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June 27, 2018

Rosemary Chiavetta, Secretary
Pennsylvania Public Utility Commission
Commonwealth Keystone Building
400 North Street, 2nd Floor
Harrisburg, PA 17120

Re: Alexia McKnight v. PECO Energy Company
Docket No. C-2017-2621057

Dear Secretary Chiavetta:

A copy of PECO's Main Brief is attached for filing.

Very truly yours,

Ward L. Smith
Counsel for PECO Energy Company

WS/adz
Enclosures

c: Honorable Darlene D. Heep, ALJ
Certificate of Service

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Alexia McKnight	:	
	:	
v.	:	Docket No. C-2017-2621057
	:	
PECO Energy Company	:	

CERTIFICATE OF SERVICE

I, Ward L. Smith hereby certify that I served a copy of PECO Energy Company's Main Brief, in the above matter, upon all interested parties via email and overnight delivery to:

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Dated: June 27, 2018

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BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Alexia and Lawrence McKnight	:	
	:	
v.	:	**C-2017-2621057**
	:	
PECO Energy Company	:	

Main Brief of PECO Energy Company

Contents

Introduction

This proceeding involves a claim by the McKnight's that installation by PECO Energy Company ("PECO") of an Advanced Metering Infrastructure ("AMI") meter at the McKnight residence in 2015 caused Mrs. McKnight to become ill. The McKnight's further claim that re-installation of the AMI meter (the meter was removed and PECO agreed not to re-install it pending the outcome of this hearing) will cause Mrs. McKnight to be ill in the future. The McKnight's allege that re-installation of the AMI meter would constitute unreasonable utility service in violation of 66 Pa. C.S. §1501.

After a full, multi-day, evidentiary hearing, the McKnight's did not prove their claims by a preponderance of the evidence. To the contrary, PECO provided substantial, persuasive evidence that its AMI meters did not and will not cause, contribute to, or exacerbate Mrs. McKnight's illness. Therefore, the McKnight's Complaint should be dismissed.

Background and Procedural History

On August 27, 2017, Alexia McKnight filed a Complaint against PECO seeking to prohibit the re-installation of an AMI meter at her home.[1] She stated that, when PECO initially installed an AMI meter at her home (since removed), it violated Section 1501 of the Public Utility Code "by creating many harmful illnesses in myself as soon and as long as the PECO AMI meter was deployed on my residence." She also requested that PECO be ordered to "never deploy" an AMI meter at her residence.

On September 13, 2017, PECO filed its Answer, in which it denied the material allegations made in the Complaint.

On October 4, 2017, a Hearing Notice was issued, setting the hearing for April 10, 2018.

On October 23, 2017, a Prehearing Order was issued. The Prehearing Order established interim deadlines of February 13, 2018 for the exchange of witness reports and March 27, 2018 for the exchange of hearing exhibits.

On February 13, 2018, the parties exchanged witness reports.

On March 23, 2018, a Corrected Hearing Notice was issued, setting hearing dates of April 10, 11, and 12, 2018.

On March 23, 2018, an Order was issued setting new dates for Complainants to provide witness reports and exhibits for newly-identified witnesses.

On March 27, 2018, PECO served its hearing exhibits on Complainants.

On March 27, April 2, and April 6, 2018, Complainants served various expert reports and hearing exhibits.

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[1] Prior to the evidentiary hearing, the McKnight's requested that Mr. McKnight be added as a Complainant.

On April 10-13, 2018, evidentiary hearings were held. Complainants appeared *pro se* and presented testimony and exhibits of Mrs. McKnight, Mr. McKnight, Peter Prociuk, M.D., Mr. William Bathgate, and William Rea, M.D. PECO was represented by Ward Smith, Esq., Shawane Lee, Esq., and Tom Watson, Esq., and presented testimony and exhibits of Mr. Bryan Uber, Mr. Glenn Pritchard, Christopher Davis, Ph.D., and Mark Israel, M.D. The transcript of the four-day hearing is more than 1,000 pages long, and hundreds of pages of exhibits were admitted into evidence.

Proposed Findings of Fact

Testimony of Alexia McKnight[2]

1. Complainants reside at 258 Hayburn Road, Chadds Ford, Pennsylvania. Apr 10 Tr. 8.
2. PECO installed an AMI meter on the McKnight residence on November 30, 2015. Apr 10 Tr. 8.
3. On May 24, 2016, PECO removed the AMI meter at Complainants' request. Apr 10 Tr. 8, 32-33.
4. Prior to installation of the AMI meter, Mrs. McKnight did not have a diagnosed medical condition, but did have a variety of physical conditions and complaints. Apr 10 Tr. 9-11.
5. Mrs. McKnight was at home when the AMI meter was installed in November 2015. Thereafter, her physical conditions and complaints worsened and she was unable to tolerate being in her house. She was unable to sleep anywhere in her house but was able to sleep in a boat in her yard. Apr 10 Tr. 9-11.
6. During the period the AMI meter was installed from November 2015 to May 2016, Mrs. McKnight began to experience symptoms that she concluded were due to a specific condition that, for privacy purposes, PECO will refer to as her "Cardiovascular Symptom." When the AMI meter was removed in May 2016, the Cardiovascular Symptom got better and her other physical conditions also improved. Her symptoms remained better throughout the summer of 2016. Apr 10 Tr. 12-13. When the AMI meter was removed, the Cardiovascular Symptom improved in a week, was much better in two weeks, and was gone by approximately mid-

[2] Both Mr. and Mrs. McKnight are doctors (of, respectively, medicine and veterinary medicine) and each normally would be referred to as "Dr. McKnight." At the hearing, the parties agreed that, in order to distinguish between their testimonies, they would be referred to as "Mr. McKnight" and "Mrs. McKnight." PECO follows that convention in its Brief.

June. The other symptoms improved "soon," perhaps within a day or so of removal of the AMI meter, but certainly within a week. Apr 10 Tr. 47-48.

7. On September 5, 2016, Mrs. McKnight returned from a business trip. Apr 10 Tr. 38. Trips are usually very hard on her and it normally takes her some days to recover from a trip. On this occasion, however, several days had gone by and she was not recovering. On September 21 she investigated and found that the AMI meter had been re-installed; from subsequent review of PECO bills she concluded that the AMI meter had been re-installed on September 9, 2016. Apr 10 Tr. 13. According to her journal entries, Mrs. McKnight did not notice that the AMI meter had been re-installed until September 21 – 16 days after she returned from her trip, and 12 days after the AMI meter was re-installed. Apr 10 Tr. 53-55, 59.
8. On November 1, 2016, at Mrs. McKnight's request, a PECO employee again removed the AMI meter and replaced it with a jumper plate (no meter). Her Cardiovascular Symptom and her other physical symptoms again improved. Apr 10 Tr. 13-15.
9. Mrs. McKnight is unable to leave her home to go to public places because, if she does so, her symptoms return. She is thus confined to her home. Apr 10 Tr. 15-16.
10. Mrs. McKnight is a doctor of veterinary medicine and practices as a veterinary radiologist. Apr 10 Tr. at 15. In that job, she sits in front of a computer all day and interprets MRI exams sent to her by other veterinarians. Apr 10 Tr. 29.
11. On September 27, 2016, Mrs. McKnight sent a letter to Craig Adams, who was then President of PECO, stating her concerns with installation of an AMI meter. Apr 10 Tr. 15-17; Complainants' Exh. 1.
12. On October 19, 2016, PECO employee Brenda Eison sent Mrs. McKnight a letter responding to Mrs. McKnight's letter to Mr. Adams. Apr 10 Tr. at 22-23; Complainants' Exh. 4.

13. On March 8, 2017, Mrs. McKnight's treating physician Dr. Peter Prociuk sent a letter to Exelon attorney Tracy Hannan, stating that installation of an AMI meter was medically contraindicated for Mrs. McKnight and requesting an accommodation under the Americans with Disabilities Act ("ADA"). Apr 10 Tr. 16-17; Complainants' Exh. 2. The basis for Mrs. McKnight's ADA claim is that she believes that she has electrical hypersensitivity ("EHS"), which she finds very disabling. Apr. 10 Tr. 18. She has experienced symptoms of EHS since about 2007. Apr 10 Tr. 60-61.
14. On May 8, 2017, PECO counsel Ward Smith responded to the communication to Ms. Hannan, stating that he had reviewed the ADA and that Mrs. McKnight's claim did not provide a basis for an accommodation under that statute. Apr 10 Tr. 17-18; Complainants' Exh. 3.
15. The McKnight's formal complaint also contained a claim regarding "stray voltage," but as of the hearing date that claim is "not really a concern" and is "not a part of this complaint." Apr 10 Tr. 19. The stray voltage issue has been resolved. Apr 10 Tr. 43. *See also* Mr. McKnight's confirmation that the stray voltage issue has been resolved at Apr 10 Tr. 87-88.
16. Sometime in 2016 at the advice of a consultant, the McKnight's began to turn off some of the power in their home before retiring for the night; they continue to do so now. Doing so allows Mrs. McKnight to sleep, whether the AMI meter is on the house or not, although she does continue to suffer other symptoms while the power is off. During that same period the McKnight's hired an electrician to remove wireless signals, dimmer switches, and other electrical devices that they found irritating. Apr 10 Tr. 19-21, 39-40.
17. Mrs. McKnight is asking that PECO accommodate her by using an analog meter that does not use radio frequency transmissions to communicate. Apr 10 Tr. 21.

18. Prior to the AMI meter being installed in 2015, the McKnight house had an AMR meter since approximately 2001. Apr 10 Tr. 21. The McKnight's have lived in the house since 2003. Apr 10 Tr. 72.

19. After Mrs. McKnight filed her complaint, she contacted Dr. William Rea in Dallas, Texas to test her for EHS. She chose Dr. Rea because he was the only physician she could locate, anywhere on "the planet," who was experienced at testing for EHS. Dr. Rea conducted a series of tests, including exposing Mrs. McKnight to real and sham exposures of electric and/or magnetic fields (EMF). He prescribed a number of treatment modalities, including immune modulation treatment and neutralization injections. Mrs. McKnight still gets ill after she is exposed to EMF, but recovers more quickly than she did before being treated by Dr. Rea. The symptoms that she experiences are variable in type – for example, she suffers from various types of headaches – and are also variable as to how long it takes for the symptoms to develop after she is aware that is exposed to EMF, but it is often about 30 minutes later. Apr 10 Tr. 27-29.

20. The McKnight's took steps to reduce other sources of EMF in their home, such as wi-fi and Blue Tooth, and hardwired their computers. Apr 10 Tr. 29-30.

21. Mrs. McKnight rarely travels because she finds it hard; when she leaves her home her symptoms "always recur and "recur reliably." Apr 10 Tr. 30.

22. Mrs. McKnight owns a cell phone. She uses it in wireless mode once every four or five months for between 30 seconds and two minutes. Her husband also owns a cell phone, which he never uses at home. Apr 10 Tr. 33-35.

23. The McKnight property is approximately 1.9 acres. Apr 10 Tr. 35.

24. The McKnight meter box is located on the west side of the house approximately 20 feet from the front door. It is at basement level. The bedroom in which Mrs. McKnight sleeps is on the same side of the house on the second floor. Apr 10 Tr. 35-36. The bed itself is across the bedroom on the wall opposite the wall which has the meter board. Apr 10 Tr. 65-66.
25. The boat in which Mrs. McKnight had been sleeping has been sold, but it was previously located about 60 or 70 feet from the meter board in the side yard. Apr 10 Tr. 36. (Mr. McKnight and Mr. Pritchard later corrected this to be a distance of 120 feet. Apr 10 Tr. 85, Apr 12 Tr. 194-95.)
26. Mrs. McKnight saw a cardiologist for her Cardiovascular Symptom. The cardiologist conducted tests for her Cardiovascular Symptom on May 23, May 27, June 16 and June 20, 2016. Apr 10 Tr. 39. By the time she had the test on June 16, the AMI meter had been removed for several weeks and the Cardiovascular Symptom had gone away. Apr 10 Tr. 48. (All four of these tests showed normal cardiovascular function. Apr 13 Tr. 206-213.)
27. At the time of her testimony, Mrs. McKnight did not recall that Dr. Rea required her to sign any disclosures stating that his treatments were "not endorsed, sanctioned, or supported by the Texas Medical Board." Apr 10 Tr. 40-42. However, in a Late-Filed Exhibit provided on May 14, 2018, Mrs. McKnight confirmed that she had signed such a disclosure, and provided a copy of it as Appendix B to that filing.
28. Mrs. McKnight believes that there are three potential mechanisms by which PECO's AMI meter may have made her sick: (1) "dirty electricity;" (2) radio frequency transmissions; and (3) a theory postulated by Mr. Bathgate (and later identified as the "secondary antenna effect"). Apr 10 Tr. 42-45. She does not "know [that] anybody really knows exactly the

mechanism." Apr 10 Tr. 43. *See also* Mr. McKnight's testimony regarding three mechanisms at Apr 10 Tr. 90-92.

29. Mrs. McKnight kept a diary of some events related to installation and removal of the PECO AMI meter. The journal contains an entry on May 9, 2016 that discusses health, in which Mrs. McKnight noted that on that day the house wasn't quite as uncomfortable with less symptoms and less Cardiovascular Symptoms; Ms. McKnight journaled that she wondered whether PECO had reprogrammed or replaced the AMI meter that was in place at that time. Apr 10 Tr. 49-53, 58.
30. Mrs. McKnight will not accept relocation of the meter board and the AMI meter as an accommodation. Apr 10 Tr. 61.
31. Mrs. McKnight will not accept PECO's new meter types (the Aclara meter and the Sensus Stratus meter) as an accommodation. Apr 10 Tr. 61-62.
32. When Mrs. McKnight was tested by a cardiologist for her Cardiovascular Symptom on May 23, 2016, she suffered from the Cardiovascular Symptom all day long – except for the exact moment that the doctor tested her. Apr 10 Tr. 70-71.

Testimony of Lawrence McKnight

33. Mr. McKnight is a medical doctor. Apr 10 Tr. 80-82. He was recognized as an expert as a physician, in how to make diagnoses, how to interpret medical records, and how to read and interpret scientific research publications. Apr. 10 Tr. 92-96.
34. After the AMI meter was installed in November 2015, "all of a sudden" Mrs. McKnight's sleep patterns became dramatically different. She was unable to sleep anywhere in the house and began sleeping in the boat in the yard. Apr. 10 Tr. 83. Mr. McKnight later clarified that

he does not recall if the sleep disturbances began the first night, or two or three nights later. Apr 10 Tr. 185-86.

