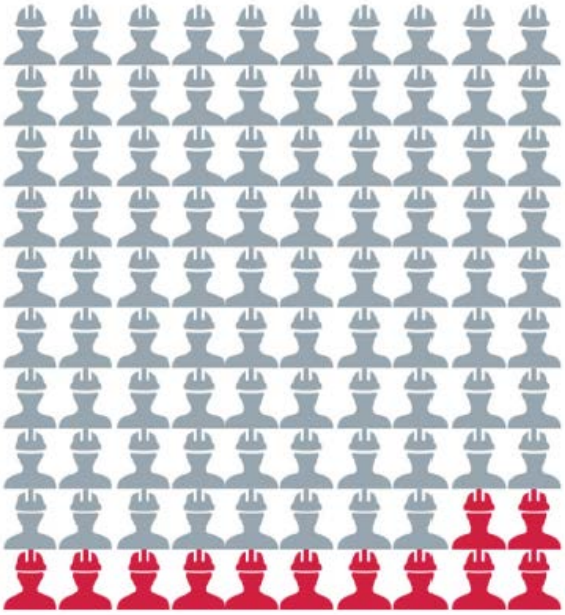
Communicating Risk and Uncertainty in Construction Safety and Health

Best practices identified from literature and CPWR research

12%



SEPTEMBER 2025

CHRIS RODMAN, CLAYTON SINYAI, JESSICA BUNTING

CPWR
THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

Table of Contents

Summary 1

Background 1

Methods 2

Results 4

Discussion 9

References 10

Appendix A: Demographics 11

Appendix B: Hearing Loss Flyer Results 13

Appendix C: Nanomaterials Flyer Results 15

Appendix D: Copies of Flyers 17

 CPWR is the research and training arm of NABTU. Production of this document was supported by cooperative agreement OH 009762 from the National Institute for Occupational Safety and Health (NIOSH). The contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

Summary

Previous research at CPWR about communicating safety and health information to workers was primarily concentrated on general communication practices, such as focusing on the primary message, using appropriate literacy levels, and providing specific calls to action.[1] Our Research to Practice (r2p) team recognized that it was also important to know more about good practices for communicating risk in a way that resonates with workers. Much of the communication about risk concerns events that *may* happen: a worker exposed to a chemical on the job *may* suffer illness, a worker at height who is not wearing fall protection *may* fall and be injured. Information delivered to the worker contains an element of risk, which is sometimes quantifiable but other times less certain. To learn more about effectively communicating risk and uncertainty with construction workers, the r2p team reviewed literature from other industries and designed a survey to test some of the good practices identified, ultimately confirming their application to the construction industry.

Those recommendations for people communicating risk and uncertainty include:

1. Be open about what you don't know.
2. Don't forget your denominator.
3. Use charts, graphs and pictographs to visualize data.
4. Framing is important.
5. Analyze your audience.
6. Make a "Mental Model" of the risk.
7. Pretest your message, materials and graphics with the intended audience before distributing widely.

Background

When communicating safety and health information, it is important hazards, risks, and solutions be explained in terms that can be understood and acted upon by the target audience. In this context, risk may be thought of as the interaction between hazard and exposure and their combined impact on the health or safety of the worker. CPWR–the Center for Construction Research and Training (CPWR) aims to move safety and health research and solutions into practice by educating and influencing a variety of construction industry stakeholders. One target audience is construction workers. While the employer is often the decision maker when it comes to safety and health policies and practices on the job, it is critical for workers to know about hazards they are exposed to and how to protect themselves, in addition to any controls, or lack thereof, implemented by the employer.

Previous research at CPWR has primarily concentrated on general clear communication practices such as a clear primary message, appropriate literacy levels, and specific calls to action.[1] Our Research to Practice (r2p) team wanted to know more about **good practices for communicating risk** in a way that resonates with workers. When communicating directly to workers, messaging often concerns **events that *may* happen**: a worker exposed to a chemical on the job ***may*** suffer illness, a worker at height who is not wearing fall protection ***may*** fall and be injured. The information delivered contains an element of risk or uncertainty of risk. To learn more about communicating risk and uncertainty with construction workers, the r2p team reviewed literature from other industries and designed a survey to test some of the good practices identified.

Methods

As a first step, CPWR's r2p team reviewed available literature on risk communication. It outlined several good practices, including:

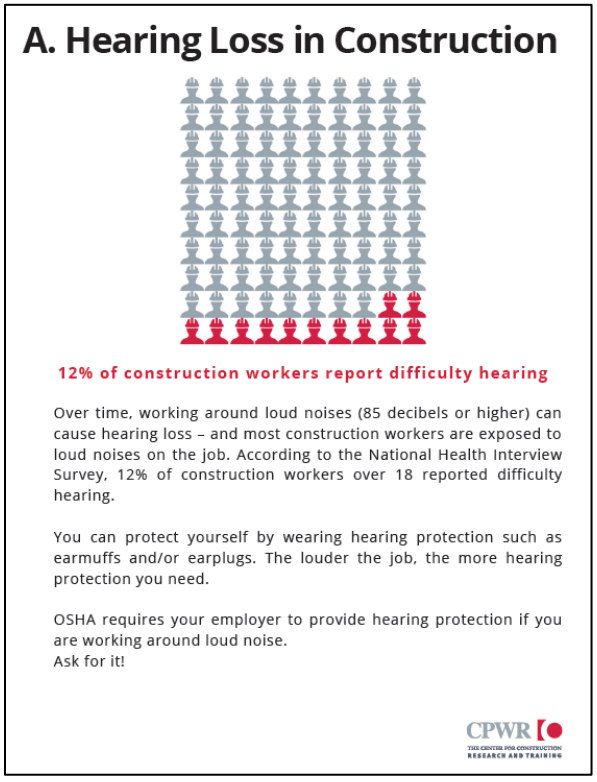
1. **Be open about what you don't know**. The Centers for Disease Control *Clear Communications Index* directs those designing health education materials to "explain what authoritative sources, such as subject matter experts and agency spokespersons, know ***and don't know*** about the topic." Ethically, public health and other professionals are required to disclose uncertainty when informing the public of health risks so members of the public can make informed decisions. Although some worry that acknowledging uncertainty can undermine their health message, research suggests that disclosing uncertainty does not necessarily reduce trust in the source of information.[2,3]
2. **Don't forget your denominator**. Many risks are quantifiable. But too often, experts simply report the total number of negative outcomes without a denominator, or they focus on the *relative* risk of a negative outcome. Relative risk compares the probability of an event occurring within the exposed group to the probability of the same event occurring to a separate (differently exposed) group. For example, "construction workers are X times more likely than those in other industries to develop X disease".
   In comparison, *absolute* risk represents the probability of an event occurring to an individual within the exposed group. For example, "X in X construction workers will experience a soft tissue injury leading to multiple days off work during their career".
   When possible, use absolute risk rather than relative risk to describe a hazard.[4]
3. **Use charts, graphs and pictographs to visualize data**. A percentage statistic conveys both numerator and denominator, but percentages are not intuitive to most people. Graphs can display both numerator and denominator at a glance, and multiple studies have shown that they aid audience understanding. Although no single graphic format is best for all communications tasks, many researchers have found good results with *pictographs*, also known as *icon arrays.*[5,6,7]
4. **Framing is important.** Health messages may be *gain-framed* or *loss-framed*. Gain-framed messages focus on the positive outcomes of a given action or behavior, such as "Wear hearing protection to protect your hearing and quality of life." Loss-framed messages urge action to prevent a harm, such as "Wear hearing protection to protect yourself against hearing loss." Both gain- and loss-framed appeals can be effective in different circumstances. Some research has found that gain-framed messages are more effective in promoting prevention behaviors while loss-framed messages were better at driving people to be tested for illnesses or exposures.[8,9]
5. **Analyze your audience.** Before preparing a message, analyze your intended audience. Are you addressing college graduates or high school graduates? Men or women? What is their occupation? If you are preparing risk communication for an audience of construction trades workers, your message should be tailored to their needs.[10]
6. **Make a "Mental Model" of the risk**. The roofer who is not wearing a fall harness may believe that he is not at risk of a fall. On the other hand, he may know he is at risk but doubts the efficacy of his fall harness--or he may have been told by his supervisor that the harness interferes with his work. Interview members of your intended audience to learn their attitudes and beliefs about the hazard and compare it to what experts believe about it. Then use your messages to reinforce accurate beliefs, counter inaccurate ones, and fill gaps.[11]
7. **Pretest your message, materials and graphics with the intended audience**. Whatever subject matter experts have to say about a hazard, your audience is the final judge of whether your risk communication efforts have succeeded. Are your key

messages coming across? Are members of the audience satisfied with your description of the risk and ready to take preventative action? Formal pretesting can ensure that your product is a good fit for the intended audience before using your materials widely.[10,11]

To test several of these recommendations with a construction audience, CPWR developed two flyers on hearing loss and one on nanomaterials. The risk of hearing loss in construction has been previously quantified and was selected for A/B testing with workers. One hearing loss flyer contained the risk percentage presented as a numerical statistic and the other as a graphic. Nanomaterials, the second topic analyzed, are thought to present some risk to workers' health, but there has not yet been enough research to quantify that risk. For this reason, the flyer on nanomaterials in construction was developed to determine how workers perceive risk when information is uncertain.

