the important ways in which man-made sources differ from one another is in how often and in what patterns they transmit. Some sources transmit all the time at relatively constant power levels (e.g., FM radio and television broadcasts) while others transmit all the time but vary how much power is transmitted (e.g., Wi-Fi and AM radio). Intermittent operation is used by technology that only transmits based on data transfer needs and user demand. For example, smart meters transmit only when they need to transfer data; microwave ovens only emit RF fields when they are used; and cell phones transmit both based on user demand and when they interact with the mobile network.[6]

[6] Some cell phones may also change transmission power output based upon circumstances while smart meters always transmit with the same power output.

In the case of RF exposure to sources, these transmission patterns can be simplified into a "duty cycle" of a source. Duty cycle is determined as a percentage of time a source is used based on how often the source transmits information, and the duty cycle of a device that utilizes an intermittent transmission pattern can be reported as either an operational duty cycle or an average duty cycle. For example, sources that transmit continuously, whether at constant or varying power, have a duty cycle of 100%.

The duty cycle of a source with an intermittent transmission pattern will vary depending on use. For example, a CDMA cell phone used for 6 minutes in a 30-minute period has as a duty cycle of 20%, while one used for 1.5 minutes in a 30-minute period has a duty cycle of 5%.[7,8] In contrast, a smart meter sends information in a series of short transmissions typically of a few hundred milliseconds or less. The duty cycle of DLC smart meters depends on a number of factors (discussed in more detail in the following Section); these units have an *average* duty cycle near 0.06% (transmitting for only a few seconds per day) and a maximum expected duty cycle of 0.58% (Itron, 2011).

Reflection and Attenuation

When an electromagnetic wave reaches a boundary (such as the ground or a wall) part of the energy from the wave will reflect from that boundary and some will be transmitted through. The amount of energy reflected and the amount that passes through depends both on the frequency of the electromagnetic wave and on the material properties of the boundary.

The building materials of an individual's home therefore can have a significant effect on a person's RF exposure from external sources. For an example at the frequency of smart meters or cellular phones, an 8-inch thick concrete wall allows less than 1% of incident RF energy

---

[7] CDMA stands for "Code-Division Multiple Access." When a call is made, a CDMA phone transmits continuously. This calculated *operational* duty cycle example should not be confused with the duty cycle of the emission of a CDMA telephone when in use.

[8] GSM stands for "Global System for Mobile" communications and is another communication technology used by cellular phones. Rather than transmitting continuously, a GSM phone transmits only 1/8th of the time, but at 8 times the power of a CDMA transmission. The duty cycle *of the emissions* from a GSM telephone when in use is therefore 12.5%. If a GSM phone is used for 6 minutes in a 30-minute period, then the total duty cycle is the product of the *operational* duty cycle and the duty cycle of the emissions: 20% x 12.5% = 2.5%.

through, while a 3.5-inch thick brick wall allows about 45% of the energy through, and a 0.75-inch thick plywood wall allows over 80% of the energy through (NIST, 1997).[9]

Distance from the Source

While a boundary will cause some of the energy in an electromagnetic wave to reflect (i.e., attenuate), distance from the source also causes attenuation, even if the wave does not pass through any material that causes it to lose energy. This attenuation is due simply to the expansion of the wave, similar to the motion of water described above. When the wave is transmitted, it has a finite amount of energy concentrated at the source. As the wave expands, this same amount of energy is spread out over a larger and larger area so that the amount of energy in any particular location decreases as the wave gets farther from the source. The power density of the RF field decreases with the square of the distance from the source according to the inverse-square law.[10] So, an individual located 10 yards away from a source will be exposed to 100 times less RF energy than an individual located 1 yard away from the same source.

[9] At lower frequencies, such as those used in television or radio broadcast, the fraction of energy that passes through these materials is substantially higher.

[10] A discussion of the inverse square law specific to smart meters is provided in Appendix C.

2. Smart Meters and Mesh Networks

The primary purpose of smart meters in the DLC network is to record electricity usage at residences and other buildings and transmit that usage wirelessly back to DLC. The smart meters used by DLC communicate in the frequency range of 902 to 928 MHz.[11]

Most radio communication devices used in the United States must be certified by the FCC. The FCC certification number for the Itron Centron smart meters deployed by DLC is SK9AMI7, according to which, the transmission power of these smart meters is less than 1 watt.

Smart Meter Mesh Network

A smart meter mesh network is a collection of smart meters deployed in the same geographic area. The term mesh network derives from considering each smart meter as a node and visualizing the communication paths between each node as lines. When all the nodes in their respective locations are connected to one another by drawn lines, the resulting picture looks like wire mesh. Each smart meter in the network has the capability of communicating with other nearby smart meters as well as with cell relays, which act as collection units. The role of the collectors within the mesh network is to gather the data from the individual smart meters and send the information back to the utility company.

A smart meter network operates by transmitting information at a low power level to a nearby neighbor (a "hop"). This second smart meter transmits information onward, also at a low power level, and this step is repeated from smart meter to smart meter in several hops until the information from all the smart meters in the chain reach the collector. Figure 3 illustrates the hopping process to a collector (cell relay). The most efficient communication paths are shown by solid black arrows, typically using the shortest individual hops to get back to the cell relay. The gray arrows show alternate paths that can be used if a bottleneck or fault occurs.

[11] The Itron Centron smart meters are also capable of communicating in Industrial, Scientific, Medical (i.e., ISM) radio bands in the 2.4 to 2.5 GHz range via an IEEE standard 802.15.4 Zigbee Radio, at much lower power output of approximately 65 milliwatts.

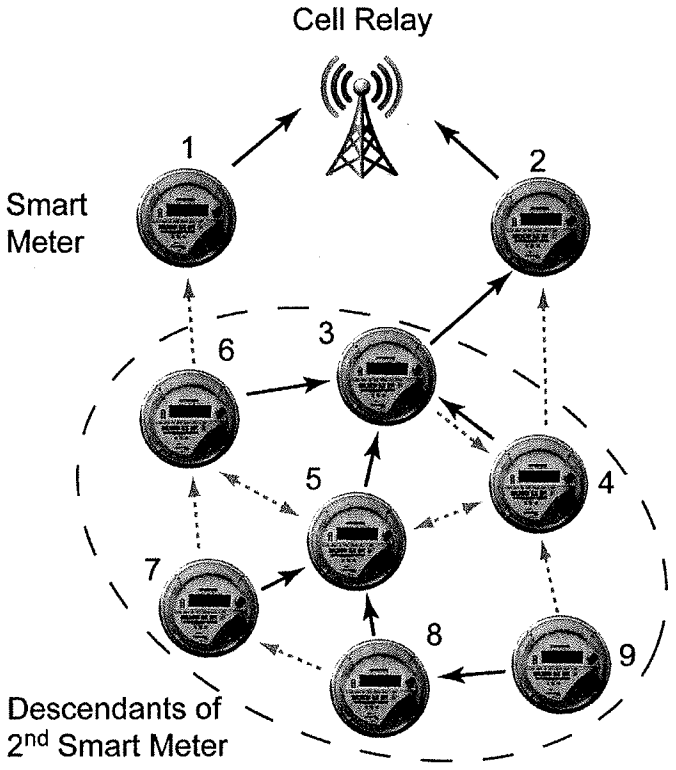


Figure 3. Illustrative example of a smart meter mesh network.

The close proximity of neighboring smart meters and the ability to communicate with one another is one of the primary advantages of a mesh network. Transmissions between nearby smart meters can be made with relatively low power levels while if meters could only communicate with the collectors then only smart meters physically close to collectors could transmit efficiently at lower power; more distant smart meters would need to transmit significantly more power.[12] In Figure 3, smart meters 1 and 2 are close enough to interact directly with the collector while smart meters 3 through 9 are too far from the collector to interact directly and use hops to transmit to smart meter 2 for transmission to the collector. Since smart meters 3 through 9 eventually transmit their data to smart meter 2, they are called descendants of smart meter 2. This scenario illustrates that while many smart meters will transmit only their own data, most meters will also transmit the data of descendant meters.

[12] For example, a smart meter located approximately 500 yards from a communicator would need to transmit a signal about 10,000 times stronger than a smart meter located 5 yards away from the collector.

Typical Smart Meter Operation

Unlike other common devices that communicate using RF fields, the amount of data a smart meter transmits is very small so they only need to communicate for a very short time each day. According to DLC, there are two to three scheduled data requests from each smart meter every 24 hours. In addition to these scheduled data requests, each smart meter must confirm its capability to connect with at least one other smart meter to maintain the communication capability of the network. This communication occurs approximately every 30 minutes by sending out a very brief beacon signal transmission.[13]

Smart Meter Duty Cycle

The amount of data each smart meter transmits will vary widely depending on where it is located within the mesh network and the amount of data it must transfer from descendants. The minimum, average, and maximum duty cycles in the DLC smart meter network are summarized in Table 1. Additional analysis regarding the OpenWay network indicates that the vast majority (97.95%) of smart meters in the DLC network transmit for less than 100 seconds per day, a duty cycle of less than 0.12% per day (Itron, 2011).

Table 1. Duty cycle of DLC smart meters*

Duty Cycle Description	Duty Cycle Value
Minimum	0.02% (18.31 seconds per day)
Average	0.06% (53.14 seconds per day)
Maximum	0.58% (497.8 seconds per day)

* Itron, (2011)

Home Area Network

In addition to the RF signals used by smart meters to communicate within the mesh network (the Local Area Network [LAN]), each smart meter is also equipped with a second RF transmitter (i.e., a Zigbee Radio) that transmits at 2.4 gigahertz (GHz) and allows the smart meter to communicate over a Home Area Network (HAN). If the consumer chooses, the HAN allows compatible appliances in the home to interact with the smart meter and evaluate how

[13] Information received from DLC.

much power that appliance consumes relative to the total power consumption of the home. The transmission power of the Zigbee Radio is approximately 10 times lower than that of the RF LAN signal from the smart meter due to the smaller distance over which communication needs to take place. The duty cycle of the Zigbee Radio is shown below in Table 2 for an idle Zigbee Radio (with no devices joined) or a meter with an example device joined (an in-home display).

Table 2. Duty cycle of the Zigbee Radio in DLC smart meters*

Duty Cycle Description	Duty Cycle Value
Idle Zigbee Radio (no devices joined)	0.01% (9.9 seconds per day)
Meter with Tendril HD (In Home Display)	0.15% (132 seconds per day)

* Information received from DLC.

3. Standards

Radiofrequency Fields

In the United States, the government agency responsible for regulating RF-emitting devices is the FCC. These regulations are included in the Code of Federal Regulations Title 47 (§1.1310 and §2.1093) and are based upon the recommendations of organizations such as the National Council for Radiation Protection and the Institute of Electrical and Electronics Engineers (IEEE), and input from federal health agencies including the Environmental Protection Agency, National Institute for Occupational Safety and Health, and the Occupational Safety and Health Administration. The IEEE developed exposure limits for electromagnetic fields based on lengthy and comprehensive assessments of the scientific literature, a process also undertaken by other international agencies such as the European-based International Commission on Non-Ionizing Radiation Protection (ICNIRP).

These limits restrict the amount of energy the FCC has determined that the body can safely absorb without adverse effect. This is described as the specific absorption rate (SAR) and is measured in units of watts per kilogram (W/kg). This quantity is difficult to measure in practice, so the FCC also provides a maximum permissible exposure that limits the strength of an RF field outside the body, which is more easily measured. The FCC limits for the general public at frequencies of smart meter transmissions (900 MHz and 2.4 GHz) are summarized in Table 3 along with the current IEEE and ICNIRP standards, which incorporate safety factors of 50 or more.[14,15,16]

---

[14] The FCC, in OET 56, 1999, states that the "...exposure criteria are based on a determination that potentially harmful biological effects can occur at an SAR level of 4 W/kg as averaged over the whole-body. Appropriate safety factors have been incorporated to arrive at limits for both whole-body exposure (0.4 W/kg for "controlled" or "occupational" exposure and 0.08 W/kg for "uncontrolled" or "general population" exposure, respectively) and for partial-body (localized SAR), such as might occur in the head of the user of a hand-held cellular telephone."

[15] Additional details regarding the exposure limits, averaging times, and body locations where SAR limits are defined are provided in OET 65, 1997 and OET 56, 1999, among others.

[16] Both ICNIRP and the IEEE are in the process of updating their standards with a focus on frequencies > 6 GHz. Publicly available information indicates no change to the standard levels at the frequencies of DLC smart meter operation. Both revised standards are expected to be released in 2019.

Table 3. Exposure limits specified by the FCC, IEEE, and ICNIRP

Agency	Power Density Limit at 900 MHz (W/m^2)	Power Density Limit at 2.4 GHz (W/m^2)	SAR Limit (W/kg)
FCC (CFR §1.1310 and §2.1093)	6	10	0.08 (Whole body) 1.6 (over any 1 gram of tissue)
ICNIRP (1998)	4.5	10	0.08 (Whole body) 2 (over any 10 gram of tissue)
IEEE, (C95.1, 2005)	4.5	10	0.08 (Whole body) 2 (over any 10 gram of tissue)

Conducted Emissions

In addition to concerns related to the RF fields produced during smart meter communication, the Complainant also has expressed concern regarding the switching mode power supply used in the smart meter. Switching mode power supplies convert electricity from alternating current (AC) to direct current (DC) power. Switching mode power supplies are more efficient and smaller than previously used linear power supplies but require filtering elements to remove higher-frequency electromagnetic noise from producing a conducted emission, or "electromagnetic energy that is propagated along a conductor" (ANSI C63.14). In the context of the electrical power grid or wiring within the home, this refers to energy that deviates from the desired pure 60-Hz sine wave. Switching power supplies are used in many household devices including most of those with power adapters (such as laptop computers) as well as desktop computers, television sets, and many other common household items. (EPRI, 2006).

Conducted emissions (including over utility wiring), also are regulated by industry and governmental organizations through standards and regulations to limit these conducted emissions. Electrical utility meters (whether analog, digital, or smart meters) are tested for conducted emissions according to the American National Standard Institute's Standard C12.1, which requires specific test procedures, and results are limited by the Code of Federal Regulations Title 47 (§15.207). The DLC Itron meters have been tested to and are in compliance with ANSI C12.1-2008 (ACS, 2011)

4. Sources of Radiofrequency Fields

Natural RF Sources

As discussed in the introduction, some of the natural sources of RF fields are produced by blackbody radiation from warm objects such as the earth and humans; the representative RF exposure values for these sources are summarized in Table 4 (ICNIRP, 2009).

Table 4. RF exposure values for common natural RF sources

Source	RF Exposure (mW/cm^2)	RF Exposure (% of FCC Limit)
Blackbody radiation from the earth	1.3	0.0027
Blackbody radiation from humans	3	0.0054

Common Manmade RF Sources

There are numerous manmade sources of RF fields, including devices used for communications and many other purposes. Communication devices commonly used in homes, businesses, and public spaces, such as mobile phones, Wi-Fi, and Bluetooth devices produce relatively weak fields; however, they are often used in very close proximity to the individual and may therefore result in higher exposures than remote (but more powerful) sources such as AM, FM, or television broadcast signals. Other devices that emit RF fields, like microwave ovens and radar guns, are used for non-communication purposes such as heating food or measuring speed and distances. A brief list of specific sources is included in Appendix B, Table B-1. Figure B-1 in Appendix B shows the many hundreds of RF communication bands used in modern society.

RF Sources Specific to the Complainant

In Response to Question 13 of DLC's First Set of Discovery Requests Directed to the Complainant, the Complainant lists a mobile phone and a microwave as the only devices within the home that "produce radio frequency" fields. The RF emissions from cellular phones are evaluated according to the FCC equipment authorization program (as are all RF-emitting devices sold in the United States), administered by the Office of Engineering and Technology (OET).

During the certification process, each device is assigned an FCC identification number, and is referenced for all associated records. The FCC evaluates exposure to RF energy from devices on the basis of where the devices are designed to be used. For devices (such as mobile phones) designed to be used in close proximity to the body, evaluation is required in close proximity to an RF phantom simulating the body, while for devices designed and generally used at least 20 centimeters (cm) from the body evaluation is required at 20 cm from the source device (CFR §2.1091 and §2.1093). In addition, testing and evaluation for the two device classes also differ. The FCC evaluates the maximum exposure from mobile phones at distances of a few centimeters or less and compliance with FCC limits is determined (using a 100% duty cycle) on the basis of SAR, which is a measure of how much energy is absorbed by the body and is measured in units of W/kg. The FCC evaluates exposure from other devices (designed to be used away from the body) at a distance of 20 cm and compliance with FCC limits is determined in terms of power density, which is a measure of the strength of the electromagnetic wave and is reported in units of watts per square meter (W/m^2) or milliwatts per square centimeter (mW/cm^2) where 1 mW/cm^2 equals 10 W/m^2.

The FCC-reported RF exposure for the mobile phone used by the Complainant, as well as for the Itron smart meters, is summarized below in Table 5. Of note is that these results are presented for a specific scenario (e.g., mobile phone held against the head of an RF phantom, or calculation of power density 20 cm from the smart meter) and do not include the effects of distance or duty cycle on the potential exposure of persons within the Complainants residence. A discussion of how these factors may affect RF exposure is presented in the following section.

Table 5. RF exposure from mobile phone used by the Complainant and the Itron smart meter as reported in FCC compliance filings

Device / module*	FCC ID	Compliance Test	Applicable FCC Limit	Location of Compliance Measurement	Measured RF Exposure	Percent of FCC Limit
Mobile Phone	BCG-E2817A	SAR	1.6 W/kg	Head	1.18 W/kg	74%
DLC Smart Meter (LAN Radio)	SK9AMI7	Power Density	0.6 mW/cm^2	20 cm from device	0.227 mW/cm^2	38%
DLC Smart Meter (Zigbee Radio)			1 mW/cm^2		0.031 mW/cm^2	3.1%

*A 100% duty cycle is assumed for all devices.

5. RF Exposure Comparison

In the previous section, the RF emissions reported by the FCC were discussed and listed in Table 5, but did not account for important factors such as distance from the source, duty cycle, or attenuation from wall materials. A discussion of the effects of each of these parameters is outlined below to provide a background for the exposure assessment for the Complainant. The calculation methods are described in Appendix C.

In addition, like all people in modern society, the Complainant encounters a large number of other RF sources with little or no control over exposure to those sources. Some examples of these sources include the local television stations such as WINP-TV, WPGH-TV, WPXI-TV, WPNT, etc., as well as local radio stations such as WESA, KDKA-FM, WKST-FM, WWSW-FM, etc., summarized below as Broadcast Towers.[17,18]

Example calculations of RF exposure for the Complainant's mobile phone, DLC smart meters, and local broadcast stations are shown in Table 6. The distance from source and the source duty cycle can have a large effect on the potential level of exposure. For example, the FCC reports that use of the cellular phone for 30 minutes would result in an exposure of 74% of the FCC limit (as shown Table 5) while a 1-minute phone call results in exposure of only 2.5% of the FCC limit (as shown in Table 6). Similarly, exposure from a DLC smart meter at a distance of 20 cm (~8 inches) directly in front of the DLC smart meter for constant transmission (at a hypothetical 100% duty cycle which is not operationally possible) would result in an exposure of 38% of the FCC limit (as shown by the FCC certification document for the SK9AMI7 Itron smart meters). In contrast, for the average duty cycle of 0.06%, the exposure at 1 yard directly in front of the DLC smart meter is 0.0029% (1/35,000th) of the FCC limit and at 1 yard behind

[17] The calculated value for "Broadcast towers inside" includes the same ~45% transmission factor as was used for the smart meter. In reality a much higher fraction of the incident energy from television or radio broadcast will pass through the walls. The exposures of the Complainant from these sources are therefore likely to be much higher than presented here.

[18] Other sources such as cellular towers, mobile phones and other communication devices used by friends and neighbors in the neighborhood are not included, so the calculated level in the category "Broadcast towers inside" is lower than what is likely present at the Complainant's residence.

the DLC smart meter is 0.00013% (1/780,000th) of the FCC limit (Table 6).[19,20] For comparison, the contribution of the existing local broadcast stations to the RF exposure inside the Complainant's residence is approximately 0.06% of the FCC limit (430 times greater than the indoor exposure from the DLC smart meter).

Table 6. Example calculations of RF exposure at 1699 Suburban Avenue for DLC smart meters, cellular phone, and local broadcast stations in typical operation

Source	Distance from source	Duty Cycle (in a 30-minute period)[a]	Calculated value (% of FCC limit)
Mobile Phone	Used at the head	1 minute call	2.5
Local Broadcast Stations	~1.5 to 10 miles away	100%	0.15
DLC Smart Meter LAN (Inside, Average)[b,c]	1 yard	0.06%	0.00013
DLC Smart Meter LAN from 1699 ½ (Inside 1699, Average)[b,c,d]	9 yards	0.06%	0.0000016
DLC Smart Meter LAN (Outside, Average)	1 yard	0.06%	0.0029

[a] The FCC specifies a 30-minute averaging period in assessing RF exposure.

[b] The exposure from the smart meter inside the home will be reduced by the exterior wall material, assumed to be brick. As discussed in Section 1, only ~45% of the energy incident on the outer wall will penetrate into the residence. This factor is included in the calculation of exposure from the smart meter inside the residence.

[c] The smart meter preferentially transmits in the forward direction. The amount of energy transmitted toward the back of the smart meter is approximately 10% that of the forward direction (EPRI, 2010). This factor of 10% is included in the calculation of exposure due to the smart meter inside the residence.