35. When the AMI meter was removed in May 2016, Mrs. McKnight's symptoms improved in a period of days or weeks; in a couple of months she stated that she felt better than she had in ten years. Apr 10 Tr. 84.

36. Mr. McKnight testified that, when the AMI meter was reinstalled in September 2016, Mrs. McKnight again suffered symptoms, although the symptoms were not as severe as in May. Apr 10 Tr. 84.

37. When Mr. McKnight comes home from work, he turns off his cell phone before entering the house. Apr 10 Tr. 85.

38. Mr. McKnight reviewed the research literature on EHS and applied that research to the symptoms experienced by Mrs. McKnight. Apr 10 Tr. at 97-102. He concluded that either (1) exposure EMF is really causing Mrs. McKnight's symptoms, or (2) she is experiencing a "nocebo" effect, which occurs when a person believes that exposure to an agent will make them ill and, consequently, when they perceive they have been exposed to that agent, they become ill, even if they have not been exposed and even if the agent in fact does not cause illness. He ultimately rejected the nocebo effect and concluded that Mrs. McKnight has EHS. Apr 10 Tr. 102-110.

39. While Mr. McKnight recognizes that the published research on EHS does not support the conclusion that EHS is caused by exposure to EMF, he believes that all such research suffers from "Type II" error, also known as a "false negative." Apr 10 Tr. 111-122 and 162-163.

40. Mr. McKnight's opinion that his wife has EHS was heavily influenced by an event that occurred while traveling with his wife. They flew to Florida and rented a car. Mrs.

McKnight became very agitated, stating that she had sudden pain when the car was turned on; Mr. McKnight then discovered that the Blue Tooth transmitter in the car was on; he turned it off and Mrs. McKnight's pain and agitation ended. Mr. McKnight was certain that Mrs. McKnight was not able to see that the Blue Tooth was on, nor to see him turn it off. Because he considers this event to be a real world equivalent of a "blind" experiment, this event was the turning point in forming his opinion that Mrs. McKnight has EHS caused by exposure to EMF and that she does not experience the nocebo effect. Apr 10 Tr. 122-25.

41. When Mrs. McKnight's complained about her Cardiovascular Symptom to Mr. McKnight, he checked her pulse and detected an irregular pulse. Apr 10 Tr. 126. According to Mr. McKnight, the Cardiovascular Symptom experienced by Mrs. McKnight is "a big deal" and can be "lethal." Apr 10 Tr. 129.

42. Mr. McKnight concluded, beyond reasonable medical certainty, that PECO's AMI meter caused Mrs. McKnight's symptoms. Apr 10 Tr. 128.

43. Scientific research can also have "Type I" errors, also known as "false positives" in which a study reports an association between an exposure and an outcome even though the exposure does not cause or contribute to the outcome. There are various ways to protect against false positives, including replication, conjoined analysis of multiple studies, and use of "double-blind" designs. Apr 10 Tr. 159-162.

44. In reaching his conclusion that EHS is a real condition, and not a nocebo effect, Mr. McKnight relied upon: (1) a 1991 study by Dr. Rea; (2) a study of a single patient by Dr. Andrew Marino; and (3) his observations of his wife. He felt that there were other studies that are "suggestive studies that in and of themselves are not sufficient evidence but can be combined together, and there's a lot of things pointing in this direction." Apr 10 Tr. 165-68.

45. In the EHS studies that did not report a relationship between EMF exposure and symptoms, the authors discussed and dismissed the argument that their results were "false negatives" or "Type II" errors, but Mr. McKnight disagreed with their analyses. Apr 10 Tr. 168-175.
46. The World Health Organization concluded that EHS is not caused by exposure to EMF; Mr. McKnight believes that, in reaching that conclusion, the World Health Organization also committed Type II error. Apr 10 Tr. 174-75.
47. When the McKnight's began to turn the power off before going to bed, Mrs. McKnight was able to sleep even though the AMI meter was still on. Apr 10 Tr. 186.
48. As to the Florida trip, Mr. McKnight stated that when they got off the plane people presumably began to use phones, that they continued to do so at the luggage carousel, and that they did not hide their usage; Mrs. McKnight did not report to him that she detected EMF exposure, but instead said that everything was going pretty well. Although Mr. McKnight's written report stated that he "vividly" recalled that Mrs. McKnight became agitated as he was "just about to start the car," that is not what happened; on the witness stand he recalled that she did not became agitated until after he started the car. When his wife started to yell with pain, Mr. McKnight's reaction was to begin "playing with" the radio and the dashboard screen of controls. He did not tell her that, in playing with the radio, he was seeking a solution to her pain. He is certain that Mrs. McKnight could not see him playing with the radio because he is certain that she had her head turned away from him; he reaches that conclusion with certainty even though he was focused on the dashboard screen the entire time, because he could see her in his peripheral vision. When he discovered that the Blue Tooth was on and turned it off, her pain and agitation went away. He is certain that she did not see him turn off the Blue Tooth. In Mr. McKnight's view, if this event was

analogized to a scientific experiment, it would not be considered to be a double-blinded experiment because Mr. McKnight, who was analogically the experimenter, was not blinded; this event, however, was not a scientific experiment. Apr 10 Tr. 187-96.

49. Mr. McKnight accepted, as a possible alternative explanation for the Florida experience, that the McKnight's had just finished a stressful trip, followed by a series of events in which Mrs. McKnight knew that she had been exposed to EMF from other passengers' cell phones and that she became tense because she believed that such exposure would cause her to suffer symptoms; that consequently she had symptoms due to that stress; and that it was a coincidence that the symptoms occurred at the same time as the Blue Tooth in the car was on. Apr 10 Tr. 196.

Testimony of Russell Brocato

50. Mr. Brocato is a retired PECO Power Quality technician. Apr 10 Tr. 208-09.

51. As part of his duties at PECO, Mr. Brocato performed investigations of and fixes for "stray voltage" problems. He was called to investigate and fix a stray voltage issue at the McKnight residence. The McKnight's did have a stray voltage problem that needed to be fixed, but there was nothing unusual about the job. It was a routine job. Apr 10 Tr. 209-210, 218.

52. Mr. Brocato did not see anything that suggested to him that the McKnight's meter box was faulty. Apr 10 Tr. 213-16, 225.

53. Stray voltage arises from loose connections and imbalance of the electrical phases. It has nothing to do with the type of meter being used. Apr 10 Tr. 222.

Testimony of Peter Prociuk, M.D.

54. Dr. Prociuk is a medical doctor who practices homeopathic medicine. Apr 11 Tr. 241-42.

55. Dr. Prociuk has been Mrs. McKnight's personal physician since 2010. Apr 11 Tr. 243.

56. Dr. Prociuk was recognized as an expert in medicine, but not as an expert in EHS. Apr 11 Tr. 246-47.

57. Dr. Prociuk reviewed medical records from Mrs. McKnight's cardiologist. Apr 11 Tr. 247-55. Those records state that "There is emerging data regarding the potential ill effects of this exposure" to AMI meters. Apr 11 Tr. 299.

58. Mrs. McKnight's Cardiovascular Symptom is "relatively benign," meaning that the results of her tests fall within the normal range of variability and "don't represent any significant long term threat to her health." Apr 11 Tr. 277. Comments in the cardiologist's medical records "says to me this is not a problem." Apr 11 Tr. 301-02. The cardiologist's medical records also do not comment about changes in the Cardiovascular Symptom with respect to exposure to AMI meters vs no exposure. Apr 11 Tr. 303.

59. In Dr. Prociuk's opinion, radio frequency transmissions from a PECO smart meter are injurious to the health of Mrs. McKnight, and are medically contraindicated, Apr 11 Tr. 255-56, and if re-installed the AMI meter will cause an exacerbation of her Cardiovascular Symptom. Apr 11 Tr. 256. His opinion is based on the temporal reports that her symptoms worsened after the installation of the smart meter on the house, because her Cardiovascular Symptom is a recognized symptom of EHS, and because her other symptoms have been observed in Switzerland and Australia by persons who state that they have EHS. Apr 11 Tr. 258. He holds those opinions to a reasonable degree of medical certainty. Apr 11 Tr. 256.

60. Dr. Prociuk also reviewed and relied upon a 1991 study by Dr. Rea, in which Dr. Rea tested a group of people for EHS and found that they were hypersensitive. Apr 11 Tr. 268.

61. The Australian study that Dr. Prociuk reviewed was by Lamech. In that study, people who self-identified as having EHS and who perceived that they had changes in health after a mandatory smart meter rollout in Australia were invited to report their perceived health changes to an internet site. This type of study can be used to formulate a new hypothesis, but can only make limited statements on causality. Apr 11 Tr. 269-70.

62. According to Dr. Prociuk, EHS has not reached the level of being a formal diagnosis, but he believes that it is a "real thing." Apr 11 Tr. 271.

63. There is no diagnostic test for EHS, and Dr. Prociuk therefore did not conduct such a test prior to making his diagnosis that Mrs. McKnight has EHS. Apr 11 Tr. 277-78.

64. Dr. Prociuk is "not sufficiently versed in the literature on EMF" to know whether studies have been published since 1991 that use the same methodology as the Rea 1991 study upon which he relied. Before the conclusions of the Rea study could be considered to be "established scientifically," one would need to see large studies performed in different research centers independently, and that hasn't been done. Apr 11 Tr. 281-82.

65. With respect to EHS, the science is in a stage of clinical infancy. Apr 11 Tr. 288-89.

66. When speaking of a connection between exposure to AMI meters and EHS, Dr. Prociuk is very mindful of the fact that the clinical science demonstrating such a connection is not well-established. Apr 11 Tr. 289.

67. When Dr. Prociuk states that exposure to an AMI is medically contraindicated even though the science is in a stage of clinical infancy and the clinical science is not well established, he does so because "as a clinician, I can make that call." Apr 11 Tr. 290. "You could say

[that's] my right or privilege or position as a clinician. Clinicians often work with incomplete pictures. That's what it's like to work on the front line. I work in real time and I have to make my best call given the information I have available . . . ." Apr 11 Tr. 296.

68. Dr. Prociuk's concerns with the AMI meter are "entirely related to EMF." He is "unaware of any other factor with respect to the smart meter that is of concern." Apr 11 Tr. 312.

Testimony of William Bathgate

69. William Bathgate is an electrical engineer who lives in Michigan. Apr 11 Tr. 322-23.

70. Mr. Bathgate was recognized as an expert in electrical engineering and in the design and measurement of power systems and radio design. Apr 11 Tr. 327-28. He was not recognized as an expert in any health field and was not allowed to express opinions on issues of health. Apr 11 Tr. 352-53.

71. "Conducted emissions" are where there are additional signals on the wire other than the primary signal. The additional signals occur at voltages and frequencies other than the primary signal. If they become too excessive, they can create interference with medical appliances or large computer system controls. Apr 11 Tr. 327-28.

72. The Federal Communications Commission ("FCC") has multiple compliance standards that Mr. Bathgate believes are primarily designed to avoid interference with other radio services. Mr. Bathgate does not believe that the FCC provides certification for health limits. Apr 11 Tr. 328-30. He believes that other agencies, such as the FDA and the EPA, are responsible for health limits. Apr 11 Tr. 331.

73. Mr. Bathgate provided pretrial reports regarding two concerns that he has with AMI meters: (1) radio frequency transmissions, and (2) conducted emissions. Apr 11 Tr. 331.

74. Underwriters' Laboratory ("UL") certification is a safety certification. Apr 11 Tr. 337-38. The top level of UL certification is "UL listed." Tr. 338.

75. PECO's Sensus Stratus Meter is UL listed; its other AMI meters are UL certified but not UL listed. Apr 11 Tr. 338.

76. For his "conducted emissions" issue, Mr. Bathgate ran tests on an Aclara I210+C AMI meter to determine if it conducts at frequencies other than normal 60 cycle signal associated with the delivery of electricity. Apr 11 Tr. 339-48. He found that the Aclara meter created what he described as "a very spiky spot," Apr 11 Tr. 347, which he attributed to the switch mode power supply in the meter. He stated that this "spiky spot" could cause interference with medical devices such as ventilators for Parkinson's disease or a CPAP machine. Apr 11 Tr. 347-48. Later, Mr. Bathgate referred to the spiky spot as "transients" and/or "dirty electricity," Apr 11 Tr. 364, although he considers "dirty electricity" to be a slang term that is not precise. Apr 11 Tr. 369. According to Mr. Bathgate, the transients created by the Aclara meter exceed the FCC's Class B certification for conducted emissions. Apr 11 Tr. 348-54, 367. In his opinion, the Aclara meter is therefore "not legal." Apr 11 Tr. 350.

77. Other consumer appliances in the home that have switch mode power supplies have filters to limit the amount of their conducted emissions. Apr 11 Tr. 357-58.

78. According to Mr. Bathgate, if you share a transformer with a neighbor who has an AMI meter that is emitting transients, your home will have the same transients even if your home has an analog meter. Apr 11 Tr. 364-65.

79. Mr. Bathgate has conducted similar conducted emission tests on numerous AMI meters made by at least five different manufacturers and found that effectively all of them violate the FCC's conducted emission standards. Apr 11 Tr. 365-66. However, it is possible to make an

AMI meter that meets the FCC's conducted emission standards if that meter uses a "capacitor pump" instead of a switch mode power supply. Apr 11 Tr. 366.

80. Notwithstanding his testimony regarding non-compliance with the FCC's conducted emission standards, Mr. Bathgate is not able to make a determination that this claimed violation of FCC regulations makes AMI meters unsafe. Apr 11 Tr. 367-68. He believes that they are "over-ranged" and present a danger of interfering with other radio services and their equipment. Apr 11 Tr. 398.

81. Mr. Bathgate conducted an experiment at the McKnight's neighbor's house to determine the radiofrequency transmission characteristics of their Landis + Gyr AMI meter. He used a model HF35C measuring device to make these measurements and, using that device, he believes that he measured Zigbee transmissions every six to seven seconds, and FlexNet transmissions every six minutes. He also measured transmissions that were much longer in duration than the transmission duration information provided by PECO, with transmissions lasting for seconds rather than milliseconds. Mr. Bathgate attributes this to his understanding that PECO uses a "collision network" where many AMI meters can interfere with each other's transmissions; their signals are thus not received; the system consequently requests that the AMI meter retransmit its packet of information; and the meters then resend, resend, and resend. Apr 11 Tr. 373-82, 447.