These flyers and accompanying surveys were distributed through several local training centers of the International Union of Painters and Allied Trades (IUPAT). Trainers known to CPWR were emailed and asked whether they were willing to take 15 minutes during a scheduled training session to pass out the flyers and conduct the survey. Those trainers willing to facilitate the survey were sent the materials and survey links. Workers received one of the hearing loss flyers (A or B), the nanomaterials flyer, and a short survey with the option to respond electronically or on paper. All respondents selected the electronic option to complete the survey.

Images 1 and 2: Hearing Loss Flyers A and B



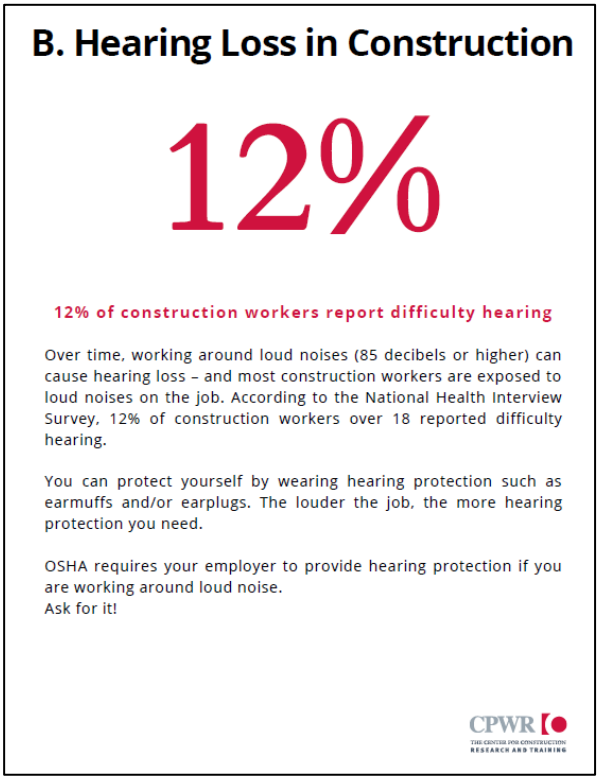
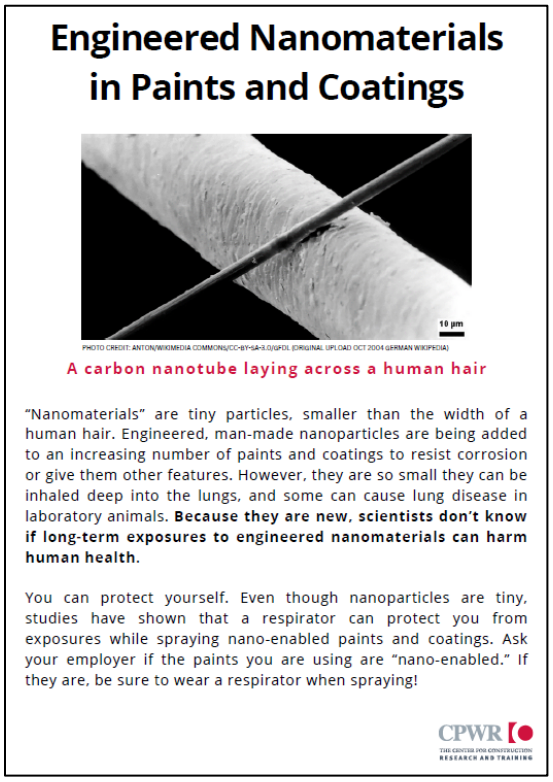


Image 3: Nanomaterials Flyer



Results

Demographics

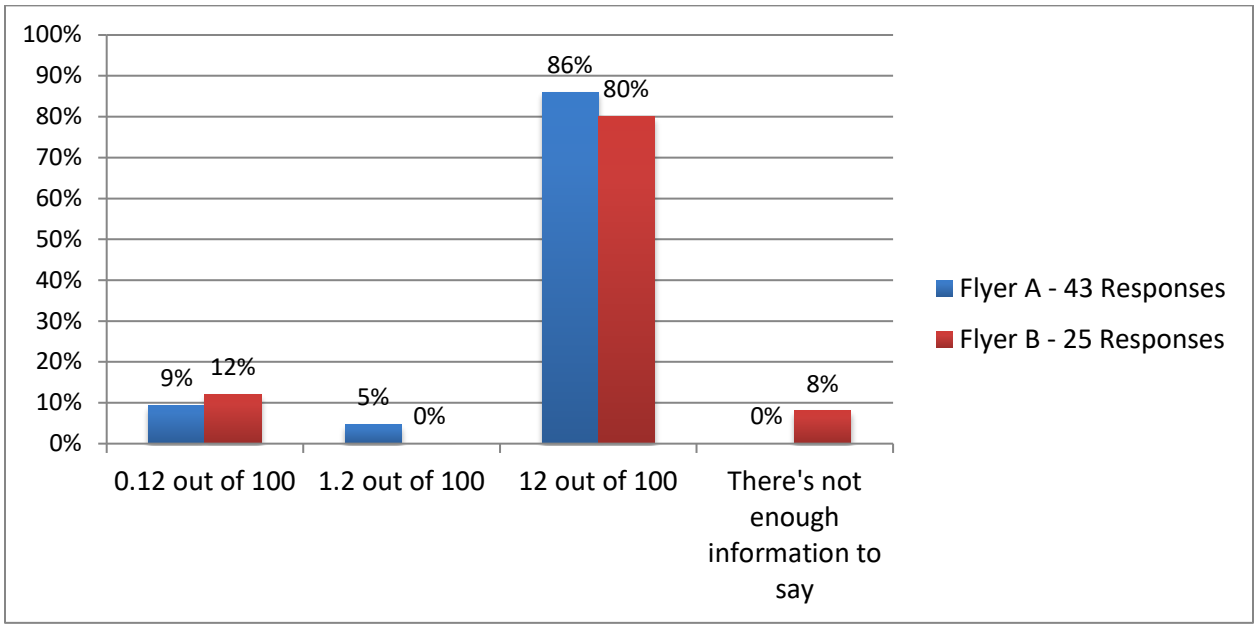
CPWR received 69 responses to the survey. Sixty-four respondents identified as male, five as female, and they ranged in age from 23 to 65 years, with a median age of 41.6. Thirty-nine respondents identified as white or Caucasian; 25 identified as Hispanic or Latino/a, one identified as black or African American, one identified as "other", and three respondents identified as multi-racial.

Thirteen respondents were apprentices and fifty-one were journey workers (five did not respond to the experience question). Nineteen respondents had completed some high school or less, twenty-five completed high school or GED, eighteen had some college, and seven had a 4-year degree or more. See Appendix A for charts of demographics.

Hearing loss flyer results

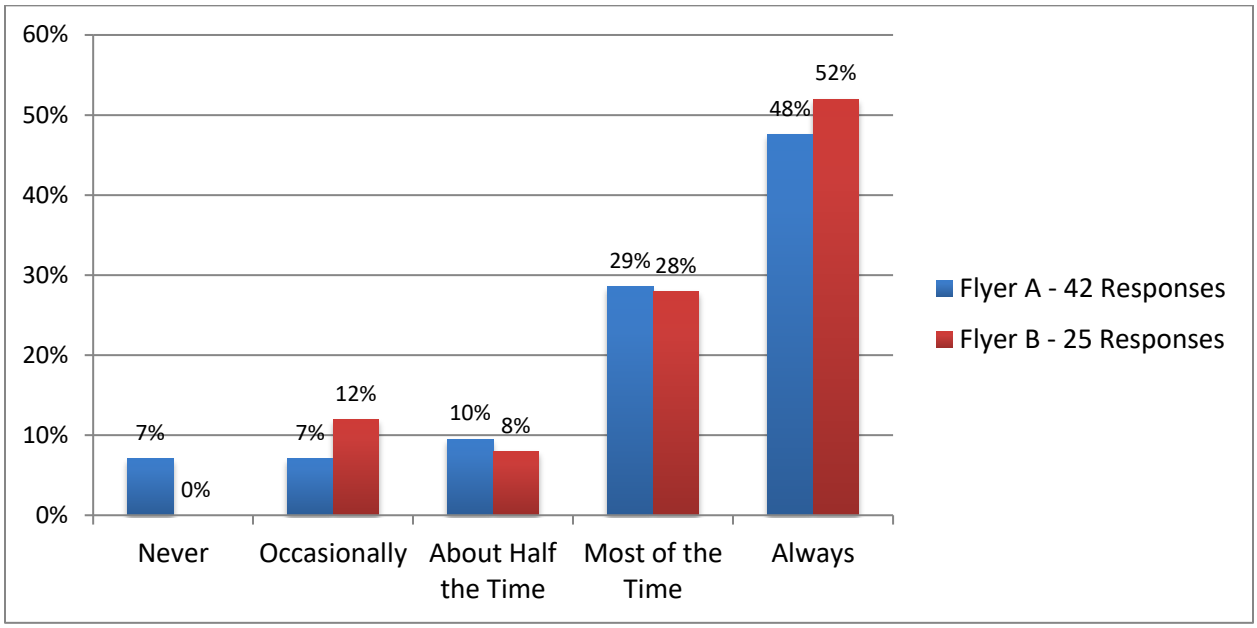
Forty-three workers received flyer A and twenty-five workers received flyer B. Both groups were asked, "According to the flyer, how many out of every 100 construction workers suffer from hearing loss?" There was no significant difference in whether being exposed to flyer A or flyer B enabled respondents to correctly answer the question: Eighty-six percent of people who received flyer A correctly answered the question, as did 80% of respondents who received flyer B. (Chart 1).

