

MEMO

To: Kathy Fendt, Mark Johnson (ESA)

Re: Responses to tasks 1 and 2 concerning updating prior reports on powerline health effects issues

Date: November 25, 2015

TASK 1

Task 1 was posed by ESA as “Tasks 1: Review EIS information on electric and magnetic fields (EMF) and document outcome of reviews. Review existing information developed for the EIS regarding EMF, including summary and findings of studies to date. Existing EIS information to be reviewed is presented in Attachment 1 to this Exhibit.” The foregoing tasks are effectively an update to Attachment 1 and therefore referred to below as an “update.”

Attachment 1 to the contract between ESA and Asher Sheppard Consulting is included by reference.

Remarks and tables concerning methodology --

Time frame. The public document of Attachment 1 was prepared in March 2014 and therefore an update would, at a minimum, need to identify relevant information from scientific research and reviews by scientific experts from early 2014 to the present (November 2015). To ensure a time overlap sufficient to capture relevant reports and articles since preparation of the text of Attachment 1, this update is based on literature searches for the complete years 2013, 2014, and to mid-November 2015.

Literature searches. Searches were made using PubMed to access scientific publications indexed for the National Library of Medicine, EMF-Portal, an EMF-specific database maintained in Germany that is kept current, and by review of a frequently updated online reference list maintained by Powerwatch (powerwatch.org.uk), an independent group in the UK focused on EMFs, whose current main developer describes himself as “one of the leading 'alternative' voices’ on “biological EMF effects.” The searches were made on the following terms with the indicated restrictions and number of retrievals.

PubMed Searches (English language)

Search Terms	Date Range	Retrieved
elf magnetic fields	All	1001
elf magnetic fields	2013-2015 *	195
elf magnetic fields AND cancer	2013-2015 *	33
elf magnetic fields AND neurological	2013-2015 *	3
elf magnetic fields AND neuron	2013-2015 *	17
elf magnetic fields AND brain	2013-2015 *	44
elf magnetic fields AND neurodegenerative	2013-2015 *	9
elf magnetic fields AND cognitive	2013-2015 *	7
elf magnetic fields AND cancer	2013-2015 *	33
elf magnetic fields AND carcinogenesis	2013-2015 *	2

elf magnetic fields AND development	2013-2015 *	31
elf magnetic fields AND reproduction	2013-2015 *	18
corona ions AND power lines**	2009-2015	2

* 01/01/2013 – 12/31/2016

** In addition to 2 papers, there were 2 published comments on Swanson et al. (2014). Searches on corona ions AND cancer yielded no additional papers.

EMF-Portal Searches (English language)

Search Terms	Filters*	Date Range	Retrieved
magnetic fields	PF + 2015 + experimental studies	2015	46
magnetic fields	PF + 2014 + experimental studies	2014	73
magnetic fields	PF + 2013 + experimental studies	2013	56
magnetic fields	PF + 2015 + epidemiol. studies	2015	16
magnetic fields	PF + 2014 + epidemiol. studies	2014	21
magnetic fields	PF + 2013 + epidemiol. studies	2013	14
magnetic fields	PF + review**	2013 - 2015	25
corona ions	PF	2009-2015	3
corona	PF, DC	2009-2015	5†

* PF = Power frequency, 50/60 Hz

** review = reviews, surveys, and summaries

† Excludes two papers on corona engineering for HVDC lines

Search of PowerWatch Child Cancer Database

Date Range	Retrieved	ELF-relevant*
2015	21	2
2014	137	2
2013	62	4

* References included in other searches. References not ELF-relevant were from the general biomedical literature on childhood cancer.

Conclusions from the literature searches on ELF magnetic fields.

The database searches identified several significant publications and a major expert panel. Although none of the publications or the expert panel review shifts overall conclusions on EMF health and safety—neither eliminating possibility of a true risk nor establishing risk from exposure—it is useful to note below several articles with the *potential* to shift conclusions found in Attachment 1.

SCENIHR final opinion (January 2015): This thorough update of the European Union committee’s 2009 expert panel review reports on all areas of the EMF literature (SCENIHR 2015). It also was summarized in a peer-reviewed journal article (Scientific Committee on Emerging Newly Identified Health Risks 2015). SCENIHR drew its conclusions from a weight-of-the-evidence methodology described in the report (SCENIHR 2015 p 27). SCENIHR’s main conclusions on ELF-EMFs reinforced a previous conclusion that the literature is inadequate to support classification as probably carcinogenic to humans (IARC Group 2A), or, more strongly as carcinogenic to humans (IARC Group 1). In contrast, the committee’s judgment on whether there is a cause-and-effect relationship between daily average magnetic field exposures of 0.3 to 0.4 μ T (levels identified from epidemiologic studies) and childhood leukemia reiterated placement in IARC Group 2B as a “possible carcinogen”: “In conclusion, the new epidemiological data do not alter the assessment that ELF magnetic field exposure is a possible carcinogen based on the reported association with childhood leukaemia risk” (SCENIHR 2015 p 156-159). The updated SCENIHR study also evaluated the possibilities that ELF magnetic fields caused changed in behavior, brain function, motor neuron disease (particularly, ALS), neurodegenerative diseases (including dementia), reproductive outcomes, and childhood health due to maternal exposure to ELF magnetic fields. In all cases SCENIHR concluded there was no proven relationship either due to weaknesses in the overall evidence, or evidence of good quality for the conclusion that there was no effect.