82. Mr. Bathgate believes that AMI meters pulse, by which he means that they send a very short packet of data. Apr 11 Tr. 377-80.

83. A cell phone transmits at 0.4 to 0.5 watts of power; an AMI meter transmits at between 1 and 2 watts of power. You thus cannot say that the AMI meter "is less than a cell phone based on that characteristic alone." Apr 11 Tr. 384-85.

84. Mr. Bathgate did measurements of UHF TV signals at the McKnight residence, and found that they were "buried in the noise." Apr 11 Tr. 385.

85. Mr. Bathgate referred to the "third mechanism" (which the McKnight's said would be discussed in his testimony) as "secondary antenna effect." Mr. Bathgate measured radio frequency fields by pointing his HF35C meter at the ground, Apr 11 Tr. 461-62, and he measured radio frequency signals as much as 150 feet from the AMI meter, which he characterized as getting measurements "from the dirt." He stated that: "I can't explain it. It's a phenomenon. And it's not the first time I've seen it. Apr 11 Tr. 386-90. He considers the secondary antenna effect to be a form of conducted emission. Apr 11 Tr. 414.

86. AMI meters do not contain unique circuit components that are not also used in many industrial and power switching systems in the market today. The components within the meters are not unusual. Apr 11 Tr. 411-12.

87. The various types of AMI meters all operate similarly, with two key differences among meter types: (1) the form of power supply – switching mode vs. capacitor pump; and (2) frequency/periodicity/power of radio transmissions. Apr 11 Tr. at 412-13.

88. When Mr. Bathgate performed his conducted emission tests on the Aclara meter, he used a meter that he obtained from Hialeah Meters. Apr 11 Tr. 415-16.

89. Although the Aclara meter that Mr. Bathgate procured and tested does not have a UL stamp on its face and thus cannot be referred to as "UL listed," the PECO Aclara meter does have a UL stamp on its face and can properly be referred to as UL listed. Mr. Bathgate tested the non-PECO version of the Aclara meter. Apr 11 Tr. 416-17.

90. When Mr. Bathgate tested the Aclara meter, the FlexNet radios were not turned on and transmitting. The tests that he performed on the Aclara meter were not related to the meter's radio transmissions. Apr 11 Tr. 417-18.

91. Mr. Bathgate has tested five or six brands of AMI meter and found that all of them that use a switch mode power supply violate the FCC's conducted emissions standards. Apr 11 Tr. 424-25, 429-30. Tens of millions of these illegal meters have been deployed over a period of four or five years. Apr 11 Tr. 425.

92. The manufacturers of AMI meters are required to verify that their devices have been tested for compliance with the FCC's standards; Mr. Bathgate has no knowledge of whether any of those manufacturers ever conducted tests to determine compliance with the FCC's conducted emission standards. Apr 11 Tr. 425-26.

93. The manufacturers use five independent testing agencies to determine whether their AMI meters are compliant with FCC's standards; Mr. Bathgate has no knowledge of whether any of those independent testing agencies ever conducted tests to determine compliance with the FCC's conducted emission standards. Apr 11 Tr. 425.

94. The FCC does random tests on AMI meters to determine whether the meters meet FCC standards; if the FCC finds a single unit out of compliance, the entire product line can be recalled; Mr. Bathgate does not know whether the FCC has ever done a random test of an AMI meter to determine whether it is in compliance with the FCC's conducted emission standards. Apr 11 Tr. 426-27.

95. Mr. Bathgate developed his concern that AMI meters violate the FCC's conducted emission standards about three years ago. He has never filed a complaint with the FCC. Apr 11 Tr. 427. Initially, Mr. Bathgate claimed that he has not filed a complaint with the FCC because,

under his top-secret government clearance, he is allowed to come to Pennsylvania to testify in open hearings about this issue, but he is not allowed to file a complaint at the FCC that claims that AMI meters do not meet the FCC's conducted emission standards. Apr 11 Tr. 427. Later he modified that testimony to state that the reason he has not brought this matter to the attention of the FCC is that he is concerned that, if he did so, the Department of Defense would cancel his top-secret clearance, thus affecting his income. Apr 12 Tr. at 13.

96. If all AMI meters were eliminated, hospitals would still need to filter for conducted emissions from other sources, including industrial sources. Examples of industrial machinery that create conducted emissions include variable speed electric motors, heat shrink equipment, and a conveyor belt motor. Examples of residential machinery that create conducted emissions include computers, refrigerator motors during start-up, compact florescent lights, and video screens. Apr 11 Tr. 430-36.

97. If wiring or a meter board near an analog meter were to overheat, the analog meter would not be able to communicate that information. Apr 11 Tr. 437-38.

98. PECO's AMI system operates in a licensed spectrum at about 901 MHz, not in the unlicensed Industrial, Scientific, and Medical Band at 902-928 MHz. Mr. Bathgate was not aware of that fact when he prepared his expert report on RF transmissions from the PECO AMI system. Apr 11 Tr. 439-44. Now that he is aware of that, his testimony regarding radio frequency transmissions from the PECO system is withdrawn; it was in error. Apr 12 Tr. 10-11.

99. When Mr. Bathgate took readings of PECO's AMI meters with the HF35C measuring device, he stood one meter (37.9 inches) away from the AMI meter. Apr 11 Tr. 448. The manufacturer's directions state that the HF35C meter should be used at a minimum distance

of two meters, and that at a measuring distance of less than two meters it is not possible to identify the source of the transmission. Apr 11 Tr. 448-49, Apr 12 Tr. 33-35; PECO Late-Filed Exh.1. Mr. Bathgate subsequently testified that, in the evening between hearing days, he ran similar tests at a two meter distance from an AMI meter and found similar results. The second test involved taking measurements for about 15 minutes. Apr 12 Tr. 23.

100. PECO's AMI system is not a mesh system. Apr 11 Tr. 451.

101. The FCC's conducted emission standards apply to unlicensed transmitters, not licensed transmitters like PECO. Apr 11 Tr. 456-57; Complainant's Joint Exh. 7. Mr. Bathgate stated that he could not identify any portion of the standards that applies to licensed transmitters, but he nonetheless believes that they do. Apr 11 Tr. 457-59.

102. Mr. Bathgate measured transients at the McKnight home, with an analog meter installed, at levels that he considers to be in compliance with FCC regulations. Apr 12 Tr. 21.

103. PECO's Landis + Gyr meters are not UL listed, but they are UL certified. Apr 12 Tr. 48-50.

Testimony of William Rea, M.D.

104. Dr. Rea is a medical doctor who has an Environmental Medicine facility in Dallas, Texas. Apr 12 Tr. 56. He is also one of Mrs. McKnight's treating physicians. Apr 12 Tr. 58.

105. Dr. Rea was recognized as a medical expert, with a specialty in EHS. Apr 12 Tr. 58.

106. Mrs. McKnight went to see Dr. Rea because she noticed that she would experience symptoms when she had been exposed to various sources of EMF. Apr 12 Tr. 60.

107. Dr. Rea reviewed medical records provided by Dr. Prociuk and Mrs. McKnight's cardiologist. Apr 12 Tr. 60-66.

108. Dr. Rea performed a laboratory test – a "blinded provocation study" -- on Mrs. McKnight, and "she reacted to the 60 hertz, the 3 kilohertz, and 5 megahertz" exposures and "did not react to any of the blanks." Dr. Rea therefore concluded that Mrs. McKnight has the ability to perceive when she is being exposed to EMF. Apr 12 Tr. 66-68.

109. Dr. Rea diagnosed Mrs. McKnight as having "electric sensitivity, and a chemical sensitivity and toxic brain encephalopathy, autonomic nervous system disease, history of arrhythmias, allergic food sensitivity, and fibromyalgia, inflamed blood vessels, vasculitis, and immune deregulation." He holds those diagnoses to a reasonable degree of medical certainty. Apr 12 Tr. 68, 77-78.

110. Dr. Rea considered and ruled out the possibility that Mrs. McKnight is experiencing a nocebo effect because "there's no evidence for that at all." Apr 12 Tr. 69.

111. People who state that they have EHS sometimes have the Cardiovascular Symptom of which Mrs. McKnight complains. Apr 12 Tr. 69-70.

112. Dr. Rea's 1991 paper was based on what he says was double-blinded research. Apr. 12 Tr. 70-71.

113. Dr. Rea recommended that Mrs. McKnight should "stay away from any smart meters" and that any smart meter "should be far away from the house." Apr 12 Tr. 72.

114. It is Dr. Rea's opinion, to a reasonable degree of medical certainty, that PECO's AMI meter caused a change in Mrs. McKnight's health. Apr 12 Tr. 74.

115. The Cardiovascular Symptom experienced by Mrs. McKnight "can kill you. She's very lucky that she didn't die." Apr 12 Tr. 75.

116. It is Dr. Rea's opinion, to a reasonable degree of medical certainty, that it would not be safe to re-install an AMI meter on the McKnight home. Apr 12 Tr. 75.

117. The double-blinded provocation study that Dr. Rea used to diagnose Mrs. McKnight's EHS is the same protocol that he used in his 1991 research paper. Apr 12 Tr. 78-79. He tested at 60 Hz, 3 kilohertz, and 5 megahertz, but not at other frequencies. Apr 12 Tr. at 79.

118. Dr. Rea signed a Mediated Agreed Order with the Texas Medical Board on August 27th, 2010. Pursuant to that Order, Dr. Rea is required to inform all patients who he treats that his treatment modalities are "not endorsed, sanctioned or supported by the Texas Medical Board." Apr 12 Tr. 80-81. Dr. Rea required Mrs. McKnight to sign such a disclosure before he treated her. Apr 12 Tr. 82; PECO Rea Cross Exh. 1. The Mediated Agreed Order is still in force today. Apr 12 Tr. 108.

119. The objectionable patient treatment that led to Dr. Rea signing the Medical Consent Order included a patient who was diagnosed with EHS. Apr 12 Tr. 82-84; PECO Rea Cross Exh. 2.

120. The State of Ohio also issued an Order that Dr. Rea's treatments are not sanctioned, endorsed or supported by the Ohio Medical Board. Apr 12 Tr. 85; PECO Rea Cross Exh. 3. The Ohio Order is still in force. Apr 12 Tr. 108.

121. Dr. Rea is a signatory of the 2015 Brussels International Scientific Declaration on Electromagnetic Hypersensitivity, which urges the international medical community to accept EHS as a "true medical condition." Apr 12 Tr. 87-92; PECO Rea Cross Exh. 4.

122. By the time Mrs. McKnight was under Dr. Rea's treatment, her Cardiovascular Symptom had cleared up. Dr. Rea's tests of her heart were normal. Apr 12 Tr. 99.

123. Although Dr. Rea only tested Mrs. McKnight for sensitivity to the three noted frequencies, she "could have been sensitive to 10 or 15 different frequencies or even more. I

didn't know that. [T]he idea was just to establish [s]he was sensitive to electromagnetic sensitivity and not psychological." Apr 12 Tr. 102.

124. The Order of the Texas Medical Board has not affected Dr. Rea's practice. The only time it comes up is when he testifies in court. Apr 12 Tr. 102.

125. Dr. Rea "found out later" that the Texas Medical Board "used to have secret hearings" at the request of insurance companies. The Texas Medical Board was subsequently "put on probation" by the legislature. Apr 12 Tr. 102-105.

Testimony of Bryan Uber

126. Bryan Uber is a Senior Supervisor, Customer Field Operations, for PECO. Apr 12 Tr. 112.

127. An AMI meter was initially installed at the McKnight residence on November 30, 2015. Apr 12 Tr. 117.

128. The AMI meter removed sometime in May 2016. It was still installed and operating on May 9, 2016. Apr 12 Tr. 117-18.

129. The AMI meter was reinstalled sometime between May 2016 and September 2016, no later than September 7, 2016. Apr 12 Tr. 118-19. (PECO later stipulated that, for purposes of this litigation, it would use September 9, 2016 as the date the AMI meter was installed the second time.)

130. Between November 30, 2016 and September 2016, PECO was not contacted by the McKnight's re their AMI meter. The first such contact was on October 18, 2016 when the McKnight's filed an executive complaint. Apr 12 Tr. 119. PECO called the customer that day to confirm receipt of the executive complaint and responded to it in writing the next day. Apr 12 Tr. 120-22.

131. On October 26, 2018, Mrs. McKnight called PECO regarding her executive complaint; PECO's AMI Department called her back the same day. Apr 12 Tr. 123-24.

132. The next communication from Mrs. McKnight was her formal complaint. Apr 12 Tr. 127.

Testimony of Glenn Pritchard.

133. Glenn Pritchard is PECO's Manager of Advanced Grid Operations. Apr 12 Tr. 141.

134. Mr. Pritchard was recognized as an expert in the design, operation, and technology of Advanced Meter Installations. Apr 12 Tr. 142-46.

135. From approximately 2000 until April 2017, PECO used an AMR meter system that was comprised of transmit-only meters that transmitted using radio frequencies. That system was shut down in April 2017. Approximately 1.7 million electric AMR meters and 500,000 gas AMR meters were deployed. Apr 12 Tr. 147-149.

136. The McKnight's had an AMR meter. Apr 12 Tr. 149.

137. The AMR meters transmitted every five minutes, or 288 times per day, for 20 milliseconds per transmission, for a total of 5.76 seconds of transmission time. Apr 12 Tr. 150.

138. PECO installed its AMI meter system in response to Pennsylvania Act 129 of 2008. Installation of AMI meters began in 2012. Apr 12 Tr. 151-52.

139. The AMI system is 100% deployed – 1.7 million electric meters, and 500,000 gas meters. Apr 12 Tr. 154.

140. The AMI meters have two radios: (1) a FlexNet module for communications with the backbone system; and (2) a ZigBee radio for communications with devices in the home. The FlexNet module transmits six to eight times per day for approximately 70 milliseconds.

The ZigBee transmits every 30 seconds until it pairs with a device; in the most recent AMI meter style the ZigBee can be remotely turned off. The total transmission time of the two radios is approximately 2.5 seconds per day. Apr 12 Tr. 154-56.