[d] The Complainant has expressed concern about two smart meters (one potentially at 1699 Suburban Avenue and the other at 1699 ½ Suburban Avenue), each on opposite sides of a duplex. The distance between the meter sockets is estimated to be approximately 30 feet. The strength of the smart meter signal decreases rapidly with distance. Therefore, the incremental RF exposure of a smart meter at 1699 ½ Suburban Avenue (at a location 1 yard away from the smart meter at 1699 Suburban Avenue, inside the residence) is 0.0000016% of the FCC limit (nearly 100 times lower than from the closer smart meter). The combined contribution of the two smart meters at a distance of 1 yard behind either one is therefore effectively the same as the exposure from just one (i.e., also 0.00013% of the FCC limit).

[19] Note that calculations both 1 yard in front of and 1 yard behind the smart meter include a "ground reflection" increase factor of 2.56, which is not included in the FCC certification document. This factor of 2.56 is referenced by the OET for powerful distant sources such as radio or television transmissions. It is included here in an abundance of caution so as to overestimate the contribution of the smart meter.

[20] These exposures are also far below the IEEE and ICNIRP guidelines discussed above.

The discussion in Section 4 detailed existing sources of RF fields, including natural sources, common manmade sources, and local sources specific to the Complainant. Figure 4 shows a graphic comparison of the cumulative contribution of local radio and television broadcast signals as outlined in Table 6, as well as the natural exposure from the earth and people, and an estimate of the average exposure from a DLC smart meter inside the residence. For reference, Figure 4 also shows the calculated RF exposure for a 1-minute mobile phone call using the mobile phone owned by the Complainant. The exposure of each source relative to the FCC limits (sorted from smallest to largest) is shown beneath a graphic depicting each source, as well as the factor describing how much larger that exposure is than the exposure from an average DLC smart meter. This figure demonstrates that not only does the RF exposure from a DLC smart meter inside a residence represent a tiny fraction of the FCC allowable limit, but that the exposure from other natural and anthropogenic sources are many times greater than that from the smart meter.

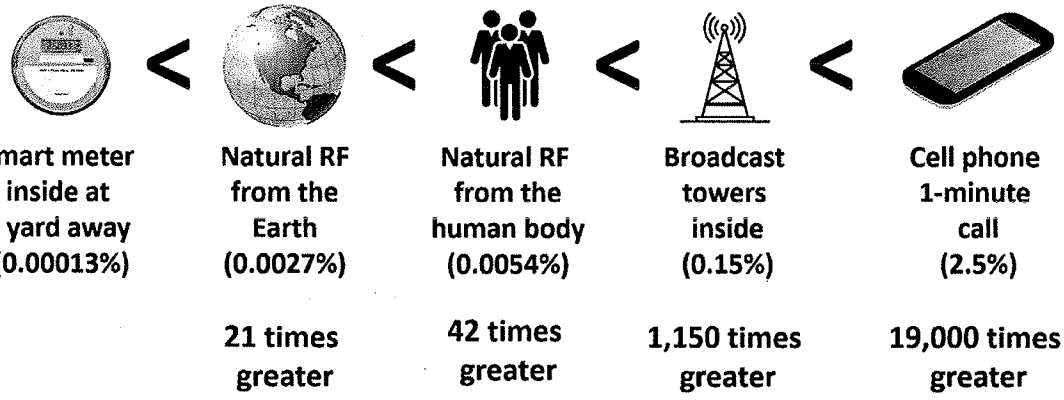


Figure 4. RF exposure of DLC smart meters relative to other RF sources.

The RF exposure as a percentage of FCC limits is shown beneath each graphic in parentheses and a comparison of how much greater each exposure is compared to the DLC smart meter is shown below that percentage.

The comparison of exposures shown in Figure 4 represents a simple comparison of some of the exposures specific to the Complainant, and for reference, the exposure from a 1-minute call using the Complainant's mobile phone. A more detailed description is shown below in Figure 5 in which the RF exposures from these sources as well as some commonly-encountered manmade sources (as described in Appendix B, Table B-1) are plotted as a percentage of the FCC limit in a bar graph. To show the very small exposures on the same scale as the larger

sources, the results are presented on a logarithmic scale where each vertical tick in the axis represents an increase by a factor of 10. The graphic is divided into two sections. The RF Exposures in General Environments portion on the right side of the figure shows the general background of RF energy encountered in rural, suburban, and urban environments, and is included to provide context for typical background levels reported in peer-reviewed literature (Joseph et al., 2012). The Typical RF Sources portion on the left side of the figure compares the RF exposures from each of the items shown above in Figure 4 with the other sources described in Appendix B, Table B-1. In Figure 5, additional scenarios for the DLC smart meter are shown for potential exposure to a smart meter outside, as well as potential exposure inside the residence from the Zigbee Radio as well as from a 2nd smart meter from the opposite side of the duplex.

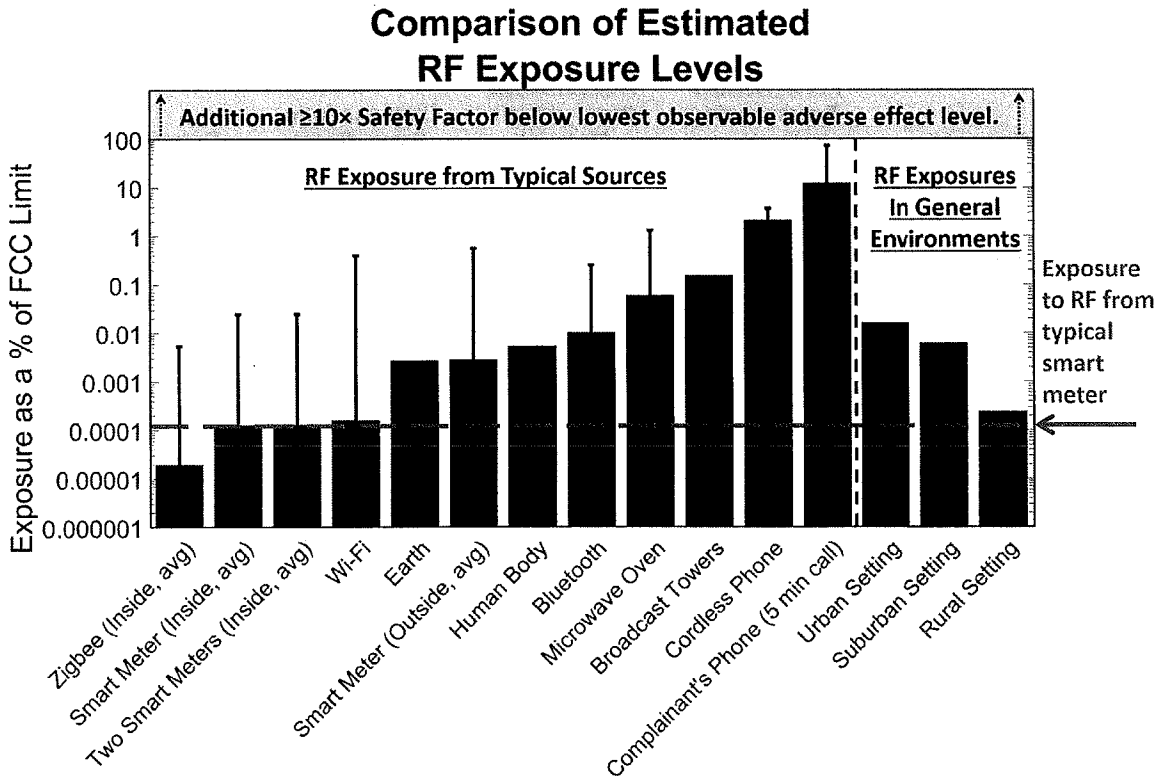


Figure 5. Comparison of RF exposure from the RF-LAN and Zigbee signals from DLC smart meters to RF exposure from other sources under typical use. The red lines show the potential range of RF levels associated with the manmade sources.

The RF exposures in general environments are reported in Joseph et al. (2012).

A red line is shown overlaid on each bar for most manmade sources in Figure 5 to provide an indication of the potential variability in the exposures for these sources. As an example, the exposure from an example DLC smart meter (both inside and outside) is detailed in Table 7. The Inside Average exposure (third blue bar from the left in Figure 5) is calculated at a distance of 1 yard behind the smart meter using an average duty cycle of 0.06%. In addition, this calculation accounts for smart meters preferentially transmitting in the forward direction so that the amount of energy directed toward the residence is approximately $1/10^{th}$ that transmitted away from the residence (EPRI, 2010). The calculation also accounts for attenuation of the signal when passing through the bricks on the side of the residence (only about 45% of the signal penetrates through the bricks).[21] Similar variability estimates are also provided for other manmade sources based on the peer-reviewed references detailed in Appendix B, Table B-1.

Table 7. Example of variability of potential smart meter exposure in different scenarios

Scenario	Forward/Back Transmission Factor	Transmission through Wall Material	Distance from Smart Meter	Duty Cycle	Calculated Value (% of FCC Limit)
Inside Minimum	0.1	0.45	10 feet	0.02%	0.0000041%
Inside Average	0.1	0.45	1 yard	0.06%	0.00013%
Inside Maximum	0.1	0.45	~8 inches	0.58%	0.025%
Outside Minimum	1	1	10 feet	0.02%	0.000091%
Outside Average	1	1	1 yard	0.06%	0.0029%
Outside Maximum	1	1	~8 inches	0.58%	0.56%

Additional Discussion

The highest calculated exposure due to the smart meter at the residence was evaluated at a distance of 20 cm (approximately 8 inches) from the DLC smart meter at the maximum duty cycle of 0.58% (approximately 500 seconds per day). This maximum calculated exposure is approximately 0.56% of the FCC limit directly in front of the smart meter or 0.025% of the FCC limit behind the smart meter in the residence. This duty cycle is far higher than average and far higher than the vast majority of smart meters because 97.95% of DLC smart meters transmit for less than 100 seconds per day—a duty cycle of less than 0.12% (Itron, 2011). The exposure then would be about five times lower than calculated above for the maximum duty cycle.

[21] Both indoor and outdoor calculations also include the conservative "ground reflection" factor of 2.56 included by the OET 65 (FCC 1997)

Furthermore, the calculations above are performed at a close distance of approximately 8 inches in front of or behind the smart meters. At greater distances, the exposure from smart meter signals will be far less. The RF exposure from a smart meter approximately 6 feet away will be only ~1/100 that of the exposure of the meter at approximately 8 inches.[22] As noted by the FCC, the RF from smart meters would comply with FCC limits on SAR, even if held against the body or clustered together at one location (Knapp, 2010).

Another way to compare the RF exposure from different sources is to determine the distance from a particular source at which the RF exposure from that source is the same as RF exposure from the earth. For indoor exposure from an average DLC smart meter (shown in Table 7), this distance is approximately 8 inches from the smart meter.[23] At distances greater than approximately 8 inches, the RF exposure from an average DLC smart meter is less than the RF exposure one constantly receives from the earth.

---

[22] For the unrealistic scenario in which the smart meter performs all transmissions from an entire day within a single 30-minute period, the duty cycle within that 30-minute period would be approximately 28% and the exposure from the smart meter at a distance of 1 yard behind the smart meter in the residence would be about 0.57% of the FCC limit. At a distance of ~8 inches in front of the smart meter and assuming that all transmissions from an entire day occur within a single 30-minute period (i.e., 28% duty cycle), the exposure from the smart meter would be less than 27% of the FCC limit, while at a distance of 1 yard in front of the smart meter the exposure for this scenario would be approximately 4% of the FCC limit.

[23] This calculation assumes the decrease in field level follows the inverse square law.

6. Conclusions

A smart meter mesh network operates by transmitting information to neighboring smart meters and passing this information from smart meter to smart meter in several hops. This network architecture allows the smart meters to operate using low power levels. Furthermore, since required information transfer is relatively limited, smart meters only transmit a small fraction of the time.

An investigation into the potential RF exposure from smart meters in the context of other sources has shown two key features. Not only does the RF exposure inside a residence from a smart meter represent a tiny fraction of the FCC allowable limit, but that the exposure from other sources both inside and outside the residence are many times greater than from a DLC Itron smart meter.

In particular, calculations have shown that the contribution of a typical DLC smart meter to RF exposure indoors would be more than 40 times less than the natural RF emitted by people, more than a thousand times less than the exposure from local broadcast television and FM radio stations, and many thousands of times less than the RF exposure from other common electronic devices. The contribution of a typical DLC smart meter to the Complainant's exposure indoors is less than the RF exposure from other existing sources and only 0.00013% (1/780,000th) of the FCC's health-based exposure limit.

7. Facts Relied Upon

In this analysis, I have relied upon facts about the characteristics of the DLC smart meters manufactured by Itron, as summarized in Table 8.

Table 8. Sources of data used to model RF signal transmission from DLC smart meters

Parameter	Value	Reference
Power Output of Itron Smart Meters	688.65 mW	FCC ID: SK9-AMI7
Gain of Itron Smart Meter Antenna	1.66	FCC ID: SK9-AMI7
Minimum Duty Cycle of DLC Smart Meters	0.02%	Itron, 2011
Average Duty Cycle of DLC Smart Meters	0.06%	Itron, 2011
Maximum Duty Cycle of DLC Smart Meters	0.58%	Itron, 2011

In this report, I have also relied upon peer-reviewed research papers, comprehensive reviews of subject matter by internationally-recognized organizations, FCC certification documents, and publications of national standards. The information relied upon is cited in text and the full source is documented in Section 8.

8. References

Advanced Compliance Solutions (ACS). EMI Test Report in Accordance with ANSI C12.1. Report 11-0134.C14.11.B, Rev. B for Itron HW 3.1, ANSI Single Phase Model Variants 1S, 2S and 12S (issued June 22, 2011). Buford, GA: ACS, 2011.

American National Standards Institute (ANSI). American National Standard Dictionary of Electromagnetic Capability (EMC) including Electromagnetic Environmental Effects (E3) – ANSI C63.14-1998. New York: IEEE, 1998.

American National Standards Institute (ANSI). American National Standard for Electric Meters—Code for Electricity Metering (ANSI C12.1). Rosslyn, Virginia: National Electrical Manufacturers Association, 2008.

Abdulla H and Badra RE. Head exposure to cellular telephones: A system-level study. 2010 IEEE Latin-American Conference on Communications 15-17 September 2010.

Code of Federal Regulations (CFR). Title 47 Telecommunication, Volume 1, §1.1310 - Radiofrequency radiation exposure limits; §2.1093 – Radiofrequency radiation exposure evaluation: portable devices; §15.207 – Conducted limits. Washington DC: Office of the Federal Register National Archives and Records Administration as a Special Edition of the Federal Register, As of December 20, 2018.

Electric Power Research Institute. An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter. Palo Alto, CA: EPRI, 2010.

Electric Power Research Institute. DC Power Production, Delivery and Utilization Power Production, Delivery and Utilization: An EPRI White Paper. Palo Alto, CA: EPRI, 2006

Federal Communications Commission (FCC). Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. OET Bulletin 65, Edition 97-01. Washington, DC: FCC, 1997.

Federal Communications Commission (FCC). Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields. OET Bulletin 56, Fourth Edition. Washington, DC: FCC, 1999.

Foster KR. Radiofrequency exposure from wireless LANs utilizing Wi-Fi technology. Health Phys 92: 280-289, 2007.

Health Protection Agency (HPA). Cordless Telephones: Digital Enhanced Cordless Telecommunications (DECT) and Other Cordless Phones. Available from http://webarchive.nationalarchives.gov.uk/20140714084352/http:/www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1195733767519

Institute of Electrical and Electronics Engineers (IEEE), IEEE Standard for Safety Levels with

Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. New York, NY: IEEE, 2005.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Exposure to High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 kHz-300 GHz). Oberschleißheim, Germany: ICNIRP, 2009.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.

Itron. Wireless Transmissions: An Examination of OpenWay Smart Meter Transmissions in a 24-Hour Duty Cycle. Itron, 2011.

Joseph W, Verloock L, Goeminne F, Vermeeren G, Martens L. Assessment of RF exposures from emerging wireless communication technologies in different environments. Health Phys 102: 161-172, 2012.

Knapp JP. Letter to Cindy Sage from Julius P. Knapp, FCC, August 6, 2010.

Mantiply ED, Pohl KR, Poppell SW, Murphy JA. Summary of measured radiofrequency electric and magnetic fields (10 kHz to 30 GHz) in the general and work environment. Bioelectromagnetics 18: 563-577, 1997.

National Institute of Standards and Technology (NIST). NIST Construction Automation Program, Report No. 3. Electromagnetic Signal Attenuation in Construction Materials (NISTIR 6055). Gaithersburg, Maryland: US Department of Commerce, 1997.

Valberg PA, van Deventer TE, Repacholi MH. Workgroup report: base stations and wireless networks-radiofrequency (RF) exposures and health consequences. Environ Health Perspect 115: 416-424, 2007.

Viel JF, Cardis E, Moissonnier M, de Seze R, Hours M. Radiofrequency exposure in the French general population: band, time, location and activity variability. Environ Int 35: 1150-1154, 2009.

Limitations

At the request of DLC, I performed an assessment of RF fields related to Itron smart meters deployed by DLC. The scope of services was determined by the circumstances associated with this case as well as applicable codes, rules, and regulations. The findings presented herein are made to a reasonable degree of engineering and scientific certainty. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation.

Appendix A

Educational Background, Qualifications, and Curriculum Vitae

EXHIBIT N2

Qualifications and Education

I am a Senior Managing Engineer in the Electrical Engineering and Computer Science Practice at Exponent, Inc., an international science and engineering firm. My work address is 17000 Science Drive, Suite 200, Bowie, MD 20715.

I earned my Bachelor of Science degree *summa cum laude* in Electrical Engineering from the University of Portland as well as a Master of Science degree and a Doctor of Philosophy degree in Electrical Engineering from Stanford University. I am a member of several technical organizations including the IEEE and the International Council on Large Electric Systems. I am a member of the IEEE Power Engineering Society Corona and Field Effects Working Group as well as the International Committee on Electromagnetic Safety, Subcommittees 3 and 4.

I am the author of numerous peer-reviewed papers and conference presentations on the topic of electromagnetic fields and the earth's geomagnetic field, as listed in my *curriculum vitae*. I was also the co-founder of an international conference series established under the auspices of the United Nations with the purpose of bringing the science of electromagnetics to developing countries and to assist in starting doctorate-level research programs in electromagnetics in those countries.

I have expertise in both applied and theoretical electromagnetics including modeling, measurement, and analysis studies of natural and manmade RF fields in the earth's environment. I regularly assist clients in evaluating RF fields from varied sources ranging from portable diesel generators to *ad hoc* networks (such as the mesh network established by smart meters) to government/military communication facilities (high-frequency band through microwave-frequency band). My work includes the evaluation of RF exposure with respect to electromagnetic interference to devices and the safety of medical and non-medical devices. My expertise is requested by federal agencies, utilities, construction developers, and patients with implanted medical devices, their physicians, and their employers.

Appendix B

Common RF Sources and FCC RF Usage Spectrum Chart

The frequency and representative RF exposure values for some manmade RF sources commonly encountered in daily life are shown below in Table B-1. Large ranges of RF exposure can be seen for several of the RF sources. These ranges are due to the large number of factors affecting exposure from a given RF source. While Table B-1 provides a list of some of the common manmade sources, it is only a very small subset of all RF sources. Figure B-1 shows the many hundreds of RF communication bands used in modern society, all of which have the potential to contribute to an RF exposure assessment. Other sources such as those from local broadcast (AM, FM, and television) stations, the mobile phones used by the Complainant and from DLC smart meters are discussed in greater detail the following section.

Table B-1. Frequency and representative RF exposure values for common manmade RF sources

Source	Frequency (MHz)	Reported Value (% of FCC Limit)*	Exposure Conditions†	Reference†
Mobile Phone	800 – 1,900	5 – 12	Personal Use	Abdulla and Badra (2009) Tables 7-10
Cordless Phone	1,880 – 1,900	0.5 – 4	Handheld Unit	HPA, 2014
Wi-Fi	2,400 – 2,484	0.00004 – 0.4	Typical Exposures	Viel et al. (2009), Table 4; Foster (2007), Table 2
Bluetooth	2,400 – 2,484	0.001 – 0.25	At 0.2 m to 3 m Distance	Valberg et al. (2007), Table 4
Microwave Oven	2,450	0.007 – 1.3	At 1 m Distance	Mantiply et al. (1997), p. 573

* RF exposure is presented as a percentage of the FCC limit to keep these exposure values both consistent and accurate. The FCC limit is defined as the applicable SAR limit, wave power density limit, or square of the field magnitude limit, all for uncontrolled environments. Both whole body exposure and spatial peak SAR for the head are used where appropriate.

† RF exposure can be heavily dependent upon situation, so exposure conditions and references are provided for each exposure value.

