

# Evaluation of Precautionary Controls for Occupational ELF Magnetic Fields in Dutch Workplaces

Joseph Bowman\* and Yvette Christopher – de Vries\*\*

*\*U.S. National Institute for Occupational Safety & Health (NIOSH)*

*\*\*Institute of Risk Assessment Sciences, Utrecht, the Netherlands*

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# Problem

- Magnetic fields at extremely low frequencies (ELF=3-3000 Hz) are Possibly Carcinogenic to Humans
  - NIEHS (1998), IARC (2002), WHO (2007)
- WHO's *Environmental Health Criteria* on ELF-MF:
  - “low-cost precautionary procedures to reduce exposures [are] reasonable and warranted ...”
- However, precautionary methods for reducing workplace exposures are lacking

# Resolution – *NIOSH project*

- NIOSH risk assessment of cancers from occupational ELF-MF [Bowman et al. 2012]
  - Risk of dying prematurely decreases by  $0.32\% \pm 0.29\%$  per  $1 \mu\text{T}$  reduction in TWA magnetic fields
  - Reducing TWA exposures above  $0.3 \mu\text{T}$  can be cost-effective
- Pilot study of precautionary exposure reductions in the Netherlands
- Publish comprehensive NIOSH document on ELF-EMF:
  - RELs based on proven neurological effects
  - Recommendations on electromagnetic interference with implants
  - Precautionary recommendations for possible cancer risks

# Goals of Dutch pilot study

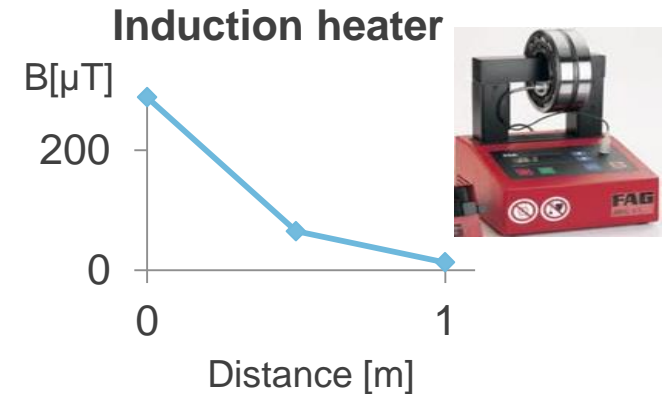
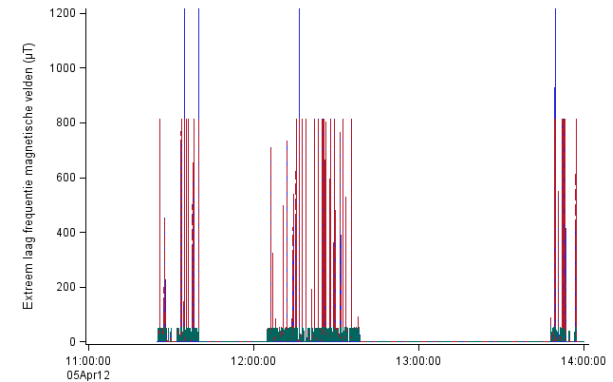
- Develop precautionary methods for reducing TWA exposures to ELF magnetic fields, and evaluate their effectiveness.
- Develop messages that will persuade industrial hygienists, employers, and workers to voluntarily adopt precautionary exposure reduction measures.

# Study Design

1. From an ELF-MF survey of 45 Dutch workplaces, recruit 3 companies with 8+ workers with TWA  $> 0.3 \mu\text{T}$ .
2. From survey monitoring and walkthrough measurements, design cost-effective reductions in long-term TWA..
3. Persuade company to train workers on work practices to reduce possible cancer risks.
4. Post-intervention monitoring.