Chart 1. How many out of every 100 construction workers suffer from hearing loss?



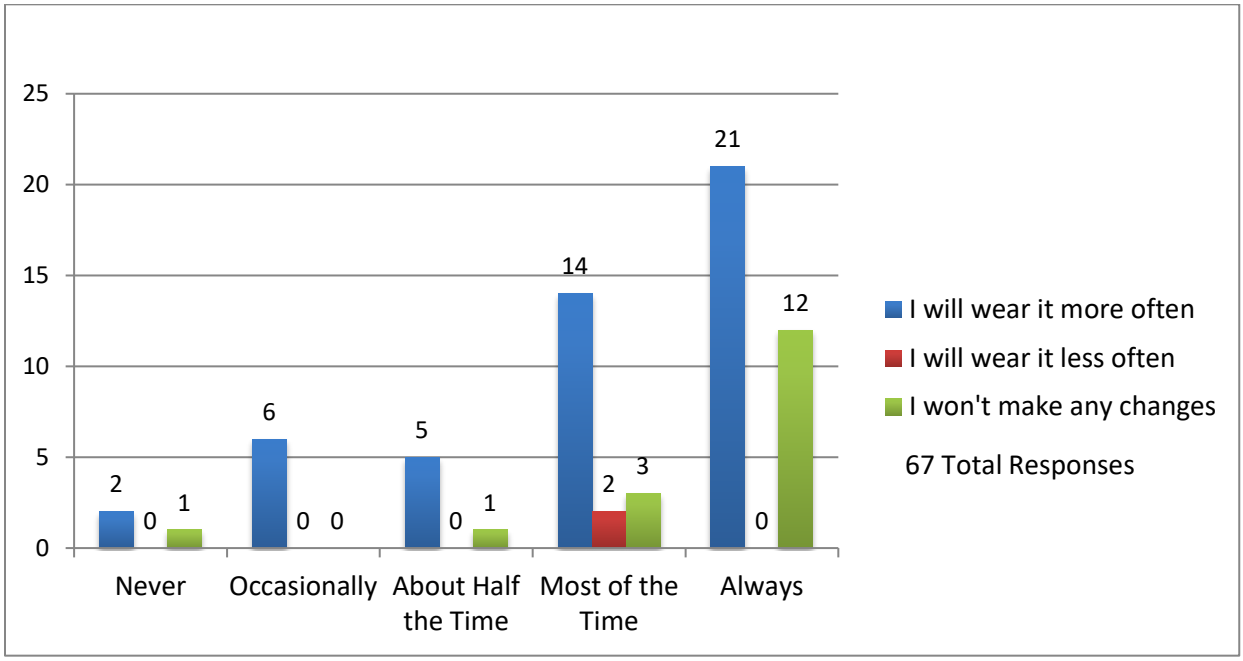
Respondents were also asked how often they wear hearing protection currently and whether they will make changes after having seen the flyers. The majority of respondents in both groups indicated that they wear hearing protection always (48% for flyer A and 52% for flyer B) or most of the time (29% for flyer A and 28% for flyer B). Only 7% of flyer A recipients and 12% of flyer B recipients said they wear it only occasionally, and 7% for flyer A and 0% for flyer B indicated they wear it never at all.

Chart 2. How often do you wear hearing protection?



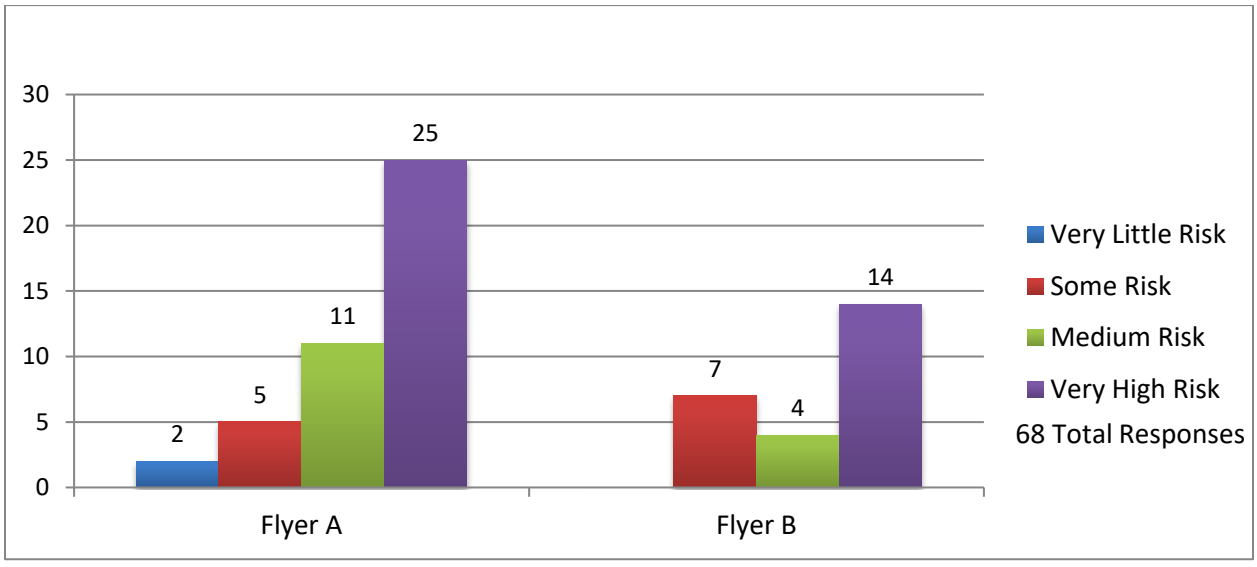
Of the 15 people who indicated they use hearing protection half the time or less, all but two indicated that they would wear it more often after seeing the flyer.

Chart 3. Will you make any changes to how often you wear hearing protection?



Finally, respondents were asked to assess their risk of hearing loss. For flyer A, nearly 84% of respondents indicated they thought their risk was medium or greater; for flyer B, 72% of respondents indicated medium or greater. These findings did not turn out to be statistically significant, however.

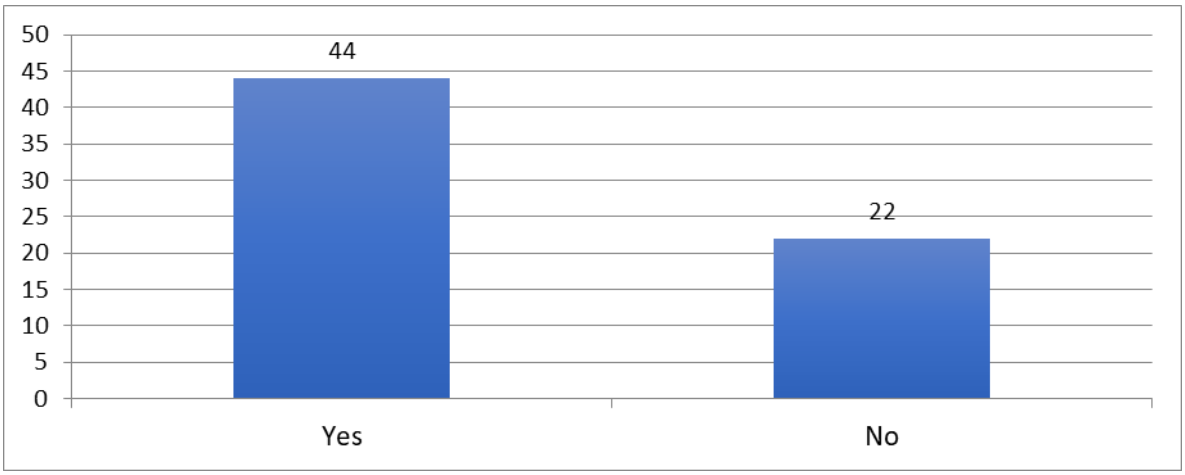
Chart 4. What is your risk of hearing loss based on the information in the flyer?



