A minerals research contract report
APRIL 1982

DESIGN, DEVELOPMENT AND VALIDATION OF A TRAINING SYSTEM FOR ROOF BOLT EQUIPMENT OPERATORS

Contract H0188039
Allen Corp. of America

BUREAU OF MINES
UNITED STATES DEPARTMENT OF THE INTERIOR

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or of the U.S. Government.

Reference to specific brands, equipment, or trade names in this report is made to facilitate understanding and does not imply endorsement by the Bureau of the Mines.

(This page replaces old Title Page)

REPORT DOCUMENTATION PAGE

1. Report No.	2.	3. Recipient's Accession No.
H0188039		

3. Title and Subtitle	5. Report Date
Design, Development, and Validation of a Training System for Roof Bolt Equipment Operators	10 April 1982
	6.

7. Author(s)	8. Performing Organization Report No.
William M. Hinton, Jr., George W. Menzer, Raymond E. Reilly, Robert M. Baker	

9. Performing Organization Name and Address	10. Project/Task/Work Unit No.
Allen Corporation of America 401 Wythe Street Alexandria, Virginia 22314	11. Contract or Grant No. H0188039
	13. Type of Report Final Report
12. Sponsoring Organization Name and Address U.S. Department of the Interior Bureau of Mines 2401 E Street, N.W. Washington, D.C. 20241	14.

15. Supplementary Notes

16. Abstract

This report describes the approach, procedures, and results of a program to develop training materials for roof bolter operators. The objective of the program was to design and produce a training sequence which would prepare roof bolter trainees for job performance.

Data was collected and analyzed using the general procedures of Instructional Systems Development (ISD). Input data came from a previous roof bolter training analysis program. This data was expanded and structured through a series of ISD steps: objectives hierarchies, media selection, syllabus, lesson specifications, and training materials development.

The resulting program consisted of an ordered sequence of 15 lessons. The media mix for the 15 lessons included lectures, slide-tape lessons, and hands-on instruction using operational roof bolters. Contents of all lessons were reviewed and approved by the Bureau.

The key recommendations were to (1) validate the materials and measure relative effectiveness of media formats; (2) survey mines for training resources and conditions - match materials to user capabilities, rather than selection state of the art technology/media; (3) develop job performance aids (JPAs) rather than simulators; (4) create a style/media/JPA development guide for use in future projects of this kind.

17. Originator's Key Words	18. Availability Statement
Training Training Program Instructional Systems Development Roof Bolting Roof Bolter Operator	

19. U.S. Security Classif. of the Report	20. U.S. Security Classif. of This Page	21. No. of Pages	22. Price
		125	

FOREWORD

This report was prepared by Allen Corporation of America, 401 Wythe Street, Alexandria, Virginia 22314, under USBM Contract No. H0188039. The contract was initiated under the Coal Mine Health and Safety Program. It was administered under the technical direction of the Pittsburgh Research Center, with Mr. James TaVoularis acting as Technical Project Officer. Mr. Frank Naughton was the contract administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period October, 1978 to April, 1982. This report was submitted by the authors on 10 April 1982.

EXECUTIVE SUMMARY

This report describes the procedures used to develop a set of training materials for roof bolter operators. It includes discussions of data developed during a previous roof bolter analysis effort, detailed procedures used to design and format the training materials, and the content and sequence of the training materials.

Objective

The objective of the roof bolter training program was to design, develop, implement, and validate a training system for operators of roof bolting machines in underground coal mines. Approaches and procedures were based on the principles of Instructional Systems Development (ISD). The use of a systematic ISD approach helped ensure that all variables which affect training course content and organization, instructional strategies, and implementation were considered during the training development process.

Data Collection and Production

The first step in the development process was verification and expansion of roof bolter training data produced in a previous program. The existing task analysis was reviewed, revised as required, and expanded into objectives hierarchies. The hierarchies contained the set of objectives for roof bolter operator training.

Training media were selected for the objectives in the hierarchies. Media included slide-tape, lecture, and actual roof bolters. The objectives were grouped and sequenced into lessons to form the roof bolter operator training syllabus.

Lesson content was defined in the lesson specifications. The lesson specifications provided all information necessary for authoring of all training materials and production of supporting graphics.

Final training materials were as follows:

Slide-tape lessons consisting of slides, tapes, student worksheets, and tests

Lecture lessons consisting of instructor guides

- Hands-on lessons (i.e., using an operational roof bolter) consisting of instructor guides

The training materials were submitted to the TPO for review. Based on the TPO's comments, the materials were revised and submitted in final form in conjunction with this report.

Implementation and Validation

The detailed review cycles used during the production phase provided partial validation of technical content and general instructional approach. Preliminary plans were developed to implement and validate the training program. Sites were contacted and tentative arrangements made during the production phase of the program. The detailed review process used during the production phase of the program provided an

initial step in validating the technical content and instructional approach of the program. Preliminary arrangements for implementing and validating the materials were made at several mines. Actual validation, however, has been delayed in order to refine the training modules and to modify or correct certain of the graphics in accordance with review and comments by Bureau of Mines experts.

Conclusions and Recommendations

- The audio-visual and workbook modules developed in the present effort, once implemented and finally validated, should be of significant value to the productivity and safety of roof-bolting operations.

- The methodology developed and lessons learned under the present contract should be applicable to, and facilitative of, future training development efforts in this general area of mine health and safety.

- It is recommended that the Bureau of Mines provide for the dissemination of these training materials to interested mining companies, and obtain feedback for refinement of these materials and development of future training modules.

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION AND PROBLEM STATEMENT

Roof bolting is a very hazardous occupation in underground coal mining. For the calendar year 1973, the roof bolting machine and roof bolter operator were involved in approximately 33 percent of all machinery-related and roof fall-related injuries.* Roof bolters were involved in the highest number of machinery-related disabling injuries with 37 percent. The next highest machine (continuous miner) accounted for 19 percent.

The two most dangerous activities for the bolter operator are inserting the bolt and drilling the roof. These two activities accounted for 49 percent and 39 percent of disabling injuries respectively. This is understandable, in part, since these two activities occur under roof that is not yet permanently supported. Other activities such as positioning the bolter, tramming, and maintenance account for a significant number of injuries. In addition, only four of the ten bolter operators killed in 1973 were killed while operating the bolter. Consequently, accident reduction measures should concentrate on activities at the working face but other activities should also be included.

Disabling injury data from 1973 indicates that 31 percent of the injured bolter operators were in their first year as a bolter, 24 percent in their second, 14 percent in their third, and 10 percent in their fourth year. This data suggests that, since the accident rate appears to decline as operator experience increases, early training may be an effective way of reducing accidents.

The first step in developing such a training program was carried out in a project entitled "Development of a Training System for Roof Bolt Equipment Operators." This project was conducted at Midwest Research Institute (MRI). It was completed in June 1977 and was the prerequisite to the program presented in this report.

The second step was the development, implementation, and validation of a roof bolter training program based upon the data and analyses from the initial study.

2.0 OBJECTIVE

The objective of the roof bolter training program was to design, develop, implement, and validate a training system for operators of roof bolting machines in underground coal mines. Approaches and procedures were based on the principles of Instructional Systems Development (ISD). The use of a systematic ISD approach helped ensure that all variables which affect training course content and organization, instructional strategies, and implementation were considered during the training development process.

---

*Miller, W.K., and McLellan, R.R. Analysis of Disabling Injuries Related to Roof Bolting in Underground Bituminous Coal Mines - 1973. IR-1017.

The primary input data for the development of the roof bolter program were the task and training requirements analysis cited above. During this program, the following tasks were carried out:

- Identification of tasks and skills required of roof bolters, along with enabling knowledge requirements.
- Identification of safety procedures and safety knowledge requirements.
- Development of behavioral objectives.
- Selection of training media.
- Development of training media.
- Cost justification in terms of productivity and safety.

Using these data, subsequent ISD steps were carried out to refine the input data and to further design, develop, implement, and validate the roof bolter training program.

3.0 TECHNICAL APPROACH

The process used for development of the roof bolter training materials consisted of a planned sequence of steps. The sequence was designed to provide an efficient flow of data and information through which ISD processes were used to expand and refine the roof bolter training data. The starting point of the program was the results of the previous roof bolter training analysis program. The end point was a set of audiovisual and written training materials.

Section 3.1 contains discussions of the steps to collect and use roof bolter training data and produce the training materials. Section 3.2 describes the revisions which were required as a result of the TPO's review of the completed roof bolter training program and the procedures used to revise the materials. Section 3.3 discusses program implementation.

3.1 Data Collection and Production

3.1.1 Task Analysis Review

The first step in defining the roof bolter training system was to review the previous task and training requirements analysis and the preliminary training methods and media. Appendix A is the original listing of roof bolter training objectives. Activities carried out to review and update the task analysis are presented in the following paragraphs.

3.1.1.1 Obtain Data

The first step in any training development program is to ensure that the data base is complete and accurate. Using the tasks in Appendix A as the baseline for training development, additional information on roof bolter operations was obtained through on-site observation, literature reviews, and personal contacts.

Visits were made to Mitikki Mine, Shannopin Mine, and U.S. Steel Cumberland Mine (and training facility) to observe roof bolter operators and to review the existing task listing. Observational information on roof bolter operations and procedures, roof control plans, and state and federal regulations was supplemented by personal contacts with a variety of mining industry personnel. The process of collecting information from the mining industry was facilitated by a retired mine superintendent who was a member of the program team. His contacts were a distinct asset during data collection and review cycles.

During the on-site visits, current training programs were reviewed. This training program information supplemented previous experience gained at Peabody Coal, Inland Steel, Monterey Coal, Consolidation Coal, Freeman United Coal Mining Company, and AMAX Coal.

An extensive literature survey was conducted. Emphasis was on collecting all relevant information on the following topics:

- Roof strata
- Roof control theory
- Roof bolting procedures and laws
- Atmospheric testing
- Roof supports (temporary and permanent)
- Roof bolting accidents
- Bolting machines

Brochures and technical data were collected from manufacturers of roof bolter machines. Pictures and drawings were either used directly or as refresher documents during materials production. Companies contacted were FMC, Acme, Fletcher, Schroeder Brothers, Lee-Norse, and Long Airdox.

3.1.1.2 Update Task Analysis

Data and information collected as discussed above were analyzed to determine impacts on roof bolter training design. The original task analysis was updated and is presented in Appendix B. The updated task analysis was expanded into a hierarchical format as discussed in the next section.

3.1.2 Objectives Hierarchies

When attempting to establish the content and sequencing of a training program, a valuable aid is to create a picture of all training program requirements, exhibiting their superordinate and subordinate relationships. Subordinate tasks are the simpler, more basic tasks (e.g., function of bolter controls) that must be mastered before the more complicated superordinate tasks (e.g., skilled boom manipulations) can be learned. A picture of these relationships is called an Objectives Hierarchy because it contains Terminal and Enabling Objectives in a hierarchical format.

Terminal and enabling objectives were developed for the tasks in the revised task listing. All objectives were formatted into hierarchies showing the subordinate, coordinate, and superordinate relationships among objectives. Appendix C contains the roof bolter hierarchies. These hierarchies formed the basis for development of the roof bolter syllabus.

3.1.3 Syllabus and Media

3.1.3.1 Candidate Media

Media alternatives from the previous study were reviewed for continued relevance in light of additional data and design considerations. No changes resulted from this review. The candidate media were as follows:

- Synchronized slide-tape (ST).
- Workbook/programmed text (WB/PT).
- Lecture supported by visuals and student guides.
- Familiarization trainer (discussed below).
- Training roof bolter (actual equipment).
- Roof bolter away from the face (actual equipment).
- Roof bolter at the face (actual equipment).

The candidate media provided a range of capabilities. Both the ST and WB/PT can be used in either an individual or group environment. The audio-visual versus textual characteristics of these two media provide different capabilities for graphic and verbal presentations. Traditional lectures offer a third alternative for academic lessons.

The familiarization trainer was designed to allow trainees to learn and practice basic roof bolter control operations in an easily controlled environment. This training was intended to prepare students to perform in a less controlled, more costly environment (i.e., an actual roof bolter). The preparatory training would allow more efficient use of the roof bolter.