141. PECO does not use a mesh system. Apr 12 Tr. 158.

142. PECO AMI meters transmit using FCC licenses at 901.1 to 901.2 megahertz. Apr 12 Tr. 158.

143. PECO does not operate a collision network; it uses a spectrum plan that allows its meters to communicate without competing with each other and without collisions. PECO's AMI meters are not asked to repeat their transmissions and do not do so; the lagging data is always included in the next scheduled transmission approximately four hours later, so such retransmission requests are not needed or used. Apr 12 Tr. 161-167.

144. PECO's Landis + Gyr meter has a FlexNet module, ZigBee radio, and switch mode power supply. Apr 12 Tr. 168. It is UL certified. Apr 12 Tr. 170.

145. PECO's Aclara meter has a FlexNet module and switch mode power supply, and is UL listed. Apr 12 Tr. 168-69, 170.

146. PECO's Sensus Stratus meter has a FlexNet modules and Zigbee radios, but the Zigbee can be turned off remotely. The Sensus Stratus has a capacitor pump, not a switch mode power supply, and is UL listed. Apr 12 Tr. 169.

147. For each of the meters used by PECO, the manufacturer and an approved testing agency obtained written equipment authorization certifications from the FCC allowing use of the meters. Apr 12 Tr. 171-72. Copies of the certifications were introduced into the record. PECO Exh. GP-11.

148. PECO's AMI meters comply with FCC regulations. Apr 12 Tr. 172.

149. By reviewing Functional Block Diagrams, Mr. Pritchard demonstrated and concluded the only functional differences between AMR meters and AMI meters is the periodicity of radio transmissions, the remote connect/disconnect switch on an AMI, and the fact that some AMI meters have a capacitor pump rather than a switch mode power supply. Apr 12 Tr. 174-78.

150. In terms of creating transients, a residential air conditioner is the residential equivalent of an industrial variable speed drive. A hair dryer is the residential equivalent of industrial shrink wrap equipment. Residential florescent and LED leading can also introduce transients. If the McKnight's or their neighbors are using any of these devices, the transients would carry through onto the McKnight's' electrical wiring. Generating stations also introduce transients. All of these transients exist regardless of the type of meter used – AMI, AMR, or analog – or if no meter at all is installed. Apr 12 Tr. 179-81.

151. PECO conducted readings of transients at the McKnight residence using a high quality Power Quality Meter. It showed that the McKnight residence, with no meter of any sort installed, is "very noisy, representing different transients . . . that are occurring in the household." Apr 12 Tr. 183-87.

152. Mr. Pritchard obtained an HF35C meter, which Mr. Bathgate had used for his measurements of the periodicity of transmissions by PECO AMI meters. He experimented with the HF35C meter in urban, suburban, and rural environments, both inside and outside of PECO's service territory, and found "tremendous variability" in the readings from the HF35C. There were readings of high spikes from background sources, and periods of zero readings when sitting directly in front of an operating PECO Landis + Gyr AMI meter. Apr 12 Tr. 187-190.

153. Mr. Pritchard also used the HF35C meter to attempt to replicate Mr. Bathgate's findings with respect to secondary antenna effect and found no correlation of readings and location that would support the secondary antenna effect. In one case he knew exactly where the electric cable was buried and measured with the HF35C directly over the cable and then several feet away, and saw no discernible effect. Apr 12 Tr. 190-91.

154. Mr. Pritchard found that the claimed "directionality" of the HF35C meter – that it only measures what it is pointed at – is "suspect," and that it in fact picks up signals from a rather broad range from 800 megahertz to 2.8 gigahertz. Apr 12 Tr. 191-92.

155. AMI meters have the ability to detect temperature changes and, when the temperature exceeds a programmed level well below the temperature of a fire, to send an alarm to PECO, which will then deploy a crew within two hours. Household wiring and meter boards can overheat regardless of the type of meter being used and, of the various meter types available, the AMI is the only meter with the functionality to detect and report such overheating. Apr 12 Tr. 192-94.

156. As an accommodation, PECO will work with the customers to relocate their meter board and connect PECO service to the newly located meter board. In that respect, Mr. Pritchard noted that there nearby neighbors have AMI meters within 230 feet of the McKnight residence, and that she was able to sleep in a boat located 120 feet from the AMI meter that was previously installed on the McKnight residence. Apr 12 Tr. 194-95.

157. PECO's Tariff allows for commercial competitors, referred to as Advanced Meter Service Providers, to enter the market and provide alternative metering services. None have done so to date. Apr 12 Tr. 195-97.

158. PECO provided an accommodation to the McKnight's by delaying installation of their AMI meter from 2012, when deployment began, until today. However, because the AMR system was decommissioned, that accommodation is no longer available. Apr 12 Tr. 197.

159. The Aclara meter does not have a ZigBee radio. Apr 12 Tr. 198-99.

160. The Sensus Stratus meter has a ZigBee radio that can be remotely disabled, and does not have a switch mode power supply. Apr 12 Tr. 199.

161. Because PECO uses a licensed, non-mesh system, PECO's AMI system has far less radio transmissions than any other utility system, including the ability to "tune down" the number of transmissions from each AMI meter. Apr 12 Tr. 199-202.

162. Mr. Pritchard believes that, if the millions of deployed meters had a problem with FCC Class B certification for conducted emissions, it would have been discovered by now. Apr 12 Tr. 231.

Testimony of Christopher Davis, Ph.D.

163. Dr. Christopher Davis is a Ph.D. physicist who is the Minta Martin Professor of Engineering and Professor of Electrical and Computer Engineering at the University of Maryland. Apr. 13 Tr. 9-12

164. Dr. Davis was recognized as an expert in the fields of physics, biophysics, chemistry, electrical engineering, electromagnetics, bioelectromagnetics, and dosimetry. Apr. 13 Tr. 16, 18.

165. The FCC has safety standards that explain the maximum permissible exposure ("MPE") that people can be exposed to if they are near a radiofrequency transmitter. The FCC's MPEs are designed to avoid human health effects from exposure to high levels of

radiofrequency fields; conversely, exposures below the MPE levels do not cause health effects. Apr 13 Tr. 23-24; PECO Exh. CD-3.

166. PECO's AMI meters do not create ionizing radiation and the transmissions from them are not capable of breaking chemical bonds. Apr 13 Tr. 24-26; PECO Exh. CD-4.

167. The radiofrequency transmissions from PECO's AMI meters are approximately 5.8 million times lower than the FCC's MPE. Apr 13 Tr. 26-29; PECO Exh. CD-5.

168. The FCC's MPE's are calculated on a 30-minute average exposure. Even the instantaneous peak transmissions from a PECO AMI meter are approximately 40 times smaller than the amount they are allowed to transmit on an averaged basis. Apr 13 Tr. 29-30; PECO Exh. CD-6.

169. The radiofrequency transmissions from PECO's AMI meters are approximately 4.4 million times lower than the guidelines of the International Commission on Non-Ionizing Radiation Protection. Apr 13 Tr. 31-34; PECO Exh. CD-7.

170. People are commonly exposed to radiofrequency fields from a variety of sources, including such common devices as cell towers, UHF transmitters, cell phones, and microwave ovens. Apr 13 Tr. 34-35; PECO Exh. CD-8.

171. The McKnight residence is continuously exposed to radiofrequency transmissions from UHF TV transmitters. At the McKnight residence, the background exposure to radio frequency fields from UHF stations is 168 times larger than the exposure of continuously sitting one meter in front of an AMI meter 24/7. Apr 13 Tr. 36-37; PECO Exh. CD-9.

172. PECO's AMI meters will reduce the radiofrequency exposure from PECO's existing AMR meters by 79%. Apr 13 Tr. 37-38; PECO Exh. CD-10.

173. In Dr. Davis's opinion, there is no reliable scientific basis to conclude that radiofrequency fields from PECO's AMI meters are capable of producing any adverse biological effects. Apr 13 Tr. 42-44; PECO Exh. CD-13.

174. PECO's AMI meters are not subject to the conducted emission standards of the FCC because those standards apply to unlicensed transmitters, and PECO's AMI meters use a licensed spectrum transmission. Apr 13 Tr. 49-51.

175. Dr. Davis has conducted measurements of the periodicity of transmission by PECO AMI meters, and they do not transmit every six to seven minutes as Mr. Bathgate testified. Dr. Davis used "expensive and extensive high quality measurement equipment," because the AMI meters "emit so infrequently, that you need extremely sophisticated equipment to capture these brief on/off periods of the RF transmissions from the meters." He was not able to say with certainty what Mr. Bathgate was measuring, other than it was sources other than a single AMI meter, and that AMI meters "don't transmit with that regularity." Apr 13 Tr. 51-53.

176. Dr. Davis measured transients both with and without an AMI meter present, for all three models of PECO AMI meters currently in use. His measurement showed that there were transients coming into the residence when only an analog meter was used. For all of the AMI meters, the addition of the AMI meter reduced the transients. "So the smart meters certainly were not generating any additional . . . transients." Apr 13 Tr. 58-61.

177. Dr. Davis reviewed Dr. Rea's 1991 study and concluded, for numerous reasons related to its design and methods, that the 1991 paper is not scientifically reliable. Apr 13 Tr. 61-67.

178. When Mrs. McKnight went outside to sleep in the boat, taking into consideration her greater exposure to UHF stations, she increased her overall exposure to radiofrequency fields. Apr 13 Tr. 67-68.

179. PECO's AMI meters have radiofrequency transmission levels that are incredibly low compared to the many other sources of radiofrequency fields in the environment that have existed for decades; the AMI exposures pale in significance compared to other sources. Apr 13 Tr. 68.

180. Harmonics and transients are normal in the delivery of electric service to residences, and exist whether an AMI meter is in use or not. Apr 13 Tr. 70-71.

181. Mr. Bathgate did not measure UHF transmissions at the McKnight residence because, even though they are hundreds of times larger than the AMI transmissions, they are still extraordinarily small. Moreover, since he claims that his HF35C meter is directional, if the HF35C works as Mr. Bathgate states, he would have had to have it pointed at the UHF transmitters in order to measure signals from them. Apr 13 Tr. 71-72.

182. The HF35C meter used by Mr. Bathgate should not be used to make scientific measurements of radiofrequency fields. It is not a National Institute of Standards and Technology calibrated, reliable meter – it's a low-cost consumer item. Apr 13 Tr. 72-73.

183. PECO's AMI meters do not produce 5 Hz, 3 kilohertz, or 5 megahertz fields. Apr 13 Tr. 75-76.

184. Dr. Davis has opened and examined PECO's AMI meters and all of their components. There is nothing in them is capable of causing any biological effects in people. Apr 13 Tr. 76.

Testimony of Mark Israel, M.D.

185. Mark Israel is a medical doctor who is Professor of Systems Biology and Pediatrics and Medicine at Dartmouth Medical School. He is also Executive Director of the Israel Cancer Research Fund. Apr 13 Tr. 176-177.

186. Dr. Israel was recognized as an expert in medicine, medical research, and radiofrequency and electromagnetic fields and health. Apr 13 Tr. 182-190.

187. Dr. Israel reviewed the scientific research literature that examine the question of whether there is a relationship between exposure to radiofrequency fields or other frequencies of EMF and people who claim to have electromagnetic hypersensitivity, or EHS. Dr. Israel prefers to use the term designated by the World Health Organization of "idiopathic environmental intolerance," or "IEI," because that term is more medically neutral in that it recognizes that the cause of the symptoms reported by these individuals is not known. His review covered over 50 published studies, a subset of which he discussed in detail. Those studies show that IEI, EHS, and the variety of symptoms attributed to it are not caused by radiofrequency fields. Apr 13 Tr. 194-202; PECO Exh. MI-3.

188. Dr. Israel reviewed the medical records provided by Mrs. McKnight's cardiologist. His cardiovascular examination of Mrs. McKnight showed that all cardiovascular outcomes were normal. The May 23 electrocardiogram had normal results. The May 27 echocardiogram was normal. The June 13 Holter test was normal. The June 20 electrocardiogram was normal. Moreover, her cardiologist did not report that Mrs. McKnight has the Cardiovascular Symptom that she claims. Apr 13 Tr. 206-213.

189. Taking a pulse is a "very unreliable method" to determine whether a person has the Cardiovascular Symptom of which Mrs. McKnight complains. Apr 13 Tr. 213-14.

190. Mrs. McKnight does not have an elevated risk of developing the Cardiovascular Symptom of which she complains. Apr 13 Tr. 214.

191. For the various diagnoses offered by Dr. Rea, such as toxic brain encephalopathy or significant immune dysfunction, if Dr. Israel saw a patient with those conditions he would consider them significant, even dangerous, and he would immediately refer the patient to a specialist. The treatment modalities described by Dr. Rea are not appropriate treatments for any of the conditions he diagnosed, and it's "remarkable" that a physician would make those diagnoses and not consult with specialists regarding treatment. Apr 13 Tr. 216-17.

192. When a medical board issues an Order like the Order issued by the Texas Medical Board issued with respect to Dr. Rea, "it's a very big deal." Apr 13 Tr. 218.

193. Dr. Rea's statement that Mrs. McKnight was "lucky she didn't die" is not medically reliable. He didn't define the type of Cardiovascular Symptom he believes she experienced or the frequency of it, and he did not prescribe any treatment for it. Apr 13 Tr. 219.

194. There are no medical records that Mrs. McKnight actually has the Cardiovascular Symptom. Apr 13 Tr. 223.

195. Mr. McKnight's criticisms of the EHS studies are not well-founded. Apr 13 Tr. 225-26.

196. The 1991 Rea study is not a reliable scientific study. Apr 13 Tr. 227.

197. The Lamech Australian survey is based on self-reports of symptoms from a population that self-identified as having EHS. It does not meet the standards of a scientific study. Apr 13 Tr. 227-28.

198. If there are no diagnostic criteria for a condition, as is the case for EHS, that means that you cannot reliably make a diagnosis of that condition. Apr 13 Tr. 228.

199. Dr. Israel's expert opinion is that there is no reliable medical basis to conclude that radiofrequency fields from PECO's AMI meters did or will cause, contribute to, or exacerbate IEI, EHS, or any symptoms or medical conditions reported by Mrs. McKnight. Apr 13 Tr. 194-202; PECO Exh. MI-3.