Nanomaterial Risk Flyer Results

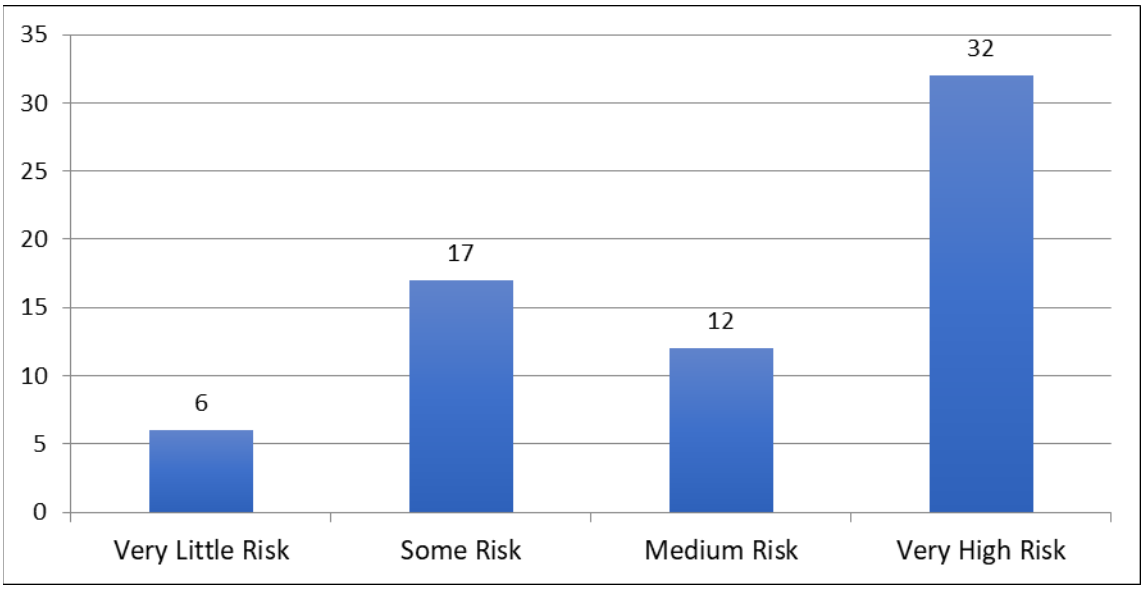
Out of 66 respondents who answered this question, exactly two-thirds responded that they were aware of nanomaterials being used in paints and coatings, with one-third saying they were not aware.

Chart 5. Before seeing this flyer were you aware that nanomaterials were being used in paints and coatings?



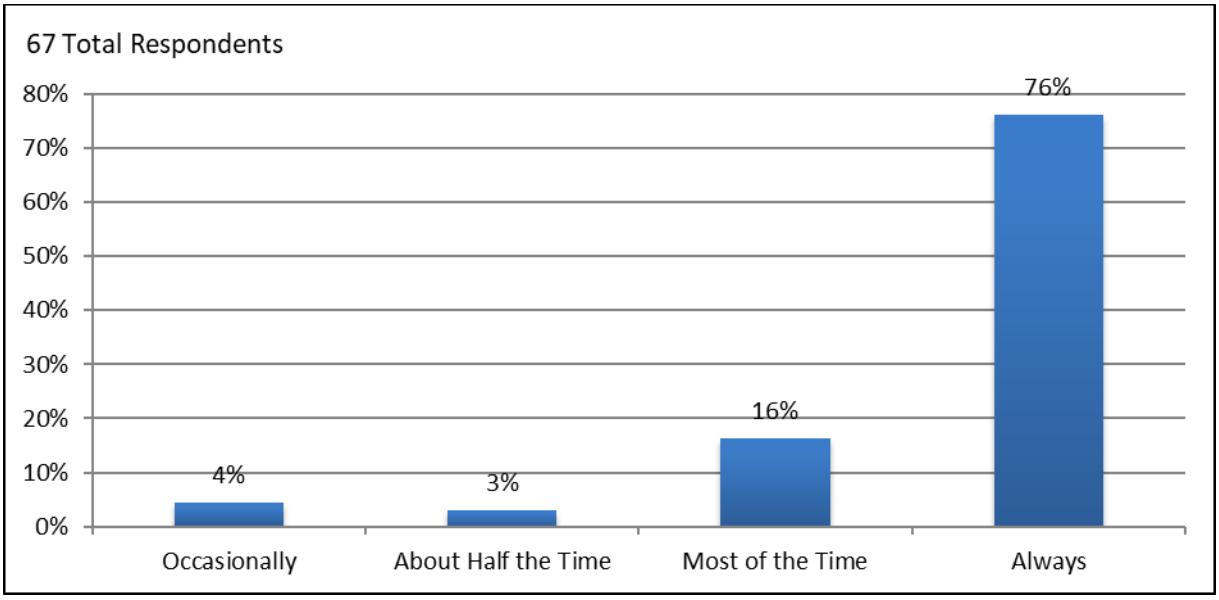
When asked, “how much risk do you think nanomaterials pose to your health based on this flyer?,” most of the workers estimated that the health risks were medium (18%) to very high (48%). Only 9% said there was very little risk and 25% said some risk (Chart 6). A little over half (58%) of respondents indicated they were aware of the health risks of nanomaterials before having seen the flyer. About two-thirds (65%) of respondents correctly identified that there was not enough information in the flyer to say how many construction workers suffer health impacts from engineered nanomaterials.

Chart 6. How much risk do you think nanomaterials post to your health based on this flyer?



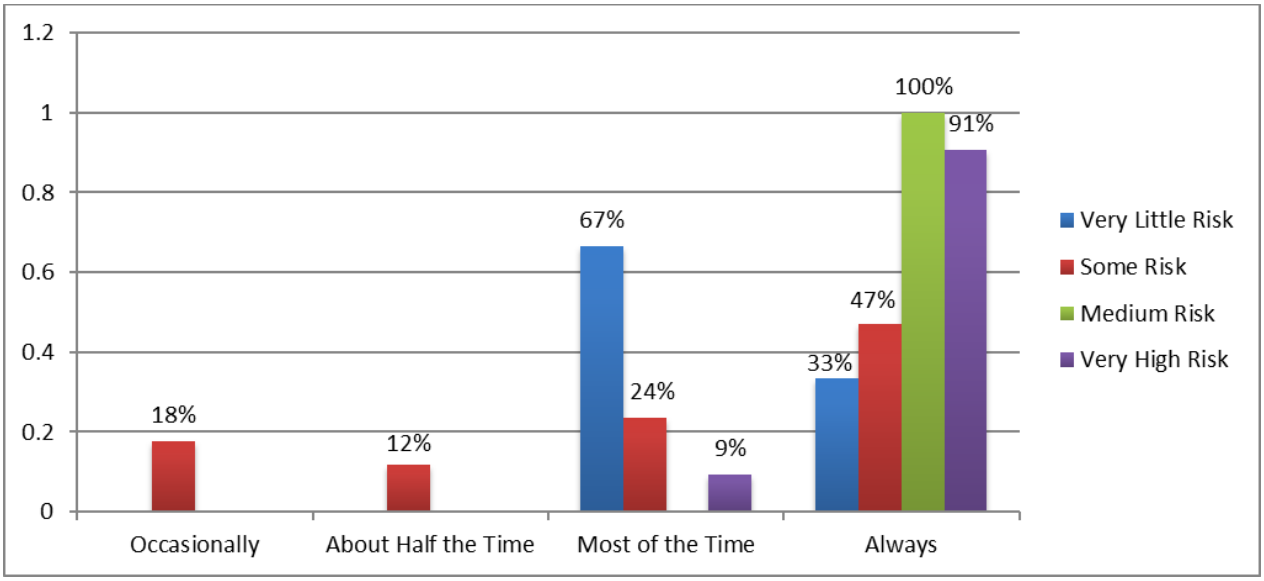
When asked what they would do if their next work assignment exposed them to nanomaterials, 76% of respondents said they would wear a respirator or N-95 dust mask all the time and 16% said most of the time. Only 7% indicated they would use this PPE half the time or less.

Chart 7. If your next work assignment exposes you to nanomaterials, how likely are you to wear a respirator and/or N-95 dust mask?



Risk perception seems to have some impact on whether workers plan to take protective measures: those who believed the risk of health problems resulting from exposure to nanomaterials was medium or very high were likely to wear a respirator most of the time or always. Conversely, those who perceived some risk we less likely to wear a respirator most of the time or always. Finally, all those who perceived very little risk indicated they would wear a respirator most of the time or always (Chart 8).

Chart 8. How likely are you to wear a respirator compared to how much risk nanomaterials pose.



Discussion

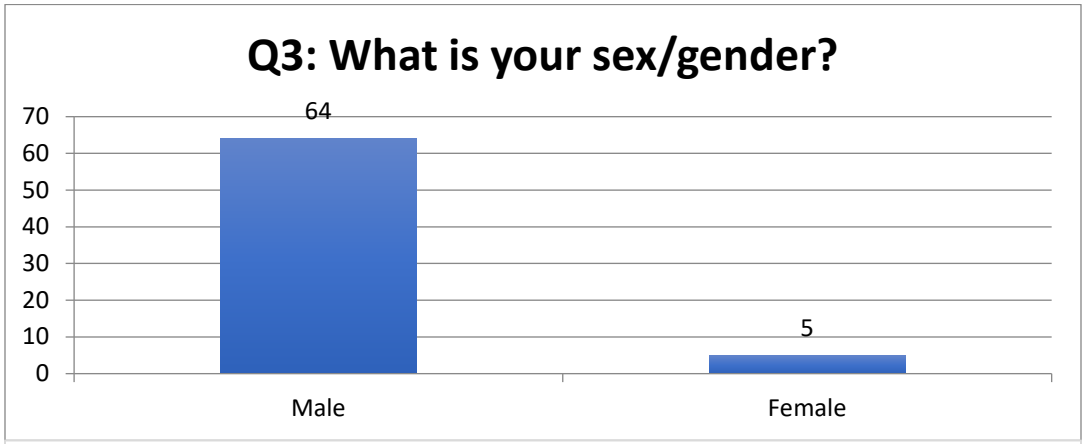
There were no statistically significant differences in responses to any of the questions for hearing loss flyers A or B. This suggests that both a written percentage and a graphic can be appropriate ways to communicate the known risks associated with exposure to excessive noise and possibly other hazards. It is possible that there is a difference between the two, but no statistical difference was found in this study's relatively small data sample. The majority of respondents already wearing hearing protection indicated they would not be making a change to their behavior, while many who did not previously wear hearing protection indicated they would make a change. This demonstrates that for those who did not previously wear hearing protection, the flyers were a motivator to change this behavior in the future. One important factor related to the hearing loss flyers may be that the hazard posed by exposure to excessive noise is well established. Because risk may be thought of as a combination of hazard and exposure, there is relatively little uncertainty about the risk posed by documented exposures to excessive noise.