The other candidate media involved use of operational roof bolters in three different environments: on the surface (i.e., training roof bolter), away from the face, and at the face. They provided different levels of job realism for practice of operations introduced on the familiarization trainer.

3.1.3.1.1 Familiarization Trainer

The familiarization trainer was developed under subcontract to Burtek, Inc. It was based on a design approach recommended in the previous roof bolter training design study. It consisted of two connected assemblies (Figure 1). One simulated roof bolter boom movements. The other simulated a set of roof bolter controls for boom extension/retraction, up/down, and left/right movements.

As the trainee operates the telescoping controls, the light segments on the two sections of the display illuminate sequentially to provide an

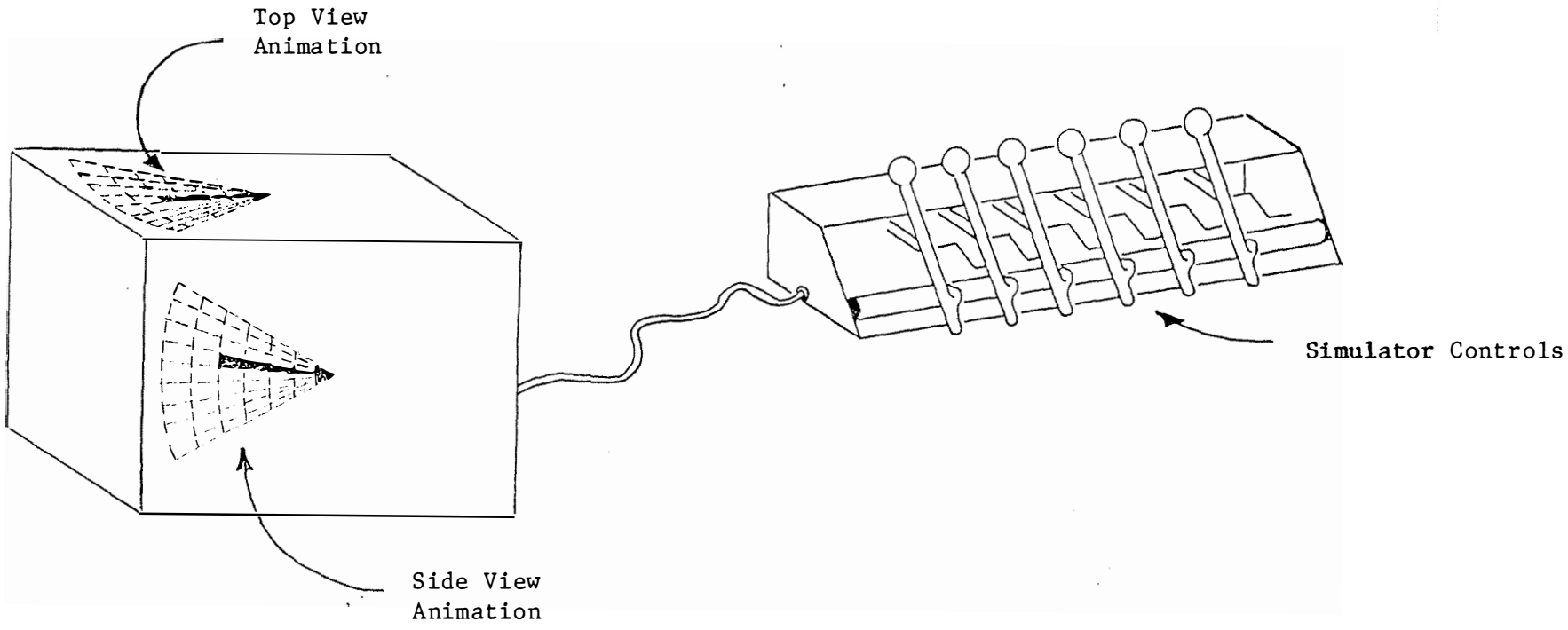


Figure 1. - Familiarization Trainer

animation of the boom extending or retracting. As the trainee operates up/down controls, the lower display animates the boom moving up and down. As the trainee operates the left/right controls, the upper display animates the boom moving right and left.

The display panel was developed using Burtek's MOD CELL (Registered and trademarked, Burtek, Inc.). This consists of aluminum barrier strips interleaved to form an "egg-crate" type structure which is bonded to a translucent fiberglass surface. Each cell contains an individual light bulb which can be controlled from the electronic system. In essence, a matrix of lights is thereby created so that groups of lights can be lighted to form the appearance of a moving, mechanical structure.

The electronics model the control system of a typical roof bolter machine. The controls operate a motor-driven switch assembly such that the motor is powered as long as the control is held in the ON position. Motor speed is adjustable by the training foreman to simulate boom swing speed of any roof bolter. The switch driven by the motor operates the appropriate groups of lights on the display panel to provide the related mechanical movement and the mechanical memory of last position. Since the lights are switched in discrete positions, the motor takes the form of a stepping or incrementing device such as a step switch.

The motor drive associated with the telescope controls has two sets of switches. One set is interlocked with the motor/switch assembly associated with rotation. The second set of switches is interlocked with the motor/switch assembly associated with the elevating controls.

The device is modularly constructed for ease of repair and replacement of bulbs. In addition, the replica of the operator's control console was constructed for ease of removal so that the controls of a different manufacturer's roof bolter machine can be mounted on the device. With this approach, a wide variety of specific machines can be accommodated from a common design. The familiarization trainer is capable of simulating control locations and slew rates of the Fletcher DDM, Lee-Norse TD2, and Acme D2.

3.1.3.2 Syllabus Development

Development of the roof bolter training syllabus and selection of the instructional medium for each lesson took place in an iterative process. Both syllabus and media variables were considered simultaneously and sequentially (e.g., selection of the actual equipment for a practice lesson was an integral part of assigning objectives to the lesson, but was not integral to grouping objectives for academic lessons).

Primary variables considered during media selection were as follows:

- Graphics requirements (desirability of high quality visuals, motion, etc.).

- Update requirements (i.e., amount of revision expected in the content).

- Number of versions required (e.g., one for each type of machine).

- Subject matter content unique to each mine (e.g., roof control plan).

- Resources required for presentation (e.g., audiovisual equipment).

- Fidelity requirements for hands-on practice (e.g., simulation, bolter on the surface, bolter away from the face, bolter at the face, etc.).

- Desirability of job aids (e.g., checklists).

Media selected included slide-tape, workbook, lecture, simulator, and a roof bolter. Alternate media were recommended under certain resource constraints (e.g., no audiovisual equipment, no roof bolter on the surface).

Objectives in the hierarchies were grouped into lessons which formed the structure of the roof bolter operator training course. Using the prerequisite relationships in the hierarchies, the lessons were sequenced into the final syllabus. The primary principle used was the requirement for academic training on a given operator task to precede hands-on training of the same task (i.e., make sure the trainee knows what and how to do it before you ask him to perform).

In designing the syllabus, external constraints played a major role. Consideration of these constraints was important to help ensure that the training syllabus could feasibly be implemented in the mining industry. Major constraints were as follows:

- Time which mine operators will realistically allocate to training (i.e., training time is lost production time). There must be a trade-off between training time and lost production time.

- Mantrip limitations for hands-on training (i.e., there is generally one mantrip per shift). This limits the potential for total integration of academic and hands-on training.

- Integration with existing mine training policies and procedures.

- Availability and feasibility of using actual equipment out of production for training.

The title and content of each academic lesson is shown in Figure 2. Figure 3 assumes all training resources are available (i.e., familiarization trainer, roof bolter on the surface or away from the face, etc.).

Lesson 1: Introduction and Preoperational Checks

A. Introduction to Course
B. Inspect Electrical System
    1. AC Power
    2. DC Power
C. Inspect Cable and Travelway
    1. Cable Splicing
D. Check Atmosphere
E. Inspect Mechanical System
    1. Materials Handling
F. Provisions

Lesson 2: Machine Operation Checks, End-of-Shift Shutdown, and Preparation for Maintenance

A. Check Equipment Operation
    1. Energize Bolter Machine - AC Power
    2. Energize Bolter Machine - DC Power
B. Machine Operation Checks
    1. Manipulate Boom
    2. Operate - Inspect Chuck
    3. Operate Tram Controls
C. Control Functions
D. End-of-Shift Shutdown
E. Preparation for Maintenance

Lesson 3: Tramming and Face Preparation

A. Tram to Work Area
B. Face Preparation
    1. Inspect Visually
    2. Sound Roof and Ribs
    3. Scale Roof and Ribs
    4. Install Temporary Support
    5. Recheck Atmosphere
    6. Determine and Mark Bolt Locations

Lesson 4: Drilling

A. Position Bolting Machine
B. Position Booms
C. Drill Hole
    1. Insert Starter Steel
    2. Drill Starter Hole

Figure 2 - Summary of Academic Lessons

Lesson 4: Drilling (Continued)

3. Using Drill Steel Extensions
4. Insert Finishing Steel
5. Complete Hole
6. Observe Drill Steel Rotation
7. Remove Drill Steel

Lesson 5: Bolting: Mechanical, Resin, and Combination

A. Prepare Bolt
B. Install Bolt: Mechanical
   1. Insert Bolt
   2. Torque Bolt
   3. Remove Wrench
C. Install Bolt: Resin
   1. Insert Bolt
   2. Mix Resin
D. Install Bolt: Combination
   1. Insert Bolt - High Coal
   2. Insert Bolt - Low Coal
   3. Secure Resin Section
   4. Secure Mechanical Section
E. Reposition Boom and/or Bolting Machine
F. Test Bolt Torque
   1. Mechanical or Combination
   2. Resin
G. Repeat Drilling and Bolting Operations
H. Remove Temporary Support
I. Tram Away From Face

Lesson 6: Roof Theory

A. Roof Theory

Workbook Lesson 1: Cable Splicing, Atmosphere Checking, and Materials Handling

A. Cable Splicing
B. Atmosphere Checking
C. Materials Handling

Workbook Lesson 2: Control Functions

A. Control Functions

Figure 2 (Continued) - Summary of Academic Lessons

- Day 1 -		- Day 2 -	
Time (Min.)	Lesson	Time (Min.)	Lesson
15	Introduction	20	Review and Plans
45	Slide-Tape Lesson 1	40	Slide-Tape Lesson 4
45	Workbook Lesson 1	30	Familiarization Trainer
10	Break	45	Slide-Tape Lesson 5
20	Workbook Lesson 2	30	Familiarization Trainer
30	Familiarization Trainer		
10	Review		
60	Lunch	60	Lunch
45	Slide-Tape Lesson 2	150	Hands-On Training: Roof Bolter at the Surface
20	Slide-Tape Lesson 6	15	Final Review
10	Break	15	Final Exam
60	Local Roof Control Plan		
30	MESA Film: "25 Feet from the Face"		
45	Slide-Tape Lesson 3		

Figure 3 - Preferred Training Schedule

3.1.4 Lesson Specifications

The next step in developing the roof bolter training materials was to determine the detailed contents of each lesson. The contents were derived from the hierarchy objectives grouped into each lesson. Outlines of each lesson, plus graphics requirements, were documented in the lesson specifications. A sample lesson specification page is shown in Figure 4.

Emphasis during the development of lesson specifications was on the accuracy of the technical information. Every effort was made to ensure that all information was current and accurate. These were as follows:

- A former mine superintendent who was knowledgeable in roof bolter operations participated in the development of the lesson specifications.

- The numerous documents and information gathered during earlier phases of the program provided quality reference material.

- Information was verified by extensive correspondence (both verbal and written) with equipment manufacturers and personnel in the mining industry.

- The lesson specifications were reviewed by high level training personnel from two large mining companies.

Another major concern was generalizability of the information across the different types of roof bolters (e.g., single boom, double boom), different types of mines (e.g., high coal, low coal, AC, DC, etc.), and across manufacturers. Significant effort was devoted to developing approaches to instruction which provided a common core of information applicable to a wide range of mines and equipment. The final roof bolter training program was essentially generic in its broad application capabilities, yet specific enough to transmit detailed procedural information.

The lesson specification phase ended with a review of the program of instruction by the TPO. After minor modifications, the program was approved for production.

