



Bureau of Mines Information Circular/1983

Health and Safety In-House and Contract Research in Fiscal Year 1984

By Staff, Division of Health and Safety Technology



UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR

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BUREAU OF MINES

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HEALTH AND SAFETY IN-HOUSE AND CONTRACT RESEARCH IN FISCAL YEAR 1984

By Staff, Division of Health and Safety Technology

ABSTRACT

This publication summarizes the research (in-house and contract projects) programmed by the Bureau of Mines for fiscal year 1984 (October 1, 1983-September 30, 1984) under its Health and Safety Technology Program. The objective of these projects is to provide an ordered and sequenced advance toward the Bureau's overall goal of providing the systems technology required to create a more healthful and safer working environment for the Nation's mining and minerals processing workers.

INTRODUCTION

The Bureau of Mines conducts a balanced, continuing in-house research and development program to accelerate systematic improvements in health and safety conditions in U.S. mines. Part I of this report outlines the Bureau's present in-house effort to all interested parties; in particular, potential contractors can refer to it when submitting USP's (unsolicited proposals), thus avoiding proposing research that duplicates work being performed by the Bureau. Part II outlines the Bureau's current projected contract research needs.

The projects presented were planned in fiscal year 1983, before Congressional passage of the Bureau's fiscal year 1984 budget. They are, therefore, subject to change based on emerging priorities and availability of funds. Contingencies may require that a significant portion of the program be deferred into fiscal year 1985 (FY 85) or beyond.

Contracts for the Health and Safety Technology Program will be awarded in strict accordance with Federal Procurement Regulations. Availability of requests for proposals (RFP's) will be formally advertised in the Commerce Business Daily. No additional information will be supplied on these projects until after the RFP's are made available and then only in strict accordance with prescribed procedures. This document is not intended to solicit proposals from the contracting community. All USP's whose content reflects the objective(s) of the proposed projects listed herein will be returned without formal review.

PROGRAM OUTLINE

The objective of the Health and Safety Technology Program is to protect the health and safety of mining and minerals processing workers while insuring that newly developed technology incorporates health and safety criteria. In achieving this objective, four fundamental and complementary requirements must be considered by the research program:

1. Contributing to the viability of a basic industry.
2. Sustaining productivity.
3. Allowing for a return on capital investment.
4. Providing material and energy to the public.

Since mining and minerals processing involve a highly integrated and inter-related set of functions, the program has been divided into a set of interrelated subprograms, each with goals that will provide systems technology solutions to the problems within the framework of these fundamental requirements.

The Health and Safety Technology Program is divided into 12 subprogram areas as shown:

Health

Respirable Dust
Radiation Hazards
Noise Control
Industrial Hygiene
Ventilation

Safety

Fire and Explosion Prevention
Methane Control
Ground Control
Industrial-Type Hazards
Postdisaster
Explosives
Systems Engineering

The objectives of these subprograms are described in the following pages, followed by the planned projects and their corresponding descriptions. The aggregate value of the planned in-house projects is approximately \$26 million, and that of the anticipated contracts \$600,000.

PART I.--IN-HOUSE RESEARCH

HEALTH

Respirable Dust

Program Objectives: To investigate basic dust control technologies and concepts aimed at preventing the generation and entrainment of respirable dust during the mining cycle. To provide new and improved technology for measuring and controlling airborne respirable dust at levels that meet or are below standards set by the Federal law for all mining and mineral processing operations.

Control of Dust Formation

1. Define the Empirical Relationship Between Cutting Parameters, Dust Generation, and Cutting Forces for Coal and Rock

Objective: To conduct basic studies to determine the relationships between forces, energy, primary dust generation, and cutting parameters for coal type, bit geometry and bit usage, and establish a generic mathematical model to optimize any cutting system for minimum dust

generation. To continue field tests using the in-seam tester for in situ dust and energy measurements and for verification of laboratory results. This is a continuation of ongoing efforts.

2. Fundamentals of Dust Formation and Entrainment

Objective: To initiate laboratory studies to define the basic parameters and behavior of coal and quartz during coal breakage and how they affect the formation and entrainment of airborne respirable dust. This is a new effort.

3. Study of Coal Dust Wettability

Objective: To determine the critical performance parameters of surfactants for coal wetting and define the characteristics of a universal surfactant. To investigate the effects of coal surface chemistry on wettability. This is a continuation of an ongoing effort.

4. Mine Inspection Data Analysis System

Objective: To conduct a statistical analysis of available dust exposure data and complete the development of the exposure index that will aid the Mine Safety and Health Administration (MSHA) in determining its future inspection and sampling strategy. This is a continuation of an ongoing effort.

Control of Generated Dust

5. Determination of the Extrinsic Parameters Governing the Quartz Exposure of Coal Mine Workers

Objective: To complete study of the six cleanest continuous mining sections. Based on the results of the roof bolter dust sources study, to identify improved methods for roof bolter dust control. To evaluate the feasibility and effectiveness of using remote control to reduce the continuous miner operator's dust exposure. To initiate a study to identify dust sources at continuous haulage operations. To explore the concept of using high-pressure atomizing nozzles for control of dust on continuous miner

sections. This is a continuation of an ongoing effort.

6. Behavior and Transport of Silica Dust in Room and Pillar Mining Operations

Objective: To study the ventilation patterns and airflow characteristics at room and pillar operations and determine their effect on the behavior and transport of silica dust. To identify specific areas where silica dust behaves differently from coal dust and determine how dust control practices need to be modified to compensate for these differences. This is a new effort.

7. Investigation of Quartz Dust Generation During the Removal of Overburden Material at Surface Coal Mines

Objective: To identify and quantify silica dust sources at surface coal operations with special emphasis on sources governing the dust exposure of highwall drill operations. This is a new effort.

8. Identification of Dust Sources and Control Strategies for Auger Extraction of Coal

Objective: To determine the dust levels at the auger-machine operator--jack-setter location, and the effects on dust levels of air turbulence due to water spray and cutterhead motion and changes in airflow patterns. To investigate new and improved water spray and ventilation concepts for more effective dust control. This is a new effort.