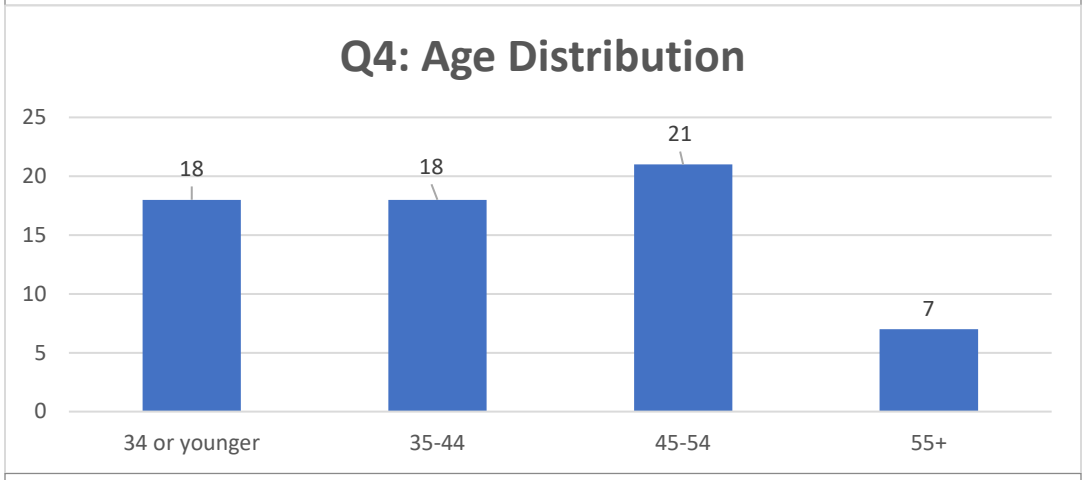
The risk posed by exposure to nanomaterials is less certain compared to that posed by exposure to noise. While exposures to nanomaterials can be measured, the hazard posed by nanomaterials is still under investigation (the nanomaterials flyer contains appropriate text which conveys uncertainty about the hazard posed by nanomaterials). The responses to the nanomaterials flyers suggested that while 66% of respondents thought that nanomaterials pose at least medium risk, 93% of them said they would wear a mask or respirator when there was a potential to be exposed to nanoparticles in the future. This higher percentage nearly coincides with the number of people who thought that nanoparticles pose some risk or more and indicates that even some risk is enough for workers to take precautions. It is possible that this means that uncertainty in the risk of health effects associated with occupational exposure to nanomaterials leads most people to assume there is at least some risk, and to protect themselves accordingly. More research is needed to test this hypothesis.

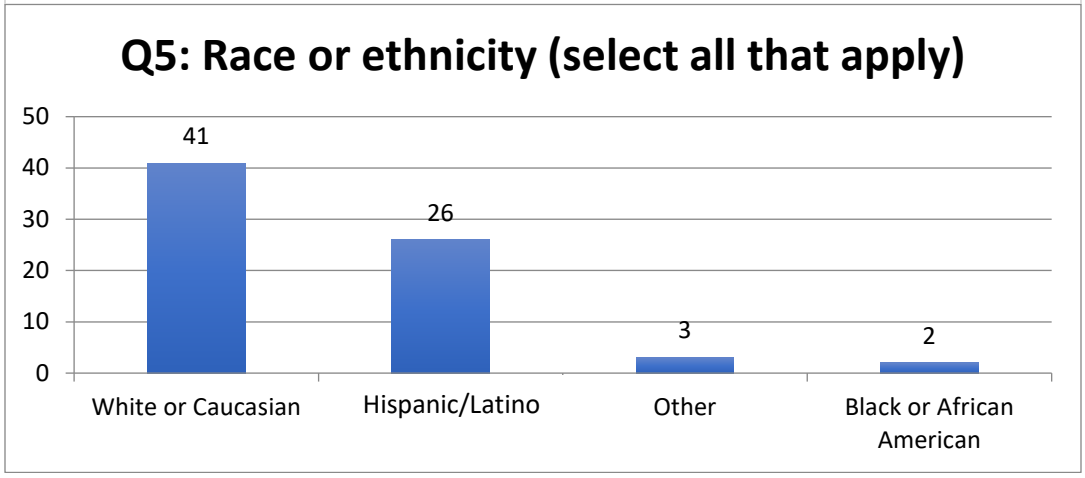
References

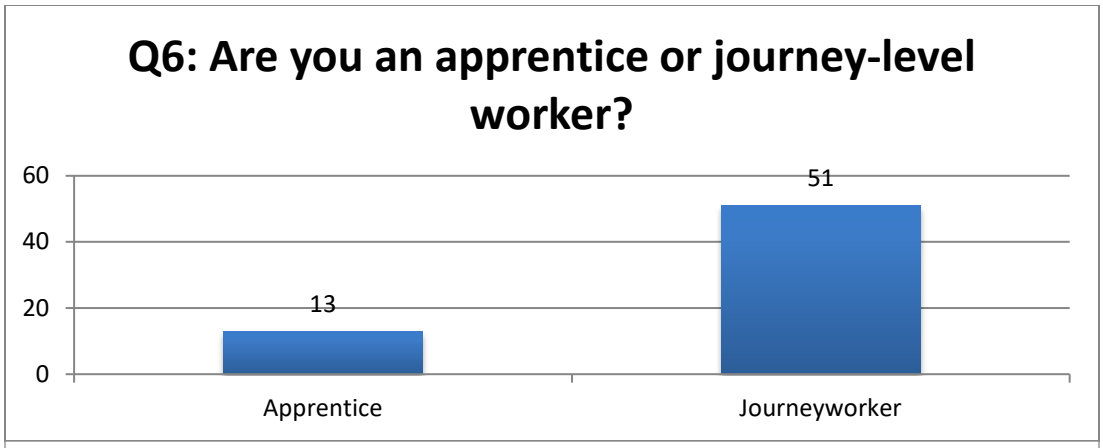
1. Sinyai, Clayton. (2019). Clear Writing for a Construction Worker Audience. https://www.cpwr.com/wp-content/uploads/Clear-Writing-for-a-Construction-Worker-Audience.pdf
2. Van Der Bles, A. M., Van Der Linden, S., Freeman, A. L., Mitchell, J., Galvao, A. B., Zaval, L., & Spiegelhalter, D. J. (2019). Communicating uncertainty about facts, numbers and science. *Royal Society open science*, *6*(5), 181870. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6549952/pdf/rsos181870.pdf
3. Van Der Bles, A. M., van der Linden, S., Freeman, A. L., & Spiegelhalter, D. J. (2020). The effects of communicating uncertainty on public trust in facts and numbers. *Proceedings of the National Academy of Sciences*, *117*(14), 7672-7683. https://www.pnas.org/doi/pdf/10.1073/pnas.1913678117
4. Garcia-Retamero, R., Okan, Y., & Cokely, E. T. (2012). Using visual aids to improve communication of risks about health: a review. *The Scientific World Journal*, *2012*.
5. Garcia-Retamero, R., & Cokely, E. T. (2013). Communicating health risks with visual aids. *Current Directions in Psychological Science*, *22*(5), 392-399.
6. Hawley, S. T., Zikmund-Fisher, B., Ubel, P., Jancovic, A., Lucas, T., & Fagerlin, A. (2008). The impact of the format of graphical presentation on health-related knowledge and treatment choices. *Patient Educ Couns*, *73*(3), 448-455. https://doi.org/10.1016/j.pec.2008.07.023
7. Tait, A. R., Voepel-Lewis, T., Zikmund-Fisher, B. J., & Fagerlin, A. (2010). Presenting research risks and benefits to parents: does format matter? *Anesthesia and analgesia*, *111*(3), 718. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3293178/pdf/nihms355838.pdf
8. Stephenson, C. M., & Stephenson, M. R. (2011). Hearing loss prevention for carpenters: Part 1-Using health communication and health promotion models to develop training that works. *Noise and Health*, *13*(51), 113.
9. Stephenson, M. R., Shaw, P. B., Stephenson, C. M., & Graydon, P. S. (2011). Hearing loss prevention for carpenters: Part 2-Demonstration projects using individualized and group training. *Noise and Health*, *13*(51), 122.
10. Lundgren, R. E., & McMakin, A. H. (2004). *Risk communication : a handbook for communicating environmental, safety, and health risks* (3rd ed.). Battelle Press.
11. Austin, L. C., & Fischhoff, B. (2012). Injury prevention and risk communication: a mental models approach. *Inj Prev*, *18*(2), 124-129. https://doi.org/10.1136/injuryprev-2011-040079
12. Kool, B., Dobson, R., Sharpe, S., Humphrey, G., Whittaker, R., & Ameratunga, S. (2020). A Web-Based Alcohol Risk Communication Tool: Development and Pretesting Study. *JMIR Form Res*, *4*(1), e13224. https://doi.org/10.2196/13224