3.1.5 Storyboards

The final step before production of the audiovisual and textual materials was development of storyboards. For the audiovisual lessons, the storyboards consisted of the script and rough graphics for each frame of instruction. An audiovisual storyboard form is shown in Figure 5.

For lecture and practice lessons, (i.e., simulator and actual roof bolters), the storyboards were draft versions of the final textual products. Lecture storyboards consisted of detailed outlines of the

Lesson: Tramming and Face Preparation

LESSON SPECIFICATIONS

Teaching Points	Media
e. Consequences of insufficient vacuum	-Consequences of insufficient vacuum. Cartoon RBO coughing and surrounded with dust.
f. Check hydraulic pressure	-Gauge set at 1200-1600 lbs./in.^{2} for mechanical bolting. -Gauge set at 800-900 lbs./in.^{2} for resin bolting.
g. Report defects to foreman	-RBO reporting defects to foreman.
3. Operate Tram Controls	-Steps in operating tram controls.
a. Remove chock blocks from wheels and stow	-RBO removing chock blocks from wheels.
b. Position body completely in cab	-RBO in cab.

Figure 4 - Sample Lesson Specification Page

Lesson Page No. _____

SLIDE-TAPE STORYBOARD FORM

Segment No. _____

Title _____

_____

Prepared by _____
Date Prepared _____
Reviewed by _____
Date Reviewed _____
Date Revised _____

Lesson Frame No. _____

Visual	Audio
Production Notes:	

Lesson Frame No. _____

Visual	Audio
Production Notes:	

Figure 5 - Slide-Tape Storyboard Form

teaching points covered in the lesson. Storyboards for lessons involving hands-on practice consisted of a listing of the lesson objectives and supplementary instructions for instructors.

3.1.6 Production

The production phase consisted of the following activities:

- Development of the graphics and photography for slides in the slide-tape lessons.
- Narration of the tapes for the slide-tape lessons.
- Final typing and duplication of all textual materials (i.e., student worksheets, tests, and instructor guides).

Slide-tape lessons consisted of a mixture of cartoons, renderings, line drawings, and word slides. Each lesson had a student worksheet containing the main teaching points. These were intended to assist students in preparing for the lesson, following its progress during presentation, and as a reference in the future. Tests were also prepared for each lesson and for end-of-course evaluation.

Draft copies of the completed lessons were packaged and submitted to the TPO. Based on the TPO's comments, a revision cycle was conducted as discussed in the next section.

3.2 Revisions

After a detailed review of the draft roof bolter training materials, the TPO submitted a set of revision requirements to Allen Corporation. These requirements and Allen's approach to revision of the materials are discussed in this section.

3.2.1 TPO's Evaluation

The TPO identified a set of problem areas to be corrected. These were as follows:

- Regimented, proceduralized information overwhelmes trainees
- Organization does not enhance retention
- Lack of trainee interaction with materials
- Poorly designed checklist for use by roof bolter operators
- Overemphasis on CFR and not enough on safety and proficiency
- The simulator is not a viable training device

From the comments it was clear that the fundamental approaches to development of the roof bolter training needed reevaluation and modification. Allen Corporation agreed with the TPO's evaluation and committed to revising the training materials.

3.2.2 Revision Approach

The revision approach developed by Allen and approved by the TPO was as follows:

- Make narrative more active and involve trainees in instruction.
- Revise operator checklist to make it easier to use.
- Provide lesson overviews to give trainees a better frame of reference.
- Improve explanations of detailed graphics or reduce detail as appropriate.
- Streamline narrative.
- Improve graphics as required.
- Eliminate the simulator as a part of the training program.

To help ensure that Allen's revised approach was consistent with Bureau expectations, it was agreed that the first slide-tape lesson would be revised, submitted to the TPO, and revisions received prior to beginning work on any of the other lessons. A major goal of this review was to achieve concurrence between the Bureau and Allen prior to full-scale revision activities.

3.2.3 Revision Techniques

Based on Bureau comments and revision approaches presented above, the roof bolter lessons were modified to improve their instructional effectiveness. With the exception of expansions to improve understanding, subject matter content was not changed. Major elements of the revision process and of the resulting materials were as follows:

- The three workbook lessons were converted to slide-tape. This change allowed media capability across lessons and more lessons to benefit from the visual advantages of a slide-tape format.
- Highly proceduralized word slides were replaced with graphics which portrayed a variety of scenes. Graphics were generally used in lieu of photographs. This was due to difficulty in obtaining underground photographs.
- The narrative was revised into a flowing dialogue rather than sequences of proceduralized steps.
- Safety points were worked into the narrative from a common sense perspective of benefit to the miner. This was in contrast to a heavy emphasis on requirements of various regulations (e.g., (CFR).

- Two unique cartoon figures were created and carried throughout the slide-tape lessons. This added continuity, emphasis to various teaching points, and improved the affective quality of the instruction.

- Multiple image slides were used to show related scenes and sequences.

- The lessons were made more interactive in order to test students' observation and comprehension during presentation. For example, slides were repeated without narrative. The lesson paused to allow students to recall the important points presented in the slide.

- Introductory and background music was selected for appropriateness to the audience.

- Narrative was written to be familiar and appeal to the audience. Humor was interspersed to increase student interest.

- Graphics were designed to create views from the miners' perspective.

- High coal/low coal distinctions were minimized by using high coal as the baseline and referencing low coal differences. This was contrasted with separate lessons for each.

- An easily used operators' checklist was developed. It was designed for ruggedness and ease of use in the mining environment.

- Test instruments included end-of-lesson, end-of-course, and within-lesson reviews.

- Hands-on lessons were reformatted to improve their ease of use.

Figure 6 is a listing of the revised syllabus. Contents of individual revised lessons are presented in Appendix D which contains the following:

- Student worksheets for each slide-tape lesson

- Instructor outlines for lectures

- Instructor guides for hands-on lessons

EVENT NUMBER	TITLE	MEDIUM
1	Program Introduction	Lecture
2	Roof Control Plan and Local Conditions	Lecture
3	Roof Support Principles	Slide/Tape
4	Roof Bolter Controls	Slide/Tape
5	The Mining Cycle	Slide/Tape
6	Atmospheric Checks and Material Handling	Slide/Tape
7	Pre-Operational Checks	Slide/Tape
8	Machine Operational Checks and Preparation for Maintenance	Slide/Tape
9	Tramming and Face Preparation	Slide/Tape
10	Positioning and Drilling	Slide/Tape
11	Bolting and End-of-Shift Shutdown	Slide/Tape
12	Introduction to On-the-Job Checklist	Slide/Tape
13	Controlled Practice	Roof Bolter
14	Controlled Practice	Roof Bolter
15	Controlled Practice	Roof Bolter
16	Final Exam	Paper Test

Figure 6 - Revised Roof Bolter Training Program

A draft version of each lesson was submitted to the TPO for review. Revisions resulting from TPO reviews were incorporated into the final version of the training materials.

3.3 Implementation and Validation

General implementation and validation procedures were developed during the production phase of the program. Development of detailed procedures for implementation depended on specific characteristics of locations selected. Topics covered in the general implementation and validation plan and an overview of each are as follows:

- Program integration: blending the roof bolter training program into ongoing mine training with a minimum of disruption and time requirements.

- Equipment storage, maintenance, and utilization: requirements to support the audiovisual equipment for slide-tape lessons.

- Training materials management: amount of slide-tape and textual material, storage requirements, and distribution procedures.

- Trainee grading and evaluation: testing philosophy, types of tests, and frequency of testing.

- Facilities utilization: facilities required to administer the roof bolter training program.

- Instructor training and utilization: approaches to prepare instructors to use the roof bolter training program.

- Trainee scheduling and management: sequence and schedule of training events and approaches to ensure smooth administration of the course.

- Validation: purpose of validation, measures to be used, and interpretation guidelines.

Due to difficulties in identifying validation sites, detailed implementation and validation plans keyed to specific locations were not developed. These site selection problems are discussed in the following paragraphs.

3.3.1 Implementation Sites

Efforts were made to locate sites that would participate in the implementation and validation of the materials. Sites contacted were:

- Emery Mining Company, Utah
- Clinchfield Coal Company, Virginia
- Peabody Coal Mine 10, Illinois
- Consolidation Coal Company, Indiana
- U.S. Steel Cumberland Mine, Pennsylvania

Final plans for implementation, however, were held in abeyance pending further review and approval of the training materials by the Bureau of Mines.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The present effort was an ambitious undertaking in that it dealt not only with a hazardous operational task -- roof bolting -- but with attempting to teach procedural and safety performance issues using

primarily cognitive (audio-visual, workbook) materials. In this respect, the creation and use of visuals in conjunction with carefully worded instructional narrative posed a major challenge. There is, moreover, a scarcity of "file photographs" that are sufficiently relevant, up-to-date, and of appropriate instructional composition, to be used directly. Since photography (usually involving flashlamps or other supplementary illumination) is often difficult if not impossible to do in an actual working mine, recourse must be had to painting or drawing the desired instructional images. This requires not only artistic and instructional creativity to achieve the desired motivational and communicative effect, but technical accuracy as well. Thus, all equipment, clothing, relative condition and location of materials and persons, and so forth, must be scrutinized for accuracy by Subject Matter Experts.

Along the same lines, another problem is that there are a variety of roof-bolter machine configurations, depending on the manufacturer. In depicting a machine in the training modules, one is faced with the dilemma of either rendering one model of machine accurately, or attempting to depict a representative or generalized version whose details cannot conform very well to any given machine.

Two other unique requirements were faced in the present program. One was in how to depict or teach the dangers and consequences of unsafe procedures. This is not as simple as it would appear, because one should emphasize proper procedures, not depict mistakes. How then might one show the negative results of improper procedures? The second requirement was for teaching the benefits of following safety regulations without preaching or appearing dogmatic.

To solve these problems we created two cartoon characters; a troll named "Grink," and a Lincolnesque "Uncle Sam." Grink was always up to mischief, so he bore the brunt of the unsafe procedures. Uncle Sam, on the other hand, gave the treatment of Federal regulations a more human and beneficial "presence." Both of these characters, plus the dozens of other renderings and cartoons created for the program, we believe, contributed significantly to the motivational and instructional aspects of the modules.

But, to capitalize on what was learned in the present contract, to facilitate and perhaps lower the cost and frequency of revision of future efforts, the following suggestions may be made.

General Recommendations

1. For those areas or items of equipment for which training development is planned several years in advance, develop a comprehensive reference file of visuals for joint use by contractors and the Bureau of Mines. The file could include all manner of visual media -- photographs, drawings, video tape -- including anything available from manufacturers, or that may be created at reasonably low cost.

2. Develop a reference document for use by developers of training materials, safety guides, and so on, that shows standard

equipment and clothing in proper format and detail. The U.S. Army, for example, to keep its manuals consistent with its doctrine, has a set of such depictions and criteria for visuals involving soldiers and military equipment.

3. Develop a comprehensive dictionary or glossary for the subject matter areas in question, especially as those terms may vary by regional or operational settings. For example, the words, "board," "plank," "log," "pole," "stick," may have different degrees of techical accuracy depending on the situation.

With just the three foregoing items, we believe that considerable time and money may be saved while producing an even higher quality and more readily accepted product.

Another lessons-learned area that bears mention is the problem of field validation of the materials developed. This is a universal obstacle in the business of training development; the mining industry is not unique in this respect. In essence, operational people involved in day-to-day work, those in the mines, for example, generally do not give high priority to developmental efforts involving training or safety. This is not to say that one cannot obtain outstanding cooperation from them under the right conditions, just that with people being what they are, training and safety are not priority items day-to-day. While field validations do need to be done, we believe that an alternate or preliminary, surrogate approach to validation may prove very useful. In essence, a validation seeks to answer two main questions: (1) do the materials teach what they are supposed to teach, and (2) will the intended users avail themselves of the materials willingly. To answer these questions, short of going directly to the intended user, would be to have a pool of representative persons who (for whatever reward is appropriate) would serve as a test and review committee. These persons, of course, must be highly knowledgeable in the technical content and operating environment in question. This approach is used to some extent by the Bureau of Mines in contracts such as the present one. Nonetheless, we are suggesting that the concept be extended, formalized, and the resulting capability be made available to contractors. In addition to their help in reviewing training materials per se, the "committee" may be of value by feeding-in their perceptions of problems or training needs in the field, and possibly in helping to gain entry to mines when it becomes time for on-site implementation and validation of training materials. Thus, serving as either a preliminary validation or as a surrogate validation, where field evaluation is impractical, this resource committee or organization would, we believe, soon pay for itself many times over, as well as facilitating contractor and Bureau liaison with the mining and mining equipment industries.

