

Information Collection Request for  
“Assessing and Evaluating Human Systems Integration Needs in Mining”

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**Part A: Justification**

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## **List of Attachments**

- Appendix A – Applicable Laws and Regulation
- Appendix B – 60 Day Federal Register Notice
- Appendix C1 – Direct Observation: Continuous Miner Operator
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- Appendix D – Task and Cognitive Task Analysis: Continuous Miner Operator
- Appendix E – Task and Cognitive Task Analysis: Fire boss
- Appendix F – Research Questionnaire: Subject Matter Expert Questionnaire
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- Appendix O – Direct Observation Research Protocol
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- Appendix Q – NIOSH Model Informed Consent Form
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The Centers for Disease Control and Prevention (CDC) requests OMB approval of a new project for the National Institute for Occupational Safety and Health (NIOSH) Mining Program for a 3-year period.

## **1. Circumstances Making the Collection of Information Necessary**

### **Background**

This information collection request (ICR) is a new request. This collection request describes data collection tasks under the project entitled “Assessing and Evaluating Human Systems Integration Needs in Mining.” This study is being conducted by the National Institute for Occupational Safety and Health. NIOSH, under P.L. 91-173 as amended by PL 95 -164 (Federal Mine Safety and Health Act of 1977), and PL 109-236 (Mine Improvement and New Emergency Response Act of 2006) (See Appendix A) has the responsibility to conduct research to improve working conditions and to prevent accidents and occupational diseases in underground coal and metal/nonmetal mines in the U.S.

With the second highest fatal injury rate in 2010, mining remains one of the most dangerous occupations in the United States. Despite continued efforts in research and regulation, tragedies like Upper Big Branch (2010) and Sago (2006) still highlight human systems integration (HSI) problems. HSI incorporates the needs of any human interaction within the system, particularly the end user, into the design process to optimize both safety and efficiency of the system. The use of HSI in the acquisition cycle is commonplace in the defense and aerospace industries - helping to minimize downstream product revisions and keeping projects on budget. The Army has developed guidelines, called MANPRINT, which require all devices to meet standards for usability, wearability, and acceptability. However, the mining industry lacks a similar set of guidelines to ensure both usability by the miner and increased safety of the working environment.

The lack of HSI guidance becomes particularly important as the adoptions of the MINER Act of 2006 as well as health and safety initiatives (End Black Lung Campaign) are tending to mandate the increased use of safety devices by mine workers (wireless communication systems, personal dust monitor, and proximity detection). These devices offer attractive health and safety benefits – improved tracking and communication, real time monitoring of respirable dust levels, and the prevention of accidental crushing by large mobile machinery. However, while the benefits of such wearable devices are easy to understand within their own context, they inevitably increase both the physical and cognitive burden on the mine worker who must carry, interact with, and ultimately make decisions with each one of the devices. The physical burden is evident in the added weight of the devices, but the cognitive effect may not be as clear. Multiple displays, and the increased amount of information being presented by multiple devices divides the miner’s attention and ultimately reduces his or her situational awareness or understanding of the environment and its effect on his or her decision making.

While we do have an understanding of how changing physical workload affects the health and safety of the miner, it is not known how the increased cognitive load that is being placed on today's mine workers will affect their health and safety. A first step to determining this impact is to understand a miner's job from the perspective of the miner. We will therefore use an HSI approach to answer a series of questions, because HSI is based on the understanding that people are the critical elements within systems and adopting a human-centric perspective of systems increases productivity and safety while decreasing costs (Tvaryanas, 2006). We will apply the HSI approach to accomplish some of the primary goals of the research project which are to determine (1) what information is critical for a mineworker to safely perform his job, (2) what processes (e.g., expertise, decision making, attention, etc.) are necessary for a mineworker to effectively perform his job and (3) how do the mineworker, their equipment and environment interact. The information collected from miners to answer these key questions will facilitate the development of mining specific HSI guidelines.

The project objective will be achieved through the specific aims listed below.

### **Project Specific Aims**

1. Identify underground mining jobs and tasks which suffer from a human systems integration breakdown as well as missing information which contributes to a less than optimal situational awareness.
2. Develop and test alternative interfaces aimed to improve the underground worker's situational awareness.

### **Privacy Impact Assessment**

No Information in Identifiable Forms (IIF) will be collected. Information will be collected both electronically and on paper. Electronic means include computer based software packages designed to collect behavioral and physiological data. Within these tasks, instruments will be used to collect information from miners and other participants about complexity of the task being performed.

### **Overview of the Data Collection system**

The research under this project focuses on determining tasks that miners must perform while working at a specific job. In addition to task information, we are interested in learning miner's perceptions of the cognitive workload associated with specific job titles as well as the information that is necessary to safely perform the various job titles. The research questions that will be answered during this project are directly related to the specific aims listed previously.

Three research design strategies will be used in the project: descriptive, experimental, and correlational designs. The portions of the project aimed to identify job titles as well as human-machine interactions at underground mining sites that are the most cognitively demanding will be conducted primarily using a descriptive research design. A descriptive research strategy is appropriate when the goal is to "generate ideas and to embark on a field of inquiry that is relatively unknown" and when the purpose is "to learn more about the nature of the program and to identify the lines of inquiry that may be productive to pursue in more focused follow-up studies" (Hedrick, Leonard, & Rog, 1993). Experimental and correlational designs will be used to determine the most effective interface designs, to measure changes in cognitive workload, to

assess how changes in situational awareness affect decision-making, and to assess the feasibility of an integrated development interface.

In order to further define the two specific aims presented above, a list of research questions is presented below. The research questions will be used to guide and implement the strategies enumerated above, and the information gathered from each research question will be used to develop the mining specific HSI guidelines.

In order to answer the research questions, several research tools and techniques will be used. These include an analysis of the Mine Safety and Health Administration (MSHA) database, direct observations, cognitive task analyses, research questionnaires, focus groups, as well as other experimental methodologies. All data collected at the beginning of this research project for Specific Aim 1 will be used to guide the development of research hypotheses that will be formulated in order to answer the research questions related to specific aim 2. This is therefore a cumulative design, because data collected early will determine what tools and hypotheses are necessary to answer later research questions.

### **Specific Aim 1**

In order to address the following research questions associated with Specific Aim 1, the following tasks will occur--an analysis of the MSHA database, direct observations (see Appendix C1 and Appendix C2), task and cognitive task analyses (see Appendix D – continuous miner operator and Appendix E fire boss), and the distribution of three research questionnaires (see Appendix F, G, and H). All of these tasks will all occur during years one and two of the project. There are five (5) research questions associated with Specific Aim 1; the following is a discussion of those questions.

Questions a-e are discussed below:

- a. What situational information or lack thereof can be identified by analyzing select injury and fatality narratives?

An analysis of the MSHA databases will be conducted in order to cull information about accidents and injuries, fatalities, and citations that have occurred over the past 10 years in underground coal mines. One of the primary goals of this analysis is to determine which situations could benefit from improved situational awareness. The accident reports will be analyzed to determine possible causes and contributing factors. Specifically, the coding will focus on what information may have mitigated the accident. The citation database will be analyzed to identify the contributing factors that are being identified by inspections and the relationship to the injuries and fatalities. The data from these analyses will be combined with data from the literature (see Steiner & Burgess-Limerick, 2007) to create a better understanding of positions assessed.

There are a variety of jobs that are performed at underground mine sites. These jobs vary in degree of complexity, physical and cognitive demands, as well as the predictability of the environment in which these jobs are performed. A preliminary analysis of the MSHA databases indicates that jobs that require the miner to operate or work in close proximity with mechanized machinery have the highest reported fatality rate and the greatest number of fatalities compared to other jobs within the mine (Bureau of Labor Statistics, 2012). It can be speculated that one reason these jobs have the greatest number of injuries and fatalities is because these jobs are both cognitively demanding and involved with the control of heavy equipment. This means that

miners performing these jobs experience greater cognitive workload demands – or greater demands on information processing resources that are necessary for task (or job) performance – and also have greater exposure/risk than a miner working with smaller scale tools (Wickens & Hollands, 2000). High cognitive workload demand may cause a miner to make errors while working because he is unable to simultaneously attend to all aspects of the job tasks and work environment or he may be slow to make a critical decision. While we do recognize that all jobs within the underground mine are important and have some level of risk associated, it is critical to focus our initial efforts on a smaller number of jobs. We have chosen to focus on two jobs that have high levels of risk and cognitive demand associated with them. Specifically, we will focus on jobs that require the miner to interact with energized equipment on a daily basis or that require the miner to perform atmospheric and environmental monitoring as part their job description. Mining positions that fit these criteria are the continuous miner operator and fire boss. Continuous miner operators have many cognitive demands as they interact with other equipment, make decisions on a minute by minute basis, are changing the environment as they perform their jobs, have high productivity demands, and often need to work with other equipment and people on a constant basis. Fire bosses are responsible for gathering and assessing and reporting important information and making decisions throughout the day and their jobs can be non-routine depending on their findings.

- b. In what situations do the continuous miner operator and fire boss perform their jobs?
- c. What are the cognitive demands of jobs a continuous miner operator and a fire boss?

A previous U.S. Bureau of Mines task analyses report will be used as a guide for the examinations of the continuous miner operator and fire boss (Bureau of Mines, 1977). First, direct observations will be done by NIOSH researchers. This task is primarily necessary because it allows NIOSH researchers to gain in-the-mine experience with an experienced miner working as a continuous miner operator or fire boss while he/she is performing a specific task. The NIOSH researcher will mainly observe the miner; however, the researcher will take notes throughout and may ask the miner questions about a specific task when it is safe to do so. The direct observation data will be compared across mines to determine the tasks and subtasks of specific jobs (e.g., fire boss and continuous miner operator) and to create task diagrams. These task diagrams will be used by NIOSH researchers to facilitate the creation of the Task and Cognitive Task Analysis (CTA) materials (see Appendix D and E).

After direct observations are complete, task and cognitive task analyses will then be conducted on the aforementioned fire bosses and continuous miner operators. In these analyses, miners with several years of experience working in each of the positions (referred to as a Subject Matter Expert, SME) will be asked to describe the order in which tasks and subtasks must be completed while performing their job. Each SME will be asked to identify the tasks and subtasks that must be performed during his/her job. This information will be used to create a task diagram. Using the task diagram, NIOSH researchers will ask the SME to identify the tasks and subtasks that require cognitive skill to perform. The goal of this is to encourage the miner to pinpoint the aspects of the job that are cognitively demanding and require judgments or critical thinking to occur.

A knowledge audit will also be conducted as a part of the CTA. The knowledge audit identifies ways in which expertise is used in a domain and the audit is to capture the most important aspects of expertise while streamlining data collection. The tasks and sub-tasks given should reflect those that were gathered during the Task Diagram. During the knowledge audit, a series of probe questions are asked. These questions center on knowledge categories. These categories include the following: diagnosing and predicting, situation awareness, perceptual skills, developing and knowing when to apply tricks of the trade, improvising, metacognition, recognizing anomalies and compensating for equipment limitations. Questions/probes are to be used to begin a discussion about specific tasks. Additional questions should also be asked during the interview to solicit information about critical cues the SME uses while performing a task as well as the strategies used and decisions made. The interviewer should also ask about potential errors that a novice could make while performing a specific task or in a certain situation.

The final step in the CTA analysis includes the use of a simulation interview. This interview is based on the presentation of a challenging scenario to the SME. Prior to performing this task, the interviews must define the major events in the task. This information will be compared to what the SME judges to be the major events. One of the primary goals of the project is to understand the miner's perspective; direct observations and Task/Cognitive Task Analyses provide this opportunity. These data will be analyzed to determine which jobs and which specific tasks within a job category require the highest level of cognitive workload to perform.

- d. Which interfaces that are commonly employed in mining are easier/harder to use based on their ability to provide the information needed?
- e. What information do miners and mining industry professionals perceive to be the most valuable on a daily basis and in an emergency situation? What are their preferences on how this information is received— timing, medium, and amount?

Prior to creating the research questionnaires, a search was conducted to determine the breadth of tools and items (e.g., anemometer, two-way communicator, etc.) that are available to the mining industry. These items were then analyzed for commonly used interfaces. To address research questions 1.d & 1.e, three research questionnaires were created. The first research questionnaire (Subject Matter Expert (SME) Questionnaire, see Appendix F) was designed to assess information importance and use in different job titles and a second to assess informational availability and preference in general (General Preference Questionnaire, see Appendix G). The General Preference Questionnaires will be administered to a variety of miners. The SME Questionnaire will be limited to the SMEs and novices; miners that have taken part in the task/cognitive task analyses and the direct observations will be recruited as participants along with any additional SMEs and novices as required to meet the target number of participants. The questions included on these two research questionnaires will focus on types of information that can be provided to the miner (e.g., methane levels, dust exposure levels, location within in the mine, etc.). We are interested in capturing miner's opinions about information availability and presentation. The research questionnaires will be analyzed to determine what information miners find most useful and also how they would like to receive this information. The third research questionnaire, the Safety Director Questionnaire (see Appendix H), was developed to assess the type of equipment used by miners working in underground coal mines. For instance, we are interested in the type/brand of multi-gas detector, methanometer (methane sniffer), Self



Contained Self Rescuer (SCSR), etc. used within underground coal mines. We are also interested in how many of each of these items a mine possesses. The target audience for this questionnaire is Safety Professionals, or the person responsible for ordering or maintaining equipment at underground coal mines. This information is relevant to the current project because the miner has to interact with and understand the information either being gathered by or communicated with the equipment. Our goal is to determine what equipment is most commonly used and then analyze the equipment to understand how the underground coal miner uses each piece of equipment to increase his situational awareness.

### **Specific Aim 2**

The outcomes associated with Specific Aim 1 will be used to formulate hypotheses addressing the research questions associated with Specific Aim 2. The hypotheses will be related to improvements in situational awareness, cognitive workload levels, interface designs, and usability identified by the miners and surveillance data. Please note that because the specific hypotheses will be formulated after initial data is collected and analyzed, the following is a presentation of two high-level research questions and a general explanation of the research that will be conducted in order to answer the questions.

- a. Assuming practical near-term constraints, what alternative solutions / interfaces will enable current technologies to better benefit mine workers in terms of usability, wearability, and situational awareness? Examples include but are not limited to mining vests to integrate currently worn technologies, mining machine control designs, and other new or improved interface designs for current technology and equipment.
- b. Assuming minimal constraints, what adaptations can be made in these products and machines to improve their usability? Examples include but are not limited to an integrated development interface, new sensor technology, expanded communication networks, increased personal informational processing, and changes to equipment design to improve functional design and provide immediate feedback on the machine movements.

In order to answer the research questions associated with Specific Aim 2, a variety of research techniques will be used including research questionnaires, experimental setups, and focus groups.

To examine the effectiveness and viability of physically integrating equipment, several groups of miners will be asked to wear mining vests. Various designs and materials for mining vests will be chosen and distributed to miners across job titles and seam height. The miners will be asked to wear the vests during their normal working hours over one month. Pre and post opinions concerning the concepts and designs of mining vests and the comfort and usability of the tested vest will be collected using research questionnaires (Appendix J). Many of the same questions will be used on the pre- and post-visit questionnaires with minor modifications for tense and context. Basic demographic and job title information will be collected as well. However, the redundant questions that are not subject to change across the testing period will be removed.

Situational awareness is critical for decision-making. Another series of experiments will be designed to determine the extent to which different integrated systems provide varying levels of

situational awareness. We will test a variety of integrated systems in order to understand how each system influences decision-making. These systems will include (1) the current miner's outfit with all mandated equipment (e.g., the belt with the Self Contained Self Rescuer (SCSR), cap lamp and battery, etc.), (2) a physically integrated system of a vest with all mandated equipment combined into its structure, and (3) a physically and technically integrated system with all the mandated sensor technology outputting to a single interface. The third system described above will be an attempt to harness the various required safety components into an integrated development interface (IDI). This IDI will communicate wirelessly with the sensors and display their results as necessary on a single display – to control the presentation of information and enable the biggest improvement in situational awareness. In this first generation device, we will demonstrate that such a system is feasible. Future work may include systems that are designed from the ground up to serve as distributed sensor networks that are truly integrated as a human/sensor system.

Participants in the situational awareness experiments will take part in a task that simulates a standard emergency. The task will occur within the virtual reality (VR) environment. All participants will use all three systems to complete the task – the order will be randomized appropriately for the number of subjects. During each VR session, participants will be expected to complete the standard emergency response based on current training. The attention and performance of the participants will be used as a correlate for situational awareness. Dependent variables will include time to complete the emergency response, the number of errors made, EEG response, gaze duration, average and peak heart rate, skin temperature, galvanic skin response and other measures as they are acquired.

At the conclusion of the experiments designed to test information presentation (and the first iteration of the IDI) a series of focus groups will be conducted. The goal of these focus groups will be to assess miners' perceptions of the IDI, their thoughts on the design of the interface, the usability of the device as well as the wearability of the device. The design of the IDI and the experiments to test the device are dependent on the information collected during the first year of the research project. We are therefore unable to write the focus group questions now. The focus group questions will be written after the MSHA database analysis, research questionnaires, direct observations, and task/cognitive task analyses have been completed and the initial iteration of the IDI and experiments to test it have been designed. We will submit those questions as a non-substantive change request, (as the burden is currently accounted for in Table A.12), for OMB review once they are complete.

Another situational awareness related task is the testing of a lighting solution for roof bolter operators and their roof bolting machines. In this task, operators will be asked about the issues they have with the design of the controls, lighting issues and any other concerns they have with their job process and equipment. This is the pre-test questionnaire portion of the Roof Bolter Questionnaire (Appendix I). Then a lighting solution that has already been studied in a series of experiments that have been published will be administered. The opinions and ideas from the post-test portion of the questionnaire will be obtained.

### **Items of Information to be Collected**

The list of information items to be collected includes, but is not limited to:

- Age
- Current job title

- Number of years of experience at current job title
- Number of years working at current mine
- Years of mining experience
- Number of mines worked
- Shift timing and frequency
- Anthropometric measurements
- Miners' responses to questions about job specific tasks and the information that is necessary to safely and effectively perform the tasks
- Miners' responses to questions about difficulties associated with using common pieces of mining equipment and opinions on how to modify equipment to increase usability
- Miners' responses to questions about presentation preferences in importance, frequency, and method
- Miners' opinions on a mining vest, its uses, and design considerations
- Miners' responses to various levels of information presentation to measure situational awareness
- Miners' responses to various interface designs to test usability
- Miner's opinions on the visual feedback system of the roof bolter intervention

Data collection instruments that are not dependent on the results of others are included with this submission.

Several of the studies include the possibility of taking photographs and/or voice recording that may preserve identifiable data. Identifiable data will only be collected from individuals who sign a talent release. Otherwise, no individually identifiable information is being collected.

### **Identification of Website(s) and Website Content Directed at Children Under 13 Years of Age**

Web-based data collection methods may be used as a means to collect data for two of the research questionnaires, specifically the General Preference and Safety Director Research Questionnaires. Participants completing these questionnaires will be invited to do so via an email, the link to the research questionnaire will be included in the email or a paper copy containing the link for convenience. For the Safety Director Research Questionnaire, potential participants who are invited to complete the research questionnaires are likely to be at least 18 years of age or older because we are inviting the Safety Directors working at underground mine sites to participate. This is a position at the mine that generally requires several years of experience and a higher level of education to attain. As a precaution, we will indicate within the email that the respondent must be 18 years or older to take part. Furthermore, none of the questions included on the Safety Director Research Questionnaire are personal in nature, the questions are focused specifically on items and tools that are used by miners working underground. Since the General Preference Questionnaire is designed to reach a wider audience, subjects will be screened to be over the age of 18 to participate by distribution as well as the inclusion of a screening question in the beginning of the questionnaire. There will be no websites directed at children under 13 years of age.

## **2. Purpose and Use of Information collection**

Since mining is a hazardous environment, it is extremely important for NIOSH to collect this information as it is our goal to improve the health and safety of all coal miners. The data

collected during the project will be used by NIOSH researchers to establish HSI guidelines specific to the mining environment; these guidelines are critical for the industry because of the increase in equipment the miner is mandated to wear and interact with while working. The goal of the guidelines is to ensure that the correct information is being provided and only when it is necessary. This project and data collection will be fully funded by the NIOSH Office of Mine Safety and Health Research (OMSHR).

As mentioned earlier, the information to be collected will guide the development of mining specific HSI guidelines. To ensure that the guidelines actually address the mining industry specifically, it is critical that we understand the specific job titles and tasks required to perform those jobs. Through an understanding of the processes that are associated with the tasks and the information that is necessary to complete the tasks, we will be able to tailor the guidelines to them. The mining task specific information is not available from any other sources. Though previous task analyses have been performed (Bureau of Mines, 1977), this information needs to be confirmed as well as updated because the mining tasks and processes have changed significantly since the Bureau of Mines report and many of the jobs have been eliminated altogether. This data collection is therefore necessary in order to have an up to date understanding of the mining tasks and processes currently used within the underground mining environment. Without this information, it will not be possible to create mining specific HSI guidelines which are critical for the industry. Overall, this work is essential for the continued safety of the mining community that mining specific HSI guidelines be established. The guidelines will aid in the development of new technology and ensure miners are provided with the necessary information to safely perform their jobs.

### **Privacy Impact Assessment Information**

No IIF is being collected.

## **3. Use of Improved Information Technology and Burden Reduction**

Approximately 50% of the information collected via data collection instruments will require respondents to fill out a paper document. Data collection related to the testing of various interface designs, the usability of interfaces, the effects of changing situational awareness on miner behavior and the influence of workload demands on miner behavior will be collected via technology based strategies. In order to reduce the burden to the miners, the majority of planned data collection will occur at the job site which is an underground mine. This will eliminate any additional travel for miners who choose to take part in data collection. A portion of our data collection will take part at the NIOSH Pittsburgh Cognitive Engineering Laboratory facility. We anticipate this occurring in the third year of the project.

## **4. Efforts to Identify Duplication and Use of Similar Information**

There are documents that exist that detail the necessity of adopting a Human Systems Integration approach to research. One example is a book that was published by the National Research Council in 2007 titled 'Human-Systems Integration in the System Development Process: A New Look.' The purpose of this book was to recommend that government agencies take a HSI approach when designing and implementing new technology. There are also HSI guidelines that currently exist and are used in other industries. For instance, the Army has adopted Manpower

and Personnel Integration – MANPRINT – to establish policies and procedures that focus on Soldier-Oriented Research. The above-mentioned HSI materials will be incorporated into the research process to develop mining specific HSI guidelines. However, to adapt these theories to the mining environment a greater understanding of the mining specific tasks and processes is needed. Preliminary research related to dangerous jobs within an underground mine (Steiner & Burgess-Limerick, 2007) and a physical task analysis of specific jobs in an underground coal mine (Bureau of Mines, 1977) do exist. However, that research is limited in scope and in some cases, out dated. The mining industry has changed and evolved since the 70s, some positions that previously existed are no longer found within the mine, and new technology has brought about new tasks and positions. Thus, there is no similar data available for the population of underground coal miners and the current jobs/tasks and technology that are used within the underground mining environment. This information is necessary for the formulation of mining specific HSI guidelines.

## **5. Impact on Small Businesses or Other Small Entities**

Up to 415 miners from various underground coal mining operations in the United States will be invited to participate in the series of studies under this project. An attempt will be made to recruit participants from larger mining operations; however, it will be necessary to also recruit participants employed by small mines (operations with 50 or fewer employees). The research questionnaire will be held to the absolute minimum required for the intended use of the data. It is critical that the same number of questions be asked at each of the mines in the sample. Otherwise, it will be impossible to make valid comparisons and to formulate appropriate conclusions and recommendations. Direct observations will take no more than 4 hours, with minimal burden on the miners, while the Task/Cognitive Task analyses will take no more than 2 hours to complete. Data collection instruments (research questionnaires: SME, General Preference, and Safety Director,) will take less than 60 minutes to complete. The Roof Bolter Questionnaire will take less than 25 minutes (10 minutes pre-test and 10 minutes post-test) to complete. The Vest Usability testing will also take a total of approximately 120 minutes to complete, 60 minutes during the pre-visit and 60 minutes during the post-visit. Focus groups will take no more than 60 minutes each and in some cases, the focus group questions will be integrated into their mandatory training.

## **6. Consequences of Collecting the Information Less Frequently**

Within recent history, several large scale tragedies have occurred within the underground mining community. These tragedies include an explosion in 2006 at the Anker West Virginia Mining Company Sago Mine in Upshur County, West Virginia that resulted in the deaths of 12 miners and an explosion in 2010 at Massey Energy's (or Performance Coal Company's) Upper Big Branch Mine in Raleigh County, West Virginia that resulted in the deaths of 29 miners. There is evidence from both events, which suggests that had miners had increased situational awareness – more current information about the environment they were working in – they may have made different decisions. For instance, had miners working on the longwall section of the Upper Big Branch mine had continuous air readings available, they would have been aware of the presence of methane gas and consequently turned off the long wall machine until the gas was properly ventilated. Adopting a HSI approach ensures that the miner is taken into consideration during the planning, designing, and implementation of new systems and technology in the underground mine environment. One of the main goals of this approach is to increase the amount of

information – or situational awareness – that the miner has during his shift. If the miner has all relevant information about the current work environment available in an efficient interface, then he can make decisions that benefit his health and safety. It is critical this research is conducted to determine which jobs and tasks miners are currently performing and assess what information the miner thinks and is necessary to safely perform the job. If this research is not conducted, progress will not be made toward the incorporation of HSI into the mining environment. The development of mining specific HSI guidelines will be the first step in addressing these usability and situational awareness problems while working to prevent tragedies like Sago and Upper Big Branch from occurring again.

The task and cognitive task analyses planned here are intended to be a one-time data collection.

To our knowledge there are no legal obstacles to reduce the burden.

## **7. Special Circumstances Relating to the Guidelines of 5 CFR 1320.5**

This request fully complies with the regulation 5 CFR 1320.5

## **8. Comments in Response to the Federal Register Notice and Efforts to Consult Outside the Agency**

A. A 60-day Federal Register Notice was published in the *Federal Register* on September 25, 2012, vol. 77, No. 185, pp. 58845-58847 (see Appendix B). No public comments were received.

B. An extensive literature review was conducted. There were no personal consults outside NIOSH.

## **9. Explanation of Any Payment or Gift to Respondents**

It is expected that NIOSH researchers will work to accommodate mine schedules by traveling to mine sites to collect data from mine workers and to meet with mine safety personnel at stake holder meetings. Historically, we have made every attempt to accommodate the needs of mine management and most importantly the needs of the mine worker. However, there may be instances when it is necessary for a mine worker to travel to the NIOSH/OMSHR research facility located in Bruceton, PA (the research facility is approximately 9 miles from downtown Pittsburgh). Miners who travel and take part in studies outside of their paid work day will be compensated for their time. We will compensate those miners at a rate consistent with their current hourly salary so that the mine worker does not lose income because he has volunteered to participate in this research project. Furthermore, we will compensate at a level consistent with the mine workers current salary level so as not to provide an additional incentive for participation. The rate will be based on their current position in the mine and will be obtained from Bureau of Labor Statistics, U.S. Department of Labor, *Career Guide to Industries, 2010-11 Edition*, Mining, on the Internet at <http://www.bls.gov/oes/current/oes299012.htm>. We anticipate having to ask no more than 70 mine workers to travel to the NIOSH/OMSHR research facility in Bruceton, PA. Majority of these mine workers are likely to be employed as either continuous miner operators or fire bosses. Continuous miner operators currently earn an average hourly salary of \$25.48 and fire bosses currently earn an average hourly salary of \$21.63. Below is an estimate of the cost for data collection if these 70 miners were to travel to Bruceton, PA.

Continuous miner operators: 57.5 hours x \$25.48 = \$1,465

Fire bosses: 57.5 x \$21.63 = \$1,244

Total Cost: \$2,709

## 10. Assurance of Confidentiality Provided to Respondents

Miners who volunteer to participate will not be asked to provide any form of identifying information (e.g., name, SSN, etc.). Thus, no IIF will be included in the data records. All participants will be assigned a coding number that will not be linked with a name or any other identifying information. All information provided by participants will be stored by CDC/NIOSH researchers in a secure manner unless compelled otherwise by law. The data will be analyzed in the aggregate form and no individual participants will be identified.

However, some of the studies may include photographic and audio data. This data will only be collected if a talent waiver is obtained.

The data collection is being reviewed by the NIOSH Internal Review Board (IRB). Please see Appendix N for a copy of the approval letters for 2 tasks included in this submission, the Direct Observation and Vest Usability Testing. Because of the nature of the research plan (there are several distinct tasks included in this OMB package) and the time during the project these tasks will be conducted (see the project schedule on page 18-19), not all IRB permissions have been obtained. Development of the research protocols for the remaining tasks is currently underway and IRB approval documents will be forwarded to OMB when they are obtained. All IRB approvals (and future submissions) are expedited reviews.

### Privacy Impact Assessment Information

**10-A.** The privacy act does not apply to this submission as no information in identifying format will be collected.

**10-B.** In terms of physical controls, the completed data collection instruments will be stored in a locked file cabinet at NIOSH's Office of Mine Safety and Health Research (OMSHR) Pittsburgh Office. This is a secure, gated facility with 24-hour security guard service. Only personnel with proper identification badges are allowed access to the site. All of the data will be entered and combined into data files that will be stored with technical safeguards in a secure, password-protected location on the CDC/NIOSH computer network. This computer network is only accessible to NIOSH employees. All networks at NIOSH are firewall protected and utilize a virtual private network. Access to this information will be restricted to researchers directly involved with the study and those who need to view the data. A training session will be conducted for all researchers about the data collection and how the data will be stored. At this training session, all researchers will be made aware of their responsibilities for protecting information being collected and maintained. At the end of the data collection, the surveys will be destroyed.

Technical Controls	Physical Controls	Administrative Controls
Passwords	Security Guards	Access to data limited to researchers directly associated with task

Firewall	Identification Badges	Training Session
Virtual Private Network (VPN)	Office and File Cabinet Locks	

NIOSH Internal Review Board provides researchers with a Model Informed Consent Form. This form is modifiable and is the template that NIOSH researchers use as the basis for the Informed Consents submitted for approval. We are attaching the Model Informed Consent Form to this submission because it will be used in all studies related to this project (see Appendix Q).

**10-C. Direct Observation (Appendix O):** Participants will sign an informed consent (Appendix K) and talent waiver (if applicable – Appendix M). The consent form describes the study, the purpose of the study, and the use of information collected from the study. All participants will be told participation is voluntary during this process and given the opportunity to decline participation.

**Task and Cognitive Task Analyses (Appendix R):** Participants will sign an informed consent and talent waiver (if applicable – Appendix M). The consent form will describe the study, the purpose of the study, and the use of information collected from the study. All participants will be told participation is voluntary during this process and given the opportunity to decline participation. A draft of the protocol along with informed consent documents has been submitted along with the package (see Appendix R). We anticipate submitting this protocol to NIOSH IRB by 6/15/2013.

**Questionnaires- General Preference, SME and Safety Director (Appendices F, G, & H):** Questionnaire participants will sign an informed consent. The consent form will describe the study, the conditions of the study, and the use of information collected from the study. All participants will be told participation is voluntary during this process and given the opportunity to decline participation. A draft of the protocol along with informed consent documents has been submitted along with the package (see Appendix R). We anticipate submitting this protocol to NIOSH IRB by 6/15/2013.

**Roof Bolter Questionnaire (Appendix I):** Questionnaire participants will sign an informed consent. The consent form will describe the study, the conditions of the study, and the use of information collected from the study. All participants will be told participation is voluntary during this process and given the opportunity to decline participation. This questionnaire will be divided into two sections (pre-test and then post-test)

**Vest Usability Testing (Appendix P):** Questionnaire participants will sign an informed consent (see Appendix L and Appendix P for the study protocol). The consent form describes the study, the conditions of the study, and the use of information collected from the study. All participants will be told participation is voluntary during this process and given the opportunity to decline participation.

**Focus Groups:** Participants who agree to take part in interviews and/or focus groups will be read a waiver of signed informed consent and asked to state, “I agree to participate in this study.” Respondents who decline to participate in the interview state, “I decline.” This informed consent will be included with a future IRB submission.

**Experimental Research Studies:** Underground coal miners will be asked to take part in experimental research studies. All participants will be given an informed consent to read and



then sign to indicate agreement of participation. All participation in the experimental research studies is voluntary. This informed consent will be included with a future IRB submission.

The study researcher who reads the consent document signs it to certify that they have accurately described the study to the respondent.

**10-D.** Respondents taking part in all parts of this research are advised in the waiver of signed informed consent and the signed informed consent that their participation is voluntary (see Appendix K, L, and Q).

No IFF is being collected.

## **11. Justification for Sensitive Questions**

Participants will not be asked questions of a sensitive nature at any point during data collection.

## **12. Estimates of Annualized Burden Hours and Costs**

A. The respondents targeted for this study include underground coal miners who perform jobs such as continuous miner operator, and fire/face boss. Approximately 20 experienced miners will be selected for task and cognitive task analysis (10 continuous miner operators and 10 fire bosses) and another group of 20 experienced miners will be selected for direct observation (10 continuous miner operators and 10 fire bosses). The amount of time to complete data collections will be 2 and 4 hours for each of the task and cognitive task analysis and direct observation respectively. While we have listed Direct Observations with burden hours, we do not anticipate disrupting the miners work schedule. In fact, we ask that the miner conducts his job in a typical manner while NIOSH researchers observe the job being performed from a safe distance. Additionally, the preference and availability research questionnaire will be administered to a sample of 75 individuals (that may include previously selected miners) from various mining operations that have agreed to participate. This sample will be distributed across several mining operations. The amount of time to complete the General Preference Questionnaire (Appendix G) will be no more than 30 minutes. The SME Questionnaire (Appendix F) will be administered to 50 miners that may include miners from the CTA and direct observation studies. The amount of time to complete the questionnaire will be no longer than 60 minutes. Thirty Safety Directors will be asked to complete the Safety Director Questionnaire, it should take approximately 30 minutes to complete. A maximum of 60 individuals will also be recruited to test the usability of several mining vest designs. Participation will take place during normal working hours for a month and the pre and post questionnaires and documentation will take no more than two hours total. The roof bolter questionnaire will also be administered twice as a pre and post-test measure which will take approximately 15 minutes to complete each time. Participation in focus groups will require about 60 minutes.

Data collection will be performed with various data collection instruments and the majority of data will be collected at the mine site in order to limit the burden on the mining organizations and the participants. The information collected early in the project, through the Direct Observations, CTA, and research questionnaires (SME, General Preference, and Safety Director) will be used to guide the development of the questions included in the focus groups. Because we have not begun data collection yet, we are unable to submit the focus group questions at this time. We will however submit these questions as a non-substantive change request, (as the burden is currently accounted for in Table A.12), to OMB for review as soon as they are created.

Additionally, a series of experiments will be conducted at the NIOSH Pittsburgh research facility. We anticipate the experimental studies taking place in year 3 of the project and we plan to limit the number of underground coal miners asked to take part in order to limit the burden. The same true for the questions that will be asked during the experimental studies. We anticipate submitting those questions to OMB as soon as we have them available.

The following table provides an estimate of the total burden hours. The estimates are based on the researcher's previous experience conducting similar methods of data collection. Data will be collected over a period of two years.

#### Estimated Total Burden Hours

<b>Type of Respondent</b>	<b>Form Name</b>	<b>No. of Respondents</b>	<b>No. Responses per Respondent</b>	<b>Average Burden per Response (in hours)</b>	<b>Total Burden Hours</b>
Mine Employee	Informed Consent	285	1	5/60	24
Mine Employee	Talent Waiver	285	1	2/60	10
Mine Employee	Demographic Questionnaire	285	1	2/60	10
Mine Employee	Task and Cognitive Task Analyses: Continuous Miner Operator	10	1	2	20
Mine Employee	Task and Cognitive Task Analyses: Fire Boss	10	1	2	20
Mine Employee	Direct Observation: Continuous Miner Operator	10	1	4	40
Mine Employee	Direct Observation: Fire Boss	10	1	4	40
Mine Employee	General Preference Questionnaire	75	1	30/60	38
Mine Employee	Subject Matter Expert Questionnaire	50	1	1	50
Mine Employee	Safety Director Questionnaire	50	1	30/60	25

Mine Employee	Roof Bolter Questionnaire	30	2	15/60	15
Mine Employee	Vest Usability Testing	60	2	45/60	90
Mine Employee	Focus Groups	30	1	1	30
Mine Employee	Lab Experiments	30	1	1	30
<b>Total</b>					442

B. The estimated total cost for this information collection is \$10,886.

#### Estimated Total Burden Costs

Type of Respondent	Total Burden Hours	Mean Hourly Wage Rate	Total Respondent Costs
Underground Mine Worker	417	\$24.12	\$10,058
Safety Director	25	\$33.12	\$828

The value assigned for the hourly wage rate is based on the average U.S. hourly wage rate for coal miners available in the following report: Bureau of Labor Statistics, U.S. Department of Labor, *Career Guide to Industries, 2010-11 Edition*, Mining, on the Internet at <http://www.bls.gov/oes/current/oes299012.htm> (visited June 14, 2012). Because we are targeting miners who perform specific jobs within the mine (e.g., continuous miner operator and roof bolter operator) an average salary for the job titles we expect to collect data from was calculated, that is the number we report as the mean hourly wage rate.

### **13. Estimates of Other total Annual Cost Burden to Respondents or Record Keepers**

None.

### **14. Annualized Cost to the Government**

The time allotted for the project is three (3) years. During this three year period, instrument development, data collection, analysis and presentation are expected to occur. The estimated hourly cost to the Federal Government is \$33.72 per hour. This includes data collection by CDC/NIOSH employees, data analysis, and report writing. The hours designated for government staff were calculated as shown in the table below. The total cost average for a three year period is \$360,914.

	<b>Hours</b>	<b>Hourly Rate</b>	<b>Cost at Hourly Rate</b>	<b>Other Costs (data collection, etc.)</b>	<b>Total</b>
<b>Federal Government Employee</b>	10,500	\$33.72	\$355,914	\$5,000	\$360,914

## 15. Explanation for Program Changes or Adjustments

This is a new data collection.

## 16. Plans for Tabulation and Publication and Project Time Schedule

Data analyses will be conducted over the life of the project. The project schedules below provide an estimate of data collection activities, analysis, and dissemination. We are requesting OMB clearance for the maximum 3 years because data collection is likely to extend into the third year.

### Project Schedule:

<b>Activity</b>	<b>Time Schedule</b>
Conduct MSHA database analysis	1-6 months after OMB approval
Contact Mines for Data Collection	1-12 months after OMB approval
Perform Direct Observations	3-9 months after OMB approval
Perform Task and Cognitive Task Analysis	6-12 months after OMB approval
Perform Vest Usability Testing	6-13 months after OMB approval
Perform Roof Bolter Testing	3-6 months after OMB approval
Administer Questionnaires	5-17 months after OMB approval
Analyze data collected from mine sites	6-19 months after OMB approval
Formulate Hypotheses for experimental research studies designed to test situational awareness, interface design, usability and cognitive workload	12-19 months after OMB approval
Collect data to test the experimental hypotheses at the NIOSH research facility	15-32 months after OMB approval
Analyze experimental data and conduct focus	20-32 months after OMB approval

groups in the field.	
Publish findings from studies	24-36 months after OMB approval
Formulate mine specific HSI guidelines	30-36 months after OMB approval

Task and cognitive task analyses will be recorded and key tasks and sub-tasks will be identified by comparing the responses for all miners who take part.

For questionnaire data, descriptive analyses will be applied to the collected data. We are mainly interested in gathering percentages – how often do participants choose a specific response when they are given several options – and means and standard deviations - when a Lickert scale is included and participants are asked to provide a rating score.

For focus group data, we will apply qualitative analysis technique to the data and look for recurring themes and trends within the data.

For the experimental research that will be conducted, descriptive statistics will be applied to the data as well as inferential statistics. Descriptive statistics can include analyzing for mean, median, and modal scores. Measures of variance will also be calculated. Inferential statistics will be applied during hypothesis testing. Specific inferential statistics will depend on the design of the study that is conducted. Because hypotheses will be formulated following the analysis of the questionnaire, focus group and interview data, the specific analysis plan has not been created yet.

### **17. Reason(s) Display of OMB Expiration Date is Inappropriate**

Not applicable. The OMB expiration date will be displayed.

### **18. Exceptions to Certification for Paperwork Reduction Act Submissions**

There are no exceptions to the certification.

### References

- Bureau of Mines. (1977). Industrial Engineering Study of Continuous Mining Systems. (USBM Contract NO J0357096). McLean, VA: J.J. Davis Associates.
- Bureau of Labor Statistics. (2012). *Census of Fatal Occupational Injuries in 2010*. Washington, DC.
- Steiner & Burgess-Limerick. (2007). Equipment Related Issues and Controls in the USA Underground Mining Industry. *Ergonomics Australia*, 21(2), 4-11.
- Tvaryanas, A. P. (2006). Human systems integration in remotely piloted aircraft operations. *Aviation, space, and environmental medicine*, 77(12), 1278-1282.
- Wickens, C., & Hollands, J. (2000). *Engineering psychology and human performance* (3rd ed.). New York: Prentice-Hall.