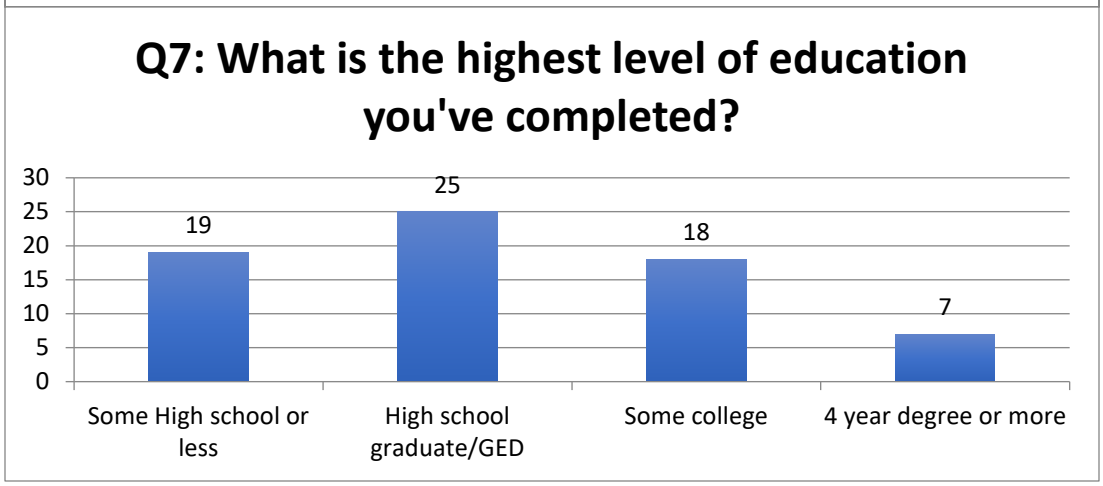
Appendix A. Demographics



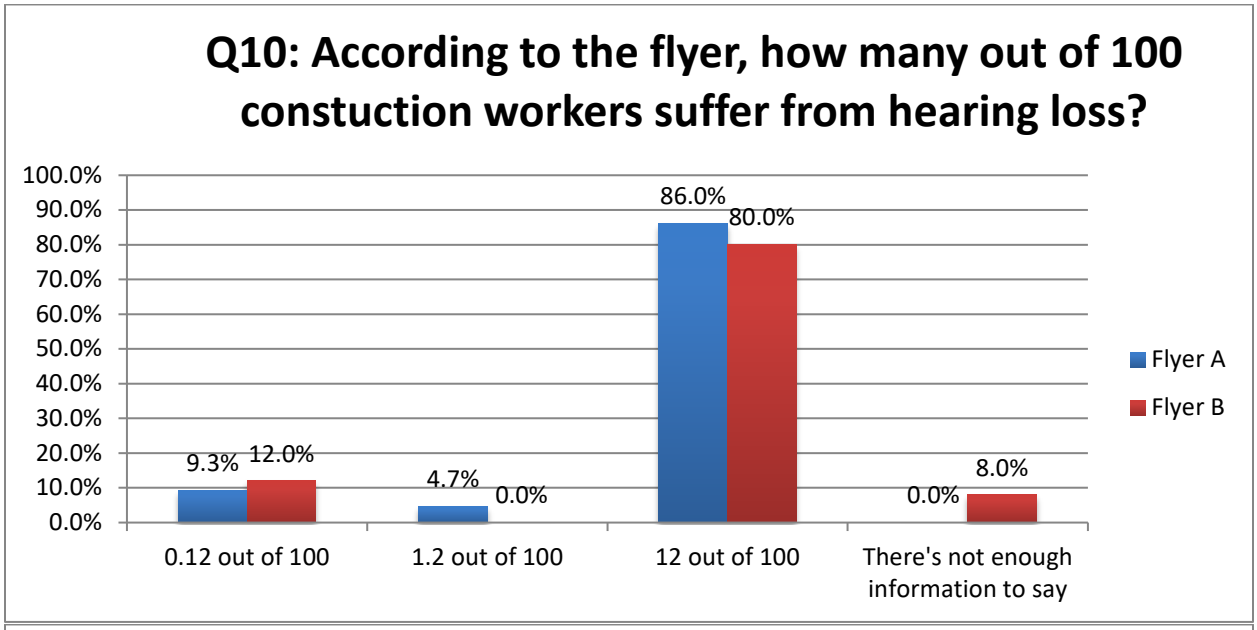


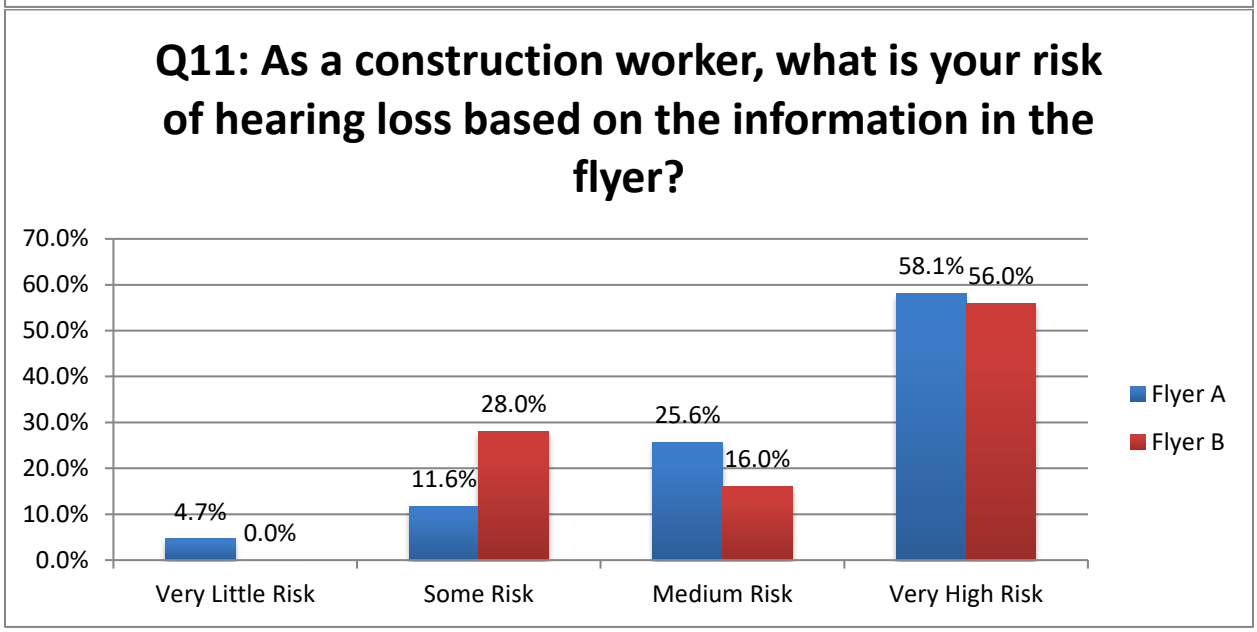


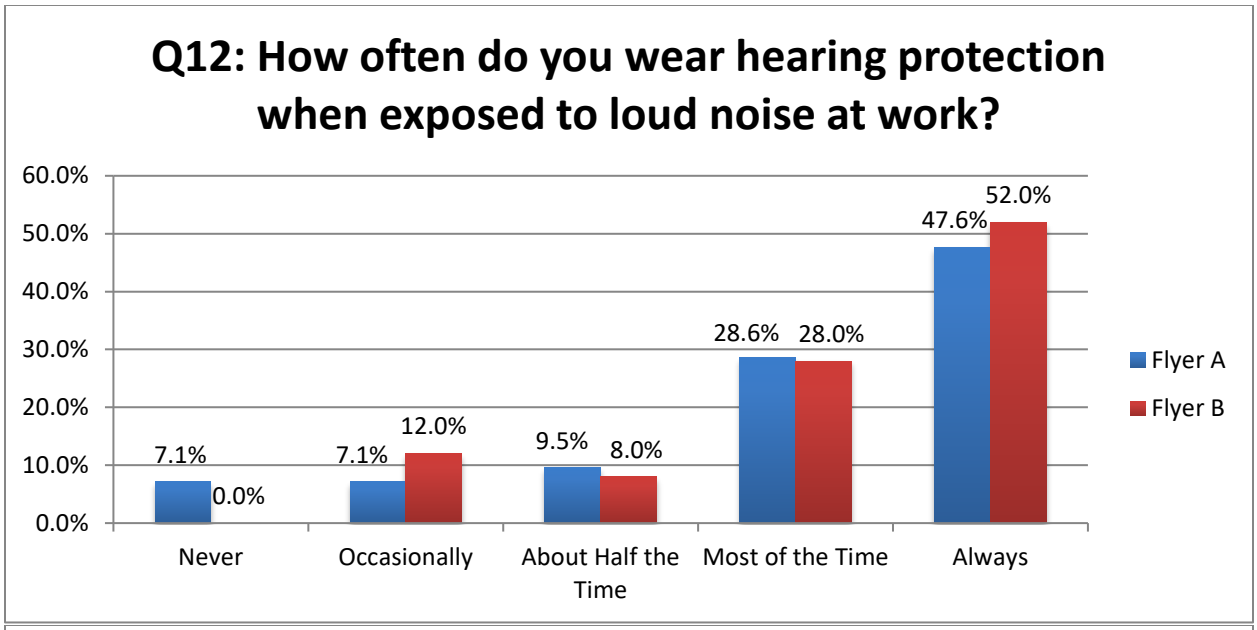

Q6: Are you an apprentice or journey-level worker?
60
40
20
0
13
51
Apprentice
Journeyworker