9. Identification and Study of the Elemental Sources and Behavior of Respirable Dust as It Relates to Longwall Dust Control

Objective: To continue to identify and study the various sources of dust and quantify their impact on the face worker's dust exposure. To determine the effectiveness of evolving dust control techniques at active longwall faces. This is a continuation of an ongoing effort.

10. Study of Mining Practices and Concepts To Reduce Longwall Dust

Objective: To identify work practices and mining cycle modifications to reduce workers' exposure to dust generated during support movement. To evaluate the performance of the most promising techniques and provide guidelines to the mining industry for implementation of those practices and procedures. This is a continuation of an ongoing effort.

11. Define and Characterize Sources of Mill Dust and Its Control

Objective: To conduct studies to define mill dust sources using a tracer gas technique and identify appropriate control measures. To determine the level of dust generated during dumping and crushing operations and investigate the most effective suppression techniques. This is a continuation of an ongoing effort.

Dust Instrumentation and Measurement

12. Study of Respirable Dust Monitoring Strategies and Evaluation of Dust Measurement Concepts

Objective: To complete the study of the tapered-element oscillating microbalance (TEOM) dust sensing technology to determine sensitivity, accuracy, precision, and other performance and reliability factors. To evaluate the performance of the MINIRAM and the continuous respirable dust monitoring system. To continue development of a monitoring strategy for controlling respirable coal mine dust. This is a continuation of an ongoing effort.

13. Determination of Silica Particle Size Distribution in Respirable Mine Dust Samples

Objective: To determine the size distribution of mineral particulates collected from underground coal mines by scanning electron microscope (SEM) image analysis with special emphasis on size of silica particulates as related to the various coal seams. To initiate similar

analysis of surface coal mine dust samples. This is a continuation of an ongoing effort.

14. Rapid and Simple Analytical Technique for Measurement of Asbestos in Dust Samples

Objectives: To investigate the technical feasibility of using electrophoresis as a means to analyze dust samples for asbestos fibers. This is a new effort.

Radiation Hazards

Program Objective: To advance the state of measurement and control technology for protection of miners from exposure to radon and radon daughters and other nuclear radiation hazards in uranium and other mines.

Control of Radiation Hazards

1. Radon Control Technology

Objective: To complete studies to determine the effectiveness of activated charcoal filters in reducing radon concentrations. To define and investigate the parameters that influence the release of radon from radium-bearing ores, and develop a computer code to model the release of radon into the mine atmosphere considering ventilation pressures, mining activities, and inactive mines. This is a continuation of an ongoing effort.

Radiation Instrumentation and Measurement

2. Personal Exposure Measurement

Objective: To investigate the sensitivity and response of passive alpha detectors for radon measurements and study methods for measuring long-lived alpha emitters. To determine physical characteristics of radon daughters in mine atmospheres. To continue to evaluate the accuracy and reliability of emerging radiation measurement technology. This is a continuation of an ongoing effort.

Noise Control

Program Objectives: To work with industry to identify noise sources in underground and surface mines and in related mineral cleaning and preparation facilities, and to abate these noise sources sufficiently to meet Federal noise exposure standards.

1. Hearing Protector Research

Objective: To determine background noise levels under earmuffs and to study errors in the two-microphone attenuation measurement method. This is a continuation of an ongoing effort.

2. Noise Abatement Profile

Objective: To implement a computerized noise abatement profile and data base for the mining industry. This is a new project.

3. Mining Equipment Noise Control

Objective: To investigate new technical approaches to quieting load-haul-dump machines, continuous miner cutting heads, jumbo-mounted drills, and handheld hard rock drills. This is a continuation of an ongoing effort.

4. Basic Technologies for Mining Noise Control

Objectives: To investigate the noise-generating mechanisms of percussion drills and chain conveyors and to study the effectiveness of various noise controls. To research engineering designs aimed at reducing longwall shearer noise levels. To investigate the effect of the mining environment on the acoustical properties of materials. This is a new project.

Industrial Hygiene (Toxic Substances)

Program Objectives: To identify and control health hazards in surface and underground mines and mineral processing plants caused by toxic gases and fumes,

and certain particulates produced by explosives, combustible materials, and diesel engines. To develop and evaluate new instrumentation for monitoring these substances. To develop and/or refine analytical techniques for measuring and characterizing toxic substances, and investigate methods for controlling the formation and accumulation of toxic products. To analyze alternative power sources that may have health advantages over existing mine diesels.

Toxic Gases and Materials

1. Toxic Fumes From Explosives and Other Materials Used in Mining

Objective: To determine the identity and quantity of fixed gases, chemical vapors, and residues produced by the detonation of explosives and by the thermal oxidative degradation and combustion of materials used in underground mining operations. To determine the effect of low-order reaction due to marginal primary, deteriorated explosives, or to improper delay intervals in the production of toxic fumes during blasting. This is a continuation of an ongoing effort.

2. Monitoring and Measurement of Contaminant Gases

Objective: To devise and evaluate methods and devices that can be used effectively and efficiently by the mining industry to evaluate, maintain, and improve the working environment in underground mines. This is a continuation of an ongoing effort.

3. Cyanide Hazard in Cleaning "State of Maine" Filters

Objective: To devise simple and reliable cleaning procedures for "State of Maine" filters, used in the mining industry to collect the gold and silver in pregnant cyanide leach solutions, that minimize employee exposure to cyanide and cyanide compounds produced during cleaning. This is a new project.

4. Measurement and Control of Welding Fumes

Objective: To assess related industry practices pertaining to measurement and control of welding and cutting fumes, dust, and radiation, and adapt this technology to confined work areas found in the mining environment. To determine the quantity and character of welding pollutants and personnel exposure levels. To propose control systems and/or isolation techniques to reduce or eliminate exposure to toxic substances resulting from welding and cutting. This is a continuation of an ongoing effort.