# Tools for Designing Controls

- Personal monitoring with task log
  - High exposure tasks
  - Duration of exposure
- Spot measurements
  - Identify sources
  - Fall off with distance
- Basic IH principles:
  - ↑ distance, ↓ time, ↓ reps
- Modeling

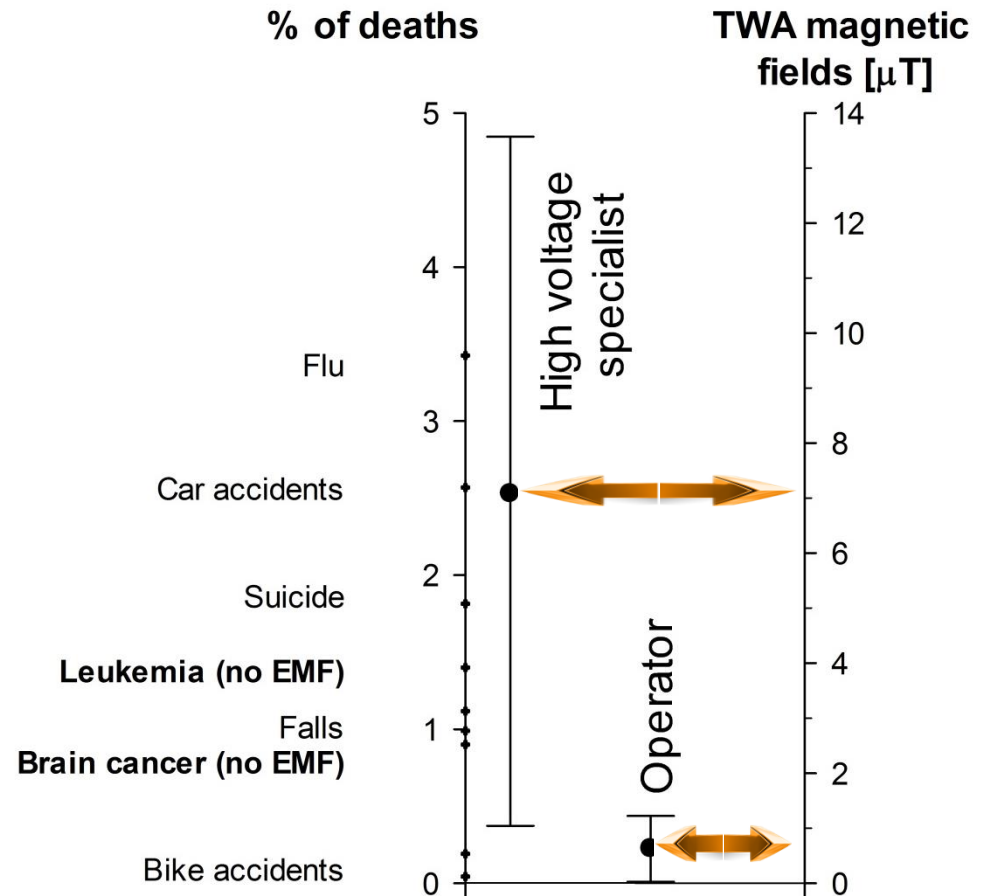


# Exposure Analyses

- Unit of exposure: Mean TWA for homogenous exposure groups (HEG)
  - Confidence limits derived from between- and within-worker variances
- Risk metrics from NIOSH risk assessment
  - Percent of excess deaths from cancers
  - Costs to the economy
  - Comparison with proven carcinogens
    - Ionizing radiation, benzene, ethylene oxide

# Worker Training Presentations

- *Train the trainer* model
- Guided by *CDC Clear Communication Index*
- Outline
  - What are magnetic fields?
  - Health risks
    - Proven → European limits
    - Possible → precautionary measures
  - How worker can reduce exposure





# Results – *Company participation*

|  | Requests | Participants | Rate |
|--|----------|--------------|------|
| Pre-measurements for survey study                  | 66       | 35           | 53%  |
| Walkthrough for precautionary study                | 18*      | 4            | 22%  |
| Presentation to IHs and foremen                    | 4        | 3            | 75%  |
| IHs agree to worker training                       | 3        | 2            | 67%  |
| Management agrees to training and post-measurement | 2        | 1            | 50%  |

\*Companies with TWAs > 0.3  $\mu$ T in at least 2 occupations

# Participating companies and strong ELF magnetic field sources

|                        |   |
|------------------------|---|
| RR car refitting plant | Magnetic fault testers, induction heaters, <b>induction furnace</b> , arc welding |
| Auto body plant        | <b>Spot resistance welding</b> , arc welding, electric power center               |
| Plastics company       | <b>Chlorine electrolysis cells</b> , rectifier room, electric power center        |
| Paper mill             | Generator, <b>transformers</b> , large motors, arc welding, electric fork lift    |