Specific Recommendations

1. Inasmuch as considerable contract resources originally planned for field evaluation of the materials were necessarily expended in bringing the training materials to the desired technical accuracy and instructional format, implementation and reaping the benefits of these materials remains as the next step, and is so recommended.

2. To assess the potential of these training materials, designed for use by the entry-level roof bolter operator, it would seem appropriate that provision be made to obtain logitudinal data by whatever means are available. We recognize the great difficulty in attempting to follow the performance and accident history of persons who will use these training materials, but any reasonable data that showed a positive effort could be of great value to future efforts along these lines.

3. On a laboratory-experimental basis, measure the relationship between the audio visual formats used (photographs, life-like renderings, cartoons) and (1) retention, and (2) transfer of training to actual roof bolter operations. A guideline on subject matter by the most effective depiction format would be a very valuable asset in future work.

4. Survey the mines and related facilities to assess the relative convenience and availability of training media (slide projectors, tape players, video tape players, etc.) in that setting, both for implementation/validation and for long-term use of training materials provided by or developed under the auspices of the Bureau of Mines.

Due to lack of industry cooperation and government-furnished subject matter experts, it is often difficult to identify appropriate knowledgeable personnel. Retired miners may be available, but are often out-of-date.

The final product of a training development program for the mining industry will be highly constrained by the characteristics of the industry (e.g., training resources available, previous training practice, production motives, etc.).

Training development for the mining industry should focus on developing high quality instruction which is compatible with current practice, rather than on state-of-the-art instruction which will not be used. Examples are as follows:

- Produce an effective audiovisual program to replace the existing manufacturer's movie.

- Develop good on-the-job training guides, rather than procuring an expensive simulator.

- Provide good lecture guides and student worksheets to support group lessons.

Despite the validation problems, the roof bolter was a successful training development program. The end products were technically accurate, instructionally effective, and aesthetically pleasing. We trust that the mining industry will be receptive to them.

APPENDIX A

ROOF BOLTER OPERATOR TRAINING OBJECTIVES

Appendix A. - Roof Bolter Operator Training Objectives

Objective	Contents Covered	Criteria	Method/Media
I. The trainee shall demonstrate a knowledge of roof and rib control concepts including operator responsibilities, definitions of terms, problems involving roof support and roof supports utilized.	Roof and Rib Control Concepts 1. Responsibility of roof-bolter operator. 2. Definitions of roof bolting terms. 3. Roof support problems. 4. Roof supports.	1. Convey in his own words his responsibility to make the roof safe for other members of his working unit. 2. Correctly associate all roof bolting terms listed in a column with their proper definition. 3. Correctly associate all roof conditions listed in a column with drawings and photographs of the conditions. 4. Correctly associate all roof conditions listed in a column with their corresponding roof fall hazard. 5. Correctly associate all roof support types listed in a column with their corresponding photograph. 6. Correctly associate all names of roof support types listed in a column with their proper functional descriptions. 7. Correctly list local roof control problems and their associated roof support types.	The trainee will be provided with individualized instruction material (tape-slide or programmed text with photographs) dealing with operator responsibilities, terms, support problems and support techniques. Subject matter for the course will come from the task analysis as well as USBM Instruction Guide 17 and corresponding slides, supplemented with photographs of actual roof conditions. The training foreman will supplement the course with lecture and photographs of local roof control problems and successful support types being employed.
II. The trainee shall demonstrate a knowledge of federal regulations pertaining to roof control plans including the procedures and materials subject to regulations.	Federal Regulations on Roof Control 1. Procedures subject to regulations. 2. Material subject to regulations.	1. Correctly designate at least 90% of those procedures which are subject to federal regulations from a column of roof-bolting procedures. 2. Correctly designate at least 90% of those materials which are subject to federal regulations from a column of roof-bolting materials.	The trainee will be provided with a tape-slide presentation and workbook concerning CFR 30 part 75 developed by Uniten Systems under cooperative agreement with the Bureau of Mines.

Objective	Contents Covered	Criteria	Method/Media
III. The trainee shall demonstrate a knowledge of acceptable procedures and materials contained in the roof control plan for that mine.	Company Roof Control Plan 1. Acceptable procedures. 2. Acceptable material.	1. Correctly answer at least 90% of the multiple choice questions concerning acceptable roof bolting procedures as stated in the roof control plan. 2. Correctly answer at least 90% of the multiple choice questions concerning acceptable roof bolting materials as stated in the roof control plan.	The trainees will receive a lecture from the training foreman utilizing the roof control plan as the text. Examples of all acceptable bolts, bearing plates, holy boards, washers, bits, etc., will be utilized as training aids. Slides of acceptable bolt spacing and other acceptable procedures taken at the mine will supplement the lecture. The recommended training program will include in the instructor guide a lecture outline and test.
IV. The trainee shall demonstrate a knowledge of roof-bolter machine controls and their functions.	Roof-Bolter Controls	1. Correctly associate all items in a column of roof-bolter control names with their proper function.	The trainee will be provided with individualized instruction material naming and describing the functions of roof-bolter controls. The training package will utilize the Acme D2 (single boom), Lee Norse TD2 (dual-boom) and Fletcher DDM (dual-boom telescoping) in the illustrations. Each of the three descriptions will stand alone and the training foreman will be free to omit descriptions of roof-bolter types not utilized in that mine and to substitute slides or photographs of that mine's roof-bolters in the presentation.

Objective	Contents Covered	Criteria	Method/Media
V. The trainee shall demonstrate a knowledge of preoperational check procedures including electrical and mechanical system inspection and equipment operation checks.	Preoperational Checks 1. Inspect electrical system. 2. Inspect mechanical system. 3. Check equipment operation.	1. Correctly indicate at least 90% of the electrical and mechanical system inspection tasks from a column of roof-bolting tasks. 2. Correctly answer at least 90% of the multiple choice questions concerning the required electrical and mechanical inspection necessary for the items pictured. 3. Correctly indicate at least 90% of the equipment and acceptable machine response operation tasks from a column of roof-bolting tasks. 4. Correctly indicate at least 90% of the roof-bolting provisions from a column of roof-bolter equipment. 5. Correctly perform at least 90% of the pre-operational checks for the training foreman utilizing the roof-bolter on the surface.	The trainee will be provided with individualized instruction material describing electrical and mechanical system inspection procedures, equipment operation checks, and correct roof-bolter machine provisions. The training foreman will supplement the classroom discussions by demonstrating proper electrial and mechanical inspections utilizing the roof-bolter on the surface. Examples of good and bad cable splices will also be presented. Academic instruction on equipment operation checks will be supplemented by practice on the familiarization trainer by the trainee with minimal supervision. Supplemental training on roof-bolter provisioning was found not to be cost effective and therefore is ommitted. Curriculum material will come from the task analysis and MESA Instruction Guide 26 (IG 26) and corresponding slides.
VI. The trainee shall demonstrate knowledge and skill in tramming the roof-bolter to the work area.	Tramming	1. Correctly indicate at least 90% of the roof-bolter tramming safety procedures from a column of roof-bolter tasks. 2. Correctly indicate at least 90% of the roof-bolter tramming operation procedures from a column of roof-bolter tasks.	The trainee will be provided with individualized instruction material which deals with safe and efficient operating procedures for tramming. This material will be supplemented by demonstration and practice under training foreman supervision utilizing a roof-bolter away from the face.

Objective	Contents Covered	Criteria	Method/Media
VI. Continued		3. Demonstrate correct roof-bolter operating and safety procedures to the training foreman utilizing a roof-bolter away from the face.	Curriculum material will come from the task analysis and MESA IG 26.
		4. Demonstrate ability to tram a roof-bolter from one location to another utilizing a roof-bolter away from the face, in not more than twice the average time (based on production time studies) required for an experienced operator to tram that distance.	
VII. The trainee shall demonstrate a knowledge of face inspection procedures including atmosphere checks and inspection of the working face.	Face Inspection 1. Check atmosphere. 2. Inspect working face.	1. Correctly answer at least 90% of the multiple choice questions concerning atmosphere checking procedures, safety precautions and the reasons for such procedures. 2. Correctly answer at least 90% of the multiple choice questions concerning face inspection procedures, safety procedures and the reasons for such procedures. 3. Correctly demonstrate roof sounding procedures for the training foreman.	The trainee will be provided with individualized instruction material concerning operational procedures, safety precautions and the reasons for each, involving atmosphere checks and working face inspection procedures. Use of a gas meter in a gas box will be included as an aid for teaching atmosphere checks. Roof sounding procedures and precautions will be emphasized as indicated in Table 4. A tape recording, made at that mine, of the sound of good and bad roof will be included in the classroom instruction. The training foreman will supplement classroom instruction with a roof sounding demonstration at a working face. A quick demonstration of atmosphere checking will also be included at this time. Classroom curriculum will come from the task analysis and MESA IG 26.

Objective	Contents Covered	Criteria	Method/Media
VIII. The trainee shall demonstrate a knowledge of face preparation procedures including scaling of loose material and the setting of jacks.	Face Preparation 1. Scale loose material. 2. Set jacks.	1. Correctly indicate at least 90% of the scaling procedures from a column of roof-bolter tasks. 2. Correctly indicate at least 90% of the scaling safety precautions from a column of roof-bolter tasks. 3. Correctly indicate at least 90% of the jack setting procedures from a column of roof-bolter tasks. 4. Correctly indicate at least 90% of the jack setting safety precautions from a column of roof-bolter tasks. 5. Demonstrate to the training foreman the ability to safely scale loose material (at a working face) and set jacks. 6. Demonstrate ability to set jacks in not more than twice the average time required by an experienced operator.	The trainee will be provided with individualized instructional material concerning loose roof material scaling procedures and precautions, and jack setting procedures and precautions. The training foreman will supplement the academic training with demonstrations of proper roof scaling procedures at a working face and proper jack setting procedures at the simulated roof. Curriculum material will come from the task analysis and MESA IG 26.
IX. The trainee shall demonstrate skill and knowledge of roof-bolter positioning procedures including tramming to face, positioning roof-bolter and marking correct bolt positions.	Position Roof-Bolter 1. Tram to face. 2. Position roof-bolter. 3. Mark bolt positions.	1. Correctly indicate at least 90% of the correct tramming procedures and safety precautions from a column of roof-bolting tasks. 2. Correctly answer at least 90% of the multiple choice questions concerning roof-bolter machine positioning. 3. Correctly anwer at least 90% of the multiple choice questions concerning bolt position marking procedures and safety precautions.	The trainee will be provided with individualized instructional material concerning tramming to the face, positioning the roof-bolter and marking bolt positions. All three areas will be supplemented with demonstrations by the training foreman using the training roof-bolter in conjunction with the simulated roof and haulageway. Tramming to the face and the positioning of the roof-bolter will be emphasized. Special

Objective	Contents Covered	Criteria	Method/Media
IX. Continued		4. Demonstrate to the training foreman the ability to tram the training roof-bolter into position while following correct safety procedures.	emphasis will be placed on getting into position quickly. Instructional material will come from the task analysis and MESA IG 26.
		5. Demonstrate to the training foreman the ability to tram the training roof-bolter into correct position in not more than twice the average time required by an experienced operator.	
X. The trainee shall demonstrate skill and knowledge pertaining to drilling operations including positioning the boom and drilling the hole.	Drilling Operation 1. Position boom. 2. Drill hole.	1. Correctly answer at least 90% of the multiple choice questions concerning unusual roof conditions as indicated by various auger reactions.	The trainee will be provided with individualized instructional material concerning procedures and safety precautions for the drilling operation (classroom instruction on boom positioning will not be cost effective). The training foreman will demonstrate proper boom positioning and supplement the classroom material on the drilling operation through demonstrations utilizing the training roof-bolter and the simulated roof. Special blocks of concrete with voids and soft layers will be utilized to demonstrate auger reaction to slips and soft strata. Trainees will practice the tasks under the supervision of the training foreman until they are capable of passing the tests.
		2. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for drilling the hole. Note: The following tests utilize the training roof-bolter and the simulated roof.	
		3. Demonstrate to the training foreman the ability to position the boom, so that the chuck is below the mark, in not more than twice the average time required by an experienced operator.	

Objective	Contents Covered	Criteria	Method/Media
X. Continued		4. Demonstrate the ability to set stab jack and raise protective canopy in not more than twice the average time required. 5. Demonstrate ability to insert starter bit in not more than twice the average time required. 6. Demonstrate ability to drill hole to desired depth in not more than twice the average time required, utilizing correct thrust rate and drilling a straight vertical hole. 7. Demonstrate ability to insert finishing bit in not more than twice the average time required. 8. Demonstrate ability to complete drilling hole in not more than twice the average time required. 9. Demonstrate ability to remove finishing bit in not more than twice the average time required. 10. Demonstrate ability to complete above procedures while observing the roof for signs indicating possible fall; being able to actuate the kill switch immediately on command; following safe and correct procedures; avoiding pinch points; and not abuse the equipment.	All of the tasks in this training objective are to be emphasized. Special emphasis is to be placed on drilling the hole. Training material will come from the task analysis and MESA IG 26.

Objective	Contents Covered	Criteria	Method/Media
XI. The trainee shall demonstrate skill and knowledge pertaining to the bolting operation including bolt preparation bolt insertion, bolt tightening, boom repositioning, and torque checking.	Bolt Preparation 1. Bolt preparation 2. Bolt insertion 3. Bolt tightening 4. Torque reading	1. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for mechanical and resin bolt preparation. 2. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for mechanical and resin bolt insertion. 3. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for mechanical and resin bolt tightening. 4. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for checking mechanical and resin bolt torque. 5. Demonstrate to the training foreman the ability to prepare a mechanical and resin bolt in not more than twice the average time required. Note: The following test utilizes the training roof-bolter and simulated roof. 6. Demonstrate to the training foreman the ability to insert a mechanical and resin bolt in not more than twice the average time required. 7. Demonstrate to the training foreman the ability to tighten a mechanical and resin bolt in not more than twice the average time required.	The trainee will be provided with individualized instructional material concerning procedures and safety precautions for mechanical and resin bolt preparation, insertion, tightening and torqueing (classroom instruction on boom repositioning will not be cost effective). The training foreman will supplement the classroom material through demonstrations utilizing actual bolts in the classroom for bolt preparation and the roof-bolter and simulated roof bolt insertion, tightening and torqueing and boom repositioning. Emphasis will be placed on bolt tightening, boom repositioning, bolt insertion and torque wrench removal with special emphasis on the first two tasks. Training material will come from the task analysis and MESA IG 26.

Objective	Contents Covered	Criteria	Method/Media
XI. Continued		8. Demonstrate to the training foreman the ability to reposition the boom in not more than twice the average time required.	
		9. Demonstrate to the training foreman the ability to check mechanical and resin bolt torque in not more than twice the average time required.	
		10. Demonstrate ability to complete above procedures while observing the roof for signs indicating a possible fall; being able to actuate kill switch immediately on command; following safe and correct procedures; avoiding pinch points; and not abuse the equipment.	
XII. The trainee shall demonstrate skill and knowledge pertaining to post-bolting procedures including jack removal and tramming away from the face.	Post Bolting Procedures 1. Jack removal 2. Tram away from face.	1. Correctly answer at least 90% of the multiple choice questions concerning procedures and safety precautions for jack removal, and tramming away from the face. 2. Demonstrate to the training foreman the ability to remove jacks, following proper procedure and safety precautions under the simulated roof, in not more than twice the average time required. 3. Demonstrate to the training foreman the ability to tram away from the face, following proper procedure and safety precautions under the simulated roof, in not more than twice the average time required.	The trainee will be provided with individualized material concerning procedures and safety precautions for jack removal and tramming away from the face. The training foreman will supplement the classroom instruction with demonstrations of proper jack removal at a working face and proper tramming away from the face under the simulated roof. Trainees will practice and be tested on jack removal under the simulated roof. Jack removal and tramming away from the face will be empahsized. Training material will come from the task analysis and MESA IG 26.

Objective	Contents Covered	Criteria	Method/Media
XIII. The trainee shall demonstrate knowledge pertaining to end of shift procedures.	End of Shift Procedures	1. Correctly indicate at least 90% of the end of shift procedures and safety precautions from a list of roof-bolter tasks. 2. Demonstrate to the training foreman the ability to conduct end of shift procedures correctly and follow safety precautions.	The trainee will be provided with individualized instructional material concerning end of shift and safety procedures. The training foreman will supplement the classroom material with a demonstration of those procedures utilizing the roof-bolter. Classroom curriculum will come from the task analysis and MESA IG 26.

APPENDIX B

ROOF BOLTER TASK ANALYSIS

Appendix B. - Roof Bolter Task Analysis

Task	Skill	Safety Knowledge	Operations Knowledge
Preoperational Checks			
1. Inspect Bolter Machine and Distribution Box	N/A	Area around box should be dry, well rock dusted, free of debris. High-voltage switch always ON unless problem exists. Circuit breaker always OFF. No temporary splice over 24 hrs old, after that must be made permanent. No splice within 25 ft of reel. Recognize cuts and bruises and bad splicing. Recognize where splice is needed. Hanging cable tightly keeps out of danger. Placement keeps cable from being damaged.	Task procedures
a. Inspect Electrical System Visually inspect area around box. High-voltage switch is ON. Circuit breaker switch is OFF. Visually inspect trailing cable. See that necessary repairs are made. Hang cable when necessary. Inspect placement of cable. Pull on cable to check reel take-up operation.			
b. Inspect Mechanical System Check all case fittings. Remove debris. Visually inspect seals-packing glands. Check for proper gap-gland box. Inspect fire suppression system. Check for oil leaks--oil level. Add oil if necessary. Check tire pressure--add if necessary. Check dust box--empty if dirty. Visually inspect dust hoses--repair or replace if worn. Visually inspect filters--clean or replace. Check control levers--all in neutral position. Place key in ignition--energize roof-bolter. Turn lights on each direction. Depress emergency kill switch in cab. Energize--check kill switches on booms.	Be able to hit kill switches in cab and on booms without having to look for them; have instinct for location.	All debris is a possible hazard and should be removed. Improperly maintained dust system leads to dust problems. Always have levers in neutral before energizing machine. This lessens the chances of unexpected movements. Kill switch may save your life--know its location and how to engage it.	Task procedures

Task	Skill	Safety Knowledge	Operations Knowledge
2. Check Equipment Operation a. Manipulate Boom Depress start button and energize. Manipulate boom in all directions. Use control levers, positioning boom to center for tramming.	Can manipulate boom properly without looking at control levers. Know locations of levers without having to look--direction lever must be pulled for boom to react correctly. Variable tramming speeds available.	Recognize when movements are improper.	Task procedures. Know correct controls to be used. Recognize improper boom movements. To perform operation efficiently must understand reason for variable speeds--direction--how movements can increase or decrease ease of operation. Must know which lever(s) and their directional movement in order to manipulate boom in the proper direction. How fast the boom reacts and what variable speeds can be utilized for proper movement.
b. Operate-Inspect Chuck Use control lever set variable speeds. Check auger retainer clamp. Inspect chuck for rounded edges, cracks, burrs.		Recognize rounded edges in chuck. Always use auger clamp to keep auger from flying loose. Important to safe operation.	Task procedures. Correct controls for chuck operation. Know which lever controls chuck speed. What variable rotation speeds may be obtained by movement of control lever in one direction or another. Importance of using variable speeds for better drilling operation.
c. Operate Tram Controls Check tram levers in cab--forward-reverse. Check tram levers on booms.			Task procedures. Correct tram controls. Always watch where tramming, don't be having to look for levers. Use variable tramming speeds.
d. General Control Check Stab jack down-up. Canopy control. Check brakes. Vacuum on head.		Must know why use stab-jack, canopy and the vacuum head.	Task procedures. Correct controls.
3. Provision Bolter Machine a. Proper tools on hand Sounding rod. Slate Bar. Torque wrench. Jack handle. Methane tester. Wrench.		Bolts used must always meet RCP specs to provide proper support.	Task procedures. Must know what bolts, plates, etc., called for in Roof Control Plan (RCP).

Task	Skill	Safety Knowledge	Operations Knowledge
b. Proper Bolt According to RCP and Sufficient Quantities			
c. Temporary Jacks (if utilized)			
d. Check That Have Sufficient Number and Types of Augers and Extensions. Check for Burrs on Augers Whicb Might Catch on Gloves.			
Tramming			
4. Tram to Work Area Communicate to others intention to tram. Depress starter button. Position body completely in cab. (If bolter so equipped) Lower canopy to proper tramming height. Check with helper that all is clear--helper watching cable. Turn lights on direction of tramming. Position boom/booms toward center of bolter. Release parking brake. Tram machine into intersection. Working section of bolter facing tram direction. Tram down center of entry. Continually watch roadway for changing conditions. Watch helper for tramming instructions.. Watch overhead clearance. Arrive work place--turn key off.	Smooth and efficient manipulation of tram controls. Must be able to operate without having to look and feel for levers. Be able to react without hesitation. Must always be concerned with changing conditions in entry.	Always communicate tramming intentions and have as much tramming clearance as possible. Must be aware of changing conditions and what actions will be necessary due to certain changes in conditions. Should always be concentrating on machine operation.	Task procedures. Correct controls.

Task	Skill	Safety Knowledge	Operations Knowledge
Face Inspection			
5. Check Atmosphere a. Check Methane Level Advance to area to be tested. Visually inspect area. Remove approved tester from case. Make test one foot from roof and rib. Do not go more than 5 ft. past last permanent support. Make test every 20 minutes. Report presence of methane to foreman immediately.	Use of Methane tester.	Know hazardous level of methane. Report immediately to foreman when methane is present. Take test every 20 minutes for safety. Test should be properly taken for true reading.	Task procedures. Important to know how to read tester, and take test. Realize problems which can arise due to presence of methane.
b. Check Oxygen Level Use approved testing device. Place tester along floor to test for deficiency. Test around gob areas. If deficiency occurs, immediately contact section foreman.	Correct use of oxygen tester.	When to use tester. How to use tester. Allowable tester response.	N/A
6. Inspect New Working Face a. Inspect Visually Observe the conditions of the following while walking to face: Roof Rib Floor - items which could cause tripping or stumbling. Conditions to watch for: Loose material--roof-rib Slips Clay veins Kettle bottoms Horsebacks Rolls	N/A	Correct visual inspection of roof, rib and floor. Able to recognize: Loose material (in roof and rib) Slips Clay veins Kettle Bottoms Horsebacks Rolls Tripping hazards on floor	N/A

Task	Skill	Safety Knowledge	Operations Knowledge
b. Sound Roof Listen to roof. Use appropriate sounding tool. Take sounding tool and strike roof--lightly then harder. Listen for sound of roof while striking. Use vibration method after sounding. Place one hand on roof with tips of fingers and thumb touching roof--arms should be fully extended thumbs toward you. Tap roof with sounding tool feeling vibrations. Test area by going from side to side but not in a straight line. Return sounding rod to proper area.	Differentiate between working roof and an impending roof fall. Proper roof striking method. Interpretation of Sound and vibration.	Sound of working roof. Sound of roof about to fall. Proper roof sounding procedure. Proper tool.	Task procedures.
c. Determine Best Bolt Pattern Decide position of bolts based on observations made during inspection and sounding, and in accordance with RCP.		Proper bolting procedures and supplemental support necessary, for each unusual roof and rib condition.	Proper bolt pattern based on RCP. Fastest method for bolting or otherwise supporting each unusual roof condition.
Face Preparation			
7. Scale Loose Material Use appropriate scaling tool. Examine tool for possible defects. Note visually where scaling is necessary. Insert flat end of tool between solid and loose material. Slowly pry towards the roof when possible. If necessary to pry downward assure good solid footing. Re-examine roof after scaling. Return scaling tool to its proper place.	Use of scaling tool.	Proper scaling procedure. When to scale or when to bolt.	Task procedures. Proper scaling tool.

Task	Skill	Safety Knowledge	Operations Knowledge
8. Set Jacks (if required) Operator carries first jack and jack bar to working area. Carry jack (rachet type) with head slightly elevated. Measure off distance from rib-according to roof control plan for first jack. Set jack on solid floor. Set jack so that it is vertical. Push top of jack toward roof by hand. Set jack so that jack rachet is toward you. Insert jack handle (rachet-type) using up and down motion until jack is tight against roof. Helper brings remainder of jacks while operator sets jacks. When jacks have been set, place jack bar in proper place. Take methane test.	Setting and tightening of jacks. Best positioning of jacks to reduce possible problems during drilling. Use of methane tester.	Do not advance more than 5 ft beyond permanent roof support. Always stand under supported roof while setting jacks. Always have back towards supported roof. Always have escape route in mind. Methane test every 20 minutes.	Task procedures. Proper locations of jacks as stated in RCP. Use quickest marking technique to measure for correct distances between jacks and between jacks and rib or face.
Position Bolter			
9. Tram to Face Check that all personnel are clear. Tram bolter forward till chuck is aligned with last row of permanent support.	Tramming near face. Tramming near jacks (if required).	Check where other personnel are located.	Task procedures. Correct controls.
10. Position Bolter Machine Single boom along left rib. Twin boom down middle of section.	Single Boom: Able to position bolter with chuck directly below mark. Twin Boom: Able to position bolter such that all holes in first row can be drilled without having to reposition.	Position machine without going under unsupported roof. Check where other personnel are located. Stay clear of boom.	Task procedures. Correct controls. Fastest way to position bolter. Task procedures. Correct controls. Correct position to reach all bolt locations without repositioning machine.

Task	Skill	Safety Knowledge	Operations Knowledge
11. Mark Correct Position of Each Bolt. Use marking device and measure proper distance. Place mark on roof for each bolt.	Proper Handling of Ruler. Proper handling of marker.	Allowable tolerance in bolt location. Correct bolting pattern including marking for unusual roof conditions.	Task procedures. Bolt locations in RCP.
Drilling Operation			
12. Position Boom (Twin Boom Only) Move boom till in proper position. Make usual check to see that helper is not in path of movement.	Able to position boom with chuck directly below mark for bolt placement.	Check where other personnel are located. Allowable tolerance in alignment with mark. Stay clear of boom.	Task procedures. Correct controls.
13. Drill Hole Set stab jack. Raise protective canopy. Drill test hole. Test hole 12 in. above the anchorage horizon of the bolts being used for support. Observe response of auger during drilling. Determine suitability of current bolt length. Leave test hole open, or plug test hole with a removeable plug. A roof bolt of compatible length with the depth of the test hole may be installed. Marking plate with a circle using paint that is distinctively different in color from the roof.	Lower quickly and smoothly. Raise quickly and smoothly. Recognize roof strata conditions by reaction of drill steel.	Keep feet clear. Keep head clear. One test hole to be drilled at each working section each shift. Hole to be 12 in. above the anchorage horizon. Test hole to aid in determining anchorage suitability of roof strata at anchorage horizon.	Task procedures. Correct controls. Task procedures. How to mark test hole.
a. Insert starter bit Raise chuck for ease of insertion. Select proper length, size auger.	Smooth and efficient boom manipulation and auger handling.	Stay clear of boom or machine movement.	Task procedures. Correct controls.

Task	Skill	Safety Knowledge	Operations Knowledge
Place auger into chuck. Engage auger clamp (if so equipped) Raise chuck till bit is within two inches of mark on roof. Manipulate boom and/or position bolter such that auger is in a vertical position.			
b. Drill Hole to Desired Depth Begin drill rotation using slow speed at first. Hold steel loosely with gloved hand to prevent auger from flying loose in case it bucks out of the hole. When bit enters roof remove hand from steel, speed up rotation and apply full feed. Periodically manipulate boom and/or reposition bolter to maintain auger in a vertical position. Watch for signs of possible roof fall. Watch reaction of steel for signs of unusual roof conditions.	Must be able to manipulate boom or move bolter to maintain steel vertical without breaking bit or drilling a crooked hole.	Recognize signs of possible roof fall. Recognize signs of unusual roof conditions.	Task procedures. Correct controls. When bit sticks reverse feed momentarily and reapply.
Hole drilled at desired depth --lower chuck continuing slow rotation. Hold steel loosely to prevent auger from flying loose as it exits hole. When bit is about to exit roof stop rotation. Lower chuck to good working level. Release auger clamp. Take auger out of chuck and place on machine in proper place.	Apply correct feed rate for maximum penetration rate without sticking or breaking steel.	Make certain operator clear of pinch points.	

Task	Skill	Safety Knowledge	Operations Knowledge
c. Insert Finishing Bit (if used) Pick up proper finishing bit. Place bit in chuck. Engage auger clamp. Raise chuck until finishing bit is inside drill hole.	Apply correct feed rate.	Recognize signs of possible roof fall.	Task procedures. Correct controls.
d. Complete Hole While rotating slowly, raise auger to top of hole. Increase rotation speed. Apply full feed. Drill to desired depth.	Good machine manipulation--knowning when to speed up rotation. Speed control without looking for levers.	Always watch roof.	Know when desired depth is obtained.
e. Remove Bit Lower chuck continuing rotation until bit is about to exit roof. Loosely hold steel to prevent auger from flying out. Stop rotation and lower chuck to workable level. Release auger clamp. Take finishing bit out of chuck. Place bit in proper place on machine.	Know when to stop rotation as bit exits roof.	Always watch for auger flying loose.	
<u>Bolting Operation</u>			
14. Prepare Bolt a. Assemble bolt Pick up proper bolt off machine single boom--helper retrieves, double boom--operator retrieves. Pick up roof plate and slide onto bolt. Take holy board and slide onto bolt (if required).	Smooth and efficient bolt assembly.	Correct bolt, plate, and holy board for roof conditions.	Task procedures.

Task	Skill	Safety Knowledge	Operations Knowledge
17. Reposition Boom or Machine Raise stab jack. Move boom or machine for next drill hole. Position so that chuck is in line with mark.	Same as position roof-bolter machine and boom.		
18. Check Bolt Torque (mechanical) Pick up torque wrench. Set indicator on wrench to zero. Place torque wrench on bolt. Spread feet well apart for balance in case wrench slips. Applying steady-even pressure turn wrench in direction that will tighten bolt. When bolt begins to turn, stop applying pressure. Remove wrench from bolt. Read gauge on wrench. If torque reading is not within correct range, adjust torque control on chuck and re-torque bolt with bolter. Check torque again with wrench. If reading still not within correct range, call foreman.	Ability to obtain good reading in minimum time. Correct torque control adjustment on chuck.	Proper standing position. Allowable range of torque readings from RCP.	Task procedures. How to adjust torque control on chuck.
19. Insert Bolt (resin) Take proper amount of resin tubes from machine. Place resin tubes into drill hole. Pick up proper bolt. Insert bolt into hole. Raise chuck until joins with bolt. Continue raising chuck using steady rate until bolt is in hole. Lower chuck.	Smooth and efficient handling of resin tubes, bolt handling, and boom manipulation.	Do not get resin on skin, or in eyes.	Task procedures. Correct controls. Use correct resin tubes (color). Use resin within specified time period.

Task	Skill	Safety Knowledge	Operations Knowledge
20. Tighten Bolt (resin) a. Insert wrench With chuck at low position-pick up wrench and place in chuck. Engage auger retainer. Raise chuck till wrench and bolt join. Seat bolt head in wrench. Raise chuck till roof plate is flush with roof.	Smooth and efficient handling of chuck and boom manipulation.	Stay clear of boom movement.	Task procedures. Correct controls.
b. Tighten bolt Engage torque lever at high speed. Rotate for approximately 20 seconds. Stop rotation. Hold chuck against roof plate for approximately 10 seconds for resin curing.	Smooth and efficient manipulation of controls.	Improper rotation time leads to insufficient mixing and reduced holding power.	Task procedures. Correct controls. Minimum mixing time. Minimum curing time.
c. Remove wrench Lower chuck to workable level. Dis-engage auger retainer. Take wrench out of chuck. Place wrench on bolter in proper place.	Smooth and efficient handling of wrench.	Make certain operator clear of pinch points.	Task procedures. Correct controls.
21. Reposition Boom or Machine Same procedures apply here as in Task 17.			
22. Check Bolt Torque (resin) Pick up approved resin bolt torque wrench. Set torque to proper ft/lb pressure called for in RCP. Place wrench on bolt. Push on wrench till hear click. Remove wrench from bolt. Check torque indication. Place wrench back on bolter.	Able to get good reading in minimum time.	Spread feet to avoid falling if wrench slips off bolt.	Task procedures. Approved resin bolt torque wrench.

Task	Skill	Safety Knowledge	Operations Knowledge
Post Bolting Procedures			
23. Remove ~~Jacks (if used)~~	Use of sounding tool.	Recognizing unusual roof conditions. Know what unusual conditions can mean concerning their effects on safety.	Task procedures.
a. Inspect Roof Around Jack Visually check for new cracks or slips. Sound roof as before. If roof appears bad, install extra bolts or other approved support as required. If unsure consult foreman.			
b. Remove Jack	Smooth and efficient handling of jacks.	Stand outby jack. Face toward working face.	
c. Place Jacks in Proper Location			
Repeat Drill and Bolting Operation Same procedures to be followed as in tasks 12-16.			
24. Tram Away from Face Gather up all supplies, place in proper location on equipment. Check that all personnel are clear. Communicate your tramming intentions. Check that cable and other equipment are clear. Release brake. Raise stab jack. Position boom or booms for tramming. Lower canopy to tramming level. Position self completely in cab. Turn lights on in direction to tram.	Able to turn around in tight space.	Notify helper you are about to tram. If bolter is trammed by walking along side, keep feet clear of wheels. Be prepared to hit kill switch (panic bar).	Task procedures. Correct controls.

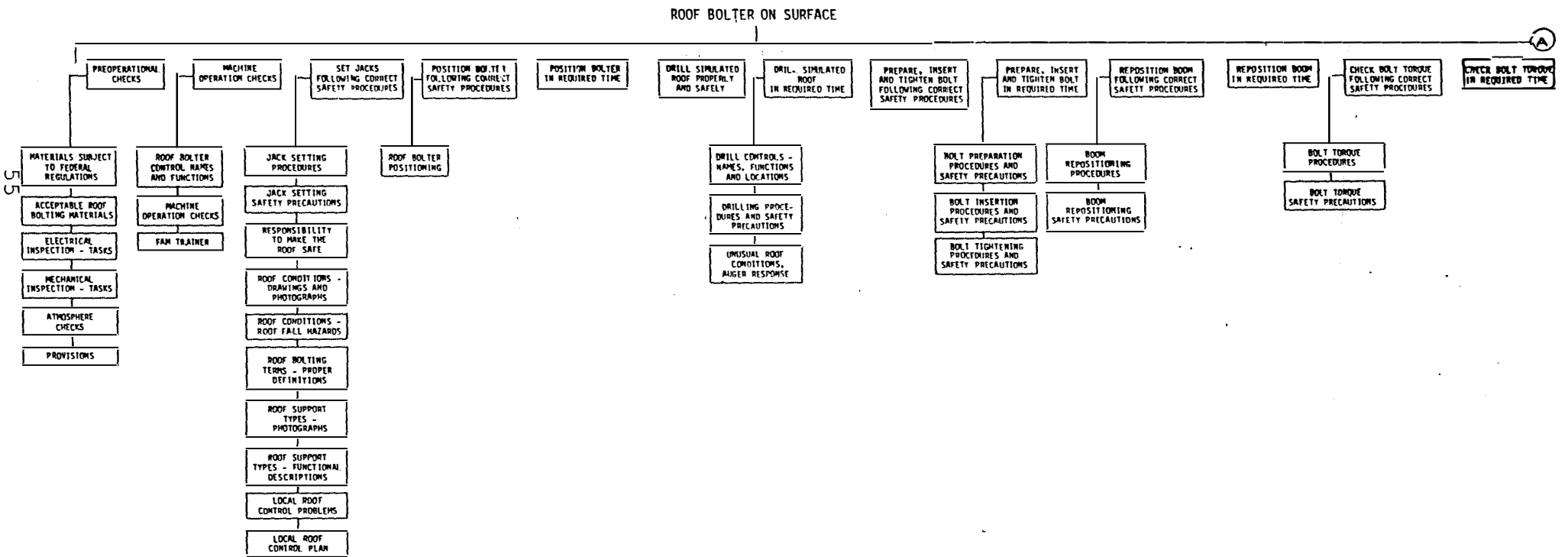
Task	Skill	Safety Knowledge	Operations Knowledge
Engage tramming controls. Tram out into entry. Turn bolter such that booms face direction you wish to tram. Turn lights on in direction you will tram. Reverse tram control. Tram down center to next working area.			
End of Shift Procedures			
End of shift shutdown. Park in safe place outby last open crosscut. Lower booms to floor. Set parking brake. Lock tram pedal. Shut off motor and lights. Check position of trailing cable.		Check where other personnel are located. Do not park where will block airways or haulageways. Avoid parking near line curtains.	Task procedures. Correct controls.

APPENDIX C

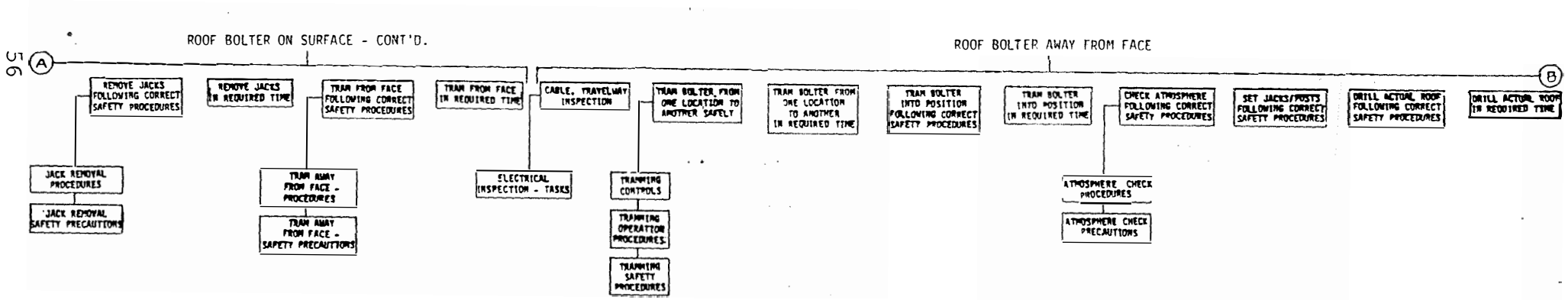
ROOF BOLTER HIERARCHIES

Appendix C. - Roof Bolter Hierarchies

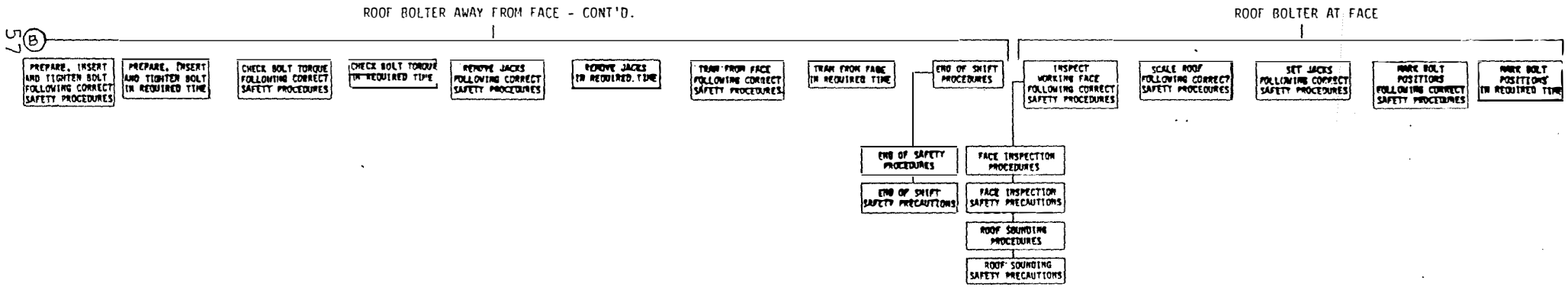
ROOF BOLTER ON SURFACE



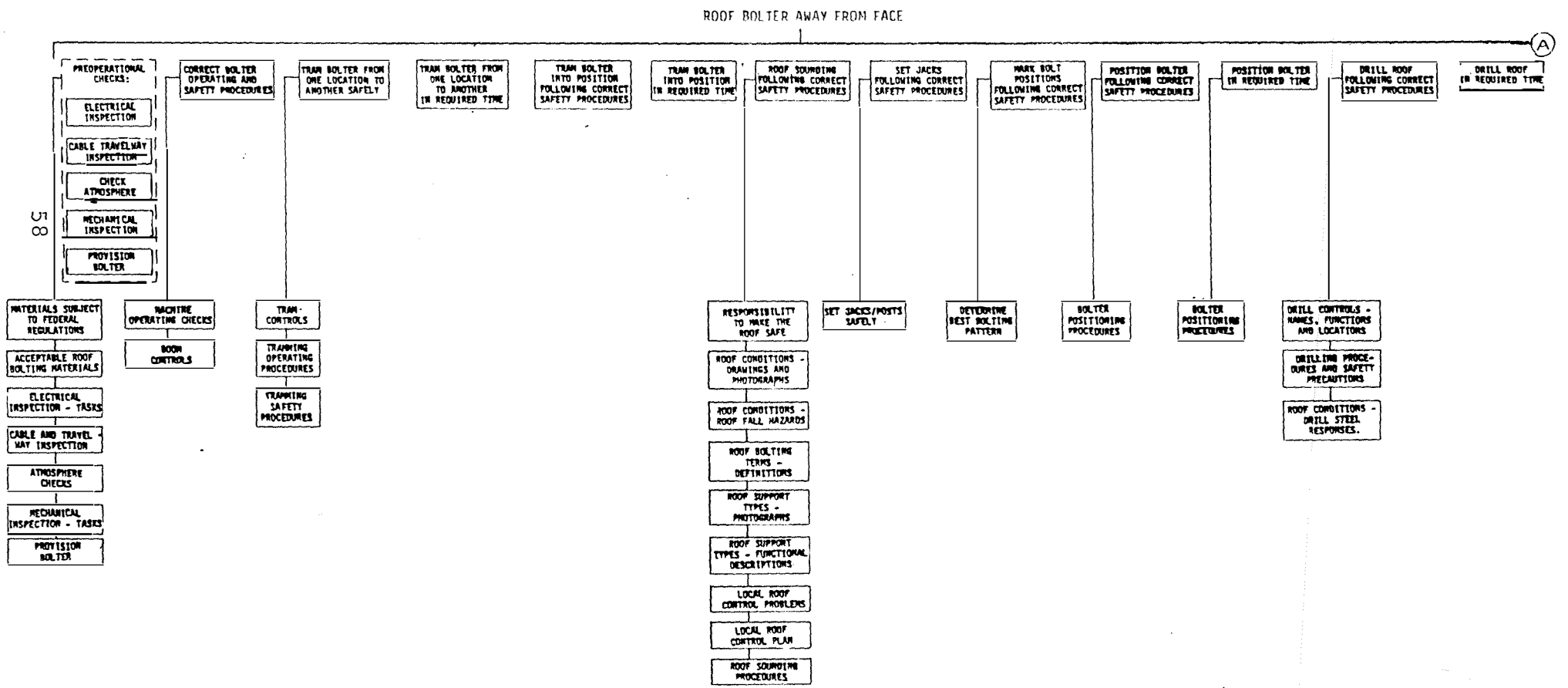
ROOF BOLTER ON SURFACE - CONT'D.

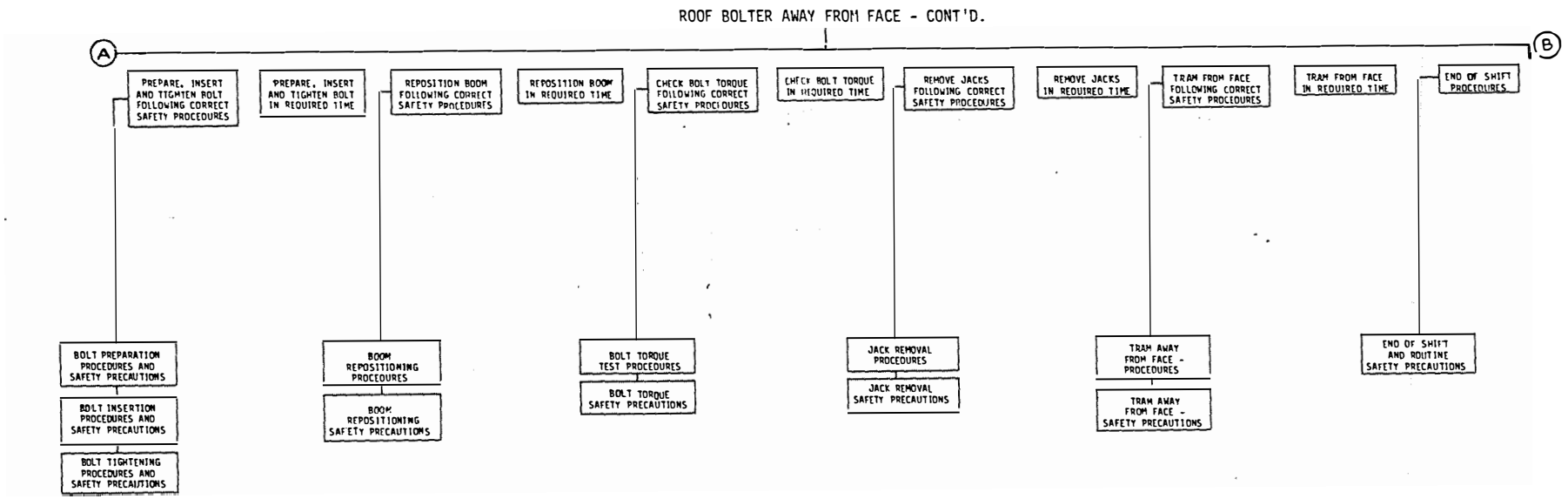


ROOF BOLTER ON SURFACE - CONT'D.

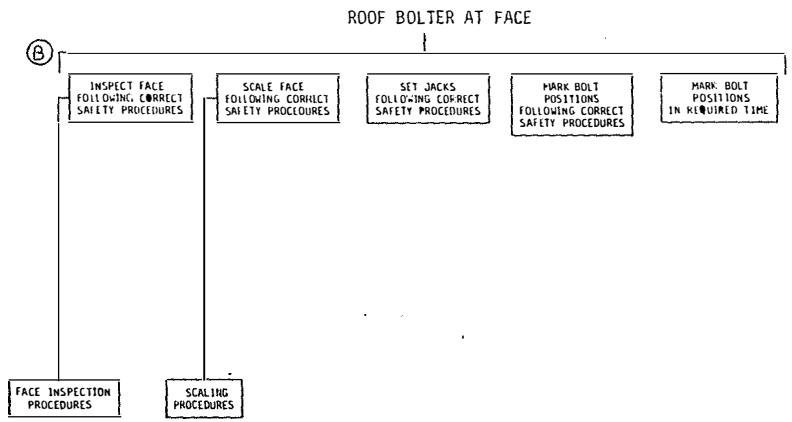


ROOF BOLTER AWAY FROM FACE

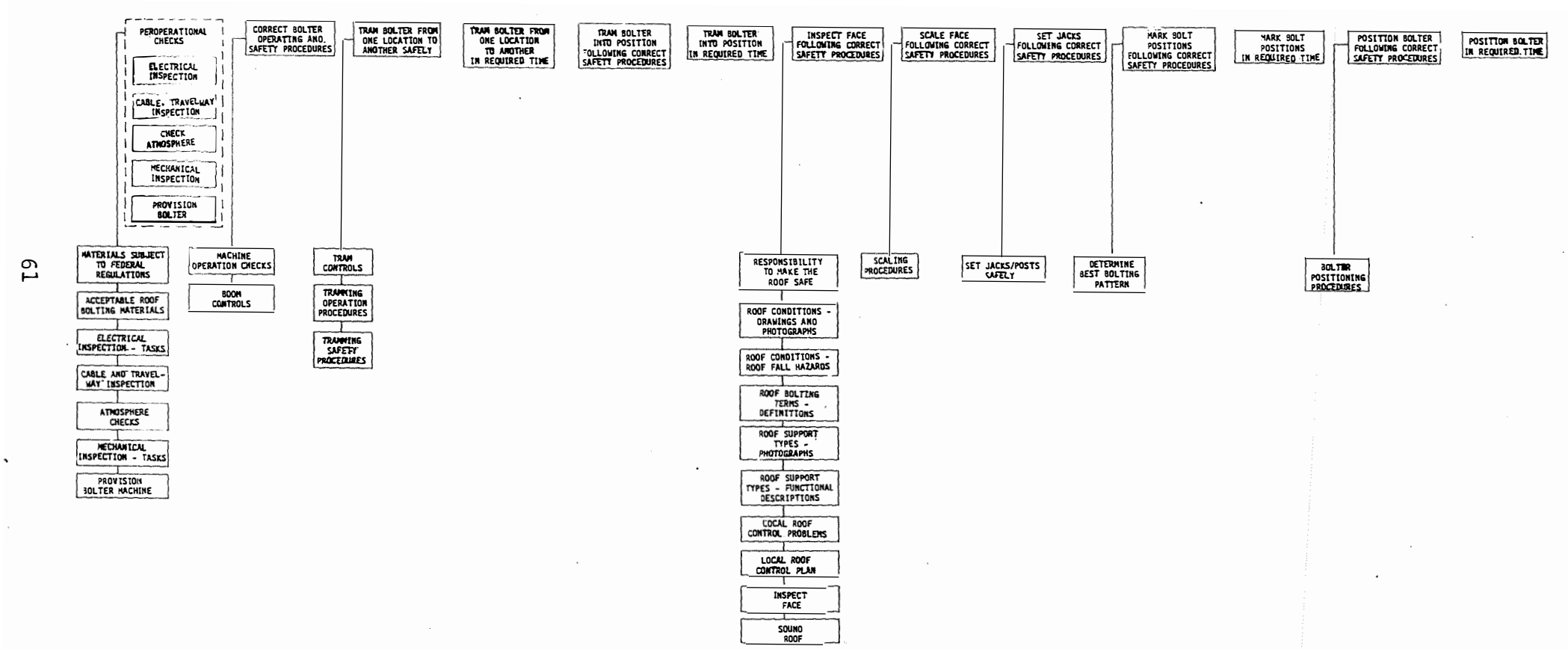



ROOF BOLTER AWAY FROM FACE - CONT'D.
A
B
PREPARE, INSERT AND TIGHTEN BOLT FOLLOWING CORRECT SAFETY PROCEDURES
PREPARE, INSERT AND TIGHTEN BOLT IN REQUIRED TIME
REPOSITION BOOM FOLLOWING CORRECT SAFETY PROCEDURES
REPOSITION BOOM IN REQUIRED TIME
CHECK BOLT TORQUE FOLLOWING CORRECT SAFETY PROCEDURES
CHECK BOLT TORQUE IN REQUIRED TIME
REMOVE JACKS FOLLOWING CORRECT SAFETY PROCEDURES
REMOVE JACKS IN REQUIRED TIME
TRAM FROM FACE FOLLOWING CORRECT SAFETY PROCEDURES
TRAM FROM FACE IN REQUIRED TIME
END OF SHIFT PROCEDURES
BOLT PREPARATION PROCEDURES AND SAFETY PRECAUTIONS
BOLT INSERTION PROCEDURES AND SAFETY PRECAUTIONS
BOLT TIGHTENING PROCEDURES AND SAFETY PRECAUTIONS
BOOM REPOSITIONING PROCEDURES
BOOM REPOSITIONING SAFETY PRECAUTIONS
BOLT TORQUE TEST PROCEDURES
BOLT TORQUE SAFETY PRECAUTIONS
JACK REMOVAL PROCEDURES
JACK REMOVAL SAFETY PRECAUTIONS
TRAM AWAY FROM FACE - PROCEDURES
TRAM AWAY FROM FACE - SAFETY PRECAUTIONS
END OF SHIFT AND ROUTINE SAFETY PRECAUTIONS

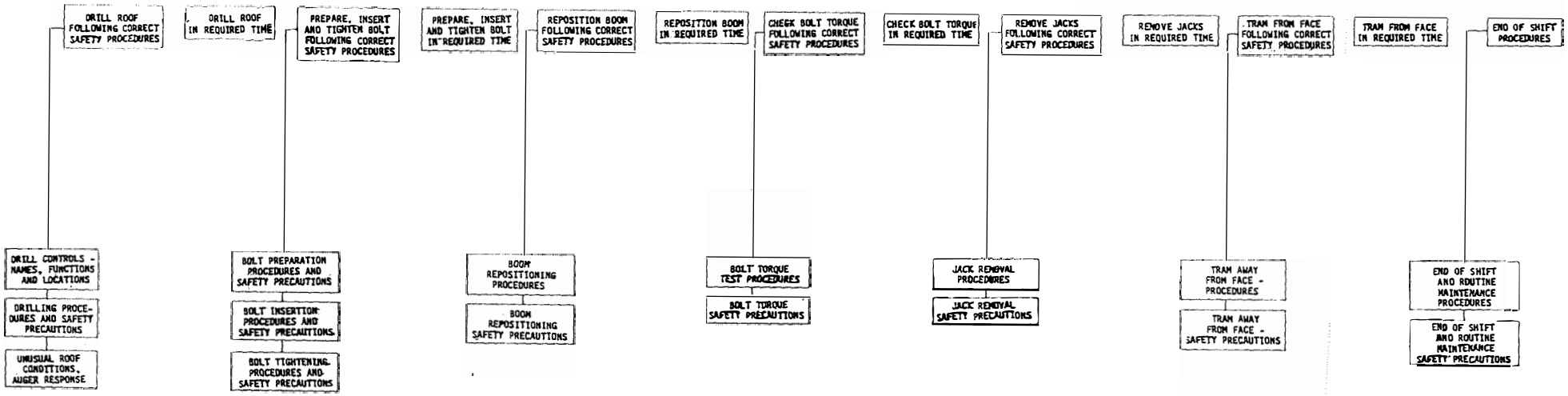
ROOF BOLTER AWAY FROM FACE - CONT'D.



ROOF BOLTER AT FACE



ROOF BOLTER AT FACE - CONT'D.



APPENDIX D

CONTENTS OF INDIVIDUAL REVISED LESSONS

AND

ROOF BOLTER OPERATOR CHECKLIST

Appendix D. - Contents of Individual Revised Lessons and Roof Bolter Operator Checklist

LESSON 1

COURSE INTRODUCTION

I. WELCOME
   A. Describe the nature and goals of the program.
      1. A self-paced media support training program.
      2. Designed to present and evaluate roof bolting knowledge and skills.
      3. The goal is to produce safe and efficient roof bolting machine operations.
   B. Describe the local rules.
      1. Management of the training program.
      2. Work rules.
      3. Local area orientation.

II. TRAINING PROGRAM PARAMETERS
   A. Program composition.
      1. List of lessons.
      2. Types of learning activities.
         a. Classroom lectures.
         b. Classroom media.
         c. Surface training.
         d. Production training.
      3. Learning materials.
         a. Slides.
         b. Tapes.
         c. Worksheets.
         d. Outlines.
         e. Reviews.
         f. Evaluation.
      4. Role of reviews.
         a. Each event is evaluated.
         b. Reviews and evaluations are more for training than testing.
         c. Hands-on practice is also evaluated.
      5. Identify the training supervisor.
   B. Evaluations
      1. Each media lesson contains some type of review/evaluation.
      2. Each is a self-test that is self-scored.
         a. Some are written.
         b. Some are viewed.
      3. Supervisors will evaluate hands-on practice.
      4. A written final exam is given.

C. Procedures.
    1. Slide-tape machines.
        a. Loading.
        b. Starting.
        c. Restarting.
        d. Reviewing.
        e. Rewinding.
        f. Unloading.
    2. Use of worksheets.
        a. A learning and study aid.
        b. Reviews and evaluations.
    3. Hands-on practice.
        a. Group size.
        b. Summary of events to be practiced.
        c. Errors and unsafe acts will be corrected.

III. COURSE IMPORTANCE
    A. Management support.
    B. Government support.
    C. The miner's special responsibility.
        1. Make the roof safe.
        2. Be efficient and productive.

LESSON 2

LECTURE GUIDE

- ROOF CONTROL PLAN AND LOCAL CONDITIONS -

This guide describes some recommendations for presenting the lecture on the roof control plan (RCP) and local conditions. Trainees should refer to a copy of the roof control plan during the lecture.

1.0 Purpose, Type, and Areas

Discuss the purpose of a roof control plan. Note that it is designed to provide a safe work place for the miner. Describe roof support procedures to be used in each area of the mine. Indicate whether your plan calls for full roof bolting or a combination of supports. Point out the areas of the mine covered by the roof control plan.

2.0 Mine Strata

One of the most important subjects in the lecture involves mine strata. Point out the rock strata diagram in the RCP. Discuss what the main roof consists of. Explain in detail the various layers of the immediate roof. If you have more detailed information than that in the RCP, show and discuss a drawing with this additional information. Discuss how much the immediate roof layers vary in thickness in the different sections of the mine.

Point out the bolt anchorage point in the strata diagram. Discuss drill reactions that indicate they have or have not drilled to a good anchorage point in the strata.

Point out any problem areas in the mine roof and how to handle them. Discuss roof defects, how often they occur, how to recognize them, and how to take down or support them. Emphasize any local procedures.

Discuss the thickness of the coal bed and how much the roof height varies. Explain how this affects drill steel length and extensions. Finally, mention the mine bottom and how it might affect tramming, stab jack effectiveness, and temporary support stability.

3.0 Support Types

It is very important that the trainees see actual roof supports that are used in your mine. Show them a jack and explain how it is raised and lowered. Show them a post, block, and wedges.

Show the trainees the types of bolts used in the mine. Show them a mechanical bolt, expansion shell, resin bolt, resin cartridge, bearing plate, and block. Assemble a complete mechanical bolt and resin bolt as required in the RCP. Show them photographs of other roof support materials, such as cribbing blocks, planks, metal strips, etc.

4.0 Installation Procedures

Next explain support installation procedures. Use the drawing of bolt locations contained in the RCP. Point out required jack and bolt locations relative to the face and rib and maximum distance between centers of supports. Also, point out the order of installation.

5.0 Safety Precautions

Most RCPs contain a list of safety precautions to be followed at that mine. Review these precautions with the trainees. Those that are the same as in the training program need not be emphasized. Precautions not contained in the training program should be stressed.

6.0 Violations, Accidents, RCP

Go over the most frequent roof control plan violations at your mine. Explain what the roof bolter operator did wrong and how it should have been done. Point out that violations generally indicate a condition potentially dangerous to roof bolter operators or their fellow miners.

Go over frequent roof bolter operator injuries and roof fall accidents. Explain which unsafe acts and violations of procedures led to the injury or fall. Point out the correct procedure in each case. Your safety director may want to present this part of the lecture.

7.0 Importance of RCP

Stress the importance of following the RCP. It is the roof bolter operator's bible and tells him how to work safely. Emphasize that the RCP is the law and takes priority over the training program and the Code of Federal Regulations.

8.0 Other Duties

Some mines have roof bolter machine operators perform duties other than those contained in the training program. These duties should be outlined at this point.

- OUTLINE OF LECTURE ON ROOF CONTROL PLAN AND LOCAL CONDITIONS -

I. INTRODUCTION
   A. Purpose of plan.
      1. Safe work place.
      2. Describe procedures.
   B. Type of support plan.
   C. Area covered.

II. MINE STRATA
- A. Rock strata diagram.
  - 1. Main roof.
  - 2. Immediate roof.
  - 3. Differences between sections.
  - 