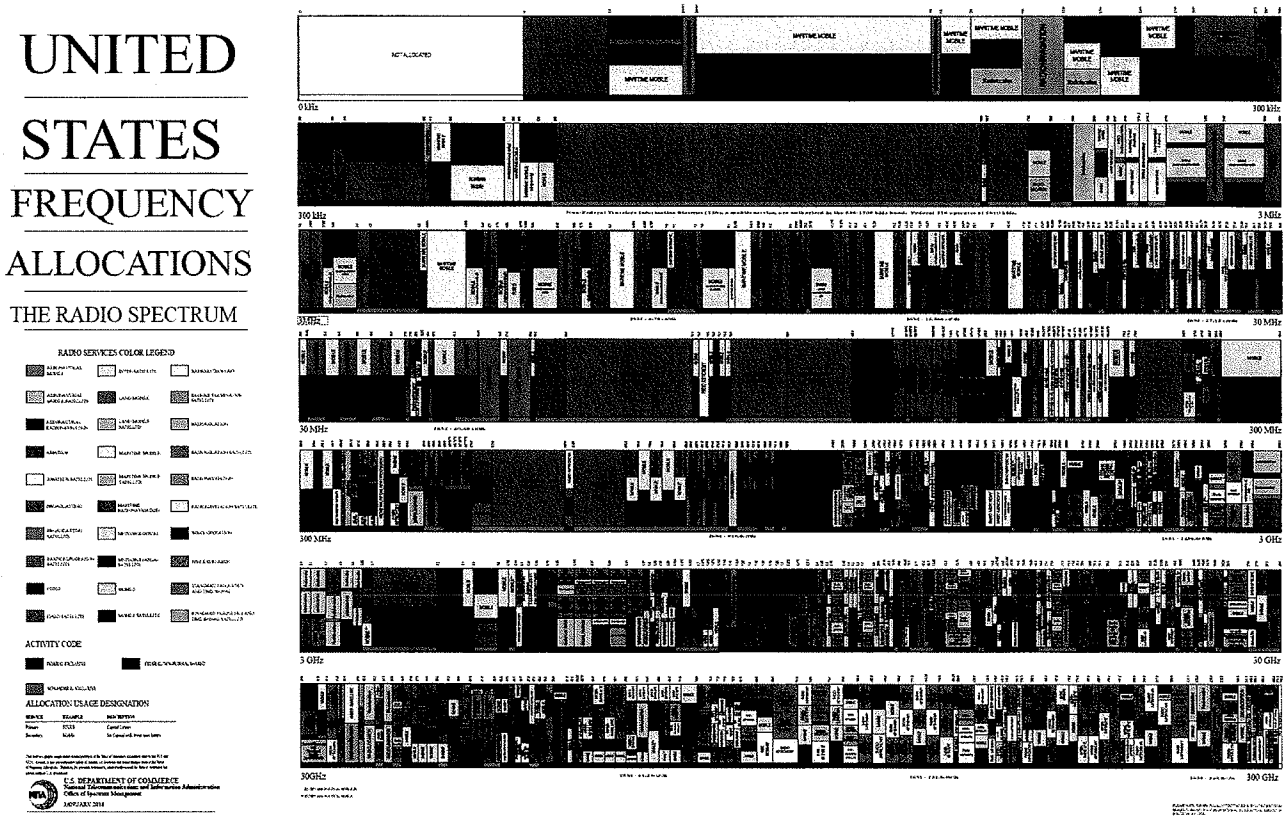


Figure B-1. Radio Spectrum Allocations in the United States

Appendix C

Example Exposure Calculation for the Complainant

Exposure from a smart meter

When a DLC Itron smart meter is transmitting, the power of that transmission is constant and so the variation in the potential exposure level (excluding the effect of any external environmental factor such as walls or distance) is determined by the duty cycle of a particular smart meter. Using a duty cycle consistent with the minimum, average, and maximum duty cycles of Itron smart meters (0.02%, 0.06%, and 0.58%, respectively), it is possible to calculate exposure levels from a smart meter based upon the duty cycle (at a particular distance).[24]

The exposure to RF energy from a smart meter (as well as most other sources of RF not used in close proximity to the body) is based upon computational modeling recommended by the FCC (OET 65) which is used to calculate the power density (S) of a signal at a distance R from the transmitter, with an input power P, an antenna gain G, transmission coefficient, T and a duty cycle of δ. The applicable formula is:

$$S = 2.56\frac{PGT}{4\pi R^2}\delta$$

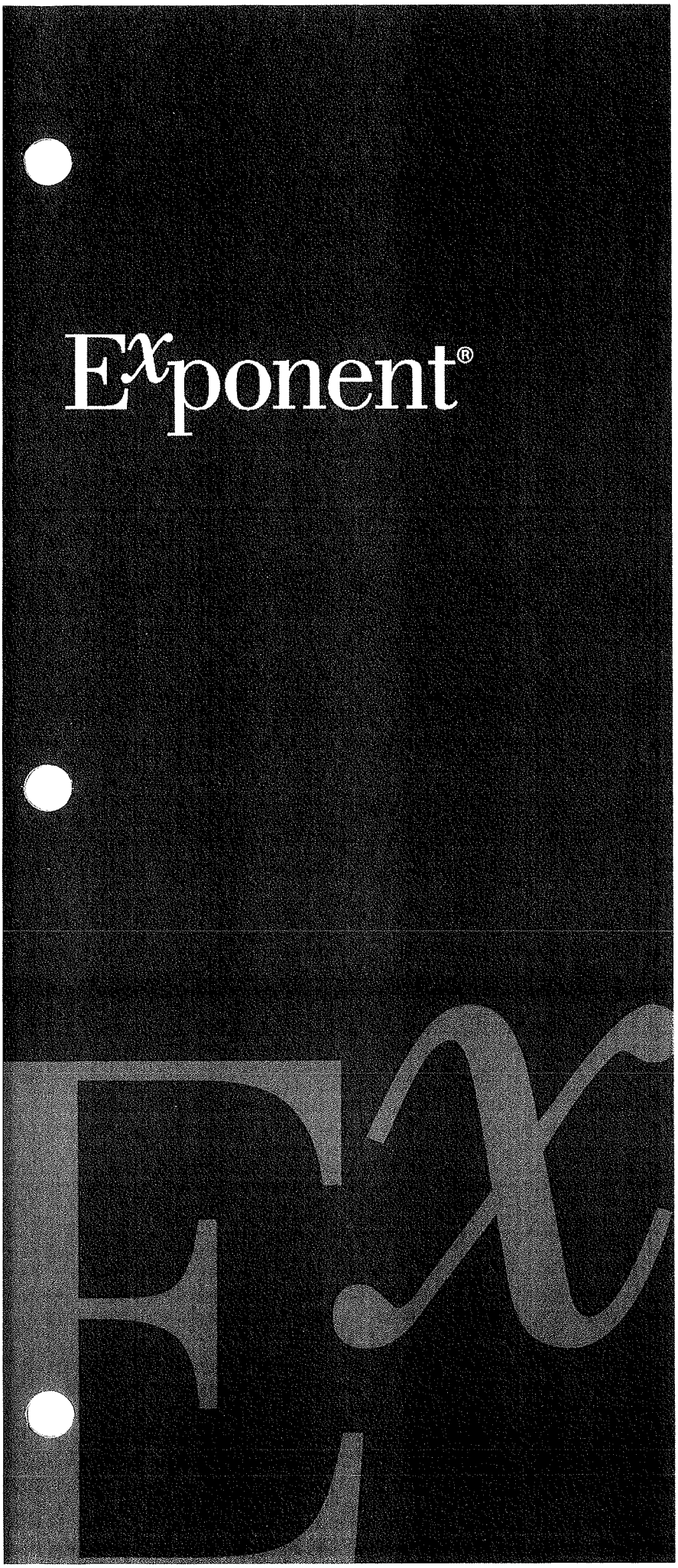
The factor of 2.56 is used to include the potential reflection of the signal from the ground that may increase the exposure above the case using the standard inverse square law. This factor of 2.56 is applied by the OET to far-away sources such as television or radio broadcast signals and is not generally applicable to the signal from a smart meter. *It is included here, however, to provide a very conservative calculation of the RF exposure from the Itron smart meters deployed by DLC.* In addition, when a signal passes through some material such as a wall a portion of the energy is reflected, reducing the amount of energy that is transmitted through the material. The transmission coefficient, T, depends on the type of material, its thickness, and the frequency of the wave. For the Itron smart meters, several exposure calculations using the above formula are summarized in Table C-1.

[24] A smart meter transmits about one-tenth as much power in the backward direction as in the forward direction. Additional factors, such as the metal backplate on a smart meter and type of wall construction are not considered in this illustrative comparison (Electric Power Research Institute [EPRI]. An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter. Palo Alto, CA: EPRI, 2010).

Table C-1. Calculations of RF exposure from DLC smart meter at the Complainant's residence

Scenario	Power (Watt)	Gain	Ground Reflection Factor (δ)	Transmission through Wall Material (T)	Distance from Source	Duty Cycle	Calculated Value (% of FCC Limit)
Smart Meter (Inside, min)	0.689	0.166	2.56	0.45	10 feet	0.02%	0.0000041%
Smart Meter (Inside, avg)	0.689	0.166	2.56	0.45	1 yard	0.06%	0.00013%
Smart Meter (Inside, max)	0.689	0.166	2.56	0.45	~8 inches	0.58%	0.025%
Smart Meter (Outside, min)	0.689	1.66	2.56	--	10 feet	0.02%	0.000091%
Smart Meter (Outside, avg)	0.689	1.66	2.56	--	1 yard	0.06%	0.0029%
Smart Meter (Outside, max)	0.689	1.66	2.56	--	~8 inches	0.58%	0.56%
2nd Smart Meter (inside, min)*	0.689	0.166	2.56	0.45	9 yards	0.02%	0.00000054%
2nd Smart Meter (Inside, avg)*	0.689	0.166	2.56	0.45	9 yards	0.06%	0.0000016%
2nd Smart Meter (Inside, max)*	0.689	0.166	2.56	0.45	9 yards	0.58%	0.000015%
Zigbee (Inside, min)	0.065	2.40	2.56	0.45	10 feet	0.011%	0.0000018%
Zigbee (Inside, avg)	0.065	2.40	2.56	0.45	1 yard	0.011%	0.000020%
Zigbee (Inside, max)	0.065	2.40	2.56	0.45	~8 inches	0.15%	0.0054%

* Representative of a second smart meter located approximately 30 feet away (such as the estimated distance between meter sockets at 1699 Suburban Ave. and 1699 ½ Suburban Ave). The evaluation here is performed at a location 1 yard from the smart meter (inside the residence) or 27 feet (9 yards) from the meter socket at 1699 ½ Suburban Ave.



Health Sciences Practice

Report of Gabor Mezei, M.D., Ph.D.

Re: Geoff Day v. Duquesne Light Company, Pennsylvania Public Utility Commission Docket Number C-2018-3003960

Ex. C

Report of Gabor Mezei, M.D., Ph.D.

Re: Geoff Day v. Duquesne Light Company,
Pennsylvania Public Utility Commission
Docket Number C-2018-300960

Prepared for

Duquesne Light Company
411 7th Avenue
Pittsburgh, PA 15219

Prepared by

Gabor Mezei, M.D., Ph.D.
Exponent, Inc.
149 Commonwealth Drive
Menlo Park, CA 94025

August 12, 2019

EXHIBIT N1

Contents

Summary of Opinions in the *Day* Matter

Based on my knowledge and familiarity with the relevant scientific literature, including the relevant weight-of-evidence reviews conducted by a number of international multidisciplinary expert panels, and the case materials presented to me in relation to the Complaint filed with the Pennsylvania Public Utility Commission against Duquesne Light Company on behalf of Geoff Day (*Day* matter), my opinions are as follows:

1. A causal relationship is not established between environmental exposure to radiofrequency (RF) fields, including RF fields specifically from smart meters owned and operated by Duquesne Light Company, and adverse human health effects, including cancers or non-cancer health effects, as claimed in the Complaint and in the Complainant's responses to discovery requests.

2. Exposure to RF fields estimated in the Day residence as a result of the operation of smart meters or from other common sources found within or outside a typical residence does not have any proven adverse effect on health.

3. The materials included in the Complaint or submitted in response to answer and new matter to the formal complaint, and discovery requests by Mr. Day do not provide a basis to reach a valid scientific conclusion that low-level RF exposure, including the RF fields associated with the operation of smart meters, causes or contributes to the development of any adverse health effects, including cancer and non-cancer health outcomes.

4. Exposure to RF fields from smart meters does not have any proven adverse effect on health, thus, scientific research does not support the claim that RF fields from smart meters would adversely affect the health of Mr. Day, or others at the Day residence.

5. The overall scientific evidence does not establish a causal relationship between RF exposure or "dirty electricity" and any of the alleged medical conditions, from which Mr. Day allegedly suffers according to his Complaint and other materials submitted in this matter, which include "insomnia, anxiety, digestive issues, diminished ability to concentrate,

restlessness, muscle fatigue and cognitive impairment," and an "appetite [that] is nearly non-existent."

My opinions are expressed herein to a reasonable degree of scientific and medical certainty. I reserve the right to revise my opinions as more information becomes available.

Introduction and Purpose

On August 10, 2018, a Complaint was filed in the *Day* matter. Among other complaints, Mr. Day alleges health effects from exposure to RF electromagnetic fields from smart meters.

Counsel for Duquesne Light Company asked me to evaluate case documents and the relevant scientific literature in relation to the *Day* matter. I was specifically asked to provide an overview of the scientific evidence on potential health effects of RF fields, evaluate whether exposure to RF fields from the smart meters owned and operated by Duquesne Light Company near the Day residence presents any health risk to Mr. Day or others, and provide a scientific evaluation of documents or other information submitted in this matter. This report summarizes my findings and opinions based on my professional qualifications, work experience, knowledge of the scientific literature on RF exposure assessment, epidemiology related to RF exposure and related scientific fields, and the reviewed case documents received in this matter. The specific materials received from Duquesne Light Company in this matter, and which I reviewed, are as follows:

1. The Formal Complaint;
2. Answer and New Matter to Formal Complaint;
3. Preliminary Objections;
4. First set of discovery requests directed to Complainant;
5. Responses and various documents produced by Mr. Day in response to answer and new matter, and discovery requests; and,
6. Amended Formal Complaint
7. Answer and New Matter to the Amended Formal Complaint
8. The Report of Benjamin Cotts, Ph.D., P.E., in the *Day* matter.

My opinions are expressed herein to a reasonable degree of scientific and medical certainty. I reserve the right to revise my opinions as more information becomes available.

Background and Qualifications

I am a medical doctor and an epidemiologist with over 25 years of experience in health research including the conduct of epidemiologic studies of both clinical outcomes and environmental and occupational health issues. I have considerable experience in conducting and evaluating epidemiologic studies and complex health assessments and exposure characterization studies related to power-frequency and RF electromagnetic fields (EMF). I am a Senior Managing Scientist in the Health Sciences practice of Exponent, a scientific and engineering firm headquartered in Menlo Park, California.

Prior to joining Exponent, I was responsible for leading a multidisciplinary scientific health research program at the Electric Power Research Institute (EPRI), a not-for-profit independent research organization. The research program's scientific work addressed potential human health effects associated with residential and occupational exposure to power-frequency and RF EMF. I have submitted expert testimony on EMF and health, and have appeared as an EMF health expert before the Alberta Utilities Commission, the Connecticut Siting Council, the Kentucky Public Service Commission, the Virginia State Corporation Commission, and the *An Bord Pleanála* (the Planning and Development Board of Ireland). I also served as a consulting expert to the staff of the California Public Utilities Commission, California Assemblyman Jared Huffman, and members and staff of the California Council on Science and Technology (CCST) during the preparation of the CCST report "*Health Impact of Radiofrequency Exposure from Smart Meters*" published in April 2011, and to the Joint Committee for Transport and Communications of the Parliament of Ireland. I was invited by the National Research Council to provide peer-review of the National Academy's Committee report titled "*Identification of Research Needs Relating to the Potential Biological or Adverse Health Effects of Wireless Communication Devices*" published in 2008.

Previous to employment at EPRI, I worked as an epidemiologist at the Toronto Western Hospital, University of Toronto, and as a practicing physician and epidemiologist at the National Institute for Dermatology in Budapest, Hungary. I trained as a medical doctor (M.D.) at the Semmelweis University of Medicine in Budapest, Hungary, and as an epidemiologist (Ph.D.) at the School of Public Health of the University of California in Los Angeles (UCLA). I

lectured at the UCLA School of Public Health, at Stanford University, and at the Electrotechnical Committee of the Hungarian Academy of Sciences, and I served as an affiliate associate professor in the Department of Environmental and Occupational Health Sciences of the University of Washington in Seattle, as a visiting scientist at the Hungarian National Research Institute for Radiobiology and Radiohygiene, and as an Associate Editor for the *Journal of Exposure Science and Environmental Epidemiology*. I was the recipient of Fogarty and Fulbright Fellowships. I am an author or co-author of over 60 scientific publications and book chapters on topics related to epidemiology of a wide range of environmental and occupational exposures (with a focus on exposure to EMF, including RF fields) and chronic diseases. A copy of my curriculum vitae is provided in Appendix A.

Health Complaints and Allegations of Health Effects in the *Day* Matter

Health Complaints of Mr. Day

According to the case-specific materials received, Mr. Day allegedly suffers from "insomnia, anxiety, digestive issues, diminished ability to concentrate, restlessness, muscle fatigue and cognitive impairment," and an "appetite [that] is nearly non-existent"—symptoms that Mr. Day appears to attribute to smart meters. Mr. Day does not provide any scientific evidence in his submissions to demonstrate that the symptoms he allegedly suffers from are caused by RF emitted by smart meters. In addition, the non-specific symptoms he allegedly suffers from and describes in his submissions may be the result of a number of causes that can be distinguished from each other only by a thorough medical evaluation (e.g. Warrell et al., 2003). Moreover, Mr. Day provided no evidence that he sought medical attention or treatment for his complaints; thus, his complaints appear to be minor in nature.

Allegations of Health Effects

In the Complaint and additional submissions in this matter, Mr. Day expresses general health concerns in association with smart meters. In support of these general health claims, he states "there are at least thousands of reports of individuals suffering functional impairment and or illness since the installation of Smart Meters where they live"; and that smart meters are "harmful devices," for which no evidence is adduced. In support of his opinion that adverse health effects are caused by exposure to low-level RF fields, Mr. Day references the BioInitiative Report (BIR). The BIR, which was published online by a self-selected group of scientists and EMF-activists, does not use valid scientific methods; thus, the conclusions expressed in the BIR cannot be considered scientifically valid. Mr. Day specifically references the classification of RF fields by the International Agency for Research on Cancer (IARC) in 2002, and claims "According to a vast body of published science, microwave radiation is proven to be harmful and damaging to all biological organisms, down to the cellular and molecular level, at relatively low power densities." None of the publications included or referenced in Mr. Day's submissions, individually or in combination, provide sufficient evidence to conclude that

environmental exposure to RF at the levels generated by smart meters causes or contributes to any adverse health effects.

Below I provide an overall evaluation of the Complaint and address the specific health-related allegations made by Mr. Day in relation to RF fields and smart meters. In support of my opinions and conclusions, I also describe the well-established scientific methods of weight-of-evidence assessments, provide an overview of health risk assessments of RF exposure conducted using the weight-of-evidence method by reputable health, scientific, and government agencies, briefly review relevant scientifically-established exposure limits, and provide a brief review of key scientific research relevant to RF exposure and health.

Evaluation of the Complaint

The materials submitted by Mr. Day in support of his allegations of health effects in association with RF exposure from smart meters, considered either separately or in combination, fail to establish any cause-and-effect relationship between RF exposure at levels below scientifically-based exposure limits and adverse health effects. The documents referenced or submitted by Mr. Day can be broadly grouped into the following categories, which I evaluate below:

1. **References to non-peer reviewed documents, mostly obtained from the Internet, without proper attribution or referencing.**

   I will not further consider these non-peer reviewed documents; these sources do not provide information that may serve as the basis of any valid scientific conclusion. Valid scientific conclusions about causality rely on systematic weight-of-evidence evaluations of research on health and exposures to RF that meet the minimum scientific criteria to have been published in peer-reviewed journals.

2. **Reference to "published science" and "thousands of reports" from the peer-reviewed scientific literature, without proper referencing.**

   I am unable to evaluate "published science," or "thousands of reports" that Mr. Day alludes to without proper identification. I will note, however, that valid scientific conclusions can only be drawn following an assessment of the *entire* body of available scientific literature, as discussed in more detail in my report below. A specific study or selected set of publications cherry-picked from the literature cannot form the basis of any valid scientific conclusion. The available body of scientific evidence published in the peer-reviewed scientific literature has been considered in the weight-of-evidence assessments and systematic reviews conducted by national and international expert panels (e.g., the World Health Organization (WHO)'s International Agency for Research on Cancer [IARC], the Health Protection Agency of the United Kingdom [HPA], and the Scientific Committee on Emerging and Newly-identified Health Risks [SCENIHR] of the European Commission). These health risk assessments, after consideration of the available evidence, did not conclude that the evidence overall confirms the existence of any adverse health effects from RF exposure.

3. **Reference to weight-of-evidence evaluations (e.g., the IARC evaluation of RF exposure).**

   Weight-of-evidence evaluations conducted by multidisciplinary panels on behalf of national and international health and scientific agencies (e.g., IARC, HPA, and SCENIHR), after properly considering the available body of scientific literature, did not conclude that there are any confirmed adverse health effects of low-level RF exposure, and provide no support to Mr. Day's allegations of health effects. The Complaint and the additional submissions, in general, disregard these weight-of-evidence conclusions about the lack of established adverse health effects, and disregard that the conclusions of these agencies were based on a thorough review of an extensive body of scientific literature that has accumulated over decades as a result of worldwide research efforts.

4. **Reference to evaluations by organizations that were *not* based on a proper weight-of-evidence evaluation of the available scientific literature (e.g., the BIR).**

   As discussed in more detail in my report below, "alternative views" most notably expressed by the BioInitiative Working Group (BIWG) in the BIR, were not reached using valid scientific methods. A number of scientific and government agencies strongly criticized the BIR for the lack of a scientific weight-of-evidence approach (e.g., EMF-NET, 2007; HCN, 2008; ACRBR, 2008; COMAR, 2009). The main limitations of the BIR and similar conclusions include the selective referencing of studies believed by the contributors to support their preconceived conclusions, systematic disregard of studies not in support of their opinion (including the laboratory animal studies not demonstrating an association), and the heavy reliance on *in vitro* studies [i.e., laboratory studies of cells and tissue]. The Internet site that posted the BIR is not sponsored by any professional scientific society, and the BIR has not been subjected to peer review by other scientists as would have occurred if the document had been submitted to a peer-reviewed scientific journal for publication.

In his submissions, Mr. Day expressed general health concerns in relation to exposure to RF fields. As discussed above, the weight-of-evidence reviews of the scientific literature did not conclude that RF fields at levels below scientifically established guideline values cause or exacerbate any adverse health effects. In particular, based on the available scientific evidence, a

causal relationship is not established between RF exposure and any of the specific conditions from which Mr. Day allegedly suffers.