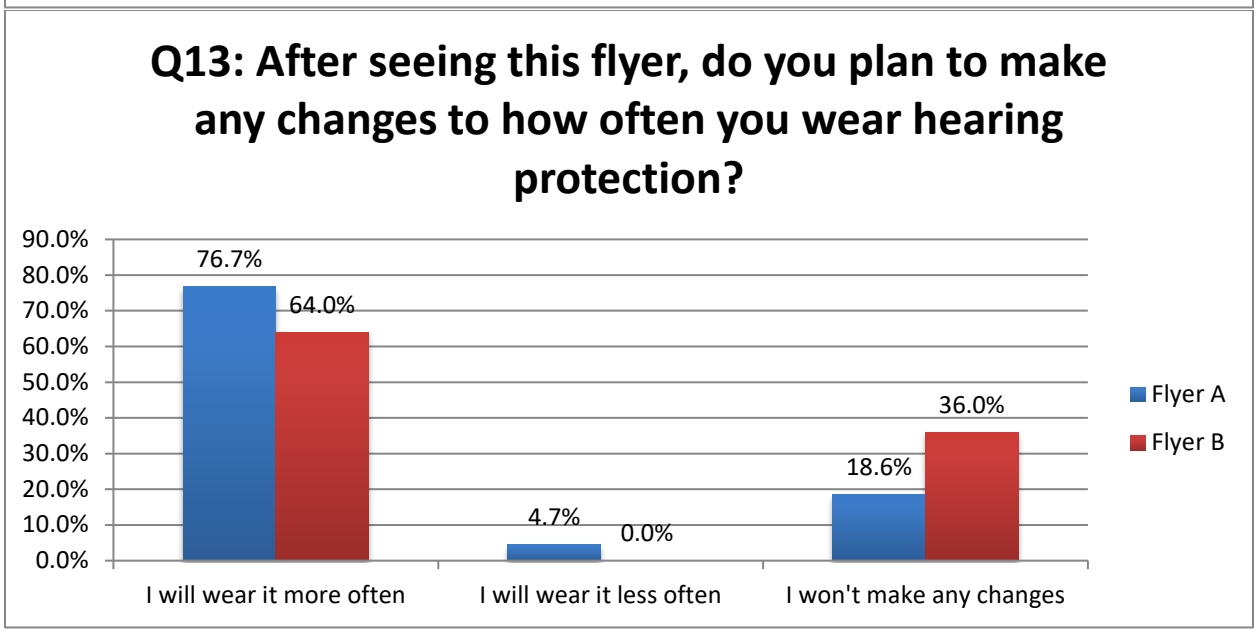

Q7: What is the highest level of education you've completed?
30
25
20
15
10
5
0
19
25
18
7
Some High school or less
High school graduate/GED
Some college
4 year degree or more