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# Precautionary measures

## *RR car refitting plant*

| Source                   | Exposure reduction measure                |
|--------------------------|---|
| <b>Induction furnace</b> | <b>Install remote control</b>             |
| Handheld fault tester    | Purchase lower emission model             |
| Metal induction heater   | Increase distance when operating          |
| <b>Arc welder</b>        | <b>Do not run cable over the shoulder</b> |



Spot measurements determine control's position



Cable crossing the body

# Precautionary measures

## *Auto body plant*

| Source                     | Exposure reduction measure                     |
|----------------------------|--|
| Arc welding                | Do not run cable over the shoulder             |
| <b>Manual spot welding</b> | <b>Re-design process</b>                       |
| Robotic spot welding       | Electric-work-only zones                       |
| Power center               | Electric-work-only zones                       |
| Other jobs                 | Training on EMF hazards and exposure reduction |



Control: Place metal parts into jig and step back to weld

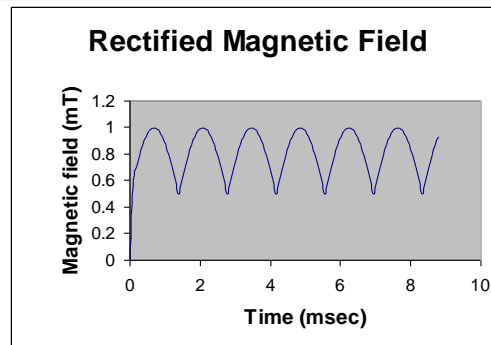
# Precautionary measures

## *Plastics plant*

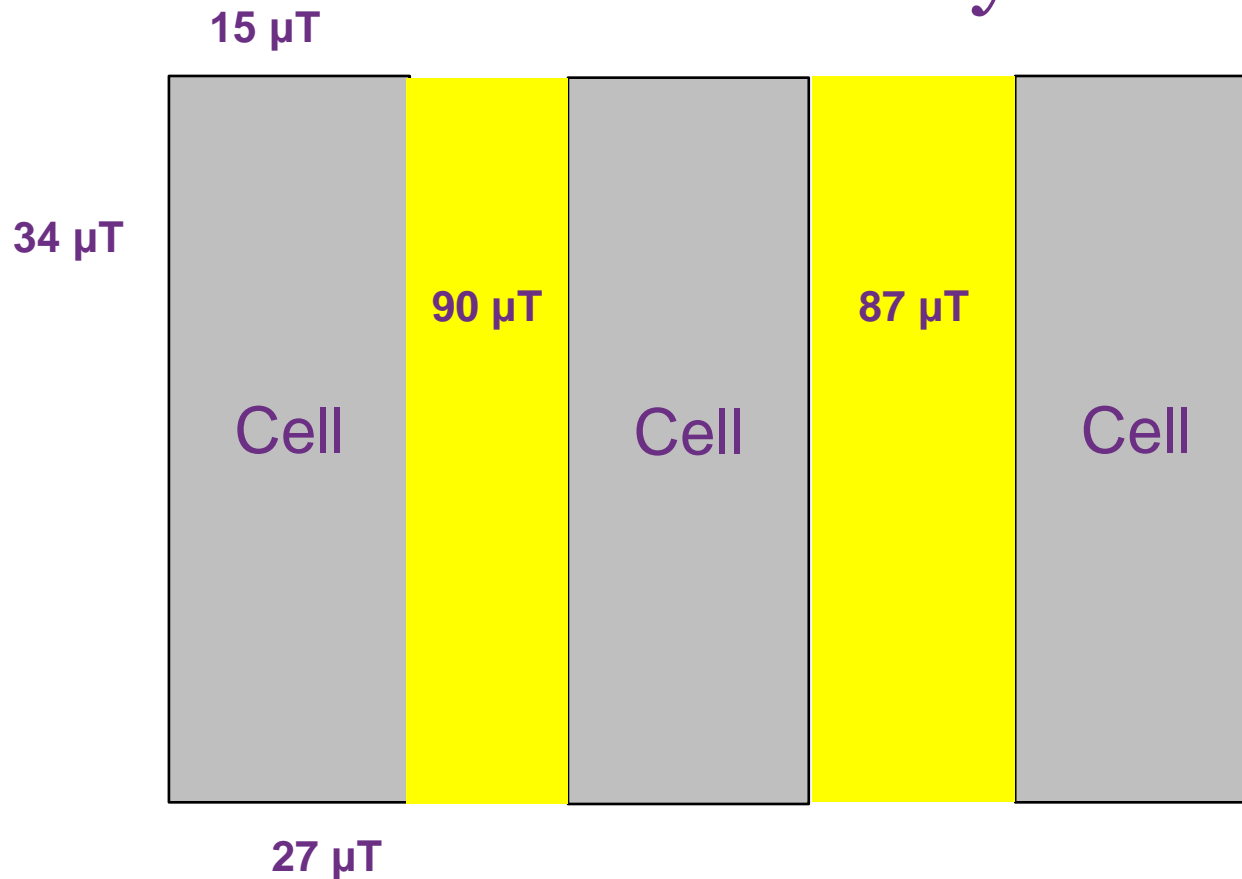
| Source             | Exposure reduction measure                     |
|--------------------|--|
| Chlorine cell hall | <b>Electric-work-only zones</b>                |
|                    | Install video cameras to decrease inspections  |
|                    | Turn surrounding cells off during repairs      |
| Power center       | <b>Electric-work-only zones</b>                |
| Rectifier room     | <b>Electric-work-only zones</b>                |
| Other jobs         | Training on EMF hazards and exposure reduction |