Diesel Engine and Alternative Power Sources

5. Research To Control Diesel Engine Particulate Emissions

Objective: To investigate the reduction of miner exposure to diesel exhaust through identification, development, and evaluation of exhaust control technology such as fuel additives and filters. This is a new project.

Ventilation

Program Objectives: To develop ventilation systems required to maintain a safe and healthful atmosphere conducive to efficient work output in noncoal mines.

1. Improving Ventilation in Noncoal Mines and Mills

Objectives: To investigate the aerodynamics of face ventilation systems in large opening mines, to apply the thermodynamic principles of air-to-water heat exchange to the cooling of hot mines, and to investigate improved mine stopping construction techniques, especially in large-opening mines. This is a continuation of an ongoing effort.

2. Improved Stopping, Door, and Overcast Construction for Oil Shale Mines

Objectives: To establish the essential characteristics of stoppings subject to blast damage, high differential pressures, and roof, rib, and floor movement. To establish the required characteristics of stoppings, doors, and overcasts employed in large-opening mines, and use these characteristics to create conceptual designs. This is a new project.

SAFETY

Fire and Explosion Prevention

Program Objectives: To reduce the potential for a fire or explosion in mineral extraction and processing operations, to minimize the danger to people on account of fires or explosions that do occur, and to diminish the vulnerability to such attendant hazards as high temperature, asphyxiating and toxic fumes, and explosive gas mixtures.

Prevention and Detection

1. Investigation of Fundamental Approaches to Fire Warning in Underground Mines Including Stench Gas, CO Indicators, and Human Response

Objective: To continue an ongoing effort to reduce fire warning time for deep underground metal mines and ensure appropriate response by miners to warning signals.

2. Hazard Detection and Instrumentation

Objective: To continue an ongoing effort to identify, evaluate, and improve upon promising fire sensors and fire-sensing systems for use in underground mines. To develop prototype systems capable of (1) remote measurement of

methane and other flammable gases and (2) low-level smoke sensing.

3. Implementation of Coal Dust-Rock Dust Regulations

Objective: To continue an ongoing effort to provide improved instrumentation to enable MSHA to more readily determine compliance with current rock dust regulations. To validate the effectiveness of techniques such as water spray systems to reduce float coal dust. To maintain awareness of non-rock-dust alternatives for explosion prevention.

4. Fires in Mine Passageways

Objective: To continue an ongoing effort to provide data on mine fire parameters, such as fire growth rate, ignition source intensity, and fire size, that can lead to improved and realistic fire detection and a more realistic planning of fire emergency procedures.

5. Characterizing the Effect of the Mining Environment on Underground Metal Mine Fire Detection

Objective: To continue an ongoing effort to perform highly complex analyses of fire growth and containment spread using real-time inputs from in-mine detection instruments.

Ignition

6. Ignitability of Mineral Dusts, Gases, and Vapors

Objective: To continue an ongoing effort to develop and promulgate new and more reliable explosivity and ignitability indices for use in classifying dusts according to their hazard potential. Continue thermal and spark-ignitability studies in a new and larger furnace to permit more accurate control over the environments simulated as a representation of those encountered in mines.

7. Fire Hazards of Mine Combustibles

Objectives: To continue an ongoing effort to evaluate flame spread

rates of mine materials under sloping conditions.

8. Pacification of Sulfide Oxidation

Objective: To continue an ongoing effort to determine the kinetics and mechanisms of low-temperature oxidation of sulfides, particularly pyrite; to identify the rate-controlling step(s). To apply the result of this study to identify chemical and physical inhibitors and validate, first in large-scale laboratory tests and ultimately in mines, the ability of these inhibitors to prevent or retard sulfide oxidation and thereby reduce the probability of mine fires and resultant loss of property and life.

9. Spontaneous Combustion Research

Objective: To continue an ongoing effort to study the self-heating of materials under realistic conditions in order to provide criteria for prediction and prevention of spontaneous combustion occurrences.

Suppression

10. Laboratory Dust Flammability Studies

Objective: To continue an ongoing effort to delineate the domain of flammability for mixtures of coal dust-rock dust-methane in air. To find new, cost-effective supplements or substitutes for rock dust, and to continue testing, calibration, and improvement of a laboratory-scale explosivity test apparatus.

11. Microscopic Structure and Composition of Combustible Dusts and Residues

Objective: To continue an ongoing effort to conduct quantitative microscopic structure studies, size distributions, and composition analyses of various dusts with the SEM, electron microscope, and to apply the data obtained to combustion research and the forensic science of postdisaster investigation.

Propagation and Extinguishment

12. Fire and Explosion Hazards of Oil Shale Mining and Oil Mining

Objective: To continue an ongoing effort to provide guidelines for fire and explosion prevention during all phases of oil shale mining and processing.

13. Full-Scale Mine Explosion Research

Objective: To continue an ongoing effort on the ignition propagation and suppression of full-scale explosions of coal dust, oil shale dust, and gas in the Bruceston and Lake Lynn Experimental Mines; and to improve and maintain the instrumentation in both facilities.

14. Prevention and Suppression of Ignitions and Explosions

Objective: To continue an ongoing effort to develop, test, and conduct field trials of (1) new tool bit materials and/or tool bit geometries for the prevention of face ignitions, (2) barriers for the suppression of gas and coal dust explosions, and (3) sintered metallic components in braking systems of underground coal mine equipment to determine the extent of the friction hazard.

15. Mine Fire Diagnostics and Extinguishment

Objective: To continue an ongoing effort to develop needed guidelines for safe reopening of a mine following sealing of a coal mine fire, to evaluate mine fire detection and suppression systems, and to evaluate full-scale fires involving other mine combustibles such as mine dusts, brattice curtains, and conveyor belts.

Methane Control

Program Objective: To develop the technology that will enhance the ability of the mining industry to more effectively control methane in underground coal mines. The technology involved ranges from determining the fundamental

factors influencing the occurrence of methane to the development of techniques to control methane in advance of and during mining.