Two publications on childhood leukemia and magnetic field exposure (Salvan et al. 2015; Zhao et al. 2014) that were not included in the expert review (SCENIHR 2015) do not, in my opinion, alter the conclusions drawn by the SCENIHR.

The Swedish Radiation Safety Authority regularly updates the EMF literature, including the areas bearing on power-frequency electric and magnetic fields. The two most recent updates contain brief reviews of research papers relevant to the update period (SSM's Scientific Council on Electromagnetic Fields 2014; SSM's Scientific Council on Electromagnetic Fields 2015). The Council’s reports identify several papers that advance the scientific research on ELF magnetic fields, some of which also are identified in this update.

However, none of the new information in these reports indicates a fundamental change from the knowledge and views that informed judgments found in Attachment 1.

Several papers identified from the database searches made noteworthy advances in the literature of a few areas (regardless of whether risk appeared to increase or decrease). Most such advances were from recent epidemiologic studies. It is in the nature of epidemiology that, especially for small or moderately elevated risks, achievement of a consensus opinion among scientific experts requires many investigations and refinements in exposure assessment. In the case of a possible causal relationship between power-frequency magnetic fields and childhood leukemia, studies have been ongoing since 1979 (Wertheimer and Leeper 1979) and especially after the mid-1980s (Savitz et al. 1988). The issue has been a major factor in public health evaluations citing power-frequency magnetic fields as a possible cause of cancer (IARC 2002), and spawned numerous efforts, including several meta-analyses, to improve exposure assessment, statistical power, and epidemiologic methods in pursuit of a definitive conclusion. The period 2013-to mid-November 2015 saw publication of national studies on powerlines and childhood leukemia from France (Sermage-Faure et al. 2013) and Italy (Magnani et al. 2015; Salvan et al. 2015) that continued the pattern of conflicting findings on low-levels of risk. By themselves, these new national studies do not change previous assessments of the related literature. In contrast, one author's review of all available data (Leitgeb 2014) led to the conclusion that there was no excess risk from ELF MF exposures because previous analyses did not view the data in a holistic manner.

This update also identified recent epidemiology papers making potentially useful advances in assessments of risks of magnetic field exposure on human reproduction (spontaneous abortion, fetal development) (de Vocht et al. 2014; Su et al. 2014), the neurodegenerative illnesses of Parkinson's Disease (Brouwer 1995; Huss et al. 2015a; Shamsi et al. 2013; van der Mark et al. 2015), Alzheimer Disease (Davanipour et al. 2014), and motor neuron disease (amyotrophic lateral sclerosis or ALS) (Fischer et al. 2015; Huss et al. 2015b; Seelen et al. 2014; Vergara et al. 2013). Public health assessments in these areas of study are not likely to be affected by the addition of a few new studies, but they are cited here to identify areas of current activity in which there is a potential for changes in currently inconclusive estimates of risk.

Twenty-five papers reviewed particular topical areas, with greatest emphasis in human studies concerning brain function, reproduction, neurodegenerative diseases, cardiac health, and topics from laboratory research conducted in animals (in vivo) and in vitro. Apart from the 51 papers in epidemiology evaluated for this update, there were a few papers studying human beings directly (for example, metabolic factors, electrosensitivity, genotoxicity), 50 papers with endpoints in animal physiology or behavior, and 114 papers conducted with in vitro methods (cell physiology, cellular genetics, cell metabolisms, etc.). Laboratory research was scanned, but not further analyzed because the thrust of this update is on research that could alter prior conclusions on risk to human health. Although laboratory research is a significant part of overall scientific evaluations of EMF health risks, particularly with regard to mechanisms of action, the focus of this update remains on epidemiology and expert assessments that include consideration of laboratory science and mechanisms of interaction.

In summary, research reported since 2013, approximately the earliest cutoff for information found in Attachment 1, shows continuing research with additional data that overall tends to improve scientific understanding, although without resolving long-standing controversies. This update identifies some areas where new studies are noteworthy, but recent research does not affect the essential accuracy and sufficiency of statements in Attachment 1, particularly statements that bear on human health risks.