Electrolysis cell hall



# *Electric-work-only Zones* in the electrolysis cell hall



## Work practices for *electric-work-only zones*

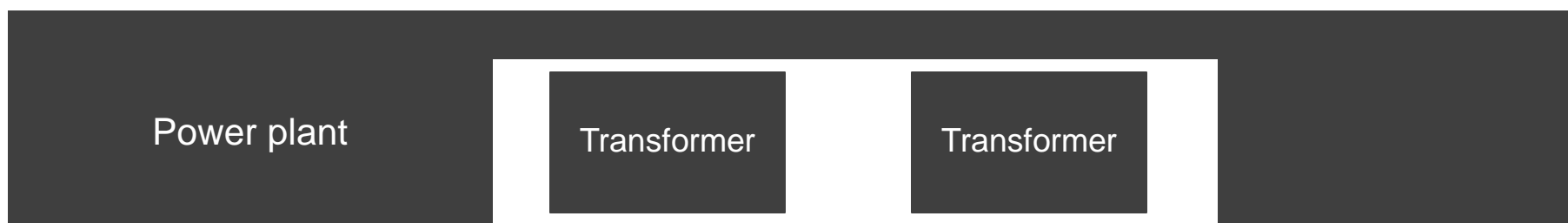
- First prepare all tools
- Step out of zone for other tasks
- Do not take any safety risks.