Scientific Review Process

In this section, I provide an overview of the well-established and generally-accepted scientific methods (i.e., the weight-of-evidence evaluation), which is used by reputable national and international health and scientific agencies for human health risk assessment. Types of health studies that are evaluated as part of risk assessments are also discussed.

Scientists around the world have conducted a large amount of scientific research and published their results on the potential health effects of RF fields over the past several decades in peer-reviewed scientific publications, The published peer-reviewed scholarly manuscripts published as part of this extensive research effort report on the results of these studies, which were conducted by a wide variety of scientists in related, but diverse, scientific disciplines. The WHO commented on this large body of research on electromagnetic fields, stating "[d]espite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals."[1] The WHO's website cites their position: "[b]ased on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields."[2]

Although much of the scientific research on electromagnetic fields and health and other scientific and health topics has been conducted by reputable scientists and laboratories, there is a large variability in the quality of scientific research, and the various types of scientific studies have varying strengths and limitations. Since it is difficult for an individual to synthesize all of this research, to impartially assess the quality of the research, and to recognize and weed out the unscientific and low-quality research results and publications, standard scientific methods have been developed by scientists to evaluate evidence to determine whether there is a cause-and-effect relationship between an exposure (e.g., RF fields) and adverse health outcomes. This section provides an overview of the well-established and generally accepted scientific review process.

---

1 http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html

2 Ibid.

The standard scientific method used by scientists to evaluate scientific research as it relates to potential adverse health outcomes is a health risk assessment, which includes a weight-of-evidence review of relevant scientific studies. Typically, multidisciplinary expert panels are convened by both national and international health and scientific agencies to conduct weight-of-evidence evaluations of the literature to arrive at a valid conclusion. It is important to note that no single study or limited group of studies can provide sufficient evidence to draw a scientific conclusion on a potential cause-and-effect relationship; the totality of the evidence needs to be considered.

Sources of Scientific Evidence for a Weight-of-Evidence Review

A systematic search of the scientific literature will identify relevant research studies to be considered in a weight-of-evidence review. Review panels typically consider the three main types of scientific studies: epidemiologic studies of human populations; experimental laboratory studies of animals or humans (*in vivo* studies); and laboratory studies of cells and tissues (*in vitro* studies). Epidemiologic, *in vivo*, and *in vitro* studies provide different but complementary information and since each type of study has particular strengths and limitations, a valid risk assessment will consider all three types of studies together.

Epidemiologic studies are classified as non-experimental because they observe human populations in their natural environment and scientists do not control the factors that influence study subjects' activity, nor can they control exposure to the agent of interest. The goal of an epidemiologic study is to measure statistical associations between exposure to a particular agent and health conditions. The two most commonly employed types of epidemiologic approaches are case-control and cohort studies. Case-control studies compare the occurrence of exposure among persons with a particular disease (cases) to that among persons who do not have that disease (controls). One of the measures of statistical association in case-control studies is an odds ratio.[3] Cohort studies follow a specific group of individuals over time, often in an occupational setting, who at the start of the study do not have the disease of interest. Scientists

[3] An odds ratio is a measure of statistical association between exposure and outcome in case-control studies and is calculated as the ratio of the odds of being exposed among the cases and the odds of being exposed among the controls.

compare the frequency of disease occurrence among those who experience exposure to a particular agent to the frequency of disease occurrence among those members of the cohort who are not exposed to that same agent. Commonly used measures of association in a cohort study are the relative risk and risk ratio.[4]

The limitations of epidemiologic studies include the scientist's inability to control exposure in the population, as already noted. This, among other drawbacks, may result in confounding in a study. Confounding, which is a key concept in epidemiology, refers to, in the simplest terms, confusion of effects. Confounding occurs when the apparent effect of one exposure on disease risk is distorted by or mixed with the effect of another exposure (i.e., the effect of a confounder). Confounding may result in overestimation or underestimation of the potential effect of an exposure on disease risk. Statistical techniques, such as stratification and co-variate adjustment, are available to adjust for the potential effects of known and measured confounders; however, residual confounding may remain even after adjustment, when the confounder is, for example, misclassified or crudely measured.

In addition, the methods used to select or recruit study subjects can result in selection and participation bias if those who are selected or recruited have inherently different characteristics than those who are not selected or choose not to participate. Scientists have developed methods to reduce the effect of these and other limitations, and epidemiologic studies typically provide the most weight in the studies considered in a weight-of-evidence review because they study humans, the species of interest in a human health risk assessment.

In vivo studies of laboratory animals typically study the effects of the agent of interest at high levels of exposure and often for durations that span the animals' lifetimes. These studies compare the rate and severity of symptoms and disease in exposed animals compared to un-exposed animals. One of the benefits of the *in vivo* animal study is that scientists can control and accurately measure exposure and other environmental factors that may influence disease development and exposure levels can be greater than that experienced by humans. A major limitation of *in vivo* animal studies is that the findings in animal studies may not be directly

[4] Relative risk and risk ratio are measures of statistical association between exposure and disease in a cohort study and is calculated as the ratio of the risk of diseases among the exposed and the risk of disease among the unexposed.

extrapolated to humans due to differences in physiology, metabolism, size, and longevity. Experimental studies are also conducted involving humans, but these studies typically contribute to an understanding of short-term effects, not long-term effects. In addition, ethical considerations prevent testing of known toxic or carcinogenic agents on humans.

In vitro studies of cells and tissues in the laboratory examine whether exposure results in certain biological changes. These observations can expand scientists' understanding of biophysical mechanisms that may lead to disease processes. Since the response of cells and tissues *in vitro* to a particular exposure may be very different than the response in intact organisms (i.e., living animals or humans), and may not directly predict adverse health effects, (e.g., AGNIR, 2012), the conclusions drawn from *in vitro* studies are extremely limited. Therefore, they receive less weight when considered in a weight-of-evidence review.

Weight-of-Evidence Review

After studies are systematically identified in the scientific literature, the strengths and weaknesses of each study are individually assessed and rated (i.e., given more or less weight) according to its overall quality. The quality of studies, among other factors, is determined by considering the number of study subjects, the design of the study, the methods used to collect data, the analysis of that data, and the potential for confounding, various biases, and random errors.

The next step in a weight-of-evidence review is to consider the totality of the evidence. The generally accepted guidance scientists use to weigh epidemiologic evidence includes the nine criteria outlined by Sir Austin Bradford Hill in his now seminal manuscript published in 1965. The nine criteria used to assess causality include strength of association, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy. Hill recommended that these guidelines should be applied when a chance association (i.e., caused by systematic error, such as confounding, bias, classification error, or random variability) could be ruled out with reasonable certainty, and cautioned that none of these criteria represent "hard-and-fast rules" and none of these criteria are "*sine qua non*" of causality,

the more the epidemiologic evidence meets these guidelines, the more persuasive the evidence is for a potential causal relationship.

Scientists use similar guidance for laboratory animal studies to weigh *in vivo* studies, including, among other criteria, whether a sufficient number of animals and exposure levels were included in the study; whether the assignment of the animals to various exposure groups was random; whether the outcome assessment and statistical analyses were conducted in a blinded manner[5]; whether health effects can be consistently demonstrated by two or more independent laboratories and in two or more species; and whether health effects can be demonstrated under different laboratory protocol. Similar guidelines are also outlined in a joint publication by the Federal Judicial Center and the National Research Council, *Reference Manual on Scientific Evidence* (FJC-NRC, 2011).

Weight-of-Evidence Evaluation of Carcinogenicity

The IARC, the cancer research agency of the WHO, is one of the leading international organizations for cancer risk assessment. In its risk assessments, which are published as Monographs, IARC primarily considers epidemiologic and *in vivo* animal studies, and evaluates *in vitro* studies to provide supplemental evidence on potential biophysical mechanisms (classified as strong, moderate, or weak) that lead to disease processes. IARC classifies the overall evidence from epidemiologic and *in vivo* animal studies into one of three categories, defined as follows.

- **Sufficient evidence**: A causal relationship can be established between exposure and cancer. This determination is based on the overall epidemiologic evidence in which positive relationships have been observed between the exposure and cancer in studies in which chance, bias, and confounding could be ruled out with reasonable confidence and on overall *in vivo* evidence in which increased incidence of cancer was observed in high

[5] Blinding in a study means that the investigators are not aware whether the animals were exposed or not exposed during the experiment and when the data are assessed. In a human experimental study, double-blinding means that neither the study participants nor the investigators are aware of participants' exposure status during the study. The lack of blinding may lead to human error or bias in a study.

quality laboratory animal studies in at least two species or from two independent laboratories.

- **Limited evidence:** A credible positive association is observed in epidemiologic studies, but chance, confounding, or bias could not be excluded as explanations for that association, and if *in vivo* studies result in an association, but the association is limited to one experiment or there are unresolved questions about study design features.
- **Inadequate evidence**: Epidemiologic studies are of insufficient quality, consistency, or statistical power, and *in vivo* studies have major qualitative or quantitative limitations or lack of data.

Based on its risk assessment evaluation, the IARC places each agent or exposure it examines into one of five Groups:

- Group 1: Carcinogenic to humans;
- Group 2A: Probably carcinogenic to humans;
- Group 2B: Possibly carcinogenic to humans;
- Group 3: Non-classifiable as to carcinogenicity to humans; and,
- Group 4: Probably not carcinogenic to humans.

Group 2B, possibly carcinogenic to humans, denotes substances and exposures for which there is limited evidence in epidemiologic studies and limited or inadequate evidence in *in vivo* studies. IARC has reviewed over 1,000 substances and exposure circumstances to evaluate their potential carcinogenicity and classified them as follows: Group 1, 120 agents; Group 2A, 82 agents; Group 2B, 311 agents; Group 3, 499 agents, Group 4, 1 agent. About 80% of the IARC's classifications fall into the possibly carcinogenic or non-classifiable category.[6] Since it is impossible in science to prove the absence of an effect, IARC has classified only one substance (caprolactam) in Group 4, which illustrates the conservative nature of IARC's risk evaluation process and the difficulty in proving the absence of an effect beyond all doubt. Only for about 20% of the substances examined by the IARC did the research show a clear-cut carcinogenic risk (Group 1, ~10%) or probable carcinogenic risk (Group 2A, ~8%); most agents

[6] http://monographs.iarc.fr/ENG/Classification/ (Last accessed on December 30, 2018).

were categorized in either Group 2B as possible carcinogenic risks or Group 3 as unable to be classified

Recent Key Reviews of RF Health Studies

In this section, I provide a summary of key recent reviews of the scientific literature on RF exposure and potential health effects. None of the comprehensive reviews that applied the scientific weight-of-evidence process concluded that the scientific evidence confirms the existence of any health effect of low-level RF exposure, including the RF fields associated with the operation of smart meters.

Numerous international and national governmental, health, and scientific agencies have conducted thorough weight-of-evidence reviews of the available scientific literature to evaluate whether exposure to RF fields may result in potential adverse health effects. To account for the large volume and complexity of available scientific information, these reviews were performed by panels assembled and appointed by these agencies, representing multiple scientific disciplines (e.g., epidemiology, toxicology, exposure assessment) with relevance to research areas related to RF fields and potential health effects. These weight-of-evidence evaluations represent scientifically based consensus opinions that provide guidance for governmental and standards setting agencies to establish exposure limits or regulations to protect the health and safety of the public, and guide future scientific research by identifying potential research gaps and priorities.

In the past several years, a number of major scientific reviews have evaluated the weight of evidence regarding RF and health including the International Commission on Non-Ionizing Radiation Protection (ICNIRP) in 2009, the Advisory Group on Non-ionising Radiation (AGNIR) for the HPA in 2012, the IARC in 2013, and the European Commission's SCENIHR in 2015, which I briefly review below. These reviews conducted proper weight-of-evidence evaluations of the scientific evidence and from those evaluations concluded that there is not sufficient evidence to conclude that exposure to low-level RF fields (i.e., below currently existing scientifically-based exposure guidelines) causes any adverse health effects, including cancer among children or adults, and adverse nervous system effects, immunological effects, cognitive effects, cardiovascular effects, reproductive effects, developmental effects, self-reported symptoms (including tinnitus), or hypersensitivity to RF fields. Additional agency reviews on exposure to RF fields and health, all expressing similar conclusions (i.e., lack of

established health effects of RF exposure at levels below scientifically-established guideline values), are listed in Appendix B.

International Commission on Non-Ionizing Radiation Protection (2009)

ICNIRP is the preeminent independent, non-governmental scientific organization for setting guidelines to protect the public from potential harmful effects of exposure to EMF, including RF fields, and it is the formally recognized organization for providing guidance on standards for non-ionizing radiation exposure for the WHO. ICNIRP systematically reviewed the available scientific evidence on exposure to high-frequency EMF and health, including numerical dosimetry, measurements, *in vitro* and *in vivo* biological laboratory studies, and epidemiologic studies. With respect to laboratory studies, ICNIRP concluded that while there are well-understood effects of RF exposure through tissue heating, the overall evidence from experimental studies does not provide consistent support for carcinogenic effects of RF exposure at non-thermal levels. ICNIRP described that there is some evidence of small changes in brain activity, but these do not represent any adverse effects.[7] ICNIRP also concluded that the "evidence from double-blind provocation studies suggests that subjective symptoms, such as headaches, that have been identified by some individuals as associated with RF exposure, whilst real enough to the individuals concerned, are not causally related to EMF exposure." With respect to epidemiologic studies, ICNIRP concluded that results of available and reviewed epidemiologic studies provide no consistent or convincing evidence of a causal relationship between RF exposure and any adverse health effect.

Health Protection Agency (2012)

The independent AGNIR of the HPA (now part of Public Health England), the United Kingdom's primary governmental authority on public health protection, conducted its systematic review of the *in vitro*, *in vivo* animal, experimental human, and epidemiologic literature in 2012. With respect to *in vitro* and *in vivo* animal studies, AGNIR concluded that

[7] Normal physiological changes (e.g., constriction of pupils or changes in brain activity) may occur as a result of everyday environmental stimuli, such as light and sound. These physiological changes, however, cannot be considered as adverse effects.

these studies provided no consistent evidence of adverse health effects of RF exposure at levels below those that produce heating. With respect to human experimental studies of acute effects of RF exposure below guideline levels, AGNIR concluded that the evidence suggests that such exposure "does not cause acute symptoms in humans, and that people, including those who report being sensitive to RF fields, cannot detect the presence of RF fields. Similarly, well-conducted studies do not suggest that exposure to RF fields gives rise to acute cognitive effects." While their review identified some scientific evidence that RF-field exposure may affect a person's brain activity, they cautioned that "the size of these reported effects is often small relative to normal physiological changes, and it is unclear whether they have any implications for health."

AGNIR found that epidemiologic studies of long-term exposure to RF fields below established guidelines provides no substantial evidence of effects, particularly those studies of cardiovascular morbidity, reproductive function, and non-cancer mortality, although they note that the literature "has been very limited." They similarly concluded that studies examining cancer risk in relation to occupational RF exposure and residential proximity to RF transmitters suffer from methodological limitations and provide no evidence for a causal relationship between exposure to RF fields and any adverse health effects. Finally, they conclude that the overall evidence from epidemiologic studies of mobile phone use and cancer risk "does not suggest that use of mobile telephones causes brain tumours [*sic*] or any other type of cancer," but they qualify this assessment by noting that "[t]he data, however, are essentially restricted to periods of less than 15 years from first exposure."

Overall, they concluded "... although a substantial amount of research has been conducted in this area, there is no convincing evidence that RF field exposure below guidance levels causes health effects in adults or children."

International Agency for Research on Cancer (2013)

In 2013, the IARC reviewed the scientific literature to evaluate potential carcinogenic effects of RF fields with a particular focus on exposures produced by close proximity to RF sources, such as from mobile phones. The IARC expert working group classified RF fields as possibly

carcinogenic (Group 2B) based on "limited evidence" for carcinogenicity of RF fields in relation to glioma and acoustic neuroma from mobile phone epidemiologic studies, and on "limited evidence" from experimental animal studies. The IARC concluded that results from epidemiologic studies of mobile phones and all other types of cancer, and from epidemiologic studies of occupational and environmental exposure to RF provided no clear indication of an association between RF exposure and cancer development. The IARC Group 2B classification does not imply that a cause-and-effect relationship is established between exposure and cancer. To the contrary, it means that artifacts, such chance, confounding and bias cannot be ruled out with scientific certainty as an explanation for the limited statistical association reported in some of the studies, because of the limitations of those studies.

Scientific Committee on Emerging and Newly Emerging Health Risks (2015)

SCENIHR is made up of independent scientific experts assembled to provide advice on public health and risk assessments to the Department of Health and Consumer Protection of the European Commission. SCENIHR provides opinions on emerging or newly-identified health and environmental risks and on broad, complex, or multidisciplinary issues requiring a comprehensive assessment of risks to consumer safety or public health and related issues not covered by other community risk assessment bodies. The mandate of SCENIHR includes the evaluation of potential health effects of EMF, including RF fields. SCENIHR's most recent report was issued in 2015.

With respect to epidemiologic studies of cancer, SCENIHR concluded that "[o]verall, the epidemiological studies on mobile phone RF EMF exposure do not show an increased risk of brain tumours [*sic*]. Furthermore, they do not indicate an increased risk for other cancers of the head and neck region. Some studies raised questions regarding an increased risk of glioma and acoustic neuroma in heavy users of mobile phones. The results of cohort and incidence time trend studies do not support an increased risk for glioma while the possibility of an association with acoustic neuroma remains open. Epidemiological studies do not indicate increased risk for other malignant diseases, including childhood cancer." With respect to potential effects of RF exposure on brain physiology, SCENIHR noted that while some studies indicated that RF may

affect brain activity, "the relevance of the small physiological changes remains unclear and mechanistic explanation is still lacking." They note, however, that "overall, there is a lack of evidence that mobile phone RF EMF affects cognitive functions in humans."

With respect to "symptoms that are attributed by some people to various RF EMF exposure," SCENIHR concluded that, based on available evidence, "RF EMF exposure is not causally linked to these symptoms." SCENIHR further concluded that evidence does not show a consistent association between RF exposure and neurological diseases, reproductive and developmental effects, and male fertility.

Reviews of Smart Meter RF Fields and Health

In this section, I provide a brief overview of evaluations conducted by various state and national government agencies in the United States and other countries specifically on potential health effects in relation to RF fields from smart meters. These evaluations concluded that there are no established health effects in relation to smart meter RF fields.

In response to public concern about potential health effects related to RF emission from smart meters, several states in the United States have formally assessed the scientific evidence on smart meters and health effects and issued their reports or statements with their conclusions and opinions.

A review conducted in Maine by the Maine Center for Disease Control in 2010 concluded in their summary statement that "our review of these agency assessments and studies do not indicate any consistent or convincing evidence to support a concern for health effects related to the use of radio frequency in the range of frequencies and power used by smart meters. They also do not indicate an association of EMF exposure and symptoms that have been described as electromagnetic sensitivity" (MCDC, 2010).

In California, the state assembly commissioned the CCST to perform an independent study to inform the debate among policy makers and the general public about the potential risk of adverse health effects due to RF field emissions from smart meters. The CCST's report concluded that "[t]he current FCC [Federal Communications Commission] standard provides an adequate factor of safety against know thermally induced health impacts of existing common household electronic devices and smart meters." They further conclude that scientific studies have neither identified nor confirmed any negative health effects from RF emissions produced by smart meters and other common electronic devices (CCST, 2011).

The Colorado Department of Public Health and the Environment issued a fact sheet in 2012, which concluded that "[s]mart Meters are unlikely to cause health effects because ... [t]o date, research does not suggest any consistent evidence of adverse health effects of RF emissions produced by Smart Meters or other common household electronic devices" (CDPHE, 2012).

The Michigan Public Service Commission issued a report in 2012 concluding that "[a]fter careful review of the available literature and studies, the Staff has determined that the health risk from the installation and operation of metering systems using radio transmitters is insignificant" (MPSC, 2012).

The Oregon Health Authority concluded in 2012 that "[b]ased on our review of these reports, evidence from the scientific literature and consultations with radiation experts, we conclude at this time that the implementation of smart meters will not adversely impact public health" (OHA, 2012).

The Public Utility Commission of Texas concluded in 2012 that "the large body of scientific research reveals no definite or proven biological effects from exposure to low-level RF signals. Further, Staff found no credible evidence to suggest that advanced meters emit harmful amounts of EMF" (PUCT, 2012). An order of the Public Utility Commission of Texas in 2013 similarly stated that "[t]he commission evaluated health, privacy, and operational concerns against advanced meters and concluded that the concerns are unwarranted" (PUCT, 2013).

The Arizona Department of Health Services conducted a study of smart meters that included measurements of RF signals at a random selection of single-family residences and apartment complexes within the state. The average and peak levels of RF were measured at 1 foot in front of meters at three times during the day. All measurements were found to comply with FCC standards. A search and review of the literature on potential effects of RF on health was performed which led the Department of Health to conclude that "[e]xposure to electric meters (AMI [advanced metering infrastructure] and AMR [automated meter reading]) is not likely to harm the health of the public" (ADHS, 2014).

A review of scientific and public health agency perspectives on RF fields related to smart meters commissioned by the Vermont Department of Health and the Vermont Public Service Department in 2014 concluded that "[b]ased on the substantial collective scientific evidence, the consensus of scientific and health agencies continues to conclude that current regulatory standards for RF from smart meters are sufficient to protect public health" (VDH/VPSD, 2014).

The legislature of North Carolina asked the Division of Public Health to perform an evaluation of existing information on RF and health related to smart meters. The team from the Division concluded that "[r]adiofrequency waves have demonstrated subtle biological effects on certain cellular systems; however there is no conclusive evidence that these changes have clinical significance ... Major reviews by various governmental organizations, both U.S. and global, have not found sufficient evidence that non-thermal effects of radiofrequency waves are a significant risk to humans ...accepted criteria to justify the application of the Precautionary Principle are not met for RF exposures from smart meters" (NCDHHS, 2015).

A fact sheet issued by Health Canada in 2011 states that based on its review "Health Canada has concluded that exposure to RF energy from smart meters does not pose a public health risk" (Health Canada, 2011). A similar fact sheet issued by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) in 2015 concluded that "there is no established scientific evidence that the low level RF EME exposure from smart meters causes any health effects including symptoms of ill health communicated by some people" (ARPANSA, 2015). More recently, Public Health England in the United Kingdom concluded in 2017 that "[t]he evidence to date suggests exposures to the radio waves produced by smart meters do not pose a risk to health" (Public Health England, 2017).

RF Exposure Standards and Guidelines

Current scientifically derived RF exposure guidelines are based on avoiding the risk to health that results from localized temperature increases in tissues and from physiological stress due to excessive whole-body heat load. A whole-body averaged energy absorption rate or specific absorption rate (SAR) of 4 watts per kilogram (W/kg) of body mass is required to result in an increase of 1 degree Celsius in the tissue temperature that may be associated with behavioral disruption. With the application of safety factors of 10 and 50, for occupational and public exposures, respectively, limits are derived on the strength of external RF fields.

Federal Communications Commission

In the United States, the FCC is the government agency responsible for regulating RF-generating devices. Their regulations specify the limit on the maximum level of permissible exposure to RF of varying frequencies, from 300 kilohertz (kHz) to 100 Gigahertz (GHz) (CFR, 2013). The FCC based their standards on the work of organizations such as the U.S. National Council for Radiation Protection (NCRP) and the Institute of Electrical and Electronic Engineers (IEEE).

The FCC established maximum permissible exposure (MPE) limits for exposure to RF (FCC, 1997) based on the recommendations of the NCRP and IEEE, as well as the U.S. National Institute for Occupational Safety and Health, the Occupational Safety and Health Administration, the Environmental Protection Agency (EPA) and the Food and Drug Administration. The FCC's MPE limits are set to protect against effects from RF exposure that can induce electric fields and currents in body tissues and cause tissue heating. Exposure, in the frequency range relevant to smart meters, is described in terms of power density, and measured in watts per square meter (W/m^2), or milliwatts per square centimeter (mW/cm^2). These units may be used to directly compare to either calculated or measured levels of RF. The FCC's MPE limits are evaluated in terms of 30-minute time-averaged values as averaged over the body dimensions. The reference levels set by ICNIRP and the IEEE International Committee on Electromagnetic Safety (ICES) are comparable to the FCC limits for frequencies that are

typically used in smart meter communication systems (i.e., frequencies of 900 MHz [megahertz] and 2.4 GHz) (IEEE, 2005; ICNIRP, 1998).

Alternative Views

In this section, I provide specific examples of views that are not based on valid scientific methods to assess the available evidence, which thus arrive at invalid conclusions regarding the existence of health effects in relation to low-level RF exposure. Such views and conclusions are contrary to conclusions of properly conducted weight-of-evidence reviews (e.g., reviews by IARC, HPA and SCENIHR).

As discussed above, none of the scientific reviews by government or scientific agencies that were properly conducted using standard scientific methods concluded that the evidence confirms the existence of any adverse health consequences in association with exposure to low-level RF fields in our daily environments.

Alternative views, such as that put forward by the BIWG in their 2007 BIR and their 2012 update, are not based on proper and rigorous evaluation of the scientific evidence. The BIWG report suffers from the following several deficiencies: the report was authored by a self-organized group of individuals from academic institutions and public interest groups, and not under the auspices of any recognized scientific organization; the conclusions expressed in the individual chapters of the document did not represent consensus opinions, rather they were the opinions of the individual contributors; the authors did not follow a weight-evidence approach, and selectively reported on studies that, in their opinions, showed some effect and supported their views; the authors mostly disregarded studies that did not show an effect, including the entire body of literature on long-term animal bioassays; and the authors did not thoroughly assess the quality of studies they evaluated. These deficiencies are likely to explain why the BIWG's conclusions are completely inconsistent with conclusions of other risk assessments that followed the generally-accepted scientific methods of weight-of-evidence evaluations.

Several scientific and governmental agencies strongly criticized the BIWG report. The Australian Centre for Radiofrequency Bioeffects Research wrote, "[a]s it stands it [the BIWG 2007 report] merely provides a set of views that are not consistent with the consensus of science, and it does not provide an analysis that is rigorous-enough to raise doubts about the scientific consensus" (ACRBR, 2008). The EMF-NET Steering Committee of the European

Commission opined the report was "written in an alarmist and emotive language and the arguments have no scientific support from well-conducted EMF research" and "[t]here is a lack of balance in the report; no mention is made in fact of reports that do not concur with authors' statements and conclusions" (EMF-NET, 2007). The Health Council of the Netherlands also questioned the authors' motivation noting "[u]pfront, therefore, the reason for writing the report was not to give an objective analysis of the current state of science that would subsequently lead to recommendations. Instead, the aim was to present information to demonstrate why current standards are inadequate" (HCN, 2008). All of these agencies concurred that BIWG did not follow the methods of a standard weight-of-evidence review and, for this reason, its conclusions and recommendations were not convincing.

Similar alternative statements expressing concern about health effects related to exposure to RF fields from smart meters were offered by, for example, the American Academy of Environmental Medicine (AAEM) and a scientist from the Santa Cruz County Health Services Agency. These alternative statements also appear to have been based on evaluations that did not follow well-established methods for weight-of-evidence assessments of the available scientific literature.

Specifically, there is no indication that any of the AAEM proclamations or opinions were based on a weight-of-evidence evaluation or a similar comprehensive and systematic review of the scientific literature. The AAEM documents merely pronounce opinions espoused by several members and make recommendations without providing a scientifically valid support for their conclusions. None of the medical conditions listed in the AAEM documents were found to be causally related to low level EMF by organizations that conducted a weight of evidence evaluation of the scientific literature (e.g., WHO, SCENIHR). The AAEM documents only list a few selected references in support for their positions. As discussed in more detail above, a few "cherry-picked" references cannot form the basis of a valid scientific conclusion. The references cited by the AAEM were available for review by organizations that conducted weight-of-evidence reviews (e.g., SCENIHR) that reached conclusions contrary to the conclusions of AAEM. In addition, many of the references cited in the AAEM documents are not specifically relevant for the frequency range used by smart meters. Criticisms to the AAEM opinions were also expressed by other organization, such as the Electric Power Research Institute (EPRI, 2012)

and the Lawrence Berkeley National Laboratory (LBNL, 2012). It is also noteworthy that AAEM is not listed as a medical specialty board recognized by the American Board of Medical Specialties.[8]

[8] https://www.abms.org/member-boards/

RF Health Research

In this section, I provide a brief overview of the relevant scientific research conducted in the past several decades on low-level RF exposure and health. For a detailed and comprehensive discussion of the relevant scientific literature, I refer to the reviews and weight-of-evidence assessments conducted by ICNIRP, HPA, IARC, and SCENIHR, as described above. Overall, none of the comprehensive evaluations conducted by these agencies concluded that the evidence confirms the existence of any adverse health effects in relation to RF exposure below currently existing exposure guidelines. The current scientific consensus as exemplified by the conclusion of the WHO is that the "current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields." Results of more recent studies published after the completion of the above-mentioned weight-of-evidence evaluations have not changed the overall conclusions expressed in these evaluations. Below I provide a brief overview of the key lines of scientific evidence related to exposure to RF fields and potential health effects.

Epidemiologic Studies of RF and Cancer

Epidemiologic studies examining potential effects of RF fields on human health outcomes can be broadly grouped into three categories: studies of occupational or military exposures to RF; studies of environmental exposure to RF (i.e., RF sources of fixed locations, such as radio and television transmitters and mobile phone base stations); and studies of personal exposure to cordless and mobile phones. In addition to these analytical epidemiologic studies, descriptive epidemiologic studies monitoring incidence trends of brain cancer are also used to assess the potential impact of mobile phone use on brain cancer development.

Epidemiologic studies of occupational and military exposures include cohort studies that follow well-defined populations exposed to RF from radar in military settings (e.g., Garland et al., 1990; Szmigielski, 1996; Szmigielski et al., 2001; Groves et al., 2002) or in the police force (e.g., Finkelstein, 1998), from use of amateur radio among operators (e.g., Milham, 1985), and from various sources in industrial settings (e.g., Armstrong et al., 1994; Morgan et al., 2000). Case-control studies of various cancer types have also assessed the potential relationship

between sources of occupational exposure to RF and cancer, and estimated exposure based on occupation or job category, used as a proxy for potential exposure to RF fields (e.g., Stang et al., 2001; Berg et al., 2006; Karipidis et al., 2007a, 2007b). While some earlier studies reported statistically significant associations between these proxy exposure measures and cancer, most recent studies have not consistently reported a risk of any type of cancer in association with occupational RF exposure.

Earlier studies of environmental RF exposures mostly consisted of studies with ecologic design or geographical correlations that compared cancer rates calculated for geographic areas (e.g., at various distances from antennae), but did not directly assess exposure of individuals (e.g., Hocking et al., 1996; Dolk et al., 1997a, 1997b; McKenzie et al., 1998; Cooper et al., 2001; Michelozzi et al., 2002; Park et al, 2004). Distance is another proxy exposure measurement used by scientists in the absence of direct measurements or modeled calculations of RF exposure; the interpretation of these results is constrained because not all people in an area have the same exposure, and it does not consider exposure from other RF sources. In addition, distance has limited accuracy because it does not consider characteristics of the source, topography, or the built environment that may also affect levels of RF fields. More recent studies of environmental RF exposure using case-control or cohort designs have improved exposure assessment and estimated RF exposure on the individual level, but none of these studies found any consistent, statistically significant positive association between total RF exposure and risk of childhood leukemia or brain cancer (Ha et al., 2007, 2008; Merzenich et al., 2008; Li et al., 2012; Hauri et al., 2014). Another study that estimated maternal exposure to RF from mobile phone base stations and the risk of cancer in their children also found no association with childhood leukemia/lymphoma or brain cancer (Elliott et al., 2010).

Cohort studies of mobile phone users with large sample sizes (Schüz et al., 2006; Frei et al., 2011; Benson et al., 2013a, 2013b) reported no associations with any types of cancer, including cancer of the head and neck, leukemia, and lymphoma. Some of these studies relied on mobile phone subscription records from mobile phone companies to determine use and estimate exposure (Schüz et al., 2006; Frei et al., 2011), which may result in exposure misclassification due to people sharing phones, using more than one phone, using company phones, and switching carriers.

A large number of case-control studies also have been conducted to assess mobile phone use and development of brain tumors. Most of these studies relied on self-reported mobile phone use to determine exposure, potentially resulting in well-documented recall bias and non-differential and differential exposure misclassification (e.g., Vrijheid et al., 2009; Toledano et al., 2018). Early case-control studies reported no association between mobile phone use and brain cancer, however, these studies included relatively short time periods of exposure (Muscat et al., 2000; Inskip et al., 2001).

Most of the more recent case-control mobile phone epidemiologic studies belong to one of two sets of studies: the multinational, comprehensive studies conducted by the INTERPHONE Study Group and the series of case-control studies conducted by a research group in Sweden. The INTERPHONE Study Group is comprised of a consortium of 16 research groups in 13 countries in Europe, Asia, North America, and Australia/New Zealand (Cardis et al., 2007, 2011; Interphone Study Group, 2010, 2011). The majority of studies by the INTERPHONE Study Group—both studies conducted in individual countries and pooled-analyses of data from several countries—show no significant positive association between self-reported mobile telephone use and risk of glioma, meningioma, and acoustic neuroma. The pooled analysis found that those who had ever been a regular mobile telephone user was associated with a significantly lower risk of glioma and meningioma, although this association was possibly due to selection bias, that is, greater participation among controls who had ever used mobile telephones than those who had not (Interphone Study Group, 2010; Cardis et al., 2011). A significant risk increase was observed in the highest of 10 categories of cumulative call time when all the data were combined in one analysis; however, the authors noted that there were implausible values of reported use in those highest categories, and they could not rule out chance or reporting bias as an explanation for the findings (Interphone Study Group, 2010, 2011).

Hardell and colleagues in Sweden conducted another series of case-control studies of malignant and benign brain tumors (e.g., Hardell et al., 1999, 2013). While all the Hardell et al., studies reported a significant positive association between mobile phone use and risk of brain tumors, with evidence of a positive exposure-response trend and especially with longer latency, concerns about selection bias, recall bias, interviewer bias, and multiple hypothesis testing,

along with unclear exposure definitions and study inclusion criteria, limit the strength of the authors' conclusions. The higher odd ratios reported in these studies are not consistent with results from other epidemiologic studies, including those from the Swedish INTERPHONE group (Lonn et al., 2005).

There is little epidemiologic evidence regarding mobile telephone use and risk of brain tumors in children. One case-control study of children and adolescents (aged 7–19 years) reported no exposure-response relationship between the amount of mobile telephone use and risk of brain tumors. In addition, the study did not detect an increased risk of brain tumors in those brain areas that received the highest amount of exposure (Aydin et al., 2011). Similarly, there are few case-control studies of mobile telephone use and the risk of parotid and salivary gland tumors, leukemia, non-Hodgkin lymphoma, uveal melanoma, testicular cancer, intratemporal facial nerve tumor. Existing studies on these outcomes do not reveal a consistent or convincing positive association and have the same general limitations as other case-control studies.

Because RF exposure from mobile phones has been hypothesized to affect primarily the development of brain cancer and because mobile phone use has dramatically increased in the past couple of decades in all modern societies, incidence trends of brain cancer have been examined in several countries in recent years. These studies, however, reported no observable increase brain cancer incidence during a period of substantial increase in mobile phone use (e.g., Cook et al., 2003; Röösli et al., 2007; Deltour et al., 2009; Inskip et al., 2010; de Vocht et al., 2011; Aydin et al., 2012; Shibui, 2012; McKean-Cowdin et al., 2013; Karipidis et al., 2018; Nilsson et al., 2019; Röösli et al., 2019). While some studies reported an increase in the rate of glioblastoma multiforme (i.e., "high-grade" brain tumors), they also reported a corresponding decrease in other types of brain tumors, a pattern that more likely was produced by a shift in tumor classification, and improvements in diagnostic technology over time rather than mobile phone use (e.g., Philips et al., 2018; de Vocht, 2019).

Laboratory Animal Studies of RF and Cancer

A review of experimental studies of studies of RF exposures in rats and mice between 1982 and 2011 was reported in by IARC in 2013. The conclusion was that, in aggregate, the studies

provided "limited evidence in experimental animals for the carcinogenicity of radiofrequency radiation." No rationale as to how the studies were rated or evaluated was provided. An updated review of these and some newer studies and analyses prompted SCENIHR (2015) to conclude "[o]verall, because a considerable number of well-performed studies using a wide variety of animal models have been mostly negative in outcome, the animal studies are considered to provide strong evidence for the absence of an effect." This review commented on the study by the U.S. NTP then underway, stating that "[l]ong-term absorption of RF energy at that level will have a considerable impact on thermoregulation, and induce compensatory changes in metabolism, as well as reducing food consumption and spontaneous activity." The studies reviewed by these agencies applied exposures with SARs below 8 mW/kg, but several involved exposures to SARs at much higher levels between 2- 5 W/kg.

National Toxicology Program

In 2000, the NTP began the design and planning for a study of rats and mice to be exposed to RF fields simulated to be similar to those of mobile phones with signal modulations characteristic of 2G mobile phones (GSM) and 3G mobile phones (CDMA). The results have been summarized most completely in two draft technical reports in February 2018 (NTP, 2018a, 2018b). Final reports were published in November 2018 (NTP, 2018c, 2018d).

Pilot studies of exposures for 5 days provided strong evidence confirming that exposure of rats to RF fields at 900 MHz and mice to RF fields at 1,900 MHz resulting in SAR levels of 10 W/kg or 12 W/kg for 10 minutes on and 10 minutes off for 18.3 hours per day produced excessive increases in body temperature leading to death in rats. In addition, the study reports that increases in body temperature above 1 degree Celsius (°C) may occur in rats and mice at exposure levels above 4 and 6 W/kg.

Twenty-eight-day studies involved the exposure of groups of pregnant females and groups of adult male and non-pregnant female rats to GSM or CDMA RF fields at 0, 6, or 9 W/kg, and adult male and non-pregnant female mice to GSM or CDMA RF fields at 5, 10, and 15 W/kg for 18.3 hours per day (cycles of 10-minutes on, 10-minutes off) for 28 days. Significant reductions in body weight were measured in rats post-pregnancy (in lactation) exposed to GSM or CDMA fields at 9 W/kg; dose-related reductions in body weight were also seen in the pups at 9 W/kg.

Similar, but apparently not significant, trends were seen in male and female adult rats as well. The body temperatures of pregnant female rats were significantly increased at 6 and 9 W/kg with GSM and CDMA exposure. Some significant decreases in the body temperatures of female pups exposed to GSM RF also were reported. In mice, exposures of males to GSM RF at 5 and 10 W/kg and CDMA at 10 and 15 W/kg significantly increased body temperatures. No effects of GSM or CDMA on the body weights of male or female mice were reported.

Two-year studies involved the exposure of rats to GSM or CDMA RF (1.5, 3, or 6 W/kg) beginning prior to birth (in utero exposure beginning on gestational day 5) through to the end of life. Mice were similarly exposed to GSM or CDMA RF (2.5, 5, or 10 W/kg) for their lifetimes, but these exposures began in adulthood. As in the shorter-term studies, significant reductions in body weight gains of pregnant female rats as well as their male and female pups were dose-related with GSM exposure. Significantly increased survival over the 2-year period of male rats exposed to GSM fields was reported at all SAR levels in a dose-related fashion. The survival of male rats exposed to CDMA at 1.5 and 3 W/kg was also increased. Similarly, survival of female rats increased in a dose-related fashion with exposure to CDMA and at 6 W/kg.

The examination of multiple organs of rats at the end of the study showed dose-related increased incidences of cardiomyopathy in the right ventricle of males at 3 and 6 W/kg (GSM) and at all SAR levels (CDMA). The rate at 6 W/kg was higher than the historical range among unexposed control rats in previous NTP studies. A trend for malignant schwannomas of the heart to increase with GSM and CDMA SAR level was observed in male rats, but the rate was only elevated above historical controls at 6 W/kg in CDMA males. An increase in the rate of brain glial tumors was not reported at any exposure levels in male rats exposed to CDMA, but a weak trend was noted.

Groups of 105 male and female mice exposed to GSM and CDMA also were evaluated after 2 years of exposure at different SAR levels than rats. The survival of male mice exposed to GSM at 5 W/kg and CDMA at 2.5 W/kg was higher than unexposed control mice. The examination of multiple organs of mice at the end of the study showed higher rates of malignant lymphoma in female mice exposed to GSM at 2.5 and 5 W/kg and to CDMA at 2.5 W/kg. Opposite effects of CDMA RF on liver cancer were reported for male mice (a decrease in

carcinomas at 2.5 W/kg and an increase of hepatoblastoma at 5 W/kg). All tumor rates were within the range of historical rates of control rats reported in other NTP studies.

Tests for reparable DNA damage after 14 weeks of exposure showed trends for damage to increase with SAR level in 1 of 3 brain regions of male mice (CDMA and GSM) and female rats (CDMA), in 2 of 3 brain regions in male rats (CDMA), in liver in female mice (CDMA), and in blood of both sexes of rats exposed to CDMA. No damage to chromosomes in red blood cells in rats or mice exposed to GSM or CDMA was reported. These observations were not linked in the report to histological observations on the brain or any other tissues.

Overall, the draft results of the NTP study indicate that exposure to levels of RF that cause heating of the body,[9] can have acute adverse effects, and that life-long exposure at slightly lower levels also may increase survival with increasing SAR exposure. Increased rates of malignant tumors above the rates in unexposed controls and historical controls in the hearts of GSM- and CDMA-exposed males provide, as the report states, "some evidence of carcinogenic activity" in rats. The report stated that data evaluated for mice only provided "equivocal evidence of carcinogenicity" with GSM and CDMA exposure. The data deserve additional scrutiny because, although the statistical testing for some measures such as body weight were adjusted for multiple comparisons, other measures like tumor incidence were not. Given the thousands of pair-wise and trend comparisons made between exposed and control rats and mice in these reports, one must assume that a substantial fraction of the statistically-significant differences reported were statistical false positive findings (i.e., occurred by chance alone). The SAR level that is considered the threshold above which adverse effects of whole-body RF exposure may be expected is 4 W/kg in rats, non-human primates, and humans (D'Andrea, 1999) and this has led for federal agencies in the United States to set the standard for whole-body exposure of the general public to 0.08 W/kg (FCC, 1997).

Following a review by an outside *ad hoc* peer-review panel conducted in March 2018, the NTP released its final reports in November 2018 (NTP, 2018c; 2018d). In the final reports, even

[9] Tissue heating is a well-established effect of RF exposure at sufficiently high levels. Scientifically-established RF exposure limits, however, are set well below levels at which adverse heating of the tissue or body may occur. Thus, the study findings of the NTP study are, in general, not informative with respect to potential effects of low-level RF exposure from everyday sources, including smart meters.

though the actual study results remained unchanged, the NTP upgraded some of their statements based on the review panels' recommendations, and stated that there was "clear evidence" that RF exposure was associated with development of schwannoma in the hearts of male rats, and "some evidence" for tumors in the brain and adrenal glands of male rats. Even though the maximum RF exposures to mice were 67% higher than for rats, the evidence for any effects was weaker for mice and was rated as "equivocal"

Ramazzini Institute

A recent study conducted at the Ramazzini Institute in Italy exposed rats to 1,800 MHz GSM RF fields for 19 hours per day from gestational day 12 (in utero) until the end of life at calculated SAR levels of 0.001 W/kg, 0.03 W/kg, or 0.1W/kg. A partial summary of the results was selected by the authors for publication earlier this year (Falcioni et al., 2018). The exposures were planned to simulate RF exposures in the environment from a fixed mobile antenna, not a mobile phone. The rats were exposed in cages with 5 rats per cage with a minimum of approximately 200 rats per sex per group. Body temperature was not measured.

The investigators did not report that they had randomly assigned the rats to the control or treatment conditions, which is a major flaw in the design of the experiment (Hooijmans, 2014). No effects on food or water intake, body weight, or survival in male or female rats were reported. The investigators reported 120 additional statistical calculations to describe the potential differences between groups of rats exposed or not exposed to RF fields on numerous measures. Using a criterion of $p < 0.05$, one would expect about six statistically significant differences to be reported just by chance alone in the two tables of data presented. But from all the calculations, only one single table entry indicated a statistically significant difference. In male rats at the highest exposure of 50 V/m (said to correspond to a SAR of 0.1 W/kg), 1.4% were diagnosed with a schwannoma in the heart whereas no rats were diagnosed with this tumor among the control rats. No other differences in the entire report were statistically significant. If these calculations had been corrected for multiple comparisons as had been done in the NTP study, there would be no statistical differences between the groups exposed to RF and the control group at all. Moreover, the claim of the investigators that the large number of rats in each group makes it a better study than the NTP study is undercut because they exposed the rats in cages of five and so the cage, and not the individual rats, should have been the experimental

unit for analysis. Thus, observations on each rat were not necessarily independent of the others in the cage and so the sample size for all the analyses should have been divided by 5 for the calculations of statistical significance. Another reason to be cautious about this study is that EPA has criticized the Ramazzini Institute's assessments of histological data and EPA has "decided not to rely on RI [Ramazzini Institute] data on lymphomas and leukemias in IRIS [Integrated Risk Information System] assessments" (USEPA, 2013), and has warned risk assessors about problems with the cancer bioassays conducted by the Ramazzini Institute. These problems include the accuracy of the cancer diagnoses; the categorization of tumors; errors in identifying cellular changes such as leukemia/lymphoma in certain tissues that appear to be due to infections and tissue inflammation; a unexplained significant rise in the incidence of leukemia/lymphomas over time in control groups unrelated to the exposure under study; the lack of complete reporting and documentation of analytical specifications; failure to control or analyze for potential litter effects; and the use of common controls for multiple studies (Gift et al., 2013).

In September 2018, ICNIRP published a brief summary and evaluation of the recently published studies of NTP and the Ramazzini Institute. Overall, ICNIRP concludes that "consideration of their [NTP and Ramazzini Institute studies] findings does not provide evidence that radiofrequency EMF is carcinogenic," and that these "studies do not provide a consistent, reliable and generalizable body of evidence that can be used as a basis for revising current human exposure guidelines." In a statement issued in November 2018 on the NTP studies, the Director of the Food and Drug Administration's (FDA) Center for Devices and Radiological Health opined that the findings of the NTP studies "should not be applied to human cell phone usage." The FDA further concluded that "[b]ased on our ongoing evaluation of this issue, the totality of the available scientific evidence continues to not support adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits. We believe the existing safety limits for cell phones remain acceptable for protecting the public health." A third commentary on these studies was offered in a newsletter by a group of scientists assembled by the Swiss Federal Office for the Environment (BERENIS, 2018). The limited commentary reported on selected aspects of these studies and pointed out "the results of the NTP study are mostly relevant for the exposure situation when using a mobile phone close to

the body. In contrast, the Ramazzini study observed carcinogenicity at levels as high as the environmental exposure limits, with no statistically significant effect at lower doses."

In summary, the newest animal studies of chronic exposure to RF fields do not alter the weight of evidence accumulated from previous research reviewed by scientific agencies indicating that RF fields at very low levels are not harmful. The NTP reports suggest potential adverse effects of short- and long-term exposure to RF at levels at or above historically recognized thresholds for causing increases in body temperatures and adverse effects of RF exposure upon which exposure standards are based. Further, the results of the Ramazzini study are consistent with no effect of RF at exposure levels that are about 100-fold lower than those of the NTP study, a finding consistent with prior research.

Studies of Potential Health Effects Other Than Cancer

While cancer development was the primary focus of many studies related to RF exposure and potential health effects, an important body of literature has also accumulated on potential health effects other than cancer. The examined non-cancer health outcomes included, among others, neurocognitive effects, reproductive and developmental effects, various cardiovascular conditions and diseases, nervous system effects, and immunological effects. Epidemiologic and laboratory studies on potential non-cancer outcomes of RF exposure have been systematically and repeatedly reviewed (e.g., Ahlbom et al.; 2004, Feychting, 2005, 2011; AGNIR, 2012; SCENIHR, 2015). Overall, the scientific literature is not in support of a causal relationship between low-level RF exposure and any of the examined non-cancer health outcomes.

Studies Related to Non-Specific Symptoms and Hypersensitivity

Overall, the scientific literature does not establish a causal link between exposure to EMF, including RF fields, and any non-specific symptoms or "electromagnetic hypersensitivity." A number of studies investigated the potential relationship between exposure to RF fields and various non-specific symptoms. Many of these studies relied on self-reported exposures, cross-sectional designs, and small sample sizes. These studies contributed little, if any, insight to our understanding of the potential effects of RF fields. Over 40 experimental studies examined the

relationship between exposure to either EMF or RF fields and electromagnetic hypersensitivity, also called idiopathic environmental intolerance attributed to EMF (IEI-EMF). The symptoms claimed to be associated with to IEI-EMF generally include dizziness, palpitations, skin itching, dry mouth, sleep disorders, and digestive problems. A number of the studies of IEI-EMF are limited because they did not utilize double-blinding techniques. A group of higher quality human experimental trials, epidemiologic studies and field intervention studies that examined the occurrence of headache, dizziness, concentration problems, sleep disturbances, or fatigue due to RF-field exposure did not provide consistent evidence of increased occurrence of symptoms or symptom patterns with exposure (Danker-Hopfe et al., 2010; Heinrich et al., 2010, 2011; Mohler et al., 2010, 2012; Röösli et al., 2010; Röösli and Hug, 2011; Frei et al., 2012). Scientists recognize that a person's symptoms may be real, and in some cases severe, however, well-conducted provocation studies consistently demonstrate that those who reported RF sensitivity cannot differentiate between exposure and no exposure scenarios, and that the reported symptoms are not causally related to RF exposure (Röösli et al., 2010; Röösli and Hug, 2011; Rubin et al., 2011).

In its fact sheet on "electromagnetic hypersensitivity," the WHO states that symptoms reported by individuals identified as having "electromagnetic hypersensitivity" are real and can be severe, but that "[w]ell controlled and conducted double-blind studies have shown that symptoms were not correlated with EMF exposure." The WHO further states that "EHS [electromagnetic hypersensitivity] is not a medical diagnosis, nor is it clear that it represents a single medical problem," and that "[t]reatment of affected individuals should focus on the health symptoms and the clinical picture, and not on the person's perceived need for reducing or eliminating EMF in the workplace or home."[10] Correspondingly, the most recent revision of the WHO's International Classification of Diseases (10th Revision)[11] does not include a specific category for "electromagnetic hypersensitivity" or IEI-EMF.

With respect to "electromagnetic hypersensitivity," the most recent comprehensive review by SCENIHR (2015) concluded that "[s]ymptoms that are attributed by some people to various RF EMF exposure can sometimes cause serious impairments to a person's quality of life. However,

[10] https://www.who.int/peh-emf/publications/facts/fs296/en/

[11] https://icd.who.int/browse10/2010/en

research conducted since the previous SCENIHR Opinion adds weight to the conclusion that RF EMF exposure is not causally linked to these symptoms. This applies to the general public, children and adolescents, and to people with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF). Recent meta-analyses of observational and provocation data support this conclusion."

Finally, Mr. Day has expressed concern about an exposure termed "dirty electricity," that is unrelated to RF fields produced by the Duquesne Light Company's smart meters that communicate at a frequency of 902 to 928 megahertz (MHz). The term "dirty electricity" refers to "the electromagnetic energy flowing along a conductor that deviates from a pure 50/60-Hz sine wave..." (de Vocht, 2010). The frequency of these currents and voltages and associated fields are not well defined but are generally about 10,000-fold lower than the smart meter RF communication signals (de Vocht, 2010). Many electronic devices such as radios, televisions, cable system routers, and virtually any device powered by electricity may be sources and such devices are subject to federal regulations (Code of Federal Regulations 101.15). Smart meters are tested according to ANSI C12.1-2014 (American National Standard for Electric Meters—Code for Electricity Metering). Mr. Day has provided no evidence that Duquesne Light Company's smart meters are a significant source of "dirty electricity" or produce various adverse symptoms claimed to be caused by "dirty electricity." A recent systematic review of the literature on exposure assessment and epidemiology related to "dirty electricity" concluded that the currently available scientific evidence does not support such claims (de Vocht and Olsen, 2016).

Summary and Conclusion

A large body of scientific literature has accumulated over the past several decades about exposure to RF fields and potential health effects. This area has been extensively studied and the literature includes a variety of scientific studies, including epidemiologic studies of human populations, experimental studies of laboratory animals and humans (*in vivo* studies), and laboratory studies of cells and tissues (*in vitro* studies). As the WHO states, "scientific knowledge in this area is now more extensive than for most chemicals."[12] The WHO also notes that "[w]ith more and more research data available, it has become increasingly unlikely that exposure to electromagnetic fields constitutes a serious health hazard, nevertheless, some uncertainty remains." The available scientific literature has been periodically and repeatedly reviewed by multidisciplinary panels convened by a number of national and international governmental health and scientific agencies to evaluate the overall scientific evidence on whether RF EMF at levels typically encountered in our environment pose any risk to human health. None of these expert panels, including those assembled for example by ICNIRP, HPA, IARC, and SCENIHR, has concluded that low-level exposure to RF fields (i.e., exposure below currently existing scientifically-established guideline levels) causes any adverse health effects, including cancer or any other chronic diseases. The IARC evaluation (IARC, 2013) and the press release issued in relation to the announcement of their main findings (IARC, 2011) specifically noted that the evidence from studies of environmental exposures (i.e., RF sources with fixed location, such as radio and television antennae and mobile phone base stations) and cancer development was "judged inadequate" to suggest an association.

Evaluations of potential health effects of RF emissions specifically from smart meters conducted by multiple states in the United States and other governmental agencies all concluded that the available scientific evidence does not support a claim for the existence of any health effects as a result of exposure to RF fields from smart meters.

The estimated potential exposure to RF fields from smart meters at the Day residence is a small fraction of RF exposure from all other sources, and is well below internationally-accepted,

[12] http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html

scientifically-based exposure guidelines, such as those set by ICNIRP, ICES, and specifically by the FCC. These exposure levels are also well within the range that could be experienced in other households in the United States. According to Dr. Cotts' evaluation in his expert report filed in this case, the contribution of a typical Duquesne Light Company's smart meter to the Complainant's exposure indoors is less than the RF exposure from other existing sources and only 0.00013% (1/780,000th) of the FCC's health-based exposure limit.

Based on my knowledge and familiarity with the relevant scientific literature, including the relevant weight-of-evidence reviews conducted by a number of international multidisciplinary expert panels, and the case materials presented to me in relation to the Complaint filed with the Pennsylvania Public Utility Commission against Duquesne Light Company on behalf of Geoff Day (*Day* matter), my opinions are as follows:

1. A causal relationship is not established between environmental exposure to RF fields, including RF fields specifically from smart meters owned and operated by Duquesne Light Company, and adverse human health effects, including cancers or non-cancer health effects, as claimed in the Complaint and in Complainant's related submissions.

2. Exposure to RF fields estimated in the Day residence as a result of the operation of smart meters or from other common sources found within or outside a typical residence does not have any proven adverse effect on health.

3. The materials included in the Complaint and in related submissions by Mr. Day do not provide a basis to reach a valid scientific conclusion that low-level RF exposure, including the RF fields associated with the operation of smart meters, causes or contributes to the development of any adverse health effects, including cancer and non-cancer health outcomes.

4. Exposure to RF fields from smart meters does not have any proven adverse effect on health, thus, scientific research does not support the claim that RF fields from smart meters would adversely affect the health of Mr. Day, or others at the Day residence.

5. The overall scientific evidence does not establish a causal relationship between RF exposure or "dirty electricity" and any of the alleged medical conditions, from which Mr. Day

allegedly suffers according to her Complaint and other materials submitted in this matter, which include "insomnia, anxiety, digestive issues, diminished ability to concentrate, restlessness, muscle fatigue and cognitive impairment," and an "appetite [that] is nearly non-existent."

My opinions are expressed herein to a reasonable degree of scientific and medical certainty. I reserve the right to revise my opinions as more information becomes available.

Limitations

At the request of counsel for Duquesne Light Company, Exponent prepared this report that provides an overview of the scientific literature on potential health effects of RF electromagnetic fields and evaluates whether exposure to RF fields from smart meters owned and operated by Duquesne Light Company near the residence of Mr. Day, presents any health risk to Mr. Day or others. The findings presented herein are made to a reasonable degree of scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material as it becomes available, and through any additional work, or review of additional work performed by others.

The scope of services performed during this investigation may not adequately address the needs of other users of this report, and any re-use of this report or its findings, conclusions, or recommendations presented herein for other purposes are at the sole risk of the user. My opinions are expressed herein to a reasonable degree of scientific certainty. I reserve the right to revise my opinion as more information becomes available.

References

Advisory Group on Non-ionising Radiation (AGNIR). Health Effects from Radiofrequency Electromagnetic Fields. Report of the Independent Advisory Group on Non-ionising Radiation. London, England: Health Protection Agency, 2012.

Ahlbom A, Green A, Kheifets L, Savitz D, Swerdlow A, ICNIRP Standing Committee on Epidemiology. Epidemiology of health effects of radiofrequency exposure. Environ Health Perspect 112:1741–1754, 2004.

Arizona Department of Health Services (ADHS), Office of Environmental Health. Public Health Evaluation of Radio Frequency Exposure from Electronic Meters. October 1, 2014.

American Academy of Environmental Medicine (AAEM). Community Resource: AAEM Position Papers. Wichita, Kansas: American Academy of Environmental Medicine, 2012.

Armstrong B, Theriault G, Guenel P, Deadman J, Goldberg M, Heroux P. Association between exposure to pulsed electromagnetic fields and cancer in electric utility workers in Quebec, Canada, and France. Am J Epidemiol 140: 805-820, 1994.

Australian Centre for Radiofrequency Bioeffects Research (ACRBR). ACRBR Position Statement on BioInitiative Report. ACRBR, December 18, 2008.

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Smart Meters and Health. March 2015. https://www.arpansa.gov.au/understanding-radiation/radiation-sources/more-radiation-sources/smart-meters (Last accessed on April 18, 2018.)

Aydin D, Feychting M, Schüz J, Tynes T, Andersen TV, Schmidt LS, Poulsen AH, Johansen C, Prochazka M, Lannering B, Klaeboe L, Eggen T, Jenni D, Grotzer M, Von der Weid N, Kuehni CE, Röösli M. Mobile phone use and brain tumors in children and adolescents: a multicenter case-control study. J Natl Cancer Inst 103: 1264-1276, 2011.

Aydin D, Feychting M, Schüz J, Röösli M, Cefalo study team. Childhood brain tumours and use of mobile phones: comparison of a case-control study with incidence data. Environ Health 11: 35, 2012.

Benson VS, Pirie K, Schüz J, Reeves GK, Beral V, Green J. Authors' response to: The case of acoustic neuroma: comment on mobile phone use and risk of brain neoplasms and other cancers. Int J Epidemiol 43:275, 2013a.

Benson VS, Pirie K, Schüz J, Reeves GK, Beral V, Green J, Million Women Study Collaborators. Mobile phone use and risk of brain neoplasms and other cancers: prospective study. Int J Epidemiol 42: 792-802, 2013b.

Berg G, Spallek J, Schüz J, Schlehofer B, Böhler E, Schlaefer K, Hettinger I, Kunna-Grass K, Wahrendorf J, Blettner M; Interphone Study Group, Germany. Occupational exposure to radio frequency/microwave radiation and the risk of brain tumors: Interphone study group, Germany. Am J Epidemiol 164: 538-548, 2006.

BioInitiative Working Group (BIWG). Cindy Sage and David O. Carpenter, Editors. BioInitiative Report: A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation at www.bioinitiative.org. December 31, 2012. http://www.bioinitiative.org/report/wp-content/uploads/pdfs/BioInitiativeReport2012.pdf.

California Council on Science and Technology (CCST). Health Impacts of Radio Frequency Exposure from Smart Meters. Sacramento, California: California Council on Science and Technology, 2011.

Cardis E, Richardson L, Deltour I, Armstrong B, Feychting M, Johansen C, Kilkenny M, McKinney P, Modan B, Sadetzki S, Schüz J, Swerdlow A, Vrijheid M, Auvinen A, Berg G, Blettner M, Bowman J, Brown J, Chetrit A, Christensen HC, Cook A, Hepworth S, Giles G, Hours M, Iavarone I, Jarus-Hakak A, Klaeboe L, Krewski D, Lagorio S, Lonn S, Mann S, McBride M, Muir K, Nadon L, Parent ME, Pearce N, Salminen T, Schoemaker M, Schlehofer B, Siemiatycki J, Taki M, Takebayashi T, Tynes T, van Tongeren M, Vecchia P, Wiart J, Woodward A, Yamaguchi N. The INTERPHONE study: design, epidemiological methods, and description of the study population. Eur J Epidemiol 22: 647-664, 2007.

Cardis E, Armstrong BK, Bowman JD, Giles GG, Hours M, Krewski D, McBride M, Parent ME, Sadetzki S, Woodward A, Brown J, Chetrit A, Figuerola J, Hoffmann C, Jarus-Hakak A, Montestruq L, Nadon L, Richardson L, Villegas R, Vrijheid M. Risk of brain tumours in relation to estimated RF dose from mobile phones: results from five Interphone countries. Occup Environ Med 68: 631-640, 2011.

Code of Federal Regulations (CFR). Title 47 Telecommunication, Volume 1, §1.1310 - Radiofrequency radiation exposure limits, pp. 319-321. Washington DC: Office of the Federal Register National Archives and Records Administration as a Special Edition of the Federal Register, As of October 1, 2013. https://www.gpo.gov/fdsys/pkg/CFR-2013-title47-vol1/pdf/CFR-2013-title47-vol1.pdf

Colorado Department of Public Health and Environment (CDPHE). Fact Sheet on Smart Meters and Associated Health Concerns. Denver, Colorado: Colorado Department of Public Health and Environment, 2012.

Committee on Man and Radiation (COMAR). COMAR technical information statement: expert reviews on potential health effects of radiofrequency electromagnetic fields and comments on the Bioinitiative Report. Health Phys 97:348-356, 2009.

Cook A, Woodward A, Pearce N, Marshall C. Cellular telephone use and time trends for brain, head and neck tumours. N Z Med J 116: U457, 2003.

Cooper D, Hemming K, Saunders P. Re: "Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter; II. All high power transmitters." Am J Epidemiol 153: 202-204, 2001.

D'Andrea JA. Behavioral effects of microwave irradiation. Bioelectromagnetics 20: 64–74, 1999.

Danker-Hopfe H, Dorn H, Bornkessel C, Sauter C. Do mobile phone base stations affect sleep of residents? Results from an experimental double-blind sham-controlled field study. Am J Hum Biol 22: 613-618, 2010.

de Vocht F. "Dirty electricity:" what, where, and should we care? J Expo Sci Environ Epidemiol 20:399-405, 2010.

de Vocht F. Analyses of temporal and spatial patterns of glioblastoma multiforme and other brain cancer subtypes in relation to mobile phones using synthetic counterfactuals. Environmental Research 168 (2019) 329–335.

de Vocht F and Olsen RG. Systematic Review of the Exposure Assessment and Epidemiology of High-Frequency Voltage Transients. Front Public Health 4:52, 2016.

de Vocht F, Burstyn I, Cherrie JW. Time trends (1998-2007) in brain cancer incidence rates in relation to mobile phone use in England. Bioelectromagnetics 32: 334-339, 2011.

Deltour I, Johansen C, Auvinen A, Feychting M, Klaeboe L, Schüz J. Time trends in brain tumor incidence rates in Denmark, Finland, Norway, and Sweden, 1974-2003. J Natl Cancer Inst 101: 1721-1724, 2009.

Dolk H, Shaddick G, Walls P, Grundy C, Thakrar B, Kleinschmidt I, Elliott P. Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter. Am J Epidemiology 145: 1-9, 1997a.

Dolk H, Elliott P, Shaddick G, Walls P, Thakrar B. Cancer incidence near radio and television transmitters in Great Britain. II. All high power transmitters. Am J Epidemiol 145: 10-17, 1997b.

Electric Power Research Institute (EPRI). Comments: A Perspective on Two Smart Meter Memoranda - EMF and RF Health Assessment and Safety. Comment 1024952. Palo Alto, CA: EPRI, February 2012.

Elliott P, Toledano MB, Bennett J, Beale L, de Hoogh K, Best N, Briggs DJ. Mobile phone base stations and early childhood cancers: case-control study. BMJ 340: c3077, 2010.

EMF-NET Coordination Action – The Steering Committee (EMF-NET). Comments on the BioInitiative Working Group Report (BioInitiative Report). European Commission, 2007.

Falcioni L, Bua L, Tibaldi E, Lauriola M, De Angelis L, Gnudi F, Mandrioli D, Manservigi M, Manservisi F, Manzoli I, Menghetti I, Montella R, Panzacchi S, Sgargi D, Strollo V, Vornoli A,

Belpoggi F. Report of final results regarding brain and heart tumors in Sprague-Dawley rats exposed from prenatal life until natural death to mobile phone radiofrequency field representative of a 1.8 GHz GSM base station environmental emission. Environ Res 165:496-503, 2018.

Federal Communications Commission (FCC). Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. Edition 97-01, OET Bulletin 65. Washington, D.C.: Federal Communications Commission, 1997.

Federal Judicial Center and National Research Council (FJC-NRC). Reference Manual on Scientific Evidence. Washington, DC: National Academies Press, 2011.

Feychting M. Non-cancer EMF effects related to children. Bioelectromagnetics Suppl 7:S69-S74, 2005.

Feychting M. Mobile phones, radiofrequency fields, and health effects in children--epidemiological studies. Prog Biophys Mol Biol 107:343-348, 2011.

Finkelstein MM. Cancer incidence among Ontario police officers. Am J Ind Med 24:157-162, 1998.

Food and Drug Administration (FDA). Statement from Jeffrey Shuren, M.D., J.D., Director of the FDA's Center for Devices and Radiological Health on the National Toxicology Program's report on radiofrequency energy exposure. November 1, 2018. https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm624809.htm

Frei P, Poulsen AH, Johansen C, Olsen JH, Steding-Jessen M, Schüz J. Use of mobile phones and risk of brain tumours: update of Danish cohort study. BMJ 343: d6387, 2011.

Frei P, Mohler E, Braun-Fahrländer C, Fröhlich J, Neubauer G, Röösli M, team Q. Cohort study on the effects of everyday life radio frequency electromagnetic field exposure on non-specific symptoms and tinnitus. Environ Int 38: 29-36, 2012.

Garland FC, Shaw E, Gorham ED et al. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy personnel. Am J Epidemiol 132: 293-303, 1990.

Gift JS, Caldwell JC, Jinot J, Evans MV, Cote I, Vandenberg JJ. Scientific considerations for evaluating cancer bioassays conducted by the Ramazzini Institute. Environ Health Perspect 121: 1253-1263, 2013.

Groves FD, Page WF, Gridley G, Lisimaque L, Stewart PA, Tarone RE, Gail MH, Boice JD, Jr., Beebe GW. Cancer in Korean War navy technicians: mortality survey after 40 years. Am J Epidemiol 155: 810-818, 2002.

Ha M, Im H, Lee M, Kim HJ, Kim BC, Gimm YM, Pack JK. Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. Am J Epidemiol 166: 270-279, 2007.

Ha M, Im H, Kim B-C, Gimm Y-M, Pack J-K. Five authors reply. Am J Epidemiol 167: 884-885, 2008.

Hardell L, Nasman A, Pahlson A, Hallquist A, Hansson Mild K. Use of cellular telephones and the risk for brain tumours: A case-control study. Int J Oncol 15: 113-116, 1999.

Hardell L, Carlberg M, Soderqvist F, Mild KH. Pooled analysis of case-control studies on acoustic neuroma diagnosed 1997-2003 and 2007-2009 and use of mobile and cordless phones. Int J Oncol 43: 1036-1044, 2013.

Hauri DD, Spycher B, Huss A, Zimmerman F, Grotzer M, von der Weid N, Spoerri A, Kuehni CE, Röösli M for the Swiss National Cohort and the Swiss Paediatric Oncology Group. Exposure to radio-frequency electromagnetic fields from broadcast transmitters and risk of childhood cancer: a census-based cohort study. Am J Epidemiol 179: 843-851, 2014.

Health Canada. Smart Meters. December 2011. https://www.canada.ca/en/health-canada/services/healthy-living/your-health/products/smart-meters.html (Last accessed on April 18, 2018.)

Health Council of the Netherlands (HCN). BioInitiative Report (U-5601/EvR/iv/673-L1 Publication nr 2008/17E). The Hague: HCN, 2008.

Heinrich S, Thomas S, Heumann C, von Kries R, Radon K. Association between exposure to radiofrequency electromagnetic fields assessed by dosimetry and acute symptoms in children and adolescents: a population based cross-sectional study. Environ Health 9: 75, 2010.

Heinrich S, Thomas S, Heumann C, von Kries R, Radon K. The impact of exposure to radio frequency electromagnetic fields on chronic well-being in young people--a cross-sectional study based on personal dosimetry. Environ Int 37: 26-30, 2011.

Hill AB. The Environment and Disease: Association or Causation? Proc R Soc Med 58: 295-300, 1965.

Hocking B, Gordon IR, Grain HL, Hatfield GE. Cancer incidence and mortality and proximity to TV towers. Med J Aust 165: 601-605, 1996.

Hooijmans CR, Rovers MM, de Vries RB, Leenaars M, Ritskes-Hoitinga M, Langendam MW. SYRCLE's risk of bias tool for animal studies. BMC Med Res Methodol doi: 10.1186/1471-2288-14-43, 2014.

Inskip PD, Tarone RE, Hatch EE, Wilcosky TC, Shapiro WR, Selker RG, Fine HA, Black PM, Loeffler JS, Linet MS. Cellular-telephone use and brain tumors. NEJM 344: 79-86, 2001.

Inskip PD, Hoover RN, Devesa SS. Brain cancer incidence trends in relation to cellular telephone use in the United States. Neuro Oncol 12: 1147-1151, 2010.

Institute of Electrical and Electronics Engineers (IEEE), IEEE Standard for Safety Levels with

Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. New York, NY: IEEE, 2005.

International Agency for Research on Cancer (IARC). Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields – Volume 102. Lyon, France: IARC, 2013.

International Agency for Research on Cancer (IARC). IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans. Press Release No. 208, May 31, 2011. http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Phys 74: 494-522, 1998.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). Exposure to High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 kHz-300 GHz). Oberschleißheim, Germany: ICNIRP, 2009.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP Note on Recent Animal Carcinogenesis Studies. April 9, 2018. https://www.icnirp.org/cms/upload/publications/ICNIRPnote2018.pdf

Interphone Study Group. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Int J Epidemiol 39: 675-694, 2010.

Interphone Study Group. Acoustic neuroma risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. Cancer Epidemiol 35: 453-464, 2011.

Karipidis KK, Benke G, Sim R. Occupational exposure to ionizing and non-ionizing radiation and risk of glioma. Occup Med 57: 518-524, 2007a.

Karipidis KK, Benke G, Sim R, Kauppinen T, Kricker A, Hughes AM, Grulich AE, Vajdic CM, Kaldor J, Armstrong B, Fritschi L. Occupational exposure to ionizing and non-ionizing radiation and risk of non-Hodgkin lymphoma. Int Arch Occup Environ Health 80: 663-670, 2007b.

Karipidis K, Elwood M, Benke G, Sanagou M, Tjong L, Croft RJ. Mobile phone use and incidence of brain tumour histological types, grading or anatomical location: a population-based ecological study. BMJ Open 8: e024489, 2018.

Lawrence Berkeley National Laboratory (LBNL). Review of the April 12, 2012 American Academy of Environmental Medicine (AAEM) submittal to the Michigan Public Service Commission. LBNL, 2012.

Li CY, Liu CC, Chang YH, Chou LP, Ko MC. A population-based case-control study of radiofrequency exposure in relation to childhood neoplasm. Sci Total Environ 435-436: 472-478, 2012.

Lonn S, Ahlbom A, Hall P, Feychting M, Swedish Interphone Study G. Long-term mobile phone use and brain tumor risk. Am J Epidemiol 161: 526-535, 2005.

Maine Center for Disease Control & Prevention (MCDC). Maine CDC Executive Summary of Review of Health Issues Related to Smart Meters. Augusta, Maine: Maine Center for Disease Control & Prevention, Division of Environmental Health, Maine Department of Health and Human Services, 2010.

McKean-Cowdin R, Razavi P, Barrington-Trimis J, Baldwin RT, Asgharzadeh S, Cockburn M, Tihan T, Preston-Martin S. Trends in childhood brain tumor incidence, 1973-2009. J Neurooncol 115: 153-160, 2013.

McKenzie DR, Yin Y, Morrell S. Childhood incidence of acute lymphoblastic leukaemia and exposure to broadcast radiation in Sydney--a second look. Aust N Z J Public Health 22: 360-367, 1998.

Merzenich H, Schmiedel S, Bennack S, Bruggemeyer H, Philipp J, Blettner M, Schüz J. Childhood leukemia in relation to radio frequency electromagnetic fields in the vicinity of TV and radio broadcast transmitters. Am J Epidemiol 168: 1169-1178, 2008.

Michelozzi P, Capon A, Kirchmayer U, Forastiere F, Biggeri A, Barca A, Perucci CA. Adult and childhood leukemia near a high-power radio station in Rome, Italy. Am J Epidemiol 155: 1096-1103, 2002.

Michigan Public Service Commission (MPSC). U-17000 Report to the Commission. Lansing, Michigan: Michigan Public Service Commission, 2012.

Milham S. Silent keys: leukaemia mortality in amateur radio operators (letter). Lancet 1: 812, 1985.

Mohler E, Frei P, Braun-Fahrländer C, Fröhlich J, Neubauer G, Röösli M, Qualifex T. Effects of everyday radiofrequency electromagnetic-field exposure on sleep quality: a cross-sectional study. Radiat Res 174: 347-356, 2010.

Mohler E, Frei P, Fröhlich J, Braun-Fahrländer C, Röösli M, Qualifex team. Exposure to radiofrequency electromagnetic fields and sleep quality: a prospective cohort study. PLoS One 7: e37455, 2012.

Morgan RW, Kelsh MA, Zhao K, Exuzides KA, Heringer S, Negrete W. Radiofrequency exposure and mortality from cancer of the brain and lymphatic/hematopoietic systems. Epidemiology 11: 118-127, 2000.

Muscat JE, Malkin MG, Thompson S, Shore RE, Stellman SD, McRee D, Neugut AI, Wynder EL. Handheld cellular telephone use and risk of brain cancer. JAMA 284: 3001-3007, 2000.

National Toxicology Program (NTP). NTP Technical Report on the Toxicology and Carcinogenesis Studies in Hsd: Sprague Dawley SD Rats Exposed to Whole-Body Radio

Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones. Draft Report for Peer Review. Research Triangle Park, NC: NTP, 2018a. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf

National Toxicology Program (NTP). NTP Technical Report on the Toxicology and Carcinogenesis Studies in B6C3F1/N Mice Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones. Draft Report for Peer Review. Research Triangle Park, NC: NTP, 2018b. https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr596peerdraft.pdf

National Toxicology Program (NTP). NTP Technical Report on the Toxicology and Carcinogenesis Studies in Hsd: Sprague Dawley SD Rats Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones. Research Triangle Park, NC: NTP, 2018c. https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr595_508.pdf

National Toxicology Program (NTP). NTP Technical Report on the Toxicology and Carcinogenesis Studies in B6C3F1/N Mice Exposed to Whole-Body Radio Frequency Radiation at a Frequency (900 MHz) and Modulations (GSM and CDMA) Used by Cell Phones. Research Triangle Park, NC: NTP, 2018d. https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr596_508.pdf

Nilsson J, Jaras J, Henriksson R, Holgersson G, Bergstrom S, Estenberg J, Augustsson T, Bergqvist M. No Evidence for Increased Brain Tumour Incidence in the Swedish National Cancer Register Between Years 1980-2012. Anticancer Res 39: 791-796, 2019

North Carolina Department of Health and Human Services (NCDHHS), Division of Public Health, Occupational and Environmental Epidemiology Branch, Health Impacts of Advanced Metering Systems (Smart Meters). August 24, 2015.

Oregon Health Authority (OHA). Letter of July 17, 2012, to Roger Gray, General Manager, Eugene Water & Electric Board, from Katrina Hedberg, MD, MPH, State Epidemiologist, Oregon Public Health Division. Portland, OR: Oregon Health Authority, 2012.

Park SK, Ha M, Im H-J. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. Int Arch Occup Environ Health 77:387-394, 2004.

Philips A, Henshaw DL, Lamburn G, O'Carroll MJ. Brain tumours: rise in Glioblastoma Multiforme incidence in England 1995-2015 suggests an adverse environmental or lifestyle factor. J Environ Pub Health, 2018. doi: 10.1155/2018/7910754. Available at https://www.hindawi.com/journals/jeph/aip/7910754/

Public Health England. Smart Meters: Radio Waves and Health. https://www.gov.uk/government/publications/smart-meters-radio-waves-and-health/smart-meters-radio-waves-and-health#exposures-from-smart-meters, June 2017. (Last accessed on April 18, 2018.)

Public Utility Commission of Texas (PUCT). Health and RF EMF from Advanced Meters. An

Overview of Recent Investigations and Analyses. Austin, TX: Public Utility Commission of Texas, Infrastructure & Reliability Division, 2012.

Public Utility Commission of Texas (PUCT). Rulemaking Related to Advance Metering Alternatives. Order Adopting New §25.133 and Amendment to §25.214 as Approved at the August 9, 2013 Open Meeting, 2013.

Röösli M, Michel G, Kuehni CE, Spoerri A. Cellular telephone use and time trends in brain tumour mortality in Switzerland from 1969 to 2002. Eur J Cancer Prev 16: 77-82, 2007.

Röösli M, Frei P, Mohler E, Hug K. Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations. Bull World Health Organ 88: 887-896F, 2010.

Röösli M and Hug K. Wireless communication fields and non-specific symptoms of ill health: a literature review. Wien Med Wochenschr 161:240-250, 2011.

Röösli M, Lagorio S, Schoemaker MJ, Schuz J, Feychting M. Brain and Salivary Gland Tumors and Mobile Phone Use: Evaluating the Evidence from Various Epidemiological Study Designs. Annu Rev Public Health. 40:221–38, 2019.

Rubin GJ, Hillert L, Nieto-Hernandez R, van Rongen E, Oftedal G. Do people with idiopathic environmental intolerance attributed to electromagnetic fields display physiological effects when exposed to electromagnetic fields? A systematic review of provocation studies. Bioelectromagnetics 32: 593-609, 2011.

Schüz J, Jacobsen R, Olsen JH, Boice JD, Jr., McLaughlin JK, Johansen C. Cellular telephone use and cancer risk: update of a nationwide Danish cohort. J Natl Cancer Inst 98: 1707-1713, 2006.

Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR). Potential Health Effects of Exposure to Electromagnetic Fields (EMF). Brussels, Belgium: Scientific Committee on Emerging and Newly Identified Health Risks, 2015.

Shibui S. [The present status and trend of brain tumors based on the data of the Brain Tumor Registry of Japan]. Brain Nerve 64: 286-290, 2012.

Stang A, Anastassiou G, Ahrens W, Bromen K, Bronfeld N, Jockel KH. The possible role of radiofrequency radiation in the development of uveal melanoma. Epidemiology 12: 7-12, 2001.

Swiss Federal Office of the Environment. Newsletter of the Swiss expert group on electromagnetic fields and non-ionising radiation (BERENIS). Evaluation of the NTP and Ramazzini studies. Special Issue November 2018.

Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. Sci Total Environ 180: 9-17, 1996.

Szmigielski S, Sobiczewska E, Kubacki R. Carcinogenic potency of microwave radiation: Overview of the problem and results of epidemiological studies on Polish military personnel. Eur J Onol 6: 193-199, 2001.

Toledano MB, Auvinen A, Tettamanti G, Cao Y, Feychting M, Ahlbom A, Fremling K, Heinavaara S, Kojo K, Knowles G, Smith RB, Schüz J, Johansen C, Poulsen AH, Deltour I, Vermeulen R, Kromhout H, Elliott P, Hillert L. An international prospective cohort study of mobile phone users and health (COSMOS): Factors affecting validity of self-reported mobile use phone. Int J Hyg Environ Health 221: 1-8, 2018.

U.S. Environmental Protection Agency (USEPA). Update on Ramazzini Institute Data in IRIS Assessments. USEPA, 2013. https://www.epa.gov/iris/update-ramazzini-institute-data-iris-assessments.

Vermont Department of Health/Vermont Public Service Department (VDH/VPSD). Radio Frequency Radiation and Health: Smart Meters Montpelier, Vermont: Vermont Department of Health, 2012.

Vrijheid M, Armstrong BK, Bedard D, Brown J, Deltour I, Iavarone I, Kewski D, Lagorio S, Moore S, Richardson L, Giles GG, McBride M, Parent M-E, Siemiatycki J, Cardis E. Recall bias in the assessment of exposure to mobile phones. J Exp Sci Environ Epidemiol 19: 369-381, 2009.

Warrell DA, Cox TM, Firth JD, Benz EJ. (Eds.) Oxford Textbook of Medicine, 4th Edition. Oxford: Oxford University Press, 2003.

Appendix A

Appendix A – Curriculum vitae of Gabor Mezei, M.D., Ph.D.

EXHIBIT N1

Exponent®
Engineering & Scientific Consulting

Gabor Mezei, M.D., Ph.D.
Senior Managing Scientist | Health Sciences
149 Commonwealth Drive | Menlo Park, CA 94025
(650) 688-7341 tel | gmezei@exponent.com

Professional Profile

Dr. Mezei is a physician and epidemiologist with over 25 years of experience in research of clinical outcomes and environmental and occupational health issues. He designed, conducted and evaluated epidemiologic investigations and directed multidisciplinary research programs related to children's health (including childhood leukemia and brain cancer), adult cancers (e.g., leukemia, brain and breast cancer), neurodegenerative diseases (e.g., Alzheimer disease and amyotrophic lateral sclerosis [Lou Gehrig disease]), reproductive health outcomes (including birth defects), occupational injuries and ergonomics. He has been involved in studies of various occupational and environmental exposures, including electromagnetic fields (EMF), mineral fibers (asbestos), air pollutants and metals (welding fumes).

Dr. Mezei has expertise and experience in quantitatively and qualitatively aggregating epidemiologic evidence (via literature reviews, meta-analyses, and pooled analyses) for environmental and occupational risk assessments. Dr. Mezei appeared as an expert in hearings at several state (US) and provincial (Canada) public utility commissions and a parliamentary committee in Ireland.

Prior to joining Exponent, Dr. Mezei directed a multidisciplinary scientific research program at the Electric Power Research Institute designated to address potential human and animal health effects associated with residential and occupational exposure to power frequency and radiofrequency EMF. He also directed occupational health and safety research focusing on injury surveillance, ergonomics evaluations, and occupational exposure assessments. Earlier, at the Toronto Western Hospital, University of Toronto, he conducted research to identify clinical factors affecting hospital stay, adverse clinical and surgical outcomes and hospital readmissions following ambulatory surgery. He was a practicing physician at the National Institute for Dermatology in Budapest, Hungary.

Dr. Mezei trained as a physician (M.D.) at the Semmelweis University of Medicine in Budapest, Hungary, and as an epidemiologist (Ph.D.) at the School of Public Health of the University of California in Los Angeles (UCLA). He was the recipient of Fogarty and Fulbright Fellowships. He served as an affiliate associate professor in the Department of Environmental and Occupational Health Sciences of the University of Washington in Seattle, Washington, as a visiting scientist at the Hungarian National Research Institute for Radiobiology and Radiohygiene in Budapest, Hungary, and as an associate editor at the Journal of Exposure Science and Environmental Epidemiology. Dr. Mezei lectured at Stanford University, the UCLA School of Public Health, and the Electrotechnical Committee of the Hungarian Academy of Sciences. Dr. Mezei is an author or co-author of over 60 scientific publications and book chapters on topics related to the epidemiology of environmental and occupational exposures and chronic diseases (such as cancer and neurodegenerative diseases), adverse clinical outcomes, and environmental exposure assessment.

EXHIBIT N1

Academic Credentials & Professional Honors

Ph.D., Epidemiology, University of California, Los Angeles (UCLA), 1995

M.D., Medicine, Semmelweis University of Medicine, 1990

Fogarty Fellowship, 1992-1995

Fulbright Fellowship, 1994-1995

Languages

Hungarian

Publications

Mezei G, Chang ET, Mowat FS, Moolgavkar SH. 2017. Epidemiology of mesothelioma of the pericardium and tunica vaginalis testis. Ann Epidemiol 27(5):348-359. With erratum; Ann Epidemiol 2018;28(63).

Volberg V, Fordyce T, Leonhard M, Mezei G, Vergara X, Krishen L. Injuries among electric power industry workers, 1995-2013. J Safety Res 2017 Feb; 60:9-16.

Lewis RC, Minguez-Alarcon L, Meeker JD, Williams PL, Mezei G, Ford JB, Hauser R. Self-reported mobile phone use and semen parameters among men from a fertility clinic. Reproductive Toxicology 2017; 67: 42-47. (E-pub: November 9, 2016)

Fordyce TA, Leonhard MJ, Watson HN, Mezei G, Vergara XP, Krishen L. An analysis of fatal and non-fatal injuries and injury severity factors among electric power industry workers. American Journal of Industrial Medicine 2016; 59 (11): 948-958. (E-pub: June 27, 2016)

Tell RA, Hooper HC, Sias GG, Mezei G, Hung P, Kavet R. Electromagnetic field associated with commercial solar photovoltaic electric power generating facilities. Journal of Occupational and Environmental Hygiene 2015; 12 (11): 795-803.

Oksuzyan S, Crespi CM, Cockburn M, Mezei G, Vergara X, Kheifets L. Race/ethnicity and childhood leukemia: a case-control study in California. Journal of Epidemiology and Community Health 2015; 69 (8): 795-802. (E-pub: March 19, 2015)

Kheifets L, Crespi C, Hooper C, Oksuzyan S, Cockburn M, Ly T, Mezei G. Epidemiologic study of residential proximity to transmission lines and childhood cancer in California: Description of design, epidemiologic methods and study population. Journal of Exposure Science and Environmental Epidemiology 2015; 25(1):45-52.

Vergara X, Kheifets L, Mezei G. Case-control study of occupational exposure to electric shocks and magnetic fields and mortality from amyotrophic lateral sclerosis in the U.S., 1991-1999. Journal of Exposure Science and Environmental Epidemiology 2015; 25(1):65-71.

Mezei G, Sudan M, Izraeli S, Kheifets L. Epidemiology of childhood leukemia in the presence and absence of Down syndrome. Cancer Epidemiology 2014; 38(5):479-489.

Slusky DA, Does M, Metayer C, Mezei G, Kavet R, Selvin S, Buffler PA. Potential role of selection bias in the association between childhood leukemia and residential magnetic field exposure: a population-based assessment. Cancer Epidemiology 2014; 38(3):307-313.

Souques M, Plante M, Ostiguy G, Goulet D, Deschamps F, Mezei G, Modolo J, Lambrozo J, Legros A.

EXHIBIT N1

Anecdotal report of magnetophosphene perception in 50 mT 20, 50 and 60 Hz magnetic fields. Radioprotection 2014; 49(1):69-71.Okokon E, Roivainen P, Kheifets L, Mezei G, Juutilainen J. Indoor transformer stations and ELF magnetic field exposure: use of transformer structural characteristics to improve exposure assessment. Journal of Exposure Science and Environmental Epidemiology 2014; 24(1):100-104.

Frei P, Poulsen AH, Mezei G, Pedersen C, Salem LC, Johansen C, Roosli M, Schuz J. Residential distance to high voltage power lines and risk of neurodegenerative diseases: A Danish population-based case-control study. American Journal of Epidemiology, 2013; 177(9):970-978.

Tell RA, Kavet R, Mezei G. Characterization of radiofrequency field emissions from smart meters. Journal of Exposure Science and Environmental Epidemiology 2013; 23 (5):549-553.

Vergara X, Kheifets L, Oksuzyan S, Cho YS, Mezei G. Occupational exposure to extremely low frequency magnetic fields and neurodegenerative diseases: A meta-analysis. Journal of Occupational and Environmental Medicine 2013; 55(2):135-146.

Oksuzyan S, Crespi CM, Cockburn M, Mezei G, Kheifets L. Birth weight and other perinatal factors and childhood CNS tumors: A case-control study in California. Cancer Epidemiology 2013; 37(4):402-409.

Schüz J, Grell K, Kinsey S, Linet MS, Link MP, Mezei G, Pollock BH, Roman E, Zhang Y, McBride MN, Johansen C, Spix C, Hagihara J, Saito AM, Simpson J, Robison LR, Dockerty JD, Feychting M, Kheifets L, Frederiksen K. Extremely low frequency magnetic fields and survival from childhood acute lymphoblastic leukemia: An international follow up study. Blood Cancer Journal 2012; 2: e98.

Oksuzyan S, Crespi CM, Cockburn M, Mezei G, Kheifets L. Birth weight and other perinatal characteristics and childhood leukemia in California. Cancer Epidemiology 2012; 36: e359-e365.

Tell RA, Sias GG, Vazquez A, Sahl J, Turman JP, Kavet RI, Mezei G. Radiofrequency fields associated with the Itron smart meter. Radiation Protection Dosimetry 2012; 151(1):17-29.

Hicks JB, McCarthy SA, Mezei G, Sayes CM. PM1 particles at coal- and gas-fired power plant work areas. Annals of Occupational Hygiene 2012; 56(2):182-193.

Slusky DA, Mezei G, Metayer C, Selvin S, Von Behren J, Buffler PA. Comparison of racial differences in childhood cancer risk in case-control studies and population-based cancer registries. Cancer Epidemiology 2012; 36(1):36-44.

Roosli M, Jenni D, Kheifets L, Mezei G. Extremely low frequency magnetic field measurements in buildings with transformer stations in Switzerland. Science of the Total Environment 2011; 409(18):3364-3369.

Stone A, Marklin R, Seeley P, Mezei G. A collaborative effort to apply ergonomics to electric utility workers at generating stations. WORK: A Journal of Prevention Assessment and Rehabilitation 2011; 39(2):103-111.

Kheifets L, Ahlbom A, Crespi CM, Feychting M, Johansen C, Monroe J, Murphy M, Oksuzyan S, Preston-Martin S, Roman E, Saito T, Savitz D, Schüz J, Simpson J, Swanson J, Tynes T, Verkasalo P, Mezei G. A pooled analysis of extremely low frequency magnetic fields and childhood brain tumors. American Journal of Epidemiology 2010; 172(7):752-761.

Hareuveny R, Kandel S, Yitzhak NM, Kheifets L, Mezei G. Exposure to 50 Hz magnetic fields in apartment buildings with indoor transformer stations in Israel. Journal of Exposure Science and Environmental Epidemiology 2011; 21(4):365-371.

EXHIBIT N1

Fordyce TA, Morimoto L, Coalson J, Kelsh M, Mezei G. Neck injuries among electric utility workers, 1995-2007. Journal of Occupational and Environmental Medicine 2010; 52(4):441-449.

Kheifets L, Ahlbom A, Crespi CM, Draper G, Hagihara J, Lowenthal RM, Mezei G, Oksuzyan S, Schüz J, Swanson J, Tittarelli A, Vinceti M, Wunsch Filho V. Pooled analysis of recent studies of magnetic fields and childhood leukemia. British Journal of Cancer 2010; 103(7):1128-1135.

Mezei G, Gadallah M, Kheifets L. Residential magnetic field exposure and childhood brain cancer: a meta-analysis. Epidemiology 2008; 19(3):424-430.

Mezei G, Spinelli JJ, Wong P, Borugian M, McBride ML. Assessment of selection bias in the Canadian case-control study of residential magnetic field exposure and childhood leukemia. American Journal of Epidemiology 2008; 167(12):1504-1510.

Kheifets L, Monroe J, Vergara X, Mezei G, Afifi AA. Occupational EMF and leukemia and brain cancer: An update to two meta-analyses. Journal of Occupational and Environmental Medicine 2008; 50(6):677-688.

Thuroczy G, Janossy G, Nagy N, Bakos J, Szabo J, Mezei G. Exposure to 50 Hz magnetic fields in apartment buildings with built-in transformer stations in Hungary. Radiation Protection Dosimetry 2008; 131(4):469-473.

Ilonen K, Markkanen A, Mezei G, Juutilainen J. Indoor transformer stations as predictors of residential ELF magnetic field exposure. Bioelectromagnetics 2008; 29(3):213-218.

Kheifets L, Bowman JD, Checkoway H, Feychting M, Harrington M, Kavet R, Marsh G, Mezei G, Renew D, van Wijngaarden E. Future needs of occupational epidemiology of extremely low frequency (ELF) electric and magnetic fields (EMF): Review and recommendations. Occupational and Environmental Medicine 2009; 66(2):72-80.

Li CY, Mezei G, Sung FC, Silva M, Chen PC, Lee PC, Chen LM. Survey of residential extremely-low-frequency magnetic field exposure among children in Taiwan. Environment International 2007; 33(2):233-238.

Li CY, Sung FC, Chen FL, Lee PC, Silva M, Mezei G. Extremely-low-frequency magnetic field exposure of children at schools near high voltage transmission lines. Science of the Total Environment 2007; 376(1-3):151-159.

Mezei G, Benyi M, Muller A. Mobile phone ownership and use among school children in three Hungarian cities. Bioelectromagnetics 2007; 28(4):309-315.

Li CY, Mezei G, Sung FC, Silva M, Lee PC, Chen PC, Chen LM. Assessment of nonresponse bias in a survey of residential magnetic field exposure in Taiwan. Bioelectromagnetics 2007; 28(5):340-348.

Schuz J, Svendsen AL, Linet MS, McBride ML, Roman E, Feychting M, Kheifets L, Lightfoot T, Mezei G, Simpson J, Ahlbom A. Nighttime exposure to electromagnetic fields and childhood leukemia. An extended pooled analysis. American Journal of Epidemiology 2007; 166(3):263-269.

Foliart DE, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R, Pollock BH. Magnetic field exposure and prognostic factors in childhood leukemia. Bioelectromagnetics 2007; 28(1):69-71.

Foliart DE, Pollock BH, Mezei G, Iriye R, Silva JM, Ebi KL, Kheifets L, Link MP, Kavet R. Magnetic field exposure and long-term survival among children with leukemia. British Journal of Cancer 2006; 94(1):161-164. (Corrigendum. British Journal of Cancer 2006; 94(6):940).

EXHIBIT N1

Savitz DA, Herring AH, Mezei G, Evenson KR, Terry JW, Kavet R. Physical activity and magnetic field exposure in pregnancy. Epidemiology 2006; 17(2):222-225.

Mezei G, Kheifets L. Selection bias and its implications for case-control studies: a case study of magnetic field exposure and childhood leukemia. International Journal of Epidemiology 2006; 35(2):397-406.

Poole C, Greenland S, Luetters C, Kelsey JL, Mezei G. Socioeconomic status and childhood leukemia: A review. International Journal of Epidemiology 2006; 35(2):370-384.

Mezei G, Borugian MJ, Spinelli JJ, Wilkins R, Abanto Z, McBride ML. Socioeconomic status and childhood solid tumor and lymphoma incidence in Canada. American Journal of Epidemiology 2006; 164(2):170-175.

Szabo J, Mezei K, Thuroczy G, Mezei G. Occupational 50 Hz magnetic field exposure measurements among female sewing machine operators in Hungary. Bioelectromagnetics 2006; 27(6):451-457.

Kheifets L, Mezei G, Greenland S. Comment concerning "Childhood leukemia and residential magnetic fields: Are pooled analyses more valid than the original studies?" Bioelectromagnetics 2006; 27(8):674-675.

Mezei G, Bracken TD, Senior R, Kavet R. Analyses of magnetic-field peak-exposure summary measures. Journal of Exposure Science and Environmental Epidemiology 2006; 16(6):477-485.

Borugian MJ, Spinelli JJ, Mezei G, Wilkins R, Abanto Z, McBride ML. Childhood leukemia and socioeconomic status in Canada. Epidemiology 2005; 16(4):526-531.

Mezei G, Cher D, Kelsh M, Edinboro C, Chapman P, Kavet R. Occupational magnetic field exposure, cardiovascular disease mortality and potential confounding by smoking. Annals of Epidemiology 2005; 15(8):622-629.

Forssen UM, Mezei G, Nise G, Feychting M. Occupational magnetic field exposure among women in Stockholm County, Sweden. Occupational and Environmental Medicine 2004; 61(7):594-602.

Mezei G, Kavet R. Power frequency magnetic field exposure and childhood leukemia — Epidemiologic evidence and research perspectives. Central European Journal of Occupational and Environmental Medicine 2004; 10(2):115-126.

Tong D, Wong J, Chung F, Friedlander M, Bremang J, Mezei G, Streiner D. Prospective study on incidence and functional impact of transient neurologic symptoms associated with 1% vs 5% hyperbaric lidocaine in short urologic procedures. Anesthesiology 2003; 98(2):485-494.

Higgins PP, Chung F, Mezei G. Postoperative sore throat after ambulatory surgery. British Journal of Anaesthesia 2002; 88(4):582-584.

Foliart DE, Iriye RN, Silva JM, Mezei G, Tarr KJ, Ebi KL. Correlation of year-to-year magnetic field exposure metrics among children in a leukemia survival study. Journal of Exposure Analysis and Environmental Epidemiology 2002; 12(6):441-447.

Sahl J, Mezei G, Kavet R, McMillan A, Silvers A, Sastre A, Kheifets L. Occupational magnetic field exposure and cardiovascular mortality in a cohort of electric utility workers. American Journal of Epidemiology 2002; 156(10):913-918.

Mezei G, Kheifets LI. Clues to the possible viral etiology of childhood leukemia. Technology 2002; 9(1-2):3-14.

Mezei G, Kheifets LI, Nelson LM, Mills KM, Iriye R, Kelsey JL. Household appliance use and residential exposure to 60-Hz magnetic fields. Journal of Exposure Analysis and Environmental Epidemiology 2001; 11(1):41-49.

Chung F, Mezei G. Adverse outcomes in ambulatory anesthesia — What can we improve? Ambulatory Surgery 2000; 8(2):73-78.

Chung F, Mezei G, Tong D. Adverse events in ambulatory surgery: A comparison between elderly and younger patients. Canadian Journal of Anesthesia 1999; 46(4):309-321.

Chung F, Mezei G. Adverse outcomes in ambulatory anesthesia. Canadian Journal of Anesthesia 1999; 46(5/II):R18-34.

Sinclair DR, Chung F, Mezei G. Can postoperative nausea and vomiting be predicted? Anesthesiology 1999; 91(1):109-118.

Chung F, Mezei G, Tong D. Pre-existing medical conditions as predictors of adverse events in day-case surgery. British Journal of Anaesthesia 1999; 83(2):262-270.

Mezei G, Chung F. Return hospital visits and hospital readmissions after ambulatory surgery. Annals of Surgery 1999; 230(5):721-727.

Chung F, Mezei G. Factors contributing to a prolonged stay after ambulatory surgery. Anesthesia & Analgesia 1999; 89(6):1352-1359.

Book Chapters

Moolgavkar SH, Chang ET, Mezei G, Mowat FS. Epidemiology of mesothelioma. Chapter 3. In, Asbestos and Mesothelioma. Testa J (Ed.). Springer Nature. Pages 43-72, 2017.

Mezei G, Vergara X. Adult cancer and extremely low-frequency magnetic fields. In: Röösli M. Epidemiology of Electromagnetic Fields, Chapter 10, pp 161-184. CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2014.

Kheifets L, Mezei G. Extremely low frequency electric and magnetic fields. In: Hunter's Diseases of Occupations, 10th edition. Baxter PJ, Aw TC, Cockcroft A, Durrington, Harrington JM (eds), Chapter 55, pp. 663-674, Hodder Arnold, United Kingdom, 2010.

Mezei G, Kheifets L. Radiofrequency fields. In: Hunter's Diseases of Occupations, 10th edition. Baxter PJ, Aw TC, Cockcroft A, Durrington, Harrington JM (eds), Chapter 56, pp. 675-681, Hodder Arnold, United Kingdom, 2010.

Kheifets L, Mezei G. Extremely low frequency electric and magnetic fields. In: Encyclopedia of Quantitative Risk Assessment. Everitt B, Melnick E (eds), pp. 691-693, John Wiley & Sons, United Kingdom, 2008.

Appendix B

Agency Reviews and Opinions on Exposure to RF Fields and Health

Table 1. Agency Reviews and Opinions on Exposure to RF Fields and Health

Year	Organization	Review	Link
2016	Swedish Radiation Safety Authority	Research 2016:15 – Recent Research on EMF and Health Risk – Eleventh Report from SSM's Scientific Council on Electromagnetic Fields, 2016	https://www.stralsakerhetsmyndigheten.se/en/publications/reports/radiation-protection/2016/201615/
2015	New Zealand Ministry of Health	Interagency Committee on the Health Effects of Non-ionising Fields: Report to Ministers 2015	https://www.health.govt.nz/
2015	Scientific Committee on Emerging and Newly Identified Health Risks	Opinion on Potential Health Effects of Exposure to Electromagnetic Fields (EMF)	https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_041.pdf
2015	Swedish Radiation Safety Authority	Research 2015:19 – Recent Research on EMF and Health Risk – Tenth Report from SSM's Scientific Council on Electromagnetic Fields, 2015	https://www.stralsakerhetsmyndigheten.se/contentassets/ee7b28e0fee04e80bcaf84c24663a004/201519-recent-research-on-emf-and-health-risk---tenth-report-from-ssms-scientific-council-on-electromagnetic-fields-2015
2014	Swedish Radiation Safety Authority	Research 2014:16 – Ninth Report from SSM's Scientific Council on Electromagnetic Fields, 2014	https://www.stralsakerhetsmyndigheten.se/contentassets/08b2f497b3ad48cf9e29a1d0008e7d82/201416-recent-research-on-emf-and-health-risk-ninth-report-from-ssms-scientific-council-on-electromagnetic-fields-2014
2013	British Columbia Centre for Disease Control and Canadian National Collaborating Centre for Environmental Health	Radiofrequency Toolkit for Environmental Health Practitioners	http://electromagnetichealth.org/wp-content/uploads/2013/07/RadiofrequencyToolkit_v4_06132013.pdf
2013	French Agency for Food, Environmental and Occupational Health & Safety	OPINION of the French Agency for Food, Environmental and Occupational Health & Safety Concerning the Update of the "Radiofrequency Electromagnetic Fields and Health" Expert Appraisal"	https://www.anses.fr/en/system/files/AP2011sa0150RaEN.pdf
2013	Health Council of the Netherlands	Mobile Phones and Cancer. Part 1: Epidemiology of Tumours in the Head	https://www.gezondheidsraad.nl/en/task-and-procedure/areas-of-activity/environmental-health/mobile-phones-and-cancer-part-1
2013	International Agency for Research on Cancer	IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 102. Non-Ionizing Radiation, Part 2: Radiofrequency Electromagnetic Fields	https://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf

Year	Organization	Review	Link
2013	Swedish Radiation Safety Authority	Research 2013:19 – Eighth Report from SSMs Scientific Council on Electromagnetic Fields	https://www.stralsakerhetsmyndigheten.se/contentassets/7f20edcd0b024940bca450d596568e30/201319-eighth-report-from-ssms-scientific-council-on-electromagnetic-fields
2013	Swiss Federal Office for the Environment	Radiation from Transmission Installations and Effects on Health	https://www.bafu.admin.ch/bafu/en/home/topics/electrosmog/publications-studies/publications/radiation-from-transmission-installations-and-effects-on-health.html
2012	Advisory Group on Non-ionizing Radiation for the Health Protection Agency of the United Kingdom	Health Effects from Radiofrequency Electromagnetic Fields	https://www.ices-emfsafety.org/wp-content/uploads/2014/11/AGNIR_report_2012.pdf
2012	Norwegian Institute of Public Health	Low-Level Radiofrequency Electromagnetic Fields - An Assessment of Health Risks and Evaluation of Regulatory Practice	https://www.fhi.no/en/publ/2012/svake-hoyfrekvente-elektromagnetiske-felt--en-vurdering-av-helserisiko-og-f/
2011	Health Council of the Netherlands	Influence of Radiofrequency Telecommunications Signals on Children's Brains (2011)	http://www.gezondheidsraad.nl/sites/default/files/201120E.pdf
2010	European Health Risk Assessment Network on Electromagnetic Fields Exposure	Deliverable Report D2 - Risk Analysis of Human Exposure to Electromagnetic Fields	http://efhran.polimi.it/docs/EFHRAN_D2_final.pdf
2010	European Health Risk Assessment Network on Electromagnetic Fields Exposure	Deliverable Report D-3 - Report on the Analysis of Risks Associated to Exposure to EMF: *In Vitro* and *In Vivo* (Animals) Studies	http://efhran.polimi.it/docs/IMS-EFHRAN_09072010.pdf
2010	Latin American Experts Committee on High Frequency Electromagnetic Fields and Human Health	Non-Ionizing Electromagnetic Radiation in the Radiofrequency Spectrum and its Effects on Human Health, with a Review on the Standards and Policies of Radiofrequency Radiation Protection in Latin America	http://www.wireless-health.org.br/downloads/LatinAmericanScienceReviewReport.pdf
2010	Swedish Radiation Safety Authority	Recent Research on EMF and Health Risk -- Seventh Annual Report from SSMs Independent Expert Group on Electromagnetic Fields	http://www.stralsakerhetsmyndigheten.se/Publikationer/Rapport/Stralskydd/2010/201044/

Year	Organization	Review	Link
2009	EMF-NET: European Commission 6th Framework Programme Coordination Action	EMF-NET: Effects of the Exposure to Electromagnetic Fields: From Science to Public Health and Safer Workplace. Deliverable D17: Report on Health Effects of RF with Recommendations for Non-Ionising Radiation Protection and Research Needs Deliverable D15_c: Report on New Epidemiological Studies on Static Fields, ELF, Intermediate Frequencies, and RF	https://www.emf.ethz.ch/fileadmin/redaktion/public/downloads/4_wissen/externes_material/Interphone%20Cardis_%20Report%20on%20health%20effects%20of%20RF.pdf
2009	Health Council of the Netherlands	Electromagnetic Fields: Annual Update 2008	http://www.gezondheidsraad.nl/sites/default/files/200902.pdf
2009	International Commission on Non-ionizing Radiation Protection	Exposure to High Frequency Electromagnetic Fields, Biological Effects and Health Consequences (100 kHz – 300 GHz)	https://www.icnirp.org/en/publications/article/hf-review-2009.html
2009	Scientific Committee on Emerging and Newly Identified Health Risks	Health Effects of EMF Exposure	http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_022.pdf

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

GEOFF DAY,	:	
	:	
Complainant,	:	
	:	
vs.	:	No: C-2018-3003960
	:	
DUQUESNE LIGHT COMPANY,	:	
	:	
Respondent.	:	

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a true copy of Duquesne Light Company's Reply to Complainant's Exceptions upon the participants listed below in accordance with the requirements of 52 Pa. Code § 1.54 (relating to service by a participant):

Geoff Day
1699 Suburban Avenue
Pittsburgh, PA 15216
Via Regular Mail

Pennsylvania Public Utility Commission
Office of Special Assistants
ra-OSA@pa.gov
Via Email

Dated this 11th day of May, 2020

/s/ Paul Shane Miller
Jeremy V. Farrell, Esquire
PA I.D. No. 316258
jfarrell@tuckerlaw.com

Paul Shane Miller, Esquire
PA I.D. No. 319174
smiller@tuckerlaw.com
Counsel for Respondent,
Duquesne Light Company

1500 One PPG Place
Pittsburgh, PA 15222
(412) 566-1212
(412) 594-5619 (fax)

TADMS:5314461-1 014657-158498