Summary of Argument

Complainants have the burden of proof in this proceeding. After a full, multi-day, evidentiary hearing, the McKnight's did not prove their claims by a preponderance of the evidence. To the contrary, PECO provided substantial, persuasive evidence that its AMI meters did not and will not cause, contribute to, or exacerbate Mrs. McKnight's illness. Therefore, the McKnight's Complaint should be dismissed.

Argument

I. Burden of Proof – The Complainants Have the Burden of Proof

It is axiomatic in all Commission formal complaint proceedings that the Complainant has the burden of proof. *Samuel J. Lansberry, Inc. v. Pa. PUC*, 578 A.2d 600 (Pa. Cmwlth. 1990), *alloc. denied,* 529 Pa. 654, 602 A.2d 863 (1992).

The Commission has recently affirmed that the normal burden of proof rule applies to AMI/health claims. *Frompovich v PECO*, C-2015-2474602 (Opinion and Order. May 3, 2018) (pp. 12-14); *Mary Paul v PECO*, C-2015-2475355 (Opinion and Order, June 14, 2018) (pp. 11-13).

The McKnight's claim that installation of an AMI meter caused Mrs. McKnight to suffer ill health, and that re-installation of an AMI meter would cause her to suffer ill health again. In order to prevail, the McKnight's must prove those claims by a preponderance of the evidence. As demonstrated in the remainder of this Brief, they did not do so.

II. The Complainants' testimony did not demonstrate that PECO's AMI meter caused or will cause Mrs. McKnight to be ill

A. Mrs. McKnight's Testimony

Mrs. McKnight testified she has EHS, and that radiofrequency fields from PECO's AMI meter thus causes her to experience illness, including the Cardiovascular Symptom. She primarily discussed four reasons why she holds this belief: (1) the temporal relationship of her symptoms as the AMI meter was installed or removed; (2) examination by her cardiologist; (3) Dr. Prociuk's diagnosis; and (4) Dr. Rea's diagnosis. PECO will defer discussion of Dr. Prociuk and Dr. Rea until later sections of this Brief.

Mrs. McKnight's reliance upon, and interpretation of, the examination by her cardiologist is one of the most interesting aspects of her testimony. Mrs. McKnight's cardiologist examined her and gave her a series of four cardiovascular diagnostic tests over a period of about a month. Apr. 10 Tr. 39. His examination of her and all four diagnostic tests showed that she had normal cardiac function. Apr 13 Tr. 206-13. Yet, from this, Mrs. McKnight concluded that the cardiologist's examination proved that she had the Cardiovascular Symptom – it had just gone away by the time he tested her. Apr 10 Tr. 48.

PECO notes its AMI meter was removed on May 24, 2016, Apr 10 Tr. 8, 22-23, and the first normal cardiovascular test was done on May 23, 2016, Apr 10 Tr. 39 – that is, the first normal test was done while the AMI meter was still installed. Moreover, a second cardiovascular test was done on May 27, 2016 – three days after the AMI meter was removed – and it was also normal. Apr 10 Tr. 39, Apr 13 Tr. 206-13. Mrs. McKnight testified that her Cardiovascular Symptom improved about a week after the AMI meter was removed, Apr 10 Tr. 47-48; a cardiovascular test three days after removal thus should have shown evidence that she had such symptoms. It did not.

Setting aside such issues of temporality, however, one must focus on the broader point that every test taken by Mrs. McKnight's cardiologist showed that she has normal cardiovascular function. Apr 13 Tr. 206-13. Similarly, when she was examined by Dr. Rea she had normal cardiovascular function. Apr 12 Tr. 99. Her treating physician, Dr. Prociuk, reviewed those same records and testified that the results are "relatively benign," meaning that the results of her tests fall within the normal range of variability and "don't represent any significant long term threat to her health." Apr 11 Tr. 277. He stated further that the cardiologist's medical records "says to me this is not a problem." Apr 11 Tr. 301-02. In other words, there is no medical

evidence from any of Mrs. McKnight's treating physicians to support the conclusion that she has the Cardiovascular Symptom.

PECO recognizes that on one occasion Mr. McKnight took Mrs. McKnight's pulse and detected an irregular pulse. Apr 10 Tr. 126. However, as Dr. Israel noted, taking a pulse is a very unreliable method for determining whether a person has the Cardiovascular Symptom, and the purpose of the various cardiovascular tests done by Mrs. McKnight's cardiologist it to determine whether the irregularities seen in the informal pulse-taking are in fact indicative of a true cardiovascular problem. Apr 13 Tr. 213-14. Those tests did not confirm the preliminary pulse test done Mr. McKnight. To the contrary, they all showed that Mrs. McKnight is not suffering from the Cardiovascular Symptom.

As to the larger issue of temporality, Mrs. McKnight was aware when the AMI meter was installed and when it was removed. (She was at home for the Nov. 2015 installation, Apr 10 Tr. 8-11; the meter was removed on May 24, 2016 at her request, Apr 10 Tr. 32-33.) On one occasion, the AMI meter had been in place for some time before she felt bad enough to investigate whether it had been re-installed. (When the meter was re-installed on September 9, she did not feel bad and investigate until September 21, when she checked and saw that the meter had been reinstalled. Apr 10 Tr. 13, 53-55, 59.)

It is also noteworthy that, on May 9, 2016, Mrs. McKnight felt better and believed that the AMI meter might have been removed or reprogrammed, even though it had not. Apr 10 Tr. 49-53, 58. And, when Mrs. McKnight went outside to sleep in the boat and felt better, taking into consideration her greater exposure to UHF stations, she felt better even though she had increased her overall exposure to radiofrequency fields. Apr 13 Tr. 67-68.

In sum, the temporality of the Cardiovascular Symptom and Mrs. McKnight's other symptoms, when compared to the dates that the AMI meter was installed and removed, do not support the view that her symptoms were tied to the presence or absence of the AMI meter – except for the circumstances when she knew that the AMI meter had been installed or removed, in which case her symptoms sometimes temporally tracked the presence or absence of the meter.

Knowledge of exposure can trigger the nocebo effect, in which knowledge that exposure is occurring triggers actual symptoms even though the underlying exposure is not causing those symptoms. PECO Exh. MI-3.

Overlaying all of this information is the testimony of Dr. Davis, described in more detail later, that regardless of whether the AMI meter was installed or not, Mrs. McKnight was being exposed to radiofrequency fields from other sources that are much larger than those created by PECO's AMI meters.

Taken all together, then, Mrs. McKnight's testimony does not support a conclusion that her symptoms were caused, contributed to, or exacerbated by PECO's AMI meter.

B. Mr. McKnight's Testimony

Mr. McKnight stated that that there are three potential mechanisms by which PECO's AMI meter may have made her sick: (1) the effect of transients, sometimes known as "dirty electricity;" (2) radio frequency transmissions; and (3) a theory postulated by Mr. Bathgate (and later identified as the "secondary antenna effect"). Apr 10 Tr. 90-92.

Mr. McKnight provided no testimony or evidence in support of the theories of "transients" or "secondary antenna effect." Testimony on those issues was provided by Mr. Bathgate, and will be responded to in the section of this Brief that addresses Mr. Bathgate's testimony.

As to the question of whether radio frequency transmissions from PECO's AMI meters caused or will cause Mrs. McKnight's EHS, Mr. McKnight primarily relied upon his view that most of the published research suffers from "Type II" errors and thus is reporting "false negatives, and his observations of his wife.

As to Mr. McKnight's views on Type II errors and false negatives, it is enough to say Mr. McKnight clearly is an outlier in this theory. In the EHS studies that did not report a relationship between EMF exposure and symptoms, the authors discussed and dismissed the argument that their results were "false negatives" or "Type II" errors – Mr. McKnight simply disagreed with their analyses. Apr 10 Tr. 168-175. Dr. Israel explained, however, that these studies analyzed and properly accounted for the possibility of Type II error. Apr 13 Tr. 225-26. There are more than 50 such studies that show that IEI, EHS, and the variety of symptoms attributed to it are not caused by radiofrequency fields. Apr 13 Tr. 194-202; PECO Exh. MI-3. Moreover, since the World Health Organization supports the view that EHS is not caused by radiofrequency fields, in order for Mr. McKnight to be correct about Type II error, one must assume that even the World Health Organization made the mistake of overlooking Type II error in these studies. Apr 10 Tr. 174-75. PECO respectfully submits that this establishes Mr. McKnight as being an outlier with his Type II analysis.

As to Mr. McKnight's observations of his wife, the primary and most salient example he gave was their trip to Florida, where he was certain that she had exhibited a "blind" reaction to being exposed to a Blue Tooth signal. On cross-examination, however, PECO demonstrated that when the McKnight's got off the plane people presumably began to use phones, that they continued to do so at the luggage carousel, and that they did not hide their usage of their phones; Mrs. McKnight did not report to Mr. McKnight that she detected EMF exposure, but instead said

that everything was going pretty well; that although Mr. McKnight's written report stated that he "vividly" recalled that Mrs. McKnight became agitated as he was "just about to start the car," that was incorrect, as he now recalls that she became agitated after she entered and he started the car; that when his wife started to yell with pain, Mr. McKnight's reaction was to begin "playing with" the radio and the dashboard screen of controls – but he is certain that Mrs. McKnight could not see him playing with the dashboard because he is certain that she had her head turned, even though he was focused on the dashboard screen the entire time, because he could see her in "his peripheral vision;" that he did not tell her that, in playing with the dashboard, he was seeking a solution to her pain; and he is certain that she did not see him turn off the Blue Tooth and he did not say anything about turning off the Blue Tooth, but her pain subsided. If this event was analogized to a scientific experiment, it would not be considered to be a double-blinded experiment because Mr. McKnight, who was analogically the experimenter, was not blinded; this event, however, was not a scientific experiment. Apr 10 Tr. 187-96.

Moreover, Mr. McKnight accepted, as a possible alternative explanation for the Florida experience, that the McKnight's had just finished a stressful trip, followed by a series of events in which Mrs. McKnight knew that she had been exposed to EMF from cell phones and that she became tense because she believed that such exposure would cause her to suffer symptoms; that consequently she had symptoms due to that stress; and that it was a coincidence that the symptoms occurred at the same time as the Blue Tooth in the car was on. Apr 10 Tr. 196.

Mr. McKnight's observations of his wife thus do not rise to the level of proving, by a preponderance of the evidence, that PECO's AMI meters cause, contribute to, or exacerbate Mrs. McKnight's symptoms.

C. Mr. Brocato's Testimony

Mr. Brocato's testimony was not related to the McKnight's' health claims. Indeed, after extensive on-the-record discussion and demands for proffers, the significance, if any, of Mr. Brocato's testimony remains unclear. To the extent that such clarity is provided in the McKnight's Main Brief, PECO will respond in its Reply Brief.

D. Dr. Prociuk's Testimony

Dr. Prociuk primarily testified that he is certain that Mrs. McKnight has EHS, and that her EHS was caused by and will be exacerbated by PECO's AMI meters. However, Dr. Prociuk was recognized as an expert in medicine, but not as an expert in EHS. Apr 11 Tr. 246-47. His opinions on this issue should thus be given little if any weight.

Moreover, Dr. Prociuk expressed two opinions that appear to be completely contradictory. On the one hand, he stated that the clinical science on EHS is in its clinical infancy and that, when speaking of a connection between exposure to AMI meters and EHS, he is very mindful of the fact that the clinical science demonstrating such a connection is not well-established. Apr 11 Tr. 288-89. On the other hand, he testified, to a reasonable degree of medical certainty, that installation of a meter is medically contraindicated for Mrs. McKnight because he believes that she has EHS. Apr 11 Tr. 296.

The key to unlocking this contradiction is found later in Dr. Prociuk's testimony, where he states that as a clinician he often works with "incomplete pictures," and this gives him the "right or privilege" to reach a conclusion even in the absence of scientific evidence because "that's what it's like to work on the front line." Apr 11 Tr. 296.

With all due respect to the important and difficult role played by clinicians, a clinical opinion that is admittedly based on science in its clinical infancy and science that has not established a connection between exposure to radiofrequency fields and EHS does not meaningfully contribute to a determination of whether PECO's AMI meters cause, contribute to, or exacerbate Mrs. McKnight's ill health – and certainly does not constitute a preponderance of evidence supporting that conclusion. Such an opinion proves only that, in a clinical setting, Dr. Prociuk is willing to act *as though such proof exists* –even though he frankly and candidly admitted that such proof does not exist.

In the hearing room, however, the question is not what Dr. Prociuk would do in the clinic when faced with an "incomplete picture." The question is whether the picture has been scientifically completed sufficiently to prove causation. Dr. Prociuk admitted that such scientific proof does not exist, and his testimony therefore does not support a finding that PECO's AMI meters cause, contribute to, or exacerbate adverse health.

E. Mr. Bathgate's Testimony

The most critical aspect of Mr. Bathgate's testimony is that it had nothing to do with health or safety of PECO's AMI meters. He stated that the standards about which he testified, and the concerns that he raised about PECO's AMI meters, are related to whether operation of the AMI meters will interfere with the operation of other radio services. Apr 11 Tr. 328-331. Indeed, he was not recognized as an expert in any health field and was not allowed to express opinions on issues of health. Apr 11 Tr. 352-53. Thus, even if Mr. Bathgate's testimony were to be accepted on its face, it would provide no evidence in support of the McKnight's' health claims.

As to his specific theories: First, Mr. Bathgate offered the view that PECO's AMI meters will interfere with communications with other devices because, he initially said, PECO's AMI meters will have multiple transmissions, for a variety of reasons, in unlicensed spectrum space. On the second day of his testimony, Mr. Bathgate admitted that he had not properly studied the PECO system before providing his testimony; that he now acknowledged that PECO's system operates in a licensed spectrum; and that his testimony on radio frequency interference was thus in error and was withdrawn. April 11 Tr. 439-44; Apr 12 Tr. 10-11.

Second, Mr. Bathgate offered the view that PECO's AMI meters – and in fact all of the tens of millions of AMI meters that have been nationally deployed over the last half decade – violate the FCC's limits on "conducted emissions" and thus have the potential to interfere with the operation of medical devices such as CPAP machines. Apr 11 Tr. 347-48. Elsewhere, Mr. Bathgate referred to this claimed phenomenon as "transients" and/or "dirty electricity," Apr 11 Tr. 364, although he considers "dirty electricity" to be a slang term that is not precise. One variation of his "conducted emissions" argument is his view that AMI meters have a "secondary antenna effect" in which, he claims, they conduct radiofrequency transmissions through the ground in violation of FCC regulations. Apr 11 Tr. 386-90, 414.