Decrease time in high field areas

# Precautionary measures

## *Paper mill*

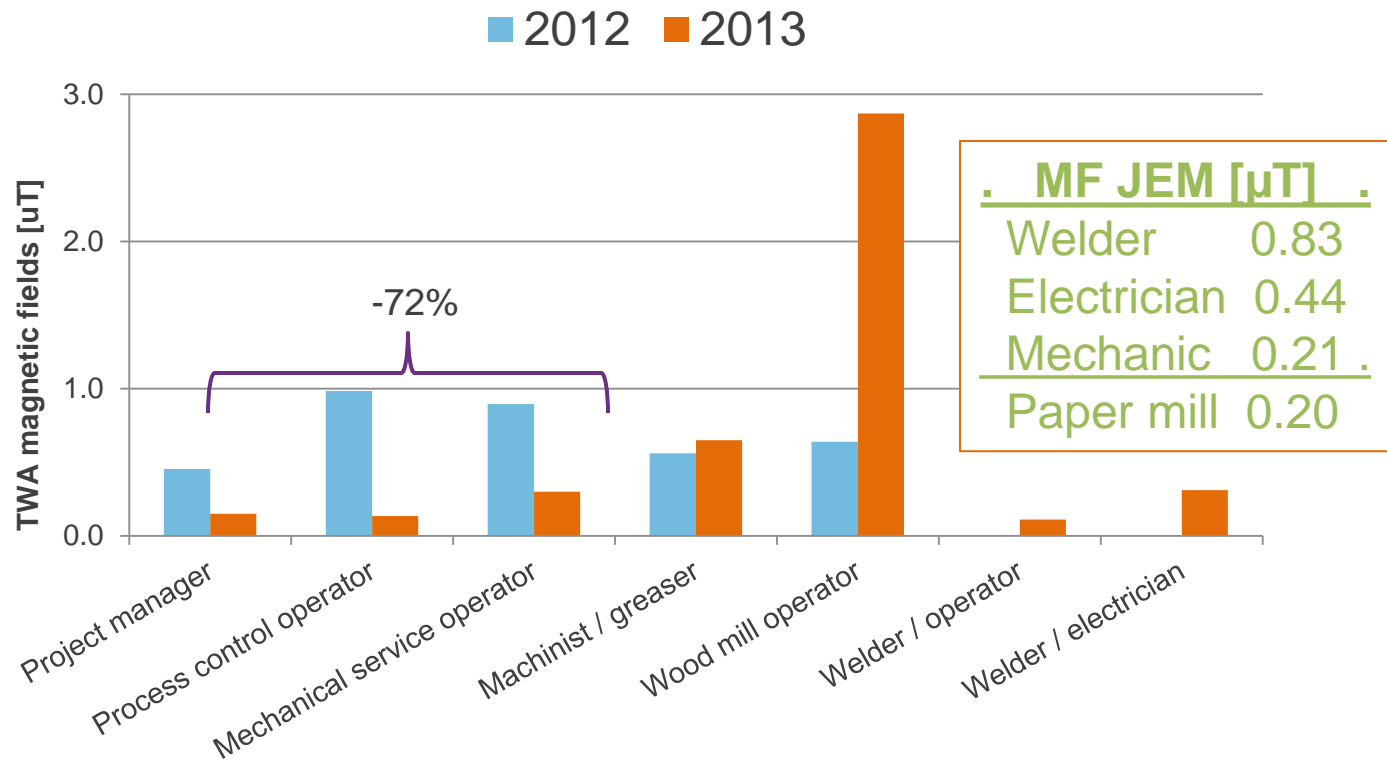
| Source                         | Exposure reduction measure                     |
|--------------------------------|--|
| Power plant                    | <b>Electric-work-only zones</b>                |
| <b>Transformers by walkway</b> | <b>No-go zone</b>                              |
| Arc welding                    | Do not run cable over the shoulder             |
| Maintenance mechanics          | Identify sources to avoid, e.g. large motors   |
| Other jobs                     | Training on EMF hazards and exposure reduction |



19.0  $\mu$ T

**Do not go into *no-go zone* except for work.**

# Effects on exposures – *Paper mill*





# Lessons Learned – *Controls*

- Low-cost measures can substantially reduce TWA magnetic field exposures
- Measures designed with basic IH principles + monitoring and walkthru data
- Developed models for setting boundaries on *electric-work-only* & *no-go zones*
- Workers easily trained to identify high-field sources

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# Lessons Learned – *Barriers to Implementation*

## Reasons for not participating

- Controversy over science
- The C word
- Different than OEL compliance
- Not a regulation
- Other risks are higher priority

## Replies

- Cite WHO, etc.
- Cancers raise concerns
- Precaution is a new paradigm
- Goodwill value with workers and community
- Wait until EMF and cancer is a priority

**Lesson: Message needs improvement.**

# Next Steps

- Focus groups with IHs to improve message
- Create EMF control bands
  - Link controls suggested by Dutch study to the EMF *Source Exposure Matrix* from our cancer epidemiology studies
- Complete draft *Current Intelligence Bulletin*, so the review / approval process can start



# Questions?

For more information, write me at

[JBowman@cdc.gov](mailto:JBowman@cdc.gov)

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