Fundamental Factors

1. Fundamental Factors Affecting Methane in Coal and Associated Strata

Objective: To determine the influences of geology on the occurrence and emission of methane. This is a new project.

2. Understanding the Mechanisms of Gas Outbursts in Coal

Objective: To assess the potential for and the minimizing of gas outburst hazards in coal mines. This is a new project.

3. The Geology of Methane in Metal and Nonmetal Mines

Objective: To determine the influence of geology on the occurrence and emission of methane in metal and nonmetal mines. This is a new project.

Control in Advance of Mining

4. Vertical Borehole Methane Drainage Longwall Mine Safety

Objective: To evaluate improved techniques of vertical borehole drainage for longwalls. This is a new project.

Control During Mining

5. Protection of Methane Drainage Systems

Objective: To investigate improved techniques for protecting methane drainage systems. This is a new project.

6. Methane Drainage for Low Permeability Coalbeds

Objective: To influence horizontal drilling and completion technology for use in low-permeability coalbeds. This is a new project.

7. Longwall Gob Gas Control Using Cross Measure Boreholes

Objective: To evaluate new techniques for gob degasification. This is a new project.

8. Development of Methane Control Strategies in Metal and Nonmetal Mines

Objective: To develop and evaluate specific methane control strategies for metal and nonmetal mines. This is a new project.

9. Ventilation for Methane Control

Objective: To conduct research on improved ventilation techniques for methane control in coal mines. This is a continuation of an ongoing effort.

Ground Control

Program Objectives: To develop technology that can be applied by the mining industry to reduce accidents due to the failure of underground mine roof, face, and ribs, and the collapse of surface mine and waste embankment slopes.

Mine Design and Development

1. Delineation of Abandoned Mine Workings and Other Mining Hazards With Integrated Geophysics

Objective: To field-test seismic, radar, controlled-source audio magnetotelluric, and resistivity techniques, determine relationships of various geophysical methods, and determine most appropriate methods for identification of mine hazards through multiple data set analysis. This is a continuation of an ongoing effort.

2. Structural Analysis and Design for Longwall Mining

Objective: To apply numerical modeling techniques to identify optimum entry configurations, pillar designs, and single-entry development for longwall mining of

steep coal seams and multiple seams. This is a continuation of an ongoing effort.

3. Field Investigation of Coal Mine Pillar Design

Objective: To identify major problems related to current designs of chain pillars and barrier pillars, and validate the design concepts using field instrumentation data and regressive integrity factor analysis. This is a continuation of an ongoing effort.

4. Geophysical Validation of Coal Mine Pillar Integrity

Objective: To evaluate geophysical methods for determination of the extent of and characteristics of yielded zones in coal mine pillars. This is a new project.

5. Evaluate Borehole Instruments for Rock Mechanics Investigations

Objective: To complete field and laboratory evaluation of the borehole shear tester and the improved borehole pressure cell, and initiate laboratory testing of a two-component physical property gage and a soft borehole deformation gage. This is a continuation of an ongoing effort.

6. Roof and Pillar Stability at Coal Mine Intersections

Objective: To analyze stresses and deformations in the roof and ribs at entry intersections of coal mines using numerical modeling techniques, and verify the results with field measurement of convergence and stresses. This is a new project.

7. Stress Technology for Improved Mine Design

Objective: To evaluate the effect of in situ stress fields on ground control problems and the potential of stress technology in improving mine structural design. This is a new project.

8. Geologic Studies for Coal Mine Ground Control

Objective: To classify hazardous geologic features of coal mine roof and identify suitable roof support techniques. This is a continuation of an ongoing effort.

9. Ground Control Design Procedures for Multiple-Seam Coal Mining

Objective: To assess the impacts of a previously mined coal seam on ground control in active mine workings and develop design criteria for multiple-seam coal mining. This is a continuation of an ongoing effort.

10. Health and Safety Recommendations for Single-Entry Longwall Mining

Objective: To determine recommended variances in health and safety requirements for single-entry development systems for retreat longwall mining. This is a continuation of an ongoing effort.

11. Model Studies and Field Verification of Roof Bolting Criteria

Objective: To develop design guidelines for mine roof reinforcement using various types of roof bolts by collating the results of full-scale model testing, finite-element computer analysis, and in-mine tests. This is a continuation of an ongoing effort.

12. Engineering Data Base for Coal Mine Ground Control Planning

Objective: To develop and establish a centralized geological and engineering data base for coal mine control planning and design. This is a new project.

13. Blasting Parameters That Affect Highwall Stability

Objective: To complete field evaluation of improved blasting practices for highwall stability in surface coal mines. This is a continuation of an ongoing effort.

14. Application of Geodynamic Accumulated Strain Sensor to In Situ Rock Stresses Measurement

Objective: To develop acoustic transducers for in situ rock stress measurement based on pulsed-phase-locked-loop technology and demonstrate their application. This is a continuation of an ongoing project.

15. Evaluation of Ground Stability Problems in Quarry Operations

Objective: To identify ground control hazards in deep slate quarries, and demonstrate application of geotechnical engineering to quarry planning and operations for highwall safety. This is a continuation of an ongoing effort.

16. Mine Void Mapping With Controlled-Source Audio Magnetotelluric System

Objective: To evaluate the use of a controlled-source audio magnetotelluric system previously developed under Bureau contract for mapping mine voids and geologic anomalies. This is a continuation of an ongoing effort.

17. Roof Stability Through Automated In-Mine Environmental Control

Objective: To complete the laboratory study on time-dependent behavior of coal measure rocks due to moisture effects. This is a continuation of an ongoing effort.

Hazard Detection and Monitoring Systems

18. Automated Microseismic Roof Fall Warning System

Objective: To complete verification of the capability of high-frequency, microseismic single-point transducer systems in predicting and warning against small roof falls, and transfer the innovative technology to the industry. This is a continuation of an ongoing effort.