Appendix B. Hearing Loss Flyer Results

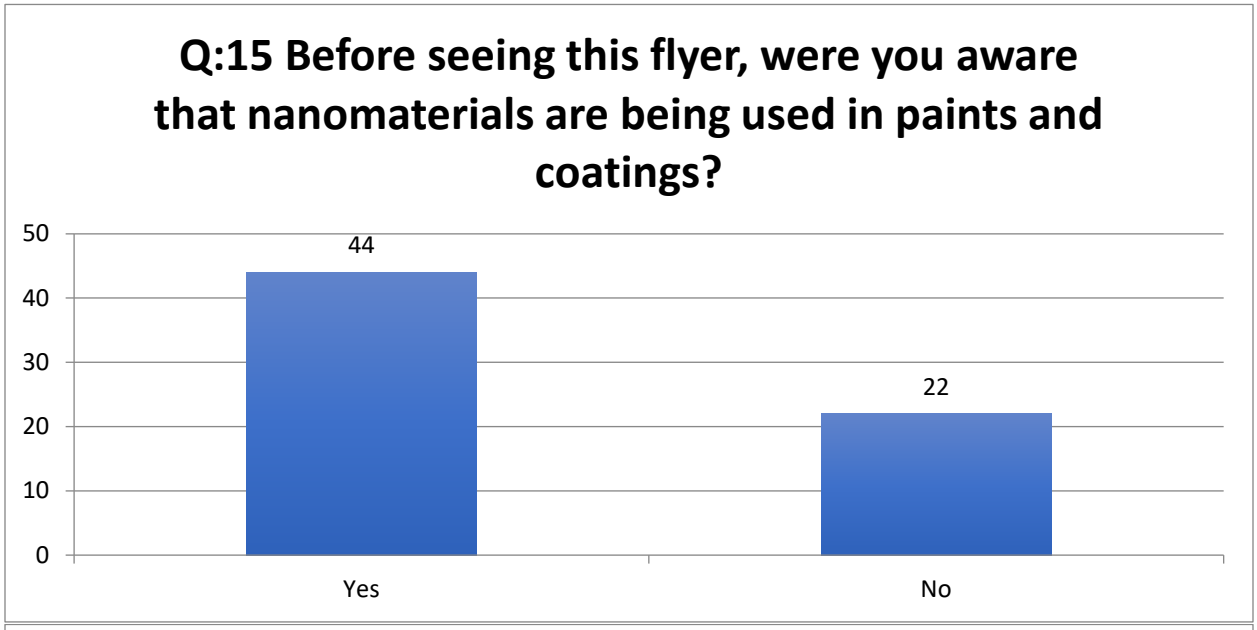


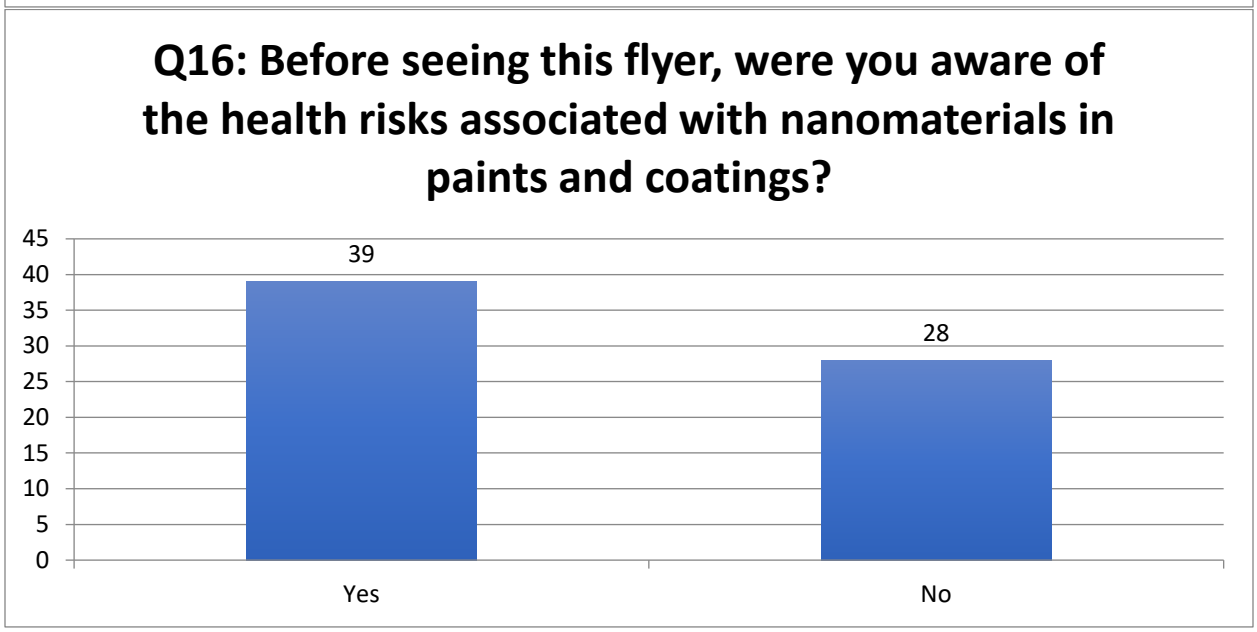


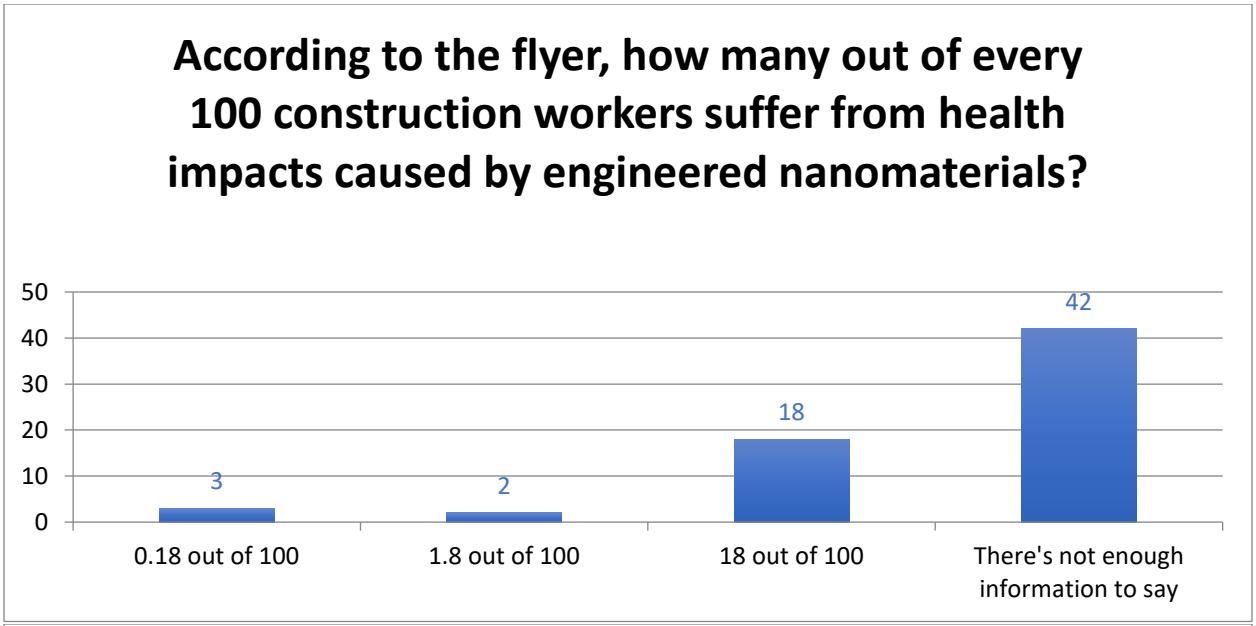

Q12: How often do you wear hearing protection when exposed to loud noise at work?
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
7.1%
0.0%
7.1%
12.0%
9.5%
8.0%
28.6%
28.0%
47.6%
52.0%
Never
Occasionally
About Half the Time
Most of the Time
Always
Flyer A
Flyer B

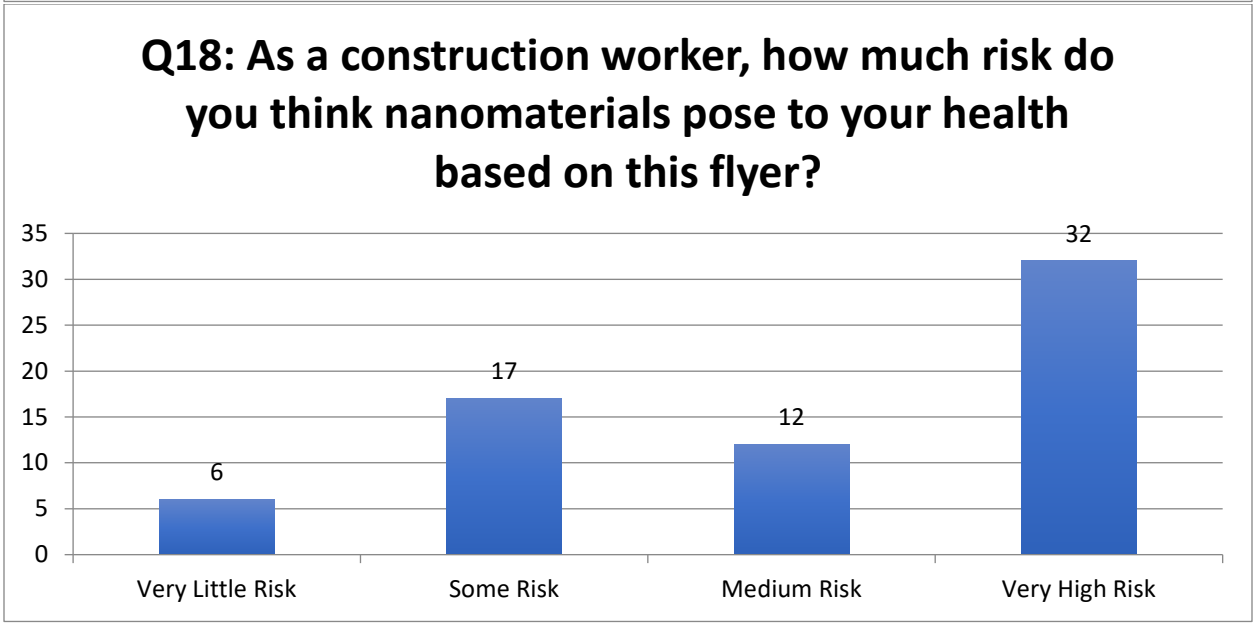

Q13: After seeing this flyer, do you plan to make any changes to how often you wear hearing protection?
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
76.7%
64.0%
4.7%
0.0%
18.6%
36.0%
I will wear it more often
I will wear it less often
I won't make any changes
Flyer A
Flyer B

Appendix 3. Nanomaterials Flyer Results






According to the flyer, how many out of every 100 construction workers suffer from health impacts caused by engineered nanomaterials?
50
40
30
20
10
0
3
2
18
42
0.18 out of 100
1.8 out of 100
18 out of 100
There's not enough information to say


Q18: As a construction worker, how much risk do you think nanomaterials pose to your health based on this flyer?
35
30
25
20
15
10
5
0
6
17
12
32
Very Little Risk
Some Risk
Medium Risk
Very High Risk

Appendix D. Copies of Flyers

A. Hearing Loss in Construction

12% of construction workers report difficulty hearing

Over time, working around loud noises (85 decibels or higher) can cause hearing loss – and most construction workers are exposed to loud noises on the job. According to the National Health Interview Survey, 12% of construction workers over 18 reported difficulty hearing.

You can protect yourself by wearing hearing protection such as earmuffs and/or earplugs. The louder the job, the more hearing protection you need.

OSHA requires your employer to provide hearing protection if you are working around loud noise.
Ask for it!

CPWR
THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

B. Hearing Loss in Construction

12%

12% of construction workers report difficulty hearing

Over time, working around loud noises (85 decibels or higher) can cause hearing loss – and most construction workers are exposed to loud noises on the job. According to the National Health Interview Survey, 12% of construction workers over 18 reported difficulty hearing.

You can protect yourself by wearing hearing protection such as earmuffs and/or earplugs. The louder the job, the more hearing protection you need.

OSHA requires your employer to provide hearing protection if you are working around loud noise.
Ask for it!

CPWR
THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Engineered Nanomaterials in Paints and Coatings

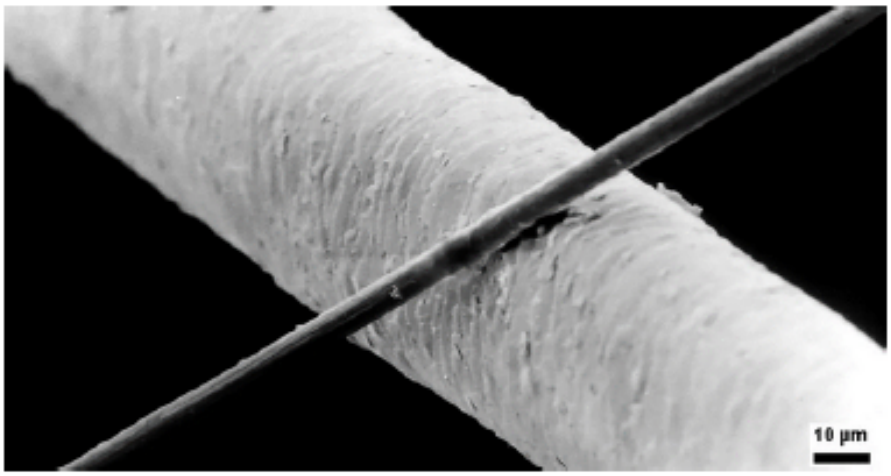


PHOTO CREDIT: ANTON/WIKIMEDIA COMMONS/CC-BY-SA-3.0/GFDL (ORIGINAL UPLOAD OCT 2004 GERMAN WIKIPEDIA)

A carbon nanotube laying across a human hair

"Nanomaterials" are tiny particles, smaller than the width of a human hair. Engineered, man-made nanoparticles are being added to an increasing number of paints and coatings to resist corrosion or give them other features. However, they are so small they can be inhaled deep into the lungs, and some can cause lung disease in laboratory animals. **Because they are new, scientists don't know if long-term exposures to engineered nanomaterials can harm human health.**

You can protect yourself. Even though nanoparticles are tiny, studies have shown that a respirator can protect you from exposures while spraying nano-enabled paints and coatings. Ask your employer if the paints you are using are "nano-enabled." If they are, be sure to wear a respirator when spraying!

CPWR
THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING