Janet Torma-Krajewski, Ph.D., CIH, CPE
Industrial Ergonomics, Inc.
9525 W 77th Drive
Arvada, CO 80005
iei1@q.com

The purpose of my comments is to acknowledge concerns that the proposed rules are very likely to result in the unintended outcome of dramatically increasing the incidence of musculoskeletal disorders ("MSDs") among those miners who would be required to frequently wear continuous personal dust monitors ("CPDMs"). This issue does not appear to have been considered during the proposed rulemaking.

MSDs occur when the forces on a body tissue (muscle, tendon, ligament and bone) are greater than the tissue can withstand. Importantly, MSDs do not occur suddenly as a consequence of a single exposure to a force. Instead, MSDs arise gradually, as a consequence of repeated or long duration exposure to lower levels of force. Even low levels of force can cause small amounts of damage to body tissues. This damage is normally repaired before an MSD occurs. However, if the rate of damage is greater than the rate at which repair can occur, an MSD may result. MSDs may also result from a combination of these mechanisms, for example, a tissue that has been weakened by cumulative damage may be vulnerable to sudden injury at lower forces. Also, if a tissue has suffered a sudden injury, it may be more prone to an MSD type injury during its recovery process (Torma-Krajewski et al. 2009).

Mining is one of the most physically demanding occupations. Mining workplaces are by nature in a constant state of change and as such can be classified as very dynamic work environments (Steiner, 1999; Scharf, 2001). Examples of physical demands and environmental stressors are working in restricted spaces, working in hot or cold environments with muddy, wet, icy or uneven ground conditions, being exposed to high levels of whole-body and segmental vibration, and performing significant amounts of manual work, such as lifting, carrying, pushing and pulling. Winn et al. (1996) analyzed ergonomic hazard data from the National Occupational Health Survey of Mining for 24 commodities associated with the Metal/Non-Metal mining industry. The authors determined that potential exposures to MSD risk factors were most likely for the following body parts: neck and/or back; forearms, arms, and shoulders; fingers and hands.

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Overall, they stated that the potential exposure to ergonomic hazards for Metal/Non-Metal miners was high compared to non-mining occupations.

Although comprehensive mine worker injury and illness data are compiled by the Mine Safety and Health Administration ("MSHA"), this database was not designed to specifically classify injuries and illnesses as MSDs. Consequently, Battelle (1999) developed selection criteria to identify MSD incidents based on a study of stratified samples of 1997 and 1998 MSHA incident data. Using these criteria, almost one third of all reported incidents from 1996 to 2000 could be classified as MSDs.

More recent MSHA injury and illness data, indicate that MSDs continue to be problematic for the mining industry. From 2000 to 2007,

- 35 percent of non-fatal lost-time injuries occurred while handling materials (lifting, pushing and pulling),
- 43.5 percent of reported injuries were sprains and strains,
- 40 percent of reported illnesses were MSDs associated with repetitive motion,
- 21.5 percent of all lost-work time involved injuries to the back, and
- the back was the most frequently reported body part injured (NIOSH 2002-2009).

We also know from MSHA data that as mine workers get older they experience higher rates of MSDs. For miners age 35 to 55, 40 percent of all injuries are MSDs, and older mine workers experience three times as many lost-time work days as do younger workers. In 2006, 52.3 percent of mine workers were 45 or older (Porter, et al. 2008). Also, with increasing age, people experience declines in muscular strength and physiological capacity past the age of 35 years, and they often develop various conditions/diseases that affect work output, such as arthritis, low back disorders/pain, and musculoskeletal disorders, past the age of 50 years. Thus, the population of current mine workers would be expected to have an increased risk of experiencing MSDs based on the type of work tasks performed, as well as their age. With this population, the need for reducing risk factor exposures is quite apparent.

An example of how the mining industry has responded to this need is demonstrated by the advances in cap light technology. During the past few years, efforts by cap light manufacturers have been directed to reducing the amount of weight carried by miners, while still maintaining an effective lighting system for them, by significantly reducing the size and weight of battery packs. The use of lithium-ion battery packs has reduce the weight carried by 75% and the size by 66% when comparing these battery packs to lead acid battery packs. Other cap light systems, such as the Strata Northern Light All-In-One Polaris cordless LED cap lamp, go a step further. These lights utilize compact, light-weight lithium ion batteries, resulting in a 92% reduction in weight as compared to the lead acid battery packs, and no weight is carried on the miner's belt. It is extremely important to continue similar efforts to not only reduce the weight carried by miners, but also to develop interventions that reduce the risk of developing MSDs. Requiring miners to carry the additional weight of a CPDM on a daily basis is contrary to addressing the needs of older miners.

As the proposed underground coal standard (Part 70 – Mandatory Health Standards for Underground Coal Mines) is currently written, miners in "designated occupations" ("DOs") will be required to wear a CPDM every day for all shifts. Mine workers in "Other Designated Occupations" ("ODOs") will be required to wear a CPDM for 56 days per year for all shifts. The CPDM is required to be worn on the miner.

The CPDM is designed to be worn on the miner's belt; it can be attached via belt loops, or pouches specifically designed for the CPDM. It weighs 6.7 pounds and is 9.57 inches (W) x 3.42 inches (D) x 6.75 inches (H). The CPDM comes equipped with a cap light and battery, which replaces the need to wear a separate cap light/battery.

Miners typically use their mine belts to carry several pieces of equipment including a self-contained self-rescuer ("SCSR"), a tool pouch and tools, cap lamp battery, multigas meter, nail pouch and an anemometer. The total weight can vary depending on the pieces of equipment needed by miners to do their job tasks, and the type of SCSR, cap lamp battery and tools provided to them. Table 1 provides the weight of some of these items. The total weight of the typical items carried by a continuous miner operator, for example, plus the belt weight, plus the CPDM weight would be approximately 29 pounds. Because it is difficult to carry both the CPDM and tool pouch on the miner's belt because of limited space on the belt and needing access to both, individual tools are sometimes carried by the miner operator, adding to the weight carried. Other miners will carry the SCSR, tool pouch and CPDM on their belts. In this situation, the CPDM is placed on the back side of the belt, limiting the ability of the miner to read the monitor. Figure 1 illustrates the items generally carried by a miner operator.

Table 1. Typical items carried and/or worn on a miner's belt and weight.

ITEM	WEIGHT (pounds)
Miner's belt (no shoulder straps)	6.3
SCSR	
CSE SR 100	5.7
Cap lamp battery - large	4.9
Cap lamp battery - small	1.7
Tool pouch + tools	5.0
Multigas meter (MSA Altair 5 multigas detector)	1.2
Anemometer	0.7
Nail pouch	0.5
Remote miner controls	3.0

Figure 1. Items carried by a miner operator that are typically attached to his belt, plus the control box for the continuous miner. In these photos, the CPDM is being worn on the miner's right side, and a rock hammer is attached to the SCSR.

No research studies have been conducted that have specifically evaluated the physiological and biomechanical effects of wearing a miner's belt and the attached equipment while performing mining-related work tasks. Also, no studies have been completed that evaluated the physiological and biomechanical impact of carrying a CPDM. However, there have been a few studies that evaluated conditions, such as asymmetrical loading and carrying methods, which can provide some insight into potential issues regarding the use of a miner's belt for carrying equipment.

Thus, in studies of letter-carrier satchels by Lin et al. (1996) and Dempsey et al. (1996), various configurations of pouches, shoulder straps and waist belts were evaluated to determine the biomechanical effects while carrying 36.2 pounds. The configuration that resulted in the lowest L5/S1 compressive forces, postural deviation, and pressure on the shoulders, and the most balanced force distribution between the feet consisted of two pouches symmetrically positioned on the right and left hip, two shoulder straps that crossed diagonally on the chest, and a waist belt. The authors of these studies cautioned that the biomechanical advantages of this particular satchel would only be realized when all components are worn symmetrically on the body and the loads carried are equally distributed between the two pouches. While the results of these two studies indicate that carrying equipment on a miner's belt may be the best option for carrying loads, the conditions recommended in these studies, symmetrical loads and symmetrical configuration of shoulder straps, may not be present or achievable in the mining environment. For example, belts with shoulder straps may not be provided to miners, shoulder straps may not be beneficial in low seam coal where miners walk in a stooped position, the individual pieces of equipment have different weights, and the remote control box for the continuous miner is carried with one shoulder strap that is diagonally placed across the chest.

A study by Arellano et al. (2009) evaluated sagittal plane gait stability while walking on a treadmill and carrying loads of 0, 10, 20, and 30 percent of body weight. The loads were symmetrically placed around the waist. Although gait stability was not affected by the loads, significant differences in increased flexion of the hip and knee at heel contact and midswing were observed for all loads. As the weight carried increased, the degree of flexion also increased. The authors speculated that these postural changes maintained dynamic stability by absorbing shock, lowering the center of gravity, and controlling the forward momentum of the body. This study would indicate that the loads carried on a miner's belt would also impact the hip and knee postures of miners. Because the ground conditions in a mine are more challenging (uneven and loose ground) than walking on a treadmill, it is not possible to determine from the study results if the postural changes observed in the laboratory study would be sufficient to maintain gait stability when walking in a mine. Also, this study did not assess the impact the observed changes in posture would have when the loads were carried on a daily basis, as is done by miners.

Wells et al. (1983) investigated the occurrence of musculoskeletal disorders in letter carriers as compared to other workers (gas meter readers) who walked but did not carry a load, as well as workers (postal clerks) who did not walk or carry loads while working. Letter carriers experienced excess shoulder, neck and back disability as compared to workers who did not carry a load or who did not either walk or carry a load. After controlling for age, body mass index, number of years on the job, and previous work with lifting or carrying tasks, the higher rates of disability in letter carriers remained. The results of this study would indicate that miners probably have an increased incidence of MSDs associated with the weight carried on their belts and the asymmetrical loading of the equipment attached to their belts.

Griefahn et al. (2003) evaluated three different designs of self-contained breathing apparatus ("SCBAs") to determine if weight or the weight distribution would have more of an impact of completing rescue tasks. Three different SCBAs were evaluated: Device B weighed less than Devices A (7.3 pounds less) and C (4.4 pounds less), and Device C distributed the weight over the middle and lower back, as compared to Devices A and B, which distributed the weight over the upper and middle back. Firefighters wearing device C completed the tasks faster, had lower heart rates, and the carrying features of this device were determined to be better than the other two devices. The authors concluded that the distribution of the weight carried was more important than the weight carried when completing firefighting tasks and that modifying the distribution of the weight resulted in lower cardiac strain. This study indicated that an increase in weight carried and the resultant increase in cardiac strain could be compensated by a redistribution of the weight towards the middle and lower back, as compared to when the original load was carried on the upper and mid back regions. Because this study demonstrated that lowering a load on the lower back could result in less physiological strain, it suggests the possibility that altering the configuration of the equipment carried by a miner may lead to physiological benefits for miners as well.

Two studies evaluated the effects of loading around the waist on gait and balance. Wu and MacLeod (2001) evaluated the effects of asymmetrical loading on the center of mass when standing. The load was placed on the right side of the pelvis and represented 10 and 30 percent of body weight. The stance width varied from narrow (7.6 cm) to normal (20 cm) to wide (33 cm). The whole body center of mass significantly shifted to the loaded side for both weights, and the center of mass was closer to the center with a narrow stance as compared to the normal and wide stance. Additionally, the orientation of all body segments, except for the head, shifted in the direction that tended to reduce the center of mass shift. The changes in center of mass and orientation of body segments were controlled by slight increases in muscle activity. However the center of mass was not restored to the original position. The second study by Qu and Nussbaum (2009) evaluated the effects of load placement around the waist (10 and 20 percent of body mass) on balance. Increased loads increased sway movements that led to postures that increased short-term instability. Increasing loads and loads placed superior to the center of mass led to less postural control and a greater risk of loss of balance or falls. These two studies demonstrate that when miners carry equipment on their belts, when the load is asymmetrical, and when the weight is increased, these factors may result in postural changes that could lead to increased risk for loss of balance and falls.

In short. the above studies provide substantial evidence that carrying a load can result in both physiological and biomechanical changes, discomfort, higher rates of MSDs, and increased risk for falls. Consequently, it is easy to see that the load carried by miners could have similar effects, which would be worsened with the additional weight of a CPDM.

As stated earlier in my statement, no research studies have actually evaluated the effects of wearing a CPDM. However, in 2008 NIOSH published IC 9501, Miners' Views about Personal Dust Monitors, which provided limited insight into ergonomic issues associated with wearing a CPDM. The main objective of IC 9501 was to document coal miners' reactions to using the CPDM and how they would use the information provided by the CPDM. In evaluating the use of the CPDM in reducing coal dust exposures, the authors of this report followed the "Health Belief Model" described by Janz et al. 2002. According to this model, perceived negative features/barriers could affect an individual's actions regarding the use of the CPDM to assess and reduce his or her dust exposures. The authors stated that "it is important to minimize discomfort or inconvenience miners experience while wearing PDMs." For this report, 30 miners at four underground coal mines were interviewed. The only questions asked regarding discomfort or inconvenience were: "Did you have any problems using the new PDM?" and "Can you think of any reasons why miners would NOT want to wear the new PDM?" Specific questions related to experiencing physical discomfort, interfacing with equipment, and wearing the CPDM were not asked. Although some issues were identified with the two questions asked, it is likely that a more comprehensive set of issues/problems would have been identified if more specific questions would have been asked. The specific issues that were identified included:

1. Size and weight of the CPDM: Several miners stated that the CPDM felt heavier and bulkier than the cap lamp battery. Some miners reported issues with sitting in equipment due to the limited space in operator compartments, and with the CPDM getting bumped when working in confined areas.
2. Light cord/sample hose: Some miners reported that the cord/hose was too long and got caught when working.
3. Attachment of the CPDM to the miner's belt: When the CPDM was attached to the belt with metal clamps, it sometimes fell off the belt. When pouches were provided to hold the CPDM, sometimes there was not enough room on the belt for the pouch because of other equipment pouches already attached to the belt.

(NOTE: No information was provided in this document regarding the number or percentage of miners who identified the above problems.)

Building on the basic information presented in IC 9501, two surveys were conducted to obtain more detailed information related to ergonomic issues with the use of the CPDM. For the first survey (S1) 11 miners, who had worn the CPDM, completed a questionnaire distributed by safety managers at several mines operated by Murray Energy Corporation. Demographic information about the mine workers participating in this survey is listed in Table 2.

Table 2: Demographic information for mine workers participating in the survey conducted at Murray Energy Mines.

MINE	AGE	YEARS MINING EXPERIENCE	POSITION	YEARS IN POSITION	SHIFTS WEARING CPDM
Century	30	6.0	Roof Bolter	4	2
Century	46	2.5	Buggy Driver	2.5	1
Century	25		Shuttle Car Operator	1.5	1
Powhatan #6 Mine	55	18	Dust Technician	2	35
New Future	40	8	Miner Operator	0.6	3
New Future	50	29	Safety Specialist	2	10+
New Future	49	30	Safety Manager	2	4 - 5
New Era	33	10	Dust Manager	2.5	Several
American Coal Co	27	5	Miner Operator	2	2
American Coal Co	27	5	Face Boss	0.5	1
American Coal Co	32	9	Miner Operator	6	6
AVERAGE	**37.6**	**11.1**		**2.3**	

A second survey (S2) was conducted at another mine located in Kentucky that is not affiliated with Murray Energy Corporation. The questionnaire was administered during an annual refresher training on April 2, 2011. Specific instructions were given to the person administering the questionnaire to encourage the participants to complete all questions truthfully and to the best of their ability and to not bias their answers in any way. The completed questionnaires were mailed directly to me and were not reviewed by anyone affiliated with Murray Energy Corporation. Twenty-seven mine workers, who had worn the CPDM for five or more shifts or had indicated that they had worn the CPDM several times, completed the questionnaire. Another twenty mine workers completed the questionnaire, but had worn the CPDM for less than five shifts. These questionnaires were omitted from the current analyses because it was assumed that they would be less representative of long-term users of the CPDM. Demographic information for the participants in this second survey is shown in Table 3.

Table 3: Demographic information for mine workers participating in the second survey (S2) conducted at a non-Murray Energy Mine.

ID NUMBER	AGE	YEARS MINING EXPERIENCE	POSITION	YEARS IN POSITION	SHIFTS WEARING CPDM
1	32	12			10
2	26	2	Scoop Operator	1	10
3	44	21	Laborer (miner/ pinman/car driver)	21	10
4	32	10	Miner Operator	3	several
5	43	10	Face Boss	2	10
6	29	10	Shuttle Car Operator	5	several
7	24	6	Roof Bolter	6	several
8	57	38	Miner Operator	20	more than 10
9	35	13.5	Miner Operator	6	a lot
10	38	12	Car Driver	1.33	over 10 times
11	36	12	Outby Support and Miner Operator	7	20
12	22	4	Miner Operator	2.5	20
13	26	6	Miner Operator	1	10
14	24	3	Car Driver	1	too many to count
15	29	6	Roof Bolter	4.5	several
16	30	10	Miner Operator	7	30
17	37	11	Miner Operator	8.5	20+
18	24	6	Miner Operator	2	several
19	33	2	Pin Man	2	12
20	25	6	Miner Operator	5	30+
21	36	7	Roof Bolter	6	several
22	22	5	Miner Operator	2	25+
23	26	7	Miner Operator	5	20
24	33	7	Miner Operator	4	6
25	36	3.5	Scoop Operator	1	6
26	30	2	Roof Bolter	1	6+
27	47	21	Miner Operator	10	9
Averages	**32.4**	**9.4**		**5.0**	

The results of both surveys, which are provided in the Appendix, identified several issues with wearing the CPDM. These issues were as follows:

1. 82% (S1) and 74% (S2) of respondents experienced problems with the CPDM
2. 82% (S1) and 85% (S2) of respondents experienced discomfort from carrying the CPDM

   The most frequently reported body parts experiencing discomfort were the hips, lower back and neck.

3. 64% (S1) and 67% (S2) of respondents reported a greater level of fatigue while carrying the CPDM
4. 55% (S1) and 52% (S2) of respondents reported problems with their balance while walking and carrying the CPDM
5. 27% (S1) and 41% (S2) of respondents reported problems with their balance while standing and carrying the CPDM
6. 73% (S1) and 70% (S2) of respondents reported that the CPDM interfered with operating equipment

   Examples of problems included: hitting levers, getting caught on the seat, interfering with miner controls (cord), getting on and off equipment, and being distracted.

7. 91% (S1) and 67% (S2) of respondents reported problems with getting on and off equipment when wearing the CPDM

   Specific mining equipment identified included shuttle cars, scoops, roof bolters and mantrips.

8. 82% (S1) and 74% (S2) of respondents reported problems with sitting in equipment when wearing the CPDM

   Specific mining equipment identified included shuttle cars, scoops, and mantrips.

9. 91% (S1) and 67% (S2) of respondents reported problems with the cord pulling on their hard hat

10. 91% (S1) and 74% (S2) of respondents reported problems with the cord catching on equipment

11. 82% (S1) and 41% (S2) of respondents identified other problems with the cord

    Examples of other problems identified included: keeps getting in the way, gets caught on equipment doors, is too stiff and too long, interferes with running the miner, gets pinched when sitting in equipment or moving the wrong way, does not fasten to hard hat or fit into the retainer on the hat, and is too long for a short person.

12. 55% (S1) and 52% (S2) of respondents reported problems with reading the monitor

    Problems identified included twisting the torso and neck to read the monitor, pulling on the belt to see the monitor, and not being able to see the monitor at all.

13. When asked for any other information about the CPDM, the following comments from both surveys were provided:

    It is heavy and bulky to wear. It's cumbersome to wear and is more of a hassle than anything.

    The hookup on machine is not very friendly. The unit makes my neck hurt. I can't wear the unit on the mantrip and it costs me more time to hook it up to my belt. More added accessories than I need hanging around my waist. At the end of my shift my neck hurts and my upper back. My waist hurts as well due to having the unit, tool pouch and rescuer (SCSR). Afraid that I'm going to break my unit as well. The cords are in my way when lacing cable on miner and taking them off. The cord is in my way when I am backing up. Cord pulls on my neck hard when hanging curtain and cable.

    Very uncomfortable to wear. Did not like at all.

    The PDM is not user friendly. There is not a "pouch" marketed to wear the unit in. Some miner's belts will not accommodate wearing the unit.

    Big, bulky, added noise when the sense of sound is important. Cable is bulky, actual CPDM is heavy. I am afraid that as a coal miner it will not be long before I will be carrying a backpack for all of my monitors.

The percentage of respondents reporting problems did vary somewhat when comparing the results of the two surveys. For some questions, the percentages were similar, while for other questions they were not. For some questions, Survey 1 had a larger percentage of participants responding affirmatively, while for other questions Survey 2 had a larger percentage of participants responding affirmatively. The percentage of respondents reporting discomfort, fatigue, and balance problems when walking were very similar when comparing the two surveys. The percentage of affirmative responses were also similar when asked if the CPDM interfered with operating equipment, and if they had any problems with reading the monitor. The questions regarding problems with the cord and getting on and off equipment had higher reporting percentages for Survey 1 than Survey 2. On the other hand, Survey 2 had a higher percentage of respondents reporting balance problems when standing than Survey 1. Therefore, it does not appear that either survey established a pattern of reporting problems more so than the other survey.

The results obtained from both surveys were very consistent in identifying the problems with wearing the CPDM. The survey results were also consistent with the problems initially described in IC 9501. These two surveys, however, were able to quantify the pervasiveness of the problems at the mines where the surveys were conducted, which for some problems were as high as 91% of the survey participants.

Because of time limitations, neither of the two surveys were conducted following typical scientific protocol. None the less, these surveys still provide valuable information regarding potential issues with wearing a CPDM and establish the need for more rigorous research studies so that these issues can be further defined and addressed.