19. Coal Mine Bounce and Outburst Studies

Objective: To assess the reliability of low-frequency microseismic monitoring techniques to delineate areas of eventual coal bounce failure, and high-frequency techniques as a warning system for outbursts. This is a continuation of an ongoing effort.

20. Three-Dimensional Remote-Sensing Data Analysis for Mine Hazard Prediction

Objective: To investigate a composite methodology to construct three-dimensional mine hazard maps by combining satellite imagery data, aerial photographs, geologic and geophysical information, and digital terrain mapping. This is a continuation of an ongoing effort.

21. In-Seam Hazard Detection Using Geophysical Techniques

Objective: To evaluate high-resolution guided wave seismic and radar technologies that are reliable and accurate in detecting and locating hazardous geologic features and mine voids within a coal seam. This is a continuation of an ongoing effort.

22. Mine Inundation Warning Systems

Objective: To complete field evaluation of practical methods and instruments for inundation warning in underground coal mines. This is a continuation of an ongoing effort.

23. Critical Parameters Controlling Roof Stability

Objective: To investigate roof-to-floor closure rate criteria for roof fall prediction using potentiometric and ultrasonic closure rate devices. This is a continuation of an ongoing effort.

24. Acoustic Cross-Borehole and In-Mine Roof Hazard Detection Systems

Objective: To complete assembly of the low-frequency, acoustic cross-borehole hazard detection system, install the instrumentation in a field logging vehicle, and conduct performance tests. This is a continuation of an ongoing effort.

25. Prediction and Control of Rock Bursts and Failures in Mines

Objective: To complete improvements of the standard microseismic rock burst monitoring system and analysis procedures, and continue collection of microseismic and electromagnetic radiation data at the Galena Mine for improving failure prediction capability. This is a continuation of an ongoing effort.

26. Detection of Imminent Rock Failure in Deep-Vein Mines

Objective: To complete field evaluation of the improved seismic rock burst monitoring system using fiber optic links for data transmission. This is a continuation of an ongoing effort.

Roof Support Systems

27. Arch Canopy Research

Objective: To determine the dynamic response of arch canopies, their structural components, and tunnel liner back-fill systems to impact loading. This is a continuation of an ongoing effort.

28. Fundamental Drill and Bolt Parameters Affecting Roof Integrity

Objective: To determine if roof bolts can be installed with uniform tension in widely varying roof conditions and determine roof stability that results. This is a continuation of an ongoing effort.

29. Ground Control System Safety Analysis

Objective: To examine ground control accident reports to determine trends and significance of conditions and circumstances contributing to accidents and fatalities. This is a continuation of an ongoing effort.

30. Inorganic Cementing Materials

Objective: To develop chemical binders and methods of application to mine roofs to increase the mine roof stability, with special attention to potential inorganic binders. This is a continuation of an ongoing effort.

31. Investigation of Factors Associated With Cutter (Shear) Roof

Objective: To perform engineering and geologic studies to determine causes of cutter roof. This is a continuation of an ongoing effort.

32. Support of Thick Coal Roofs in Western Mines

Objective: To determine optimum support devices for safe, effective support of underground mine roofs composed of thick top coal. This is a continuation of an ongoing effort.

33. Support for Large Underground Openings

Objective: To formulate, develop, and test concepts for ground support systems to stabilize large underground openings in thick-seam coal. This is a continuation of an ongoing effort.

34. Passive Roof Supports To Control Ground

Objective: To develop fundamental data on the function of passive, artificial yielding roof supports used during mining. This is a continuation of an ongoing effort.

35. Corrosion of Metallic Roof Support Elements

Objective: To develop guidelines to aid MSHA and mining personnel in predicting the life of roof support systems, determine detrimental effects of corrosive mine environments on friction rock stabilizers (split set), and help identify potential control measures. This is a continuation of an ongoing effort.

36. Nontensioned Rock Reinforcement

Objective: To develop nontensioned, full-column inorganic grouted rock bolts for use in metal and nonmetal mines; complete testing of a scaler for use in metal and nonmetal mines. This is a continuation of an ongoing effort.

37. Minimum Column Lengths for Resin-Grouted Bolts in Evaporites

Objective: To determine the minimum column lengths required to insure safe working conditions when rock conditions are such that some grout is forced out into the rock mass. This is a continuation of an ongoing effort.

38. Flexible Distributed-Load Support System

Objective: To define the interactive mechanics of flexible distributed-load supports; to determine the critical parameters that control the selection of backpacking materials; to investigate alternative materials (other than steel) for use as flexible liners; to determine how a flexible support system could be integrated into the excavation cycles in highly stressed or broken ground; and to establish and verify a theory for flexible distributed-load support that will lead to effective design and implementation of the systems. This is a new project.

39. Roof Bolt Effectiveness Monitoring Using High-Frequency Microseismic System

Objective: To evaluate data analysis techniques of self-generated rock noise (ultrasonic frequency range) as related to dynamic structural response in underground mines. This is a new project.

40. Push-Out Pillar Support System for Retreat Mining

Objective: To design and evaluate push-out pillars and the immediate support systems required to maintain a safe working area in a room and pillar retreat section. This is a new project.

Safe Support Installation

41. Support-Rock Interaction Mechanics for Full-Column Bolting

Objective: To develop fundamental knowledge and understanding of the behavior of full-column bolting in underground mines, especially using non-standard grouts and bolts. This is a continuation of an ongoing project.

42. Research on the Initiation, Monitoring, and Destressing of Coal Mine Bounces, Coal Bursts, and Gas Outbursts in Deep Western Mines

Objective: To integrate field measurements and observations with numerical analysis and laboratory studies to gain a better fundamental understanding of why a bounce, burst, or outburst occurs and how to eliminate or reduce them in coal mine entries and longwall faces. This is a new project.

43. Theory and Mechanics of Roof Truss Behavior

Objective: To develop basic data on the support characteristics of roof trusses, to determine the performance of a field roof truss tension measuring device, and to evaluate concepts to provide faster and safer installation of

trusses. This is a continuation of an ongoing project.

44. Effects of Bolt Installation Procedure on Mine Roof Stability

Objective: To determine bolting procedures that enhance or degrade roof stability. This is a continuation of an ongoing project.

45. Longwall Mining Investigations

Objective: To develop data on support loadings and strata activity associated with the development of longwall gateroad entries and subsequent mining of longwall panels; to evaluate techniques for strata stabilization and void fillings. This is a continuation of an ongoing project.

46. Systems Interaction for Support Installation

Objective: To evaluate support installation concepts that remove the miner from immediate danger when placing bolts. This is a continuation of an ongoing project.

47. Retreat Mining Geomechanics

Objective: To determine the mechanisms of roof collapse during retreat mining and establish guidelines to improve the safety of retreat mining. This is a continuation of an ongoing effort.

48. Relation of Dynamic Roof Bolt Loads to Mine Stability

Objective: To determine factors influencing roof bolt load and relate their influence to mine stability. This is a new project.

Waste Stability

49. Generic Modeling of Waste Embankments and Backfilled Structures

Objective: To design and validate generic models via mathematical analysis,

computer codes, and centrifuge testing for the evaluation of the design and construction of surface waste embankments and underground backfilled mines. This is a new project.

50. Surface Disposal of Mine Waste and Mill Tailings

Objective: To investigate methods of slurried waste deposition that will place higher strength materials close to the embankment, and concepts for the disposal of fine coal refuse that eliminate the need for slurry impoundments. This is a new project.

51. Consolidation of Coal-Clay Waste by an Improved Flocculation Technique

Objective: Demonstrate the feasibility of using an improved flocculation technique to dewater fine coal waste sludge to produce a consolidated, stable waste material. This method will be field tested using polyethylene oxide as a flocculating agent. This is a continuation of an ongoing effort.

52. Evaluation of Filter Cloth for Stabilizing Coal Mine Waste

Objective: To improve the stability of coal mine refuse piles through a determination of the long-term effectiveness of using synthetic filter cloths to assist in embankment drainage. This is a continuation of an ongoing effort.

Industrial-Type Hazards

Program Objectives: To (1) determine how the quality of training can be increased to insure miners can do their tasks safely and productively, (2) define the role of the human in all aspects of tasks required during the mining cycle, (3) determine how the human can be protected from the hazards of mining, (4) determine what information must be available to the miner and at what level to increase safety, and (5) determine what information must be available to reflect the human requirements in equipment designed for mining.

Electrical

1. Intrinsic Safety

Objective: To investigate problems related to the basic understanding of intrinsic safety, supply technical support to Bureau of Mines researchers, contractors, and MSHA, and participate in national and international committees to develop recommendations for using electrical equipment in potentially explosive atmospheres. This is a continuation of an ongoing effort.

2. Permissible Equipment

Objective: To develop a design guide and quality assurance standards for explosion-proof enclosures, begin testing a medium-high (600 to 8,000-V) voltage connector, and develop acceptance and test criteria for high-voltage permissible load centers. This is a continuation of an ongoing effort.

3. Grounding and Ground Fault Protection

Objective: To modify existing sensitive ground fault interruptors or develop new units for use in U.S. underground mines, and to test those units for durability and shock prevention and establish applicable standards for future use. This is a new project.

4. Mine Power System Safety and Reliability

Objective: To investigate mine power system problems that have the potential for causing mine fires, methane explosions, and exposure of mine personnel to electrical hazards, and to develop technology to improve the reliability and maintainability of power systems. This is a new project.

5. Inherently Safe Electrode Reactions for Use in Electrokinetic Dewatering

Objective: To investigate cathode reactions that will be inherently safe and can substitute for the hydrogen-generating reduction of water in the

electrokinetic process of dewatering mine tailings. This is a new project.

Illumination

6. Investigation of Minimal Luminance Requirements for the Mining Industry

Objective: To collect and analyze data from surface and underground mines that can be used to evaluate and recommend minimal luminance levels for the industry. This is a new project.

7. Fundamental Research on Potential Use of Large Diameter Fiber Optics for Area Illumination

Objective: To evaluate the potential use of fiber optic illumination systems in underground mines with emphasis on glare reduction, safety, reliability, maintenance, and economics. This is a new project.

Mine Communications and Monitoring

8. Mine Telemetry and Environmental Surveillance Systems

Objective: To collect basic in-mine data on environmental mine monitoring systems. The data will be used for evaluation of system reliability, sensor and transducer performance, and data security. This is a continuation of an ongoing effort.

9. Performance Standards and Systems Approach to Mine Monitoring

Objective: To develop and evaluate criteria for an intrinsically safe mine monitoring system. The research will concentrate on a systems approach, reliability, sensors, and data security. The system provides adequate safety protection that is cost effective. This is a continuation of an ongoing effort.

10. Electromagnetic Signal Propagation in Underground Mines

Objective: To evaluate techniques to improve the range and reliability of medium-frequency (MF) radio propagation

along with an investigation of MF application to in-mine data transmission. This is a continuation of an ongoing effort.

Human Factors

11. The Investigation of Improved Management Practices for the Mining Industry

Objective: To ascertain the relationship of current management practices to miners' safety, productivity, and turnover rates; and on the basis of the findings from this work, recommend approaches for the improved management of coal miners. This is a new project.

12. Human Factors of Manual Materials Handling in the Coal Mining Industry

Objective: To identify and define the hazards of manual materials handling in the coal mining industry, and to develop manual materials handling guidelines specific to the needs of the coal mining industry. This is a new project.

13. Computer Modeling of Mining Crew Stations

Objective: To determine the demands placed on mobile equipment operators while operating underground coal mining machinery and to incorporate the results into the ongoing work on developing a computer model of operator compartments. This is a continuation of an ongoing effort.

14. Reduction of Human Error Accidents in Underground Mining

Objective: To reduce mining accidents and injuries associated with "human error," and to improve productivity related to human performance. This is a continuation of an ongoing effort.

15. Research To Enhance the Conduct of New Hire, Refresher, and New Task Training

Objective: To enhance the efficiency and effectiveness of mine training

through the systematic investigation, study, and development of performance criteria and competency-based training methods. This is a continuation of an ongoing effort.

16. Fundamental Factors of Operator Alertness To Enhance Surface Mining Safety

Objective: To determine human behavioral aspects of the man-machine-workplace interface that contribute to unsafe behavior in surface mining, develop practical techniques that can correct these problems, and test such techniques under controlled conditions that simulate the mining environment. This is a new project.

17. Blasters Training for Metal-Nonmetal Miners

Objective: To prepare recommendations for the development of materials that would be used for classroom and on-the-job training of blasters in metal and nonmetal mines. This is a new project.

Mine Equipment Safety

18. Application of Robotics to Underground Mining

Objective: To conduct an intensive, systematic study directed toward greater knowledge and understanding of robotics to determine the potential for the development of mining systems that will rely primarily on robotics technology to increase safety. This is a continuation of an ongoing effort.

19. Equipment Technology for Reduced Accidents

Objective: To explore the application of innovative technology to improve health, safety, and productivity in mining. Areas addressed by the program are ground fall protection for operators of thin-seam face equipment, braking systems on mobile face equipment, worker injury related to slipping, and accidents analysis. The scope of mining areas included in the program is intentionally broad,

covering specific problem areas that lend themselves to long-term engineering solutions. This is a continuation of an ongoing effort.

20. The Fundamentals of Electromechanical Technology for Large Mobile Mine Equipment Automation

Objective: To improve safety of the mobile mine equipment operator's work environment; delineate the fundamental aspects and improve the associated technology to make mobile equipment operators more aware of their surroundings; and delineate automation priorities on large mobile mining equipment. This is a continuation of an ongoing effort.

Haulage and Materials Handling

21. Evaluation of Conveyor Belt Cleaners

Objective: To reduce belt cleanup requirements, through research to determine the parameters to increase the effectiveness of conveyor belt cleaners, and thus reduce the exposure of mine maintenance personnel to the dangerous cleanup job. This is a continuation of an ongoing effort.

22. Hoisting Systems Research

Objective: To increase the safety and efficiency of hoisting operations by (1) quantifying the effects of degradation upon the structural integrity of hoist rope and (2) studying the relationship between material deformation and energy dissipation for utilization in hoist arrestments. This is a continuation of an ongoing effort.

23. Haulage and Materials Handling Accident Reduction

Objective: To isolate the causes of powered haulage and materials handling accidents and to develop concepts and guidelines for equipment design that will reduce the injuries resulting from these operations in underground coal mines. This is a continuation of an ongoing effort.

24. Wire Rope Inspection, Retirement, Selection, and Use

Objective: To investigate present methods and, where appropriate, derive better methods for inspection, use, and selection and for combining underground mine hoist-rope and associated equipment, and to prepare new hoist-rope retirement (replacement) criteria. Existing inadequate retirement criteria will be replaced by improved criteria that will increase the reliability and safety of man and/or material hoisting operations. This is a continuation of an ongoing effort.

25. Laboratory Analysis of Wire Rope

Objective: To define and control the microstructure of wrought, pearlitic steel, wire, hoist ropes to extend fatigue life, and to perform metallurgical analyses such as chemical composition and microstructure determinations to support the needs of the entire Wire Rope Program at the Bureau of Mines Pittsburgh, Spokane, and Albany Research Centers. This is a continuation of an ongoing effort.

Postdisaster

Program Objectives: To develop the technology that will enhance the chances of miners to escape, survive, and/or be rescued following mine fire, explosion, or outbursts of gas. This involves personal protection equipment for miners and rescue teams, preplanned rescue and survival systems, and devices to detect, locate, and communicate with trapped miners.

Survival

1. Life Support for Escape and Rescue

Objective: To conduct research to investigate the physiology of escape and rescue and the use of metabolic breathing simulators in testing and design of breathing apparatus, and to enable long-term field evaluations of self-contained self-rescuers. This is a new project.

Communications

2. Evaluation of the Concept of a Medium-Frequency Radio System for Mine Rescue

Objective: To evaluate medium-frequency radio system for its application to mine rescue operations and communication with trapped miners. This is a new project.

Rescue and Mine Recovery

3. Gas Instrumentation for Rescue Teams

Objective: To quantify the effects of selected atmospheric and environmental parameters in commercially available methane detection instruments. This effort is in direct response to an MSHA request. This is a new project.

4. Evaluation of a Deep Mine Rescue System

Objective: To evaluate a deep-mine electromagnetic rescue system. This is a continuation of an ongoing effort.

Explosives

Program Objectives: To maintain surveillance over permissible explosives and related items; determine hazard characteristics of explosive substances, devices, and systems not classified as permissible; and conduct research to support MSHA in establishing and enforcing meaningful standards and in investigating accidents related to explosives. To conduct fundamental studies of explosive behavior and apply results to new technology. To develop new and improved test procedures as new mining methods are introduced and new types of explosives are formulated.

1. Development of Safer Blasting Procedures and Improved Explosive Hazard Techniques

Objective: To continue an ongoing effort that increases safety in blasting techniques and reduces explosive hazards

in underground coal mines by (1) determining how blasting parameters affect the probability of ignition in multiple-delay blasting, (2) defining and evaluating sheathed explosives for specific applications and then proposing scheduled tests for their approval, and (3) providing hazard criteria and test procedures for new explosives, blasting agents, initiating systems, and related devices involved in accidents.

2. Effect of Explosive Properties and Blasting Procedures on Incendivity and Performance

Objective: To continue an ongoing effort to evaluate new candidate permissibles and insure that certified permissibles are made to specifications. To study conditions that will improve safety and performance, including those of the relatively new water gel and water emulsion permissibles. To improve blasting procedures in gassy noncoal mines by identifying hazards of stemming in large blastholes and improving blast area security technology.

3. Basic Understanding of Deflagration and Detonation Phenomena

Objective: To continue an ongoing effort to understand conditions that cause explosives to malfunction by investigating fundamental physical thermodynamic hydrodynamic parameters.

Systems Engineering

Program Objectives: To develop methods for evaluating the impact of specific technological improvements or inadequacies on the total mining operations and identify problems whose solutions would provide the greatest health and safety benefit. To operate and maintain underground research and test facilities for use in testing and demonstrating new procedures and equipment before they are tested in commercial mines.

Systems Analysis

1. Effectiveness of Mine Systems

Objective: To continue an ongoing effort to determine cost effectiveness of Bureau safety systems and hardware in order to accelerate their adoption by the mining industry; and to perform mine hazard analyses of total mine operations and address interactions among health and safety problems that occur. To update data on mine equipment use for identifying potential hazards in coal mining operations; and to acquire data that incorporate multidisciplined, basic research on solutions to deal with emergencies, prevent or mitigate disasters, and reduce accidents.

2. Analysis of Mine Systems

Objective: To continue an ongoing effort to provide the mining industry with the most modern safety management techniques at a minimum cost to the mines.

Test Facilities

3. Operation of the Lake Lynn Laboratory

Objective: To continue an ongoing effort to operate and maintain specialized full-scale underground and surface test facilities. Examples of research activities to be pursued include (1) re-evaluation of passive barrier deployment guidelines, (2) test of triggered barrier systems mounted on a continuous miner, (3) validation of concepts on the ignition and propagation of coal dust explosions, (4) evaluation of large-scale burn tests involving explosives and blasting agents, and (5) acquisition of data for approval of sheathed explosive charges in novel applications.

4. Operation of the Safety Research Coal Mine and the Experimental Mine

Objective: To continue an ongoing effort to operate and maintain two specialized full-scale underground mine facilities located at Bruceton. Examples of research activities to be pursued include (1) identification of explosion hazards of float coal dust layers, (2) development of practical, economical, and reliable triggered and low-coal barriers, (3) determination of the effects of large fires on mine ventilation systems, (4) evaluation of sealed mine fires and their extinguishment, and (5) determination of the effects of static loading on a bulk-head anchorage system.

5. Operation of the Twilight Mine Radiation Facility

Objective: To continue an ongoing effort to operate and maintain a

specialized full-scale underground uranium mine for tests to be conducted by the Bureau's Spokane Research Center.

Assistance With Program Management

6. Health and Safety Analysis Center (HSAC) Support

Objective: To continue an ongoing effort to provide the Bureau with easy access to statistical facts relating to employment and accident information collected and compiled by HSAC.

7. Research Management and Planning System (RMAPS) Support

Objective: To continue an ongoing effort to provide a dynamic information system that is capable of handling simple or complex real-time inquiries for use as a management tool or for decisionmaking.

PART II.--CONTRACT RESEARCH

HEALTH

Respirable Dust

Program Objectives: To investigate basic dust control techniques and concepts aimed at preventing the generation and entrainment of respirable dust during the mining cycle. To provide new and improved technology for measuring and controlling airborne respirable dust at levels that meet or are below standards set by the Federal law for all mining and mineral processing operations.

Control of Generated Dust

1. Control of Respirable Quartz on Continous Mining Sections

Objective: To evaluate sources of airborne quartz dust and research control technologies that will assist mine operators in complying with respirable dust standards that are more stringent because of quartz in the dust exceeding 5 percent. This is a continuation of an ongoing effort.

2. Evaluate Fundamental Approaches to Longwall Dust Control

Objective: To evaluate the effectiveness of available dust control technology for double-drum shearer longwall sections, with special emphasis on support-generated dust and mining practices, in a coordinated, systematic program at several longwall test sections, and to make the results available to the coal mining industry. This is a continuation of an ongoing effort.

Industrial Hygiene (Toxic Substances)

Program Objectives: To identify and control health hazards to surface and underground mines and mineral processing plants caused by toxic gases and fumes, and certain particulates produced by explosives, combustible materials, and diesel engines. To develop and evaluate new instrumentation for monitoring these substances. To develop and/or refine analytical techniques for measuring and

characterizing toxic substances, and investigate methods for controlling the formation and accumulation of toxic products. To analyze alternative power sources that may have health advantages over existing mine diesels.

Diesel Engine and Alternative Power Sources

1. A Clean Internal Combustion Engine for Underground Mining Machinery

Objective: To determine the adequacy of the safety devices and systems of the prototype hydride-fueled mining vehicle currently being fabricated. This is a continuation of an ongoing effort.

Ventilation

Program Objectives: To develop ventilation systems required to maintain a safe and healthful atmosphere conducive to efficient work output in noncoal mines.

1. Effective Face Ventilation Systems for Oil Shale Mines

Objective: To develop and evaluate conceptual designs for large-opening face ventilation systems and to in-mine-evaluate two of these designs. This is a continuation of an ongoing effort.

SAFETY

Postdisaster

Program Objective: To develop the technology that will enhance the chances of miners to escape, survive, and/or be rescued following mine fire, explosion, or outbursts of gas. This involves personal protection equipment for miners and rescue teams, preplanned rescue and survival systems, and devices to detect, locate, and communicate with trapped miners.

Rescue and Mine Recovery

1. Low-Profile, Lightweight Rescue Breathing Apparatus

Objective: To develop a 2-hour, low-profile, compressed-oxygen rescue breathing apparatus suitable for use in low coal at longwall faces. This is a continuation of an ongoing effort.

2. Rescue Team Helmet

Objective: To develop a rescue team helmet that provides full head protection, an integral facepiece, communications, and a miner's lamp and is compatible with the new low-profile, lightweight rescue breathing apparatus. This is a continuation of an ongoing effort.