Mr. Bathgate was unable to explain why this alleged violation of FCC regulations has not come to attention of the many AMI manufacturers who must certify that their devices comply with FCC regulations, nor to the attention of the five independent testing agencies that perform and certify such compliance, nor to the attention of the FCC through its random checks for compliance. And, although Mr. Bathgate has been aware of this issue for three years and in this docket testified about it in a public evidentiary hearing, he himself is not comfortable bringing it to the attention of the FCC because he fears that, if he did so, the Department of Defense would

cancel his "top secret" clearance. Apr 11 Tr. 425-27; Apr 12 Tr. 13. PECO respectfully submits that it is not plausible to believe Mr. Bathgate's theory that there is a massive conspiracy (or negligence) of manufacturers, independent testing agencies and the FCC to overlook tens of millions of allegedly non-compliant AMI meters deployed throughout the country.

Moreover, Mr. Bathgate made it clear that, even if his theory of regulatory non-compliance for conducted emissions is correct, that is an issue of interference with other radio operations that has nothing to do with health or safety: "I would not stand in front of anybody and say that's safe or not safe. I wouldn't be able to make that determination." Apr 11 Tr. 367-68.

In reply, PECO provided the testimony of Mr. Pritchard and Dr. Davis that PECO's AMI meters are in compliance with FCC regulations and that, because PECO operates under a spectrum license, the regulations discussed by Mr. Bathgate are not applicable to PECO's operations. Apr 12 Tr. 172, Apr 13 Tr. 49-51. Mr. Pritchard testified that, if the millions of deployed meters had a problem with FCC Class B certification, it would have been discovered by now. Apr 12 Tr. 231. PECO also provided copies of the FCC compliance certificates for the AMI meters that are the subject of this proceeding. PECO Exh. GP-12.

In addition, to test Mr. Bathgate's theory that PECO's AMI meters create excessive transients that violate the FCC's conducted emissions regulations, Dr. Davis conducted test measurements of transients both with and without an AMI meter present, for all three models of PECO AMI meters currently in use. His measurement showed that there were transients coming into the residence when only an analog meter was used. For all of the PECO AMI meters, the addition of the AMI meter *reduced* the transients. "So the smart meters certainly were not generating any additional . . . transients." Apr 13 Tr. 58-61.

Mr. Bathgate's "conducted emission" argument does not provide a preponderance of evidence to support the conclusion that PECO's AMI meters will cause, contribute to, or exacerbate Mrs. McKnight's illness.

Moreover, if Mr. Bathgate or the Complainants believe that PECO's AMI meters do not meet the FCC's regulations, the proper forum to pursue such a claim is by filing a complaint with the FCC, not by asking this Commission to step into the FCC's enforcement shoes. This Commission does not have jurisdiction to determine whether devices comply with FCC regulations.

In addition to his two primary theories, Mr. Bathgate also testified regarding a series of measurements that he made with an HF35C meter. He claims that those measurements prove that: (1) PECO's AMI meters transmit more frequently than PECO says they do; (2) the "secondary antenna" effect exists near PECO AMI meters; and (3) that the McKnight property does not have background exposure from UHF television transmitters.

Dr. Davis testified that the HF35C meter used by Mr. Bathgate should not be used to make scientific measurements of radiofrequency fields. It is not a National Institute of Standards and Technology calibrated, reliable meter – it's a low-cost consumer item. Apr 13 Tr. 72-73.

As to the periodicity of transmissions from PECO AMI meters, Dr. Davis testified that he has conducted measurements of the periodicity of transmission by PECO AMI meters, and they do not transmit every six to seven minutes as Mr. Bathgate testified. Dr. Davis used "expensive and extensive high quality measurement equipment," because the AMI meters "emit so infrequently, that you need extremely sophisticated equipment to capture these brief on/off periods of the RF transmissions from the meters." He was not able to say with certainty what

Mr. Bathgate was measuring, other than it was sources other than a single AMI meter, and that AMI meters "don't transmit with that regularity." Apr 13 Tr. 51-53.

Mr. Pritchard obtained an HF35C meter, which Mr. Bathgate had used for his measurements of the periodicity of transmissions by PECO AMI meters. Mr. Pritchard experimented with the HF35C meter in urban, suburban, and rural environments, both inside and outside of PECO's service territory, and found "tremendous variability" in the readings from the HF35C. There were readings of high spikes from background sources, and periods of zero readings when sitting directly in front of an operating PECO Landis + Gyr AMI meter. Apr 12 Tr. 187-190.

As to the claimed secondary antenna effect, Mr. Pritchard also used the HF35C meter to attempt to replicate Mr. Bathgate's findings with respect to secondary antenna effect and found no correlation of readings and location that would support the secondary antenna effect. In one case he knew exactly where the electric cable was buried and measured with the HF35C directly over the cable and then several feet away, and saw no discernible effect. Apr 12 Tr. 190-91.

Mr. Pritchard found that the claimed "directionality" of the HF35C meter – that it only measures what it is pointed at – is "suspect," and that it in fact picks up signals from a rather broad range from 800 megahertz to 2.8 gigahertz, Apr 12 Tr. 191-92.

As to Mr. Bathgate's inability to detect background UHF transmissions at the McKnight residence using the HF35C meter, Dr. Davis explained that, even though the UHF signals are hundreds of times larger than the AMI transmissions, they are still extraordinarily small. Moreover, since Mr. Bathgate claims that his HF35C meter is directional, if the HF35C works as Mr. Bathgate states, he would have had to have it pointed at the UHF transmitters in order to measure signals from them. Apr 13 Tr. 71-72.

Finally, Mr. Bathgate admitted that he made all of those measurements at a distance of less than one meter. Apr 11 Tr. 448. The direction manual for the HF35C meter, which was discussed at hearing and is appended to this Brief as PECO Late-Filed Exh. 1, provides the following caution:

> Minimum distance 2 meters: Due to the physics of wave generation it is not possible to reliably measure the customary "power density" (W/m2) in the close vicinity of the source of radiation. For the instruments described here, the distance should be in excess of 2 meters. The nature of HF radiation requires a specific approach for . . . the identification of the sources or leaks for the pollution.

On the second day of his testimony, Mr. Bathgate attempted to rehabilitate his measurements on periodicity of AMI meter transmissions by stating that, the prior evening, he had taken 15 minutes of measurements approximately 2 meters away from a PECO Landis + Gyr meter and "saw the same type of" periodicity of transmissions as he had measured at 1 meter. Apr 12 Tr. 23.

PECO respectfully submits that Mr. Bathgate's follow-up test proves PECO's point, which is that whatever Mr. Bathgate was measuring with the HF35C meter, it was some source *other than* the PECO AMI meter. If the HF35C cannot measure accurately at one meter distance but can measure accurately at two meters distance, then moving the HF35C from one meter to two meters from the device of interest – the AMI meter -- should result in *changed* measurements, not identical measurements. The fact that measurements remained the same demonstrates that, in both cases, he was measuring *some other source* that was more than two meters distant from the HF35C for both sets of measurements.

In sum, Mr. Bathgate's testimony does not provide a preponderance of evidence, or indeed any evidence, that PECO's AMI meters will cause, contribute to, or exacerbate Mrs.

McKnight's symptoms. His testimony was concerned with possible interference with other sources of radio operations, and did not address safety or health.

F. Dr. Rea's Testimony

Dr. Rea is a medical doctor who has an Environmental Medicine facility in Dallas, Texas. Apr 12 Tr. 56. He is also one of Mrs. McKnight's treating physicians. Apr 12 Tr. 58. Dr. Rea was recognized as a medical expert, with a specialty in EHS. Apr 12 Tr. 58.

Dr. Rea performed a laboratory test – a "blinded provocation study" -- on Mrs. McKnight, and "she reacted to the 60 hertz, the 3 kilohertz, and 5 megahertz" exposures and "did not react to any of the blanks." Dr. Rea therefore concluded that Mrs. McKnight has the ability to perceive when she is being exposed to EMF. Apr 12 Tr. 66-68.

Dr. Rea diagnosed Mrs. McKnight as having "electric sensitivity, and a chemical sensitivity and toxic brain encephalopathy, autonomic nervous system disease, history of arrhythmias, allergic food sensitivity, and fibromyalgia, inflamed blood vessels, vasculitis, and immune deregulation." It is Dr. Rea's opinion, to a reasonable degree of medical certainty, that PECO's AMI meter caused a change in Mrs. McKnight's health and that it would not be safe to re-install an AMI meter. Apr 12 Tr. 74-75.

PECO does not believe that Dr. Rea's testimony should be given substantial weight, for several reasons.

First, the double-blinded provocation study that Dr. Rea used to diagnose Mrs. McKnight's EHS is the same protocol that he used in his 1991 research paper. Apr 12 Tr. 78-79. But Dr. Davis reviewed Dr. Rea's 1991 study and concluded, for numerous reasons related to its design and methods, that the 1991 paper is not scientifically reliable. Apr 13 Tr. 61-67. Dr. Israel concurred that the 1991 Rea study is not a reliable scientific study. Apr 13 Tr. 227. Dr.

Rea's diagnostic testing of Mrs. McKnight is thus based on an experimental protocol that is not scientifically reliable.

Second, Dr. Rea tested Mrs. McKnight at 60 Hz, 3 kilohertz, and 5 megahertz, but not at other frequencies. Apr 12 Tr. at 79. PECO's AMI meters do not produce 5 Hz, 3 kilohertz, or 5 megahertz fields. Apr 13 Tr. 75-76. Dr. Rea's testing of Mrs. McKnight therefore is not relevant to the 900 megahertz radio frequency fields from PECO's AMI meters.

Third, Dr. Rea is a signatory of the 2015 Brussels International Scientific Declaration on Electromagnetic Hypersensitivity, which urges the international medical community to accept EHS as a "true medical condition." Apr 12 Tr. 87-92; PECO Rea Cross Exh. 4. The obvious corollary to such a statement is that EHS has not yet been accepted by the international medical community as a "true medical condition," else why would Dr. Rea need to urge the international medical community to change its position and accept it as such?

Fourth, Dr. Rea's diagnosis and treatment of Mrs. McKnight do not provide a reason to be confident in him. Dr. Israel testified that, for the various diagnoses offered by Dr. Rea, such as toxic brain encephalopathy or significant immune dysfunction, if Dr. Israel saw a patient with those conditions he would consider those conditions to be significant, even dangerous, and he would immediately refer the patient to a specialist. The treatment modalities described by Dr. Rea are not appropriate treatments for any of the conditions he diagnosed, and it is "remarkable" that a physician would make those diagnoses and not consult with specialists regarding treatment. Apr 13 Tr. 216-17.

Fifth, Dr. Rea signed a Mediated Agreed Order with the Texas Medical Board on August 27th, 2010. Pursuant to that Order, Dr. Rea is required to inform all patients who he treats that his treatment modalities are "not endorsed, sanctioned or supported by the Texas Medical

Board." Apr 12 Tr. 80-81. Dr. Rea required Mrs. McKnight to sign such a disclosure before he treated her. Apr 12 Tr. 82; PECO Rea Cross Exh. 1. The Mediated Agreed Order is still in force today. Apr 12 Tr. 108. The State of Ohio also issued an Order that Dr. Rea's treatments are not sanctioned, endorsed or supported by the Ohio Medical Board. Apr 12 Tr. 85; PECO Rea Cross Exh. 3. The Ohio Order is still in force. Apr 12 Tr. 108.

At hearing, Dr. Rea testified that his Mediated Agreed Order was not important because he "found out later" that the Texas Medical Board "used to have secret hearings" at the request of insurance companies, and that the Texas Medical Board was subsequently "put on probation" by the legislature. Apr 12 Tr. 102-105. Your Honor gave the McKnight's the opportunity to file a late-filed exhibit to provide "any documentation showing the change in the Legislation or the Board that was testified" to. Apr 12 Tr. at 107, 109-110.

On May 14, 2018, the McKnight's filed a late-filed exhibit comprised of 218 pages of unsworn narrative and attached documents. Aside from the non-sworn covering memo from the McKnight's, the documents included:

- Appendix A: A series of letters to the Texas Medical Board arguing that sanctions should not have been imposed on Dr. Rea. This is an attempt to re-litigate the findings of the Texas Medical Board, and is not responsive to the opportunity provide by Your Honor.

- Appendix B: A disclaimer, signed by Alexia McKnight on August 28, 2017, that contains the language required by the Mediated Agreed Order: "THE TREATMENT/ANTIGEN THERAPY BEING UTILIZED AND DESCRIBED BY RESPONDENT IN THIS DISCLOSURE IS NOT ENDORSED, SANCTIONED, OR SUPPORTED BY THE TEXAS MEDICAL BOARD." This does not prove that the Texas Medical Board was put on probation by the Texas legislature; it proves that the Texas Medical Board Order was still in place at the time of Mrs. McKnight's treatment.

- Appendices C and D: Numerous publications that suggest a role for immunotherapy in treatment of patients. Presumably, this is another attempt to prove that the Texas Medical Board imposed should not have issued its Mediated Agreed Order; it in no way proves that the Texas Medical Board was put "on probation" for doing so.

- Appendix E: An article stating that a "notorious henchman" member of the Texas Medical Board was forced to resign for prescription forgery – in September 2007, which is three years *before* Dr. Rea signed his Mediated Agreed Order. The most that this could prove is that this particular bad egg was gone years before Dr. Rea's case came to closure.

- Appendix F: Docket sheets through November 2009 in a case by the Association of American Physicians and Surgeons v the Texas Medical Board; a copy of the Complaint seeking injunctive relief in that action, dated Dec. 20, 2007, in which the AAPS makes numerous claims against the Board; undated discovery questions and answers from that same litigation; four pages of legislative testimony in 2007; a September 2009 Order of the Court dismissing the AARP action for lack of subject matter jurisdiction; and a notice of appeal of that dismissal dated Feb. 18, 2010.

- Appendix G: A December 2, 2010 decision of the U.S. Court of Appeals for the Fifth Circuit vacating the trial court dismissal and remanding the case for further proceedings.