One problem with the CPDM that was identified by one miner in Survey 2 that was not identified previously either in Survey 1 or IC 9501 was the problem of distraction. This miner commented that the CPDM distracted him and kept him from doing his job safely. Although no other information is available from the survey as to why this miner thought the CPDM was a distraction, it raises serious questions about when one is focused on a specific task, such as reading the CPDM monitor and taking corrective actions if the dust concentration is high, and also needing to be aware of their environment and moving equipment. As mentioned previously, mining environments are very dynamic, which require constant vigilance to remain safe. Requiring miners to frequently focus their attention on reading a monitor that may be difficult to see and then to determine what corrective action, if any is needed, should be taken, could result in the miner missing important cues necessary for them to remain safe. This state of divided attention that may be created when focusing on the CPDM also merits further study.

The information obtained from the above research studies, the NIOSH IC 9501, and the two surveys facilitated by MEC, clearly indicate that research studies are needed to assess the full impacts of carrying a CPDM on miners, and to determine alternative approaches that would alleviate such impacts. This research should answer the following questions:

1. What is the maximum weight acceptable to miners that can be worn on the miner's belt?
2. What is the maximum weight that should be worn on miners' belts from a biomechanical and physiological perspective for both low and high coal seams?
3. What is the most appropriate configuration of equipment, including the CPDM, that is carried by miners to perform job tasks from a biomechanical and physiological perspective?
4. Do shoulder straps reduce the impact of the object weight worn on a miner's belt in both high and low coal seams from a biomechanical and physiological perspective?
5. Will wearing the CPDM on the miner's belt on a daily basis result in the development of discomfort and/or MSDs disorders?
6. Will attaching the CPDM sampling tube and light to the miner's cap on a daily basis result in the development of discomfort and/or MSDs of the neck and upper back?
7. Will the repeated twisting of the neck and back to read the CPDM screen result in the development of discomfort and/or MSDs?
8. Will wearing the CPDM on the miner's belt on a daily basis result in the development of greater fatigue levels?
9. Will wearing the CPDM on the miner's belt on a daily basis result in the development of balance problems while standing or walking?
10. Will wearing the CPDM on the miner's belt on a daily basis result in the development of gait problems while walking and/or an increase in slips, trips, and falls?
11. Will wearing the CPDM on the miner's belt interfere with sitting in any mining equipment, operating any mining equipment, and or getting on and off any mining equipment?

12. Will frequent focusing on reading the CPDM and determining appropriate corrective actions result in a state of divided attention, and if so, what impact would this have on the overall safety of miners?
13. Could the CPDM be redesigned to reduce its weight and size, improve the readability of the monitor, eliminate/modify the cord, and add signaling capacity (such as a visual signal) to warn of high dust concentrations?

In short, MSHA's desire to use the CPDM as the Agency has proposed may have an unintended consequence of increasing dramatically the prevalence of MSDs in underground coal mines. To avoid this outcome, MSHA should delay the mandate for the massive deployment of CPDMs in the proposal, until the important research tasks noted above are completed.

References

Arellano CJ, Layne CS, O'Connor DP, Scott-Pandorf M and Kurz MJ (2009). Does Load Carrying Influence Sagittal Plan Locomotive Stability? Medicine and Science in Sports and Exercise. 41(3):620-627.

Battelle Centers for Public Health Research and Evaluation (1999). Analysis of the Mine Safety and Health Administration (MSHA) accident/injury database, phase II report. NIOSH Contract Number 200-94-2837.

Dempsey PG, Ayoub MM, Bernard TM, Endsley MK, Karwowski W, Lin CJ and Smith JL (1995). Ergonomic investigation of letter-carrier satchels: Part I: Field study. Applied Ergonomics 27:303-313.

Griefahn B, Kunemund C and Brode P (2003). Evaluation of performance and load in simulated rescue tasks for a novel design SCBA: Effect of weight, volume and weight distribution. Applied Ergonomics 34:157-165.

Janz NK, Champion VL, Strecher VJ (2002). The health belief model. In: Glanz K, Rimer BK, Lewis FM, eds. Health behavior and health education: theory, research, and practice. San Francisco, CA: Jossey-Bass, Inc., pp. 45–66.

Lin, CJ, Dempsey, PG, Smith, JL, Ayoub, MM and Bernard, TM (1996) Ergonomic investigation of letter-carrier satchels: Part II. Biomechanical laboratory study. Applied Ergonomics 27(5):315-320.

NIOSH (2002). Mining Facts – 2000. US Department of Health and Human Services, National Institute for Occupational Safety and Health.

NIOSH (2003). Mining Facts – 2001. US Department of Health and Human Services, National Institute for Occupational Safety and Health.

NIOSH (2004). Mining Facts – 2002. US Department of Health and Human Services, National Institute for Occupational Safety and Health.

NIOSH (2005). Mining Facts – 2003. US Department of Health and Human Services, National Institute for Occupational Safety and Health.

NIOSH (2007). Mining Facts – 2004. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 2007-166.

NIOSH (2008) . Mining Facts – 2005. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 2008-149.

NIOSH (2008). Mining Facts – 2006. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 2008-158.

NIOSH (2009). Mining Facts – 2007. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 2009-157.

Peters RH, Vaught C, Hall E and Volkwein JC (2008). Information Circular 9501, Miners' Views about Personal Dust Monitors. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Publication No. 2008-110.

Porter WL, Mallett LG, Schwerha, DJ, Gallagher S, Torma-Krajewski J, and Steiner LJ (2008). Age Awareness Training for Miners, US Department of Health and Human Services, National Institute for Occupational Safety and Health, Information Circular 9505.

Qu X and Nussbaum MA (2008). Effects of external loads on balance control during upright stance: Experimental results and model-based predictions. Gait Posture 29(1):23-30.

Scharf T, Vaught C, Kidd P, Steiner L, Kowalski K, Wiehagen B, Rethi L, and Cole H (2001). Toward a typology of dynamic and hazardous work environments. Human and Ecological Risk Assessment, 7(7):1827-1841.

Steiner, LJ, Cornelius, KM, Turin, FC (1999). Predicting system interactions in the design process. American Journal of Industrial Medicine, 36:58-60.

Torma-Krajewski J, Steiner L and Burgess-Limerick R (2009). Ergonomic Processes: Implementation Guide and Tools for the Mining Industry. US Department of Health and Human Services, National Institute for Occupational Safety and Health, Information Circular 9509.

Wells JA, Zipp JF, Schuette PT and McEleney J (1983). Musculoskeletal disorders among letter carriers. A comparison of weight carrying, walking and sedentary occupations. Journal of Occupational Medicine. 25(11):814-820.

Winn F, Biersner R, and Morrissey S (1996). Exposure probabilities to ergonomic hazards among miners. International Journal of Industrial Ergonomics, 18:417-422.

Wu G and MacLeod M (2001). The control of body orientation and center of mass location under asymmetrical loading. Gait and Posture 13:95-101.

APPENDIX

Results for Surveys 1 (11 respondents) and 2 (27 respondents). The numbers listed in the "Yes" and "No" columns are percentages of total respondents for each survey.

QUESTIONS	SURVEY 1: MEC MINES			Survey 2: NON-MEC MINE		
	Yes	No	Comments	Yes	No	Comments
Did you experience any problems while wearing the CPDM?	82	18	Problems included: discomfort, the weight was too heavy, difficult to wear on the miner's belt, it was in the way when interfacing with equipment, and many errors occurred.	74	26	Problems included: too heavy, always in the way, too big and bulky, cannot move as fast, distracting, hose kinks or is pinched, malfunctioned
Did you experience any discomfort while wearing the CPDM or after the shift?	82	18	The body parts affected by the discomfort were: neck (55%), hip (55%), lower back (36%), and shoulders (9%).	85	15	The body parts affected by the discomfort were: neck (22%), hip (67%), lower back (52%), legs (15%), and shoulders (7%).
Did you experience a greater level of fatigue while wearing the CPDM or after the shift?	64	36	Examples of comments included: Felt like I had worked all day and night; the weight was noticeably heavier on the belt; and felt beat up	67	33	Examples of comments included: There is more weight on the side you are carrying it; makes everything more difficult, including bending over; assumes awkward body positions to protect equipment.
Did you notice any balance problems when walking and wearing the CPDM?	55	45	Examples of comments included: I was more apt to wanting to fall due to weight distribution on one side of the body as compared to the other side; fell down a lot; and walking heavier on side with CPDM.	52	48	Examples of comments included: I was leaning to one side; more weight on one side; cannot ever let my arms rest at my side; its like packing a brick around on your belt; it is harder to get up from squatting; your balance is thrown off.
Did you notice any balance problems when standing and wearing the CPDM?	27	73	Examples of comments included: Equilibrium was off; right leg gets tired quicker.	41	59	Examples of comments included: added weight causes me to stand awkwardly; get tired leaning over to counter balance the weight; heavy as hell;
Did the CPDM interfere with operating any equipment?	73	17	Problems included: hitting levers, getting caught on the seat, interfering with miner controls (cord), and getting on and off equipment	70	30	Problems included: too bulky to wear in shuttle car; bulky and hard to wear in the mantrip; distracted me from doing my job safely; gets in the way while trying to drill; always in the way.
Was the CPDM a problem when getting on and off equipment?	91	9	Problems were identified getting on and off mantrips, jeeps, shuttle cars, scoops. Other issues identified included the CPDM falling out of the pouch or catching on things, and dropping other equipment that could no longer be attached to the belt.	67	33	Examples of comments included: gets tangled up on levers; hose gets pinched on mantrip; gets caught on tram peddle in car; you can only carry so much.

Was the CPDM a problem when sitting in equipment?	82	18	Problems were identified with sitting in shuttle cars, mantrips, scoops and jeeps. Comments also identified issues with having to sit sideways, with the CPDM rubbing their side and pressing against their back, and having to take the CPDM off while sitting in equipment.	74	26	Problems were identified with not having enough room when sitting in mantrips, shuttle cars, and scoops
Did you experience any problem with the cord pulling on your cap?	91	9	Examples of comments included: It makes your cap almost twice as heavy; it pulled my cap all day long and began to hurt my neck; pulled on my hat so much it gave me a headache every time I use it; and the cord is too long and too stiff.	67	33	Examples of comments included: Cord weighs the cap down; cord is much bigger than light cord, cord is too stiff; cord catches on everything; the cord pulls your head in odd directions; and the cord does not let you turn your head very well.
Did you experience any problem with the cord catching on equipment?	91	9	Examples of comments included: Cord catches on equipment when walking around the equipment; the cord and hose are heavier, causing it to hang low and get caught; the cord catches on things more than the regular light cord; when lacing miner cable along side of miner, the cord keeps getting caught on hooks and in the way of your hands.	74	26	Examples of comments included: Gets tangled on levers; gets caught on pedals on shuttle car and levers on scoops; could cause injury when it gets caught on levers; cord is too long.
Did you experience any other problem with the cord?	82	18	Other problems identified included: keeps getting in the way, gets caught on equipment doors, is too stiff and too long, interferes with running the miner, gets pinched when sitting in equipment or moving the wrong way, and does not fasten to hard hat.	41	59	Other problems identified included: Cord is too long for a short person; it sticks too far out of the machine; and cord will pull light off hat and will not fit in retainer.
Did you have any problems with reading the monitor on the CPDM?	55	45	Examples of comments included: Unit was too far back on my belt to read it; had to twist torso and neck to view; always ended up with stiff neck by the next day; you have to put your light directly on screen to read it; and have to twist around and pull on belt to see it.	52	48	Examples of comments included: Had to move it around to see it; twisting the trunk and neck a great deal to view the monitor; not a comfortable way to carry the device and to view it; it took the place of tools that I really needed.

JANET TORMA-KRAJEWSKI, Ph.D., CIH, CPE

9525 West 77th Drive
Arvada, CO 80005
303-423-2069
ieil@comcast.net

SUMMARY

Dr. Torma-Krajewski has over 30 years experience and education in ergonomics and industrial hygiene. She has worked in an oversight role, as well as a consultant, field ergonomist and industrial hygienist, program manager, team/project lead and lead researcher. She has both private and public sector experience. Dr. Torma-Krajewski has published several articles in professional journals; and has given many presentations at national and international conferences. She has professional certifications in both ergonomics and industrial hygiene.

SIGNIFICANT ACCOMPLISHMENTS

Demonstrated to the mining industry that ergonomics could be integrated with existing safety and health programs and successfully applied to reduce musculoskeletal disorders despite the many challenges of the mining environment.

Eliminated the use of unnecessary personal protective equipment resulting in annual savings of $3 million in direct and indirect costs.

Initiated actions requiring completion of baseline industrial hygiene assessments resulting in the first comprehensive health hazard analysis in 40-year old facilities.

Developed and implemented major program elements of a comprehensive occupational safety and health program for a health care facility.

Completed numerous ergonomic job task analyses in a variety of industries (mining, health care, steel mill, manufacturing, warehousing, electronics, and government).

Conducted one of the first analyses of nursing lifting tasks according to the NIOSH Guidelines for Manual Lifting resulting in recommendations for reducing musculoskeletal disorders.

Characterized the heat stress levels in 32 miles of underground steam tunnels and demonstrated the effective use of personal heat stress monitors.

Developed the first written ergonomics program within the Department of the Army.

CERTIFICATIONS

Certified Industrial Hygienist (Comprehensive Practice) #3512
Certified Professional Ergonomist #508

CLEARANCES

DOE: Q (not active)
DOD: Secret

AWARDS

NIOSH Alice Hamilton Award for Education Materials - 2009

EDUCATION

Lock Haven State College	BS	1971	Health/Physical Education
University of Massachusetts	MS	1972	Exercise Science
Washington & Jefferson College		1973	Non-Degree (43 credits in math & science)
Pennsylvania State University	Ph.D.	1979	Applied Physiology
Colorado State University	MS	1984	Industrial Hygiene

CURRENT WORK EXPERIENCES

Colorado School of Mines, Director, Mine Safety and Health Program
Administrative Faculty/ Research Associate/ Contract Industrial Hygienist (Aug 2000 - Present)

Responsible for managing and securing funding for the Mine Safety and Health Program, which is 100 percent grant-funded. Evaluates existing programs and directs future programming initiatives of the Mine Safety and Health Training Program. Other responsibilities include developing and offering training programs (short courses, seminars and conferences) for the mining industry, which generally focus on industrial hygiene and occupational health subjects, such as noise, dust, hazard communication, and ergonomics. Develops training materials and publications addressing health topics pertinent to mining; and presents information regarding program activities at conferences.

Industrial Ergonomics, Inc.
President/Senior Ergonomist and Industrial Hygienist (1978 to Present)

Conducts comprehensive surveys, studies and job analyses to identify and evaluate chemical, physical and biologic hazards and ergonomic risk factors associated with work sites in many types of industries. Plans, conducts and directs special studies or projects concerned with occupational health problems; evaluates complex/unique work processes to assure incorporation of adequate controls. Conducts and develops training courses; develops written programs and supporting documentation. Facilitates program implementation by providing technical support to employee safety and health committees and/or ergonomic committees.

PAST WORK EXPERIENCES

National Institute for Occupational Safety and Health
Senior Service Fellow, Pittsburgh Research Laboratory (Mar 2004 – Sep 2008)

Served as a senior-level researcher and project officer in the MSD Prevention Section. Responsibilities included: (1) conducting laboratory and field research to focus on human physiological capabilities and their interactions with mining jobs, tasks, equipment, and the mine work environment; (2) designing and conducting research studies to identify and classify risk factors that are causing or may be causing traumatic injuries to miners; (3) designing and testing proposed interventions using laboratory mock-ups, full-scale demonstrations at the laboratory's experimental mines, or through field evaluation in operating mines; and (4) evaluating and recommending implementation strategies for injury prevention and control technologies. The research activities were directed toward reducing accident and injury frequencies, and improving the general quality of miners' work lives. Typical activities included: directing/leading projects and mentoring junior researchers to meet project goals; investigating methods to improve mine health and safety performance through the implementation of improved human factors design of equipment, tools, procedures, and work environments; investigating complex mining systems to resolve factors contributing to physical stressors; communicating clearly, both orally and in writing, on technical issues in a sound and logical fashion; preparing/editing government publications addressing ergonomics in mining; and presenting information regarding research activities at conferences and training sessions.

US Department of Energy, Rocky Flats Environmental Technology Site
Industrial Hygienist / Lead, Integrated Performance Team / Lead, Occupational Safety & Health Team (1991–2004)

Served as a senior-level industrial hygienist. Responsibilities included management and oversight of a broad range of industrial hygiene and occupational health programs related to site activities, such as material stabilization, decommission and decontamination, environmental restoration, waste management and facility support. Served as an advisor to management for industrial hygiene and occupational health programs. Participated in Headquarters activities - assisting in the development of DOE-wide orders, planning workshops, and writing implementation guides. The primary focus of these efforts was the prevention of chronic beryllium disease.

Served as Team Leader for the Integrated Performance Team. Responsibilities included providing technical direction for site-wide issues related to performance measures, line-item projects, cost-savings proposals, current year work authorization and budgeting; ensuring procedures were revised/developed that improved effectiveness and efficiency of programs; and ensuring strategic plans and other requirements were integrated for all program deliverables.

Served as Team Leader and Acting Branch Chief for the Occupational Safety and Health Group, with responsibility for providing technical direction to team members, stakeholders, and senior management on a variety of issues related to managing and supporting departmental programs. Also responsible for the short and long term coordination, development, and management of the technical oversight function related to a broad range of occupational safety and health disciplines. Initiated development and managed the Federal Employee Occupational Safety & Health Program. Served as a technical expert for DOE/HQ sponsored workshops and committees tasked with developing DOE-wide guidance and mandatory documents such as policy statements, manuals, technical standards and orders. Helped to establish the DOE-wide Industrial Hygiene Coordinating Committee and served as chair person.

Industrial Hygienist, US Army Environmental Hygiene Activity-West, Aurora, CO (1988-91)

Served as team leader, directing surveys of work sites throughout a 23-state region. Provided technical advice to industrial hygienists, managers, physicians and employee groups throughout the Western Region. Conducted a variety of IH surveys related to hearing conservation, indoor air quality, ergonomics, confined spaces, heat stress, respiratory protection, bloodborne pathogens, medical surveillance, and exposures to numerous chemical and physical hazards associated with painting, welding, vehicle repairs, asbestos abatement, ethylene oxide sterilization, etc. Also conducted several program reviews to determine compliance with Department of Army and OSHA regulations. Developed and presented training programs. Reviewed Department of Army and Agency policies for technical accuracy and application. Prepared technical reports, including recommendations for controlling hazardous conditions. As Acting Branch Chief, was responsible for assigning projects, scheduling, budgeting and preparing quarterly reports.

Industrial Hygienist/OSH Manager, VA Medical Center, Denver, CO (1986-88)

Responsible for developing, implementing and managing a comprehensive occupational safety and health program. Conducted industrial hygiene surveys to identify and evaluate health hazards, and to recommend appropriate corrective measures. Evaluated a wide variety of hazardous operations and processes including unusual hazards resulting from complex work processes or from combinations of hazardous materials. Reviewed project specifications and design plans developed for modifications of facilities to determine compliance with occupational health and safety requirements. Conducted and managed an occupational health training program. Served as a technical expert in hearings and court proceedings, and represented the medical center at national conferences. Acted in an advisory capacity to other District medical centers. Also responsible for developing, implementing and managing a hazardous materials management program. Major duties related to this program included developing and implementing written policy documents, developing a computerized hazardous materials inventory system, managing the hazardous waste disposal program, and organizing a spill response team. Conducted an extensive analysis of injury data that was published in a conference proceedings.

Industrial Hygienist, Fitzsimons Army Medical Center, Tooele, UT (1985-86)

Responsible for providing industrial hygiene consultative services to the Tooele Army Depot. Conducted surveys to evaluate chemical, physical and ergonomic hazards. Evaluated ventilation systems, and reviewed building plans and work processes for adequate controls. Implemented a depot-wide hearing conservation program. Developed and conducted training programs. Recommended corrective measures and controls for workplace health hazards. Implemented program to utilize microcomputers for various elements of the industrial hygiene program.

OSH Manager, Naval Medical Research Institute, Bethesda, MD (1985)

Responsible for development, implementation and management of the occupational safety and health program based on guidelines in OPNAV Instruction 5100.23B and other DOD, federal and state directives. Conducted industrial hygiene and safety surveys of laboratory, office and support facilities to identify, evaluate and control occupational and environmental hazards, and to ensure compliance with appropriate standards. Also responsible for analyzing job-related accidents and injuries to determine causal factors, and for providing written recommendations for correction and prevention. Developed and implemented health and safety training programs for all Institute personnel. Reviewed research protocols for safety and health considerations, and advised senior management personnel regarding safety and health and safety violations occurred. Assigned and supervised the activities of workplace monitors and provided guidance to approximately 25 branch safety officers. Chaired the Combined Branch Occupational Safety and Health Committee and participated on other occupational safety and health committees at the command and region level.

Industrial Hygienist, Naval Medical Clinic, Norfolk, VA (1984-85)

Responsible for providing industrial hygiene consultative services to Naval facilities serviced by the Naval Medical Command. Planned and conducted walk-through and comprehensive industrial hygiene surveys to evaluate physical, chemical and ergonomic health hazards, including indoor air pollution problems. Developed workplace monitoring programs and assisted in the implementation of major occupational health program elements, such as asbestos abatement and respiratory protection. Evaluated ventilation systems to determine effectiveness in controlling health hazards. Reviewed new work processes and recommended corrective measures and controls for workplace health hazards. Conducted industrial hygiene training for workplace monitors, and prepared technical reports and presentations.

VOLUNTEER ACTIVITIES

Served as an officer or board member for the Two Ponds Preservation Foundation since 1992.

PRESENTATIONS

Presentations - *Professional Activities*

Torma-Krajewski, J, Steiner, L. and Burgess-Limerick, R. Ergonomics Processes and Implementation Tools. ISEM IV International Seminar on Occupational Health for Mining Operations, Lima, Peru, October 27, 2010.

Torma-Krajewski, J., Ferriter, R. and Ferguson, J. Mine Rescue Training and Computer Simulations. MSHA TRAM Conference, Beckley, WV, October 13 & 14, 2010.

Steiner, L. and Torma-Krajewski, J. Building Better Jobs through Ergonomic Design. IMA-NA 2009 Industrial Minerals Technology Workshop, Clearwater, FL, March 2, 2009.

Torma-Krajewski, J. Integrating Ergonomics with S&H Programs. 4th Annual Joint Western Regional Mine Safety and Health Conference, Westminster, CO, October 28, 2008.

Torma-Krajewski, J. Applying Ergonomics: Problems to Solutions. Lafarge Safety and Health Regional Meeting, Atlanta, January 23, 2008.

Steiner, L. and Torma-Krajewski, J. Applying Ergonomics: Problems to Solutions. National Stone, Sand and Gravel ES&H Annual Meeting, Chantilly, VA, September 5, 2007.

Torma-Krajewski, J., Hipes, C., Steiner, L. and Burgess-Limerick, R. Ergonomics Interventions at Vulcan Materials Company. SME Conference - Denver, February 25-28, 2007.

Torma-Krajewski, J. and Lehman, M. Ergonomics Initiative at Badger Mining Corporation. SME Conference - Denver, February 25-28, 2007.

Torma-Krajewski, J. Ergonomics and Risk Factor Awareness Training – Training for Miners. SME Pittsburgh Local Section, May 23, 2007.

Torma-Krajewski, J. and Steiner, L. Enhancing Miner Safety and Health with Ergonomics – How to Get Started. Poster presentation at the IMA-NA Annual Technical Workshop, March 2006.

Steiner, L. and Torma-Krajewski, J. Enhancing Miner Safety and Health with Ergonomics – Case Studies. Poster presentation at the IMA-NA Annual Technical Workshop, March 2006.

Torma-Krajewski, J. Proving the Value of Ergonomics. American Industrial Hygiene Conference and Exposition, Anaheim, CA, May 2005.

Torma-Krajewski, J. Using Ergonomics to Enhance Safe Production at a Surface Coal Mine: A Case Study with Powder Crews. AIHC&E, May 2005.

Torma-Krajewski, J. Ergonomics and Mining: Ensuring a Safer Workplace. SME Conference, Salt Lake City, March 2, 2005.

Torma-Krajewski, J. Proving the Value of Ergonomics. Lucien Brouha work Physiology Symposium, Keystone, CO, September 3, 2004.

Torma-Krajewski, J. Using Ergonomics to Enhance Safe Production at a Surface Coal Mine: A Case Study with Powder Crews. American Industrial Hygiene Conference and Exposition, Anaheim, CA, May 2005.

Wiehagen, W., Torma-Krajewski, J. and Peterson, A. Using Ergonomics to Enhance Safe Production at a Surface Coal Mine: A Case Study with Powder Crews. 2004 Joint Mine Safety and health Conference and 34th Annual Institute on Mining Health, Safety and Research Conference, Salt Lake City, Utah, May 25, 2004.

Wiehagen, W. and Torma-Krajewski, J. Ergonomics and Risk Factor Awareness Training. 2004 Joint Mine Safety and Health Conference – Train-the-Trainer Workshops. Salt Lake City, Utah, May 27-28, 2004.

Torma-Krajewski, J. Achieving Worker Minimization with an Integrating Management Contract. Chronic Beryllium Disease Prevention Program: Best Practices and Lessons Learned Workshop, June 2-3, 1998.

Torma-Krajewski, J. Integration of Safety and Health with Performance Measures. Annual DOE Industrial Hygiene Meeting, May 22, 1996.

Bernard, T. and Torma-Krajewski J. Chronic Beryllium Disease and Beryllium Sensitization at Rocky Flats: A Case Control Study. American Industrial Hygiene Conference and Exposition, May 24, 1996.

Bryson, EJ and Torma-Krajewski, J. Implementation of FEOSH Requirements at the Rocky Flats Field Office. Third Annual DOE Safety and Health Conference, 1994.

Torma-Krajewski, J. Occupational Safety and Health Act Compliance at the Department of Energy Rocky Flats Environmental Technology Site, Third Annual DOE Safety and Health Conference, 1994.

Torma-Krajewski, J. Occupational Safety and Health Act Compliance at Department of Energy Facilities: A Case Study of 29 CFR 1910.120 Compliance at the Rocky Flats Plant. Waste Management 94, 1994.

Torma-Krajewski, J. Introduction to Ergonomics. Presentation for Industrial Hygiene Course at the Denver University, February 14 and April 5, 1994.

Torma-Krajewski, J. Analysis of Heat Stress Data using Techbase. Techbase User's Meeting, 1991.

Torma-Krajewski, J. Oh My Aching Back (and other parts). Coping with the Workers' Compensation Crisis - Solutions for the '90s, Colorado Compensation Insurance Authority, 1991.

Torma-Krajewski, J. A Hazardous Materials Program for a Health Care Facility. American Industrial Hygiene Conference and Exposition, 1988.

Torma-Krajewski, J. Health Hazard Evaluation of an Orthotic / Prosthetic Laboratory. American Industrial Hygiene Conference and Exposition, 1987.

Torma-Krajewski, J. Analysis of Injury Data and Job Tasks at a Medical Center. Industrial Ergonomics and Safety Conference, 1987.

Torma-Krajewski, J. Analysis of Lifting Tasks in the Health Care Industry. Occupational Hazards to Health Care Workers Symposium. University of Washington and ACGIH, 1986.

Torma-Krajewski, J. Occupational Health/Safety Considerations for Handling Hazardous Materials. HAZTECH International Conference, 1986.

Torma-Krajewski, J. Video Display Terminals: Health and Ergonomic Considerations. Twenty-Seventh Navy Occupational and Environmental Health Workshop, 1985.

Torma-Krajewski, J. Evaluation of the RD_{50} Concept as a Tool to Establish TLVs for Sensory Irritants. American Industrial Hygiene Conference and Exposition, 1984.

Torma-Krajewski, J. Ergonomics and Manual Material Handling Tasks. 13th District of Federal Safety and Health Employees, 1983.

Torma-Krajewski, J. Pros and Cons of Pre-employment Testing. AIHA Rocky Mountain Section Fall Technical Conference, 1983.

Torma-Krajewski, J. Selecting and Managing People for Material Handling Jobs. Nebraska Safety Council, 1981.

Torma-Krajewski, J. Pre-employment and Pre-placement Strength Testing in a Light Manufacturing Facility. Western Electric Plant, Lee's Summit, Missouri, 1980.

Presentations - *Volunteer Activities*

Citizen Involvement in Preserving the Two Ponds National Wildlife Refuge. Visit by the Secretary of Interior, Bruce Babbitt, to the Two Ponds National Wildlife Refuge, April 6, 1996.

Numerous presentations regarding the preservation of the Two Ponds National Wildlife Refuge have been given for Refuge events, before local government planning commission and city council meetings, and for other interested organizations.

Training / Workshops / Focus Groups

Torma-Krajewski, J., Steiner, L. and Porter, B. Process Metric Focus Group, NIOSH, Cincinnati, OH, May 2-3, 2007.

Torma-Krajewski, J. Ergonomics and Risk Factor Awareness Training. Vulcan Materials Company – Engineering Division Central Services. July 26, 2006.

Torma-Krajewski, J., Steiner, L. and Moore, S. Simple Solutions for Improving Jobs. Vulcan Materials Company – SHE Team and Safety and Health Representatives – Pilot Sites. July 26-27, 2006. (two sessions)

Torma-Krajewski, J. Ergonomics for BBS Observers - Advanced. Badger Mining Corporation, June 2006. (two sessions)

Steiner, L., Burgess-Limerick, R. and Torma-Krajewski, J. Identifying Risk Factors and Task Improvements. Vulcan Materials Company – SHE Team and Safety and Health Representatives – Pilot Sites. April 11 and 13, 2006. (two sessions)

Steiner, L. and Torma-Krajewski, J. Ergonomics Process Integration. Vulcan Materials Company Safety and Health Representatives – Pilot Sites. February 10, 2006.

Torma-Krajewski, J., Steiner, L. and Baron, K. Ergonomics and Risk Factor Awareness Train-the-Trainer. Vulcan Materials Company Safety and Health Representatives – Pilot Sites. February 10, 2006.

Torma-Krajewski, J. and Steiner, L. Ergonomics Awareness and Job Improvements. Vulcan Materials Company Safety and Health Representatives. Scottsdale, AZ. November 15, 2005.

Torma-Krajewski, J. and Wiehagen, W. Applying Ergonomics for Job Improvements. US Silica Safety and Health Representatives, October 6, 2005.

Torma-Krajewski, J. and Steiner L. Ergonomics for BBS Observers. Badger Mining Corporation, July 22-33, 2005. (two sessions)

Torma-Krajewski, J. Ergonomics and Risk Factor Awareness Training. IMA-NA Annual Technical Workshop, Las Vegas, NV, March 14, 2005.

Torma-Krajewski, J. Ergonomics Processes – Focus Group. IMA-NA Annual Technical Workshop, Las Vegas, NV, March 14, 2005.

Torma-Krajewski, J., Gallagher, S. and Lewis, P. Office Ergonomics and Risk Factor Awareness Training. Badger Mining Corporation, February 2005.

Torma-Krajewski, J., Gallagher, S. and Lewis, P. Ergonomics and Risk Factor Awareness Training. Badger Mining Corporation, February 2005. (four sessions)

Torma-Krajewski, J. Ergonomics and Risk Factor Awareness Training. Bridger Coal Company – Jim Bridger Mine. July 2001. (3 sessions)

PUBLICATIONS

Publications near completion:

Moore, S., Torma-Krajewski, J. and Steiner, L. Practical Demonstrations of Ergonomics Principles. NIOSH Information Circular. In review.

Publications (Peer and Non-Peer Reviewed)

Porter, W., Gallagher, S. and Torma-Krajewski, J. Analysis of Applied Forces and Electromyography of Back and Shoulder Muscles when Performing a Simulated Hand Scaling Task. Applied Ergonomics 41(3):411-416, 2010.

Torma-Krajewski, J., Wiehagen, W., Etcheverry, A., Turin, F. and Unger, R. Using Ergonomics to Enhance Safe Production at a Surface Coal Mine: A Case Study with Powder Crews. Journal of Occupational and Environmental Hygiene 6(10):D55-D62, 2009.

Torma-Krajewski, J., Steiner, L. and Burgess-Limerick, R. Ergonomics Processes: Implementation Guide and Tools. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Information Circular 9509, Publication Number 2009-107, 2009.

Torma-Krajewski, J., Steiner, L., Unger, R. and Wiehagen, W. Ergonomics and Risk Factor Awareness Training for Miners. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Information Circular 9497, Publication Number 2008-111, 2008.

Torma-Krajewski, J. and Lehman, M. Ergonomics Initiative at Badger Mining Corporation. International Journal of Occupational Safety and Ergonomics.14(3):351-359, 2008.

Porter, W., Gallagher, S., Schwerha, D., Mallet, L., Steiner, L. and Torma-Krajewski, J. Age Awareness Training for Miners. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Information Circular 9505, Publication Number 2008-133, 2008.

Torma-Krajewski, J. Ergonomics and Design Issues with Prill Trucks, Mining Technology 116(4):153-157, December 2007.

Torma-Krajewski, J., Hipes, C., Steiner, L. and Burgess-Limerick, R. Ergonomics Interventions at Vulcan Materials Company. Mining Engineering 59(11):54-58, 2007.

Torma-Krajewski, J., Hipes, C., Steiner, L. and Burgess-Limerick, R. Ergonomics Interventions at Vulcan Materials Company. In: Proceedings of the SME Conference - Denver, February 25-28, 2007.

Torma-Krajewski, J. and Lehman, M. Ergonomics Initiative at Badger Mining Corporation. In: Proceedings of the SME Conference - Denver, February 25-28, 2007.

Torma-Krajewski, J., Steiner, L., Lewis, P., Gust, P. and Johnson, K. Implementation of an Ergonomics Process at a US Surface Coal Mine, International Journal of Industrial Ergonomics 37:157-167, 2007.

Torma-Krajewski, J., Steiner, L., Lewis, P., Gust, P. and Johnson, K. Ergonomics and Mining: Charting a Path to a Safer Workplace. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Information Circular 9491, Publication Number 2006-141, September 2006.

Porter, W., Gallagher, S., Reinholtz, C. and Torma-Krajewski, J. The Effects of Scaling Height and Scaling Bar Design on Applied Forces and Bilateral Muscle Activity of the Back and Shoulders. In: Proceedings of the HFES Annual Conference – San Francisco, October 2006.

Torma-Krajewski, J. and Steiner, L. Enhancing Miner Safety and Health with Ergonomics: How to Make Ergonomics Work. (Poster) Industrial Mineral Association – North America Annual Technical Workshop, March 2006. (Published on IMA-NA web site)

Steiner, L. and Torma-Krajewski, J. Enhancing Miner Safety and Health with Ergonomics: Case Studies. (Poster) Industrial Mineral Association – North America Annual Technical Workshop, March 2006. (Published on IMA-NA web site)

Steiner, L., Torma-Krajewski, J. and Schwerha, D. Using Ergonomics to Enhance Safety and Health in the U.S. Mining Industry. In: Proceedings of the 31st International Conference of Safety in Mines Research Institutes Brisbane. Queensland, Australia, October 2-5, 2005. Simtars, pp. 106-111, 2005.

Unger, R., Turin, F., Wiehagen, W., Steiner, L., Cornelius, K. and Torma-Krajewski, J. Initiating an Ergonomics Process at a Surface Coal Mine. Proceedings of the 33rd Annual Institute on Mining Health, Safety and Research, Roanoke, VA, August 1-3, 2002.

Viet, S., Torma-Krajewski, J. and Rogers, J. Chronic Beryllium Disease and Beryllium Sensitization at Rocky Flats: A Case-Control Study. American Industrial Hygiene Association Journal 61:244-254, March/April 2000.

Barnard, A., Torma-Krajewski, J. and Viet, S. Retrospective beryllium exposure assessment at the Rocky Flats Environmental Technology Site. American Industrial Hygiene Association Journal 57:804-808, September 1996.

Torma-Krajewski, J. Analysis of lifting tasks in the health care industry. In: Proceedings: Occupational Hazards to Health Care Workers Symposium. ACGIH, 1987.

Torma-Krajewski, J. Analysis of injury data and job tasks at a medical center. In: Trends in Ergonomics/Human Factors IV, Part B. Shihab S. Asfour, Editor. New York: North-Holland, 1987.

Torma-Krajewski, J. Evaluation of the RD_{50} concept as a tool to establish the TLV for ammonia using exercising subjects. Master's Thesis. Colorado State University, 1984.

Torma-Krajewski, J. Plasma volume changes in fit men and women during a humid heat stress before and after acclimation. Doctoral dissertation. Pennsylvania State University, 1979.

Krajewski, J., Kamon, E. and Avellini, B. Scheduling rest for consecutive light and heavy work loads under hot ambient conditions. Ergonomics 22:975-987, 1979.

Kamon, E., Avellini, B. and Krajewski, J. Physiological and biophysical limits to work in the heat for clothed men and women. Journal of Applied Physiology, 44:918-925, 1978.