TASK 2

Task 2 was posed by ESA as: “Task 2: Review information on corona ionization, presented in Attachment 2 [ENA comments; see following].... Provide an opinion on whether the 2009 ENA summary of studies accurately conveys the findings of the studies they cite and confirm whether any other studies have been published since the date of the ENA information that substantially add to or alter ENA’s findings.”

Conclusions on corona ions as a cause of disease near powerlines: 1) review of the ENA comments (Nov. 2009) and 2) literature searches.

ENA, Energy Networks Association (Australia) prepared “Comments on the Corona-Ion Hypothesis” (2009) in recognition of the hypothesis that aerosols due to corona effects, which are common at high-voltage power lines, are the true etiologic factor causing illness associated with high-voltage overhead power lines. As a result, magnetic fields would be only a concomitant feature of high-voltage power overhead lines that have no biological or health significance.

The ENA Comments document is a concise and accurate review of the controversial question of the possible role of the magnetic field found near powerlines as a cause of childhood cancers and other diseases and an explanation of the generation of ions by the corona process on transmission lines. The ENA Comments quote at length from Henshaw and Few, the scientists who developed the hypothetical health-related role of corona ions and accurately summarized the main research findings from Henshaw and Few. Research by others working on this question and others conducting ancillary work was also presented concisely and accurately. The conclusions drawn are consistent with those of expert bodies from which the ENA Comments quote. A conclusion from the UK’s AGNIR expert group emphasized the low public health impact if corona ions were found to have adverse health effects. However, in the hypothetical case of a risk borne by a tiny fraction of the public, the principles of environmental justice and simple morality indicate that any risk limited to a small population cannot be ignored merely because the greater population is unaffected.

In summary, the ENA Comments (2009) was a good summary of the corona ion hypothesis that was placed into perspective of concerns for disease risks near high-voltage powerlines that more often are assumed to have a potential relationship to powerline magnetic fields.

Two papers were identified for the period 2009-2015 following the ENA Comments (2009). Swanson et al. (2014) found that adjustments for corona ion exposures from overhead power lines did not improve the ability to estimate risk from powerlines in comparison with a distance-only measure of exposure. The other study measured aerosols generated near automobile freeway traffic in Australia, which were at high levels in comparison to aerosols from corona ions near high-voltage powerlines (Jayaratne et al. 2015). Neither paper indicates a substantial change from the ENA Comments (2009).

The very limited research identified for 2009-2015 on corona-generated aerosols did not add support for the hypothesis that corona ions may be an etiologic factor near high-voltage powerlines.

The preceding review indicates that the ENA Comments on corona ions remain accurate and useful at the present time.

- Brouwer FP. 1995. Re: "case-control study of childhood cancer and exposure to 60-Hz magnetic fields" (letter and replies). *American Journal of Epidemiology* 141(4):375-378.
- Davanipour Z, Tseng CC, Lee PJ, Markides KS, Sobel E. 2014. Severe Cognitive Dysfunction and Occupational Extremely Low Frequency Magnetic Field Exposure among Elderly Mexican Americans. *Br J Med Med Res.* 4(8):1641-1662.
- de Vocht F, Hannam K, Baker P, Agius R. 2014. Maternal residential proximity to sources of extremely low frequency electromagnetic fields and adverse birth outcomes in a UK cohort. *Bioelectromagnetics* 35(3):201-209, Epub 2014 Jan 31.
- ENA, Energy Networks Association (Australia). 2009. Comments on the Corona-Ion Hypothesis. 4 p. <http://www.ena.asn.au/sites/default/files/comments-on-the-corona-ion-hypothesis-updated-november-2009.pdf>.
- Fischer H, Kheifets L, Huss A, Peters TL, Vermeulen R, Ye W, Fang F, Wiebert P, Vergara XP, Feychting M. 2015. Occupational Exposure to Electric Shocks and Magnetic Fields and Amyotrophic Lateral Sclerosis in Sweden. *Epidemiology.* 26(6):824-830.
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- Huss A, Spoerri A, Egger M, Kromhout H, Vermeulen R. 2015b. Occupational exposure to magnetic fields and electric shocks and risk of ALS: the Swiss National Cohort. *Amyotroph Lateral Scler Frontotemporal Degener.* 16(1-2):80-85, Epub 2014 Sep 17.
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- Jayaratne ER, Ling X, Morawska L. 2015. Comparison of charged nanoparticle concentrations near busy roads and overhead high-voltage power lines. *Sci Total Environ.* 526:14-18, Epub 2015 Apr 25.
- Leitgeb N. 2014. Childhood Leukemia Not Linked with ELF Magnetic Fields. *Journal of Electromagnetic Analysis and Applications* 6(7):174-183.
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- Salvan A, Ranucci A, Lagorio S, Magnani C. 2015. Childhood leukemia and 50 Hz magnetic fields: findings from the Italian SETIL case-control study. *International Journal of Environmental Research and Public Health* 12(2):2184-2204.
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