- Appendix H: An Act of the Texas Legislature effective September 1, 2011, setting a seven-year statute of limitations on complaints to the Texas Medical Board, prohibiting anonymous complaints and requiring the disclosure of the complainant's name when the complaint was brought by an insurance company, a requirement that hearings could be recorded; and a requirement that factual findings of the hearing officer may not be changed by the Board.

No connection between the 2011 legislation and the preceding events is demonstrated in the documents, although the McKnight's allege, in their unsworn statement, that the law was passed "in response to the above-described false allegations against physicians."

These materials do not demonstrate the Texas Medical Board was "put on probation by the legislature" and do not rehabilitate Dr. Rea; they primarily attempt to re-litigate the question of whether sanctions should have been imposed upon him. Even if one grants that these documents show that there was a great legal battle between Environmental Medicine advocates and the Texas Medical Board between 2007 and 2010, resulting in 2011 legislation, that in no way undercuts the power of Dr. Rea's Mediated Agreed Order. Dr. Rea signed that Order near the end of this dispute, on August 27, 2010. He testified that it is still in effect today and that he made Mrs. McKnight sign a copy of the required disclosure before he would treat her; Mrs.

McKnight confirmed that fact by providing an executed copy of the disclosure agreement. The rules for conducting medical complaint hearings in Texas obviously changed in 2011, but Dr. Rea's Mediated Agreed Order has remained in place for seven years after that. He is still under sanction by the Texas Medical Board.

And the Ohio Medical Board.

In sum, even with the McKnight's lengthy attempt to attack the Texas Medical Board, there are still ample reasons to conclude that Dr. Rea's opinion should be given no weight.

III. PECO provided substantial, persuasive testimony that its AMI meters did not cause, and will not cause, Mrs. McKnight to be ill

A. Mr. Uber's Testimony

Mr. Uber's testimony relates to communications between PECO and the Complainants, not to their health claims. PECO does not believe that Complainants presented or preserved material claims or testimony regarding communications issues, and therefore will not make arguments based on Mr. Uber's testimony at this time. However, if Complainants present such claims in their Main Brief, PECO will respond to those arguments in its Reply Brief.

B. Mr. Pritchard's Testimony

Glenn Pritchard is PECO's Manager of Advanced Grid Operations. Apr. 12 Tr. 141. Mr. Pritchard was recognized as an expert in the design, operation, and technology of Advanced Meter installations. Apr 12 Tr. 142-46. Mr. Pritchard provided the following testimony:

From approximately 2000 until April 2017, PECO used an AMR meter system that was comprised of transmit-only meters that transmitted, using radio frequencies. That system was

shut down in April 2017. Approximately 1.7 million electric AMR meters and 500,000 gas AMR meters were deployed. Apr. 12 Tr. 147-149. The McKnight's had an AMR meter. Apr 12 Tr. 149. The AMR meters transmitted every five minutes, or 288 times per day, for 20 milliseconds per transmission, for a total of 5.76 seconds of transmission time. Apr 12 Tr. 150.

PECO installed its AMI meter system in response to Pennsylvania Act 129 of 2008. Installation of AMI meters began in 2012. Apr 12 Tr. 151-52. The AMI system is 100% deployed – 1.7 million electric meters, and 500,000 gas meters. Apr 12 Tr. 154. The AMI meters have two radios: (1) a FlexNet module for communications with the backbone system; and (2) a ZigBee radio for communications with devices in the home. The FlexNet module transmits six to eight times per day for approximately 70 milliseconds. The ZigBee transmits every 30 seconds until it pairs with a device; in later AMI meter styles the ZigBee can be remotely turned off. The total transmission time of the two radios is approximately 2.5 seconds per day. Apr 12 Tr. 154-56.

PECO AMI meters transmit using FCC licenses at 901.1 to 901.2 megahertz. Apr 12 Tr. 158.

PECO does not operate a collision network; it uses a spectrum plan that allows its meters to communicate without competing with each other and without collisions. PECO's AMI meters are not asked to repeat their transmissions and do not do so; the same data is always included in the next scheduled transmission approximately four hours later, so such retransmission requests are not needed or used. Apr 12 Tr. 161-167.

PECO's Landis + Gyr meter has a FlexNet module, a ZigBee radio, and switch mode power supply. Apr 12 Tr. 168. It is UL certified. Apr 12 Tr. 170. PECO's Aclara meter has a FlexNet module and switch mode power supply, and is UL listed. Apr 12 Tr. 168-69, 170.

PECO's Sensus Stratus meter has a FlexNet module and a Zigbee radio, but the Zigbee can be turned off remotely. The Sensus Stratus has a capacitor pump, not a switch mode power supply, and is UL listed. Apr 12 Tr. 169.

For each of the meters used by PECO, the manufacturer and an approved testing agency obtained written equipment authorization certifications from the FCC allowing use of the meters. Apr 12 Tr. 171-72: PECO Exh. G-12. PECO's AMI meters comply with FCC regulations. Apr 12 Tr. 172.

By reviewing Functional Block Diagrams, Mr. Pritchard demonstrated and concluded the only functional differences between AMR meters and AMI meters is the periodicity of radio transmissions, the remote connect/disconnect switch on an AMI, and the fact that some AMI meters have a capacitor pump rather than a switch mode power supply. Apr 12 Tr. 174-78.

In terms of creating transients, a residential air conditioner is the residential equivalent of an industrial variable speed drive. A hair dryer is the residential equivalent of industrial shrink wrap equipment. Residential florescent and LED leading can also introduce transients. If the McKnight's or their neighbors are using any of these devices, the transients would carry through onto the McKnight's' electrical wiring. Generating stations also introduce transients. All of these transients exist regardless of the type of meter used – AMI, AMR, or analog – or if no meter at all is installed. Apr 12 Tr. 179-81.

PECO conducted readings of transients at the McKnight residence using a high quality Power Quality Meter. It showed that the McKnight residence, with no meter of any sort installed, is "very noisy, representing different transients . . . that are occurring in the household." Apr 12 Tr. 183-87.

PECO notes that Your Honor provided the McKnight's the opportunity to file a response to PECO readings as a late-filed exhibit, Apr 12 Tr. 277, and that the McKnight's took full advantage of that offer. Unfortunately, in that response they did not limit themselves to documentary evidence or discussion of issues that were part of the record; instead, they introduced off-record testimony from several witnesses for which PECO had no opportunity to cross-examine or respond.

Finally, Mr. Pritchard testified that, as an accommodation, PECO will work with the customers to relocate their meter board and connect PECO service to the newly located meter board. In that respect, Mr. Pritchard noted that their nearby neighbors have AMI meters within 230 feet of the McKnight residence, and that she was able to sleep in a boat located 120 feet from the AMI meter that was previously installed on the McKnight residence. Apr 12 Tr. 194-95. (The McKnight property is 1.9 acres.)

PECO provided an accommodation to the McKnight's by delaying installation of their AMI meter from 2012, when deployment began, until today. However, because the AMR system was decommissioned, that accommodation is no longer available. Apr 12 Tr. 197. Other accommodations include the fact that the Aclara meter does not have a ZigBee radio. Apr 12 Tr. 198-99, that the Sensus Stratus meter has a ZigBee radio that can be remotely disabled, and does not have a switch mode power supply. Apr 12 Tr. 199, and that because PECO uses a licensed, non-mesh system, PECO AMI system has far less radio transmissions than any other utility system, including the ability to "tune down" the number of transmissions from each AMI meter. Apr 12 Tr. 199-202.

C. Dr. Davis's Testimony

Dr. Christopher Davis is a Ph.D. physicist who is the Minta Martin Professor of Engineering and Professor of Electrical and Computer Engineering at the University of Maryland. Apr. 13 Tr. 9-12. Dr. Davis was recognized as an expert in the fields of physics, biophysics, chemistry, electrical engineering, electromagnetics, bioelectromagnetics, and dosimetry. Apr. 13 Tr. 16, 18. Dr. Davis provided the following testimony regarding PECO's AMI meters:

The FCC has safety standards that explain the maximum permissible exposure ("MPE") that people can be exposed to if they are near a radiofrequency transmitter. Apr 13 Tr. 23-24; PECO Exh. CD-3. The radiofrequency transmissions from PECO's AMI meters are approximately 5.8 million times lower than the FCC's MPE. Apr 13 Tr. 26-29; PECO Exh. CD-5. The FCC's MPE's are calculated on a 30-minute average exposure. Even the instantaneous peak transmissions from a PECO AMI meter are approximately 40 times smaller than the amount they are allowed to transmit on an averaged basis. Apr 13 Tr. 29-30; PECO Exh. CD-6.

People are commonly exposed to radiofrequency fields from a variety of sources, including such common devices as cell towers, UHF transmitters, cell phones, and microwave ovens. Apr 13 Tr. 34-35. PECO Exh. CD-8. The McKnight residence is continuously exposed to radiofrequency transmissions from UHF TV transmitters. At the McKnight residence, the background exposure to radiofrequency fields from UHF stations is 168 times larger than the exposure of continuously sitting one meter in front of an AMI meter 24/7. Apr 13 Tr. 36-37; PECO Exh. CD-9.

Moreover, PECO's AMI meters will reduce the radiofrequency exposure from PECO's existing AMR meters by 79%. Apr 13 Tr. 37-38; PECO Exh. CD-10. PECO's AMI meters have

radiofrequency transmission levels that are incredibly low compared to the many other sources of radiofrequency fields in the environment that have existed for decades; the AMI exposures pale in significance compared to other sources. Apr 13 Tr. 68.

Harmonics and transients are normal in the delivery of electric service to residences, and exist whether an AMI meter is in use or not. Apr 13 Tr. 70-71.

Dr. Davis has opened and examined PECO's AMI meters and all of their components. There is nothing in them is capable of causing any biological effects in people. Apr 13 Tr. 76. In Dr. Davis's opinion, there is no reliable scientific basis to conclude that radiofrequency fields from PECO's AMI meters are capable of producing any adverse biological effects. Apr 13 Tr. 42-44; PECO Exh. CD-13.

D. Dr. Israel's Testimony

Mark Israel is a medical doctor who is Professor of Systems Biology and Pediatrics and Medicine at Dartmouth Medical School. He is also Executive Director of the Israel Cancer Research Fund. Apr 13 Tr. 176-177. Dr. Israel was recognized as an expert in medicine, medical research, and radiofrequency and electromagnetic fields and health. Apr 13 Tr. 182-190. Dr. Israel provided the following testimony:

Dr. Israel reviewed the scientific research literature that examine the question of whether there is a relationship between exposure to radiofrequency fields or other frequencies of EMF and people who claim to have electromagnetic hypersensitivity, or EHS. Dr. Israel prefers to use the term designated by the World Health Organization of "idiopathic environmental intolerance," or "IEI," because that term is more medically neutral that recognizes that the cause of the symptoms reported by these individuals is not known. His review covered over 50 published studies, a subset of which he discussed in detail. Those studies show that IEI, EHS, and the

variety of symptoms attributed to it are not caused by radiofrequency fields. Apr 13 Tr. 194-202; PECO Exh. MI-3.

Dr. Israel reviewed the medical records provided by Mrs. McKnight's cardiologist. The cardiologist's examination of Mrs. McKnight showed that all cardiovascular outcomes were normal. In addition, the May 23 electrocardiogram, the May 27 echocardiogram, the June 13 Holter test, and the June 20 electrocardiogram were all normal. Apr 13 Tr. 206-213. There are no medical records that Mrs. McKnight actually has the Cardiovascular Symptom she claims. Apr 13 Tr. 223.

Dr. Israel's expert opinion is that there is no reliable medical basis to conclude that radiofrequency fields from PECO's AMI meters did or will cause, contribute to, or exacerbate IEI, EHS, or any symptoms or conditions reported by Mrs. McKnight. Apr 13 Tr. 194-202; PECO Exh. MI-3.

Conclusion

PECO respectfully submits that the McKnight's did not prove, by a preponderance of the evidence, that PECO's AMI meters will cause, contribute to, or exacerbate Mrs. McKnight's illness. To the contrary, PECO provided substantial, persuasive evidence that its AMI meters did not and will not cause, contribute to, or exacerbate Mrs. McKnight's illness. Therefore, the McKnight's Complaint should be dismissed.

Respectfully submitted,

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June 27, 2018

McKnight v PECO

C-2017-2621057

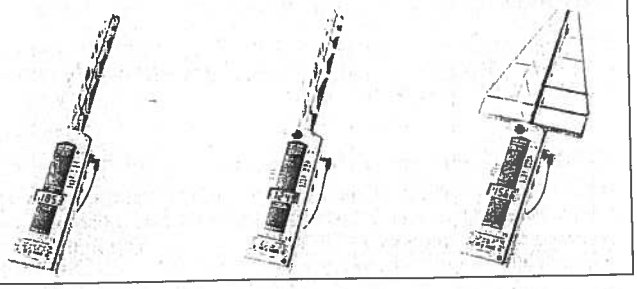
PECO Main Brief

PECO Late-Filed Exh. 1

HF35C Manufacturer's Instruction Manual

GIGAHERTZ® SOLUTIONS
Made in Germany

HF32D	HF35C	HF38B
(800MHz-2,7GHz)	(800MHz-2,7GHz)	(800MHz-2,7GHz) (3,3GHz –3dB)



Rev. 1.9 – 1705 / DRU0190

English

Control Elements and Quick Start Guide

Connecting socket for antenna cable. The antenna is inserted into the "cross like" opening at the front tip of the instrument. **Important:** Do not bend the cable too sharply or overtighten the connector screw!

„Power" **On/Off switch** (⏻ ▶ = "Off")

„Signal" For building biological assessment use „peak" (= factory setting in the HF32D). „Peak hold" simplifies the measurement (HF38B only).

„Range" Set the sensitivity according to the level of radiation (HF35C and HF38B only).

Attenuator knob for audio analysis of digital HF services (HF35C and HF38B only; the HF32D has a "Geiger counter" effect proportional to the signal)

All meters include an **Auto-Power-Off**-feature and a Low-Batt indication.

Introduction to Properties of HF Radiation and Consequences for their Measurement

Permeation of many materials
In particular for measurements inside of buildings it is important to know that construction materials are permeable for HF radiation to a varying degree. Some part of the radiation will also be reflected or absorbed. Wood, drywall, and wooden window frames, for example, are usually rather transparent spots in a house.

Polarisation
Most **H**igh **F**requency radiation ("waves") is vertically or horizontally polarised. With the antenna attached the meter measures the vertically polarised component, if the display is positioned horizontally. By rotating the meter around its longitudinal axis you will be able to pick up any polarisation plane.

Fluctuations with regard to space and time
Reflexions can cause highly localised amplifications ("hot spots"), in particular inside buildings.

In addition, most transmitters and cellular phones emit with considerably varying power during a given day and in the long term, depending on local reception and load. **Therefore repeat measurements at different times of the day on working days and at weekends. In addition it may be advisable to repeat them occasionally over the year, as the situation can change overnight.** As an example, a transmitter only needs to be tilted down by a few degrees in order to cause major changes in exposure

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levels (e.g. during installation or repair of cellular phone base stations). Most of all it is the enormous speed with which the cellular phone network expands every day that causes changes in the exposure levels.

Minimum distance 2 meters
Due to the physics of wave generation it is not possible to reliably measure the customary "power density" (W/m²) in the close vicinity of the source of radiation. For the instruments described here, the distance should be in excess of 2 meters.

The nature of HF radiation requires a specific approach for each

- the determination of the total exposure to it and
- the identification of the sources or leaks for the pollution.

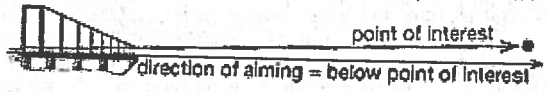
Step-by-Step Procedure to Measure the Total Exposure

When testing for HF exposure levels in an apartment, home or property, it is always recommended to **record** individual measurements on a **data sheet**. Later this will allow you to get a better idea of the complete situation.

Preliminary Notes Concerning the Antenna

As the LogPer Antenna provided with this instrument is shielded against ground influences, one should "aim" about 10 degrees below the emitting source subject to measurement so as to avoid distortions in the area of sensitivity transition (aim horizontally for moderately elevated targets such as transponder masts).

The analyser suppresses frequencies below 800 MHz to avoid the readings being disturbed by lower frequency sources. In order to measure frequencies below 800 MHz down to 27 MHz the instruments HFE35C and HFE59B are available from Gigahertz Solutions. They come with an active horizontally isotropic ultra-broad band antenna from 27 MHz up to beyond 3 GHz, the UBB27.



Settings of the Analyser

The HF32D comes with ‚Range' and ‚Signal' already set to values typical for the assessment of the impact of the HF radiation by building biology standards. Higher power densities beyond the designed range are indicated by a "1" on the left end of the display. In this case, the attenuator DG20 (available as accessory) can be applied and will allow measurements of 100 times higher fields.

The HF35C and HF38B feature additional settings as described below:

At first, set **"Range"** to "1999 µW/m²" resp. "19.99 mW/m²" (HF38B). Only if there are constantly very small readings, switch to

the next finer range[5]. **The basic rule is: as coarse as necessary, as fine as possible.**

Setting **Signal Evaluation ("Signal")**: The **peak HF radiation value**, not the average value, is regarded as the measurement of critical "biological effects" affecting the organism and to be compared to recommended safety limits. This is the standard setting!

The **average value ("RMS")** of pulsed signals is often only a very small fraction of the peak value. Nonetheless it forms the basis of most of the "official" safety limits regulations. Building biologists consider this a trivialization.

„Peak hold" (HF38B only) simplifies measurements of the total exposure by retaining the highest readings for some time (it slowly drops). Note of caution: Switch on "softly" to avoid switching peaks, which then will be retained for some time simulating unrealistic power densities. If peaks are very short and very high the holding capacity needs an instant until it is fully charged.

How to execute the measurements

Hold the HF analyzer with a **slightly outstretched arm,** your hand at the rear of the instrument.

For a rough **first overview** it is sufficient to probe for areas of higher levels of radiation simply by following the audio signals walking through the rooms of interest, directing the analyser everywhere and rotating it.

Having identified the area of interest for a closer evaluation, change the positioning of the instrument in order to analyse the actual power flux density. This is done

- by **pointing** in all directions including upwards and downwards in flats to establish the main direction of the incoming radiation,
- by **rotating** the instrument around its longitudinal axis by up to 90° to also find the plane of polarisation, and
- by **shifting** the instrument in order to find the point of maximum exposure and to avoid being trapped by local cancellation effects.

It is generally accepted to use the highest reading in the room for comparison with limit or recommended values.

Evaluating the different radio services

[5] HF38B – „Range": When switching from 'Coarse' to ‚Medium' for very small readings, it could happen, that the instrument tolerance of +/- 6 dB full range is absorbed. In this worst case there may be a factor 4 between the displayed numbers in ‚Coarse' and ‚Medium'. Example: In 'Medium' you read 150.0 µW/m². If worst comes to worst 'Coarse' might show between 0.6 und 0.03 mW/m² (instead of 0.15 mW/m² which would be the correct value). However, normally the differences shown will be much smaller. For comparing measurements (e.g. 'before' and 'after') take the same range setting.

The displays of the meters of this series show the sum of the total power density within the frequency range of the most common digital radio services. This means for the often dominating sources of DECT and GSM as well as analogue sources: Simply take the readings and compare them to the building biology standard values!

To be able to evaluate the different radio standards and transmission and modulation patterns with one single measurement technology, the following approach to compensate for these differences is recommended:

UMTS/3G, LTE/4G, WiMAX, DVB, WLAN during full data transmission:
The modulation of these high-speed services includes high, needle-like peaks compared to the average power transmitted. Such signals are referred to as "high crest factor" signals. Measure for 1 or 2 minutes by slightly panning the meter pointing to the direction of the main source, and multiply the highest value by ten for a comparison with the building biology recommendations[6]. Often you will find different telecommunication services being present at the same time. With the help of the audio analysis[7], you will be able to estimate how much of the total value shown is caused by such high crest factor signals. Depending on the proportion to the total signal, please apply the following "rules of thumb":

- Low portion of "high crest factor signals" audible: multiply display reading by 2.
- ~"Fifty-fifty"-ratio: multiply display reading by 5
- Dominating "high crest factor signals": multiply display reading by 10.

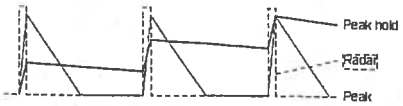
Taking into account the multiple external factors of measurement uncertainty, this approach is perfectly adequate for an assessment of the total pollution. The use of a frequency filter and service specific correction factors will allow an increased accuracy.

Radar beams are emitted by slowly rotating antennas. Therefore they are only measurable and audible for only milliseconds every few seconds. Due to the extremely fast rise-time of the signal only a rough estimation of the real signal level is possible:

- Set "Signal" to "Peak". Take the highest reading of several radar beam passes displayed and multiply it by 10.
- When using the HF38B, you can set the switch to "Peak hold" and allow for several beam passes to establish the equilibrium of charging and droop rate of the holding capacitor. The reading may take a few minutes to stabilize.

[6] Even though their standards specify far higher crest factors, the industry strives for crest limitation for economic reasons, so that the resulting correction doesn't exceed a factor of 10. For TETRA a factor of 2, for WLAN ("standby-rattling") a factor 4 is enough.
Mind the internal noise level, where a correction does not make sense.

[7] Applies for HF35C and HF38B (sound samples on our homepage). When using the HF32D, the approach would be to multiply the display value by 10 to be on the safe side, especially at low levels and when DECT phones can definitely be excluded as source.



Symbolic sketch

Smart meters transmit data to the respective providers very irregularly and in pulses, by using the locally available cell phone services. Additionally there may be pulsed in-house wireless connections. Therefore, it makes sense to keep measuring until you pick up some pulses, and if necessary, apply correction factors.

Limiting values, recommendations and precautions

The "Standard der baubiologischen Messtechnik" (Standard for Building Biology Measurements), SBM 2008, classifies measurements (per radio communication service), with a note of caution "pulsed signals to be taken more seriously than continuous ones", as follows:

Building Biology Recommendations as per SBM-2015				
Peak measurements µW/m²	**unconspicuous**	**moderately** conspicuous	**very** conspicuous	**extremely** conspicuous
	< 0.1	0.1 - 10	10 - 1000	> 1000

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In fall 2008 the "Bund für Umwelt und Naturschutz Deutschland e.V." (**BUND**) (environmental NGO) recommended a limiting value of **1 µW/m² even for outdoor** situations.

The **Landessanitätsdirektion Salzburg** (Austrian health authority) proposed already in 2002 to lower the present **"Salzburger Vorsorgewert"** (precautionary value) **to 1 µW/m²** for **indoor situations.**

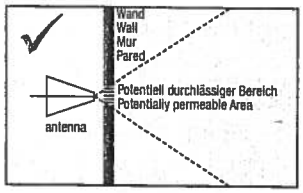
Limiting values imposed by governments are mostly considerably higher. There are indications of rethinking, though. The internet provides large collections of recommendations and data.

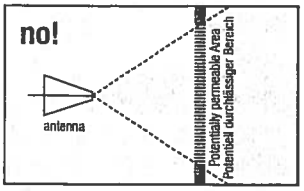
Note for users of cellular phones and WLAN: Even below the measurement range of the meters, even the highly sensitive HF38B, a reliable communication is absolutely possible.

Identification of the sources of pollution

After determination of the total exposure the next step is to find out where the radiation enters the examined room. As a first step eliminate sources from within the same room (e.g. cordless phones, wireless routers, etc.) Once this is completed, the remaining radiation will originate from outside. For remedial shielding it is important to identify those areas of all walls (including doors, windows and window frames!), of ceiling and floor, which

are penetrated by the radiation. To do this one should not stand in the centre of the room, measuring in all directions from there, but monitor the permeable areas with the antenna (LogPer) directed and positioned close to the wall/ceiling/floor. The reason for this is that the antenna lobe widens with increasing frequency. In addition reflections and cancellations inside rooms make it impossible to locate the "leaks" accurately. See the illustrating sketch below!





Audio Frequency Analysis (HF35C / HF38B only)

Many different frequencies within the frequency band between 800 MHz and 2.7 GHz, are being used by many different services. The audio analysis[5] of the modulated portion of the HF signal helps to **identify the source of a given HF radiation signal.**

Sounds and signals are very difficult to describe in writing. The easiest way to identify them is to listen to the sound samples of the different signal sources, which can be found as MP3 files on our homepage. Alternatively, you can approach known HF sources very closely and listen to and memorise their specific signal patterns.

"Marking" of unpulsed signals:
Un-pulsed signals or signal portions by their very nature are not audible in the audio analysis and therefore easily missed. For that reason, in our meters they are marked by a uniform "rattling" tone, with its volume proportional to its contents of the total signal. This "marking" has a frequency of 16 Hz (please see sound samples on our website).

For more in-depth analyses

Gigahertz Solutions offers:

- **Attenuators** for expanding the designed range of the analysers upwards for strong sources of pollution.
- **Instruments for lower HF:** For measurement of signal frequencies above 27 MHz (including: CB radioing, analogue and digital TV and radio TETRA etc.) we offer the instruments HFE35C and HFE59B.
- **Instruments for HF up to 6 GHz / 10 GHz:** For analyses for yet higher frequencies (up to abt. 6 GHz, including WLAN, WIMAX and some directional radio sources and aviation radar), we offer

[5] Turn the attenuator knob for the audio analysis fully to the left („-„) before switching the meter on, as the sound might be very loud at high field strength levels.

the HFW35C (2.4-6 GHz). For higher frequencies up to 10 GHz (Radar) the HFW59B is available.

- **Instruments for low frequencies:** Electrosmog is not limited to the Radio Frequency range! Also for the low frequency range such as power (distribution and domestic installations) and railways including their higher harmonics we offer a broad range of affordably priced instruments with high professional standards.

Please refer to our homepage for further information.

Power Supply / Auto-Power-Off

The battery compartment is at the back of the analyzer. For protection of the battery the instrument turns itself off automatically after initially 40 minutes, in the "LOW BATT" mode already after two minutes. In the "LOW BATT" mode a reliable measurements cannot be guaranteed.

Shielding done by an expert is a reliable remedy

The effectiveness of shielding done by an experienced craftsman can be verified by measurement. He has quite a number of options at his disposal. There is no "best method", however, befitting for all problems – shielding always has to be adapted to the specific situation.

Shielding, too, is covered comprehensively on our homepage which also contains further links on this issue.

Warranty

We provide a two year warranty on factory defects of the HF analyzer, the antenna and accessories.

Even though the antenna appears to be rather delicate, it is made of a highly durable FR4 base material that can easily withstand a fall from table height. The warranty also covers damages caused by such falls, should these ever occur.

The analyzer itself is **not impact proof**, due to the comparatively heavy battery and the large number of delicate components. Any damage as a result of misuse or shock is therefore excluded from this warranty.

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(µW/m² ~ V/m)

µW/m²	mV/m	µW/m²	mV/m	µW/m²	mV/m
0,01	1,94	1,0	19,4	100	194
-	-	1,2	21,3	120	213
-	-	1,4	23,0	140	230
-	-	1,6	24,6	160	246
-	-	1,8	26,0	180	261
0,02	2,75	2,0	27,5	200	275
-	-	2,5	30,7	250	307
0,03	3,36	3,0	33,6	300	336
-	-	3,5	36,3	350	363
0,04	3,88	4,0	38,8	400	388
0,05	4,34	5,0	43,4	500	434
0,06	4,76	6,0	47,6	600	476
0,07	5,14	7,0	51,4	700	514
0,08	5,49	8,0	54,9	800	549
0,09	5,82	9,0	58,2	900	582
0,10	6,14	10,0	61,4	1000	614
0,12	6,73	12,0	67,3	1200	673
0,14	7,26	14,0	72,6	1400	726
0,16	7,77	16,0	77,7	1600	777
0,18	8,24	18,0	82,4	1800	824
0,20	8,68	20,0	86,8	2000	868
0,25	9,71	25,0	97,1	2500	971
0,30	10,6	30,0	106	3000	1063
0,35	11,5	35,0	115	3500	1149
0,40	12,3	40,0	123	4000	1228
0,50	13,7	50,0	137	5000	1373
0,60	15,0	60,0	150	6000	1504
0,70	16,2	70,0	162	7000	1624
0,80	17,4	80,0	174	8000	1737
0,90	18,4	90,0	184	9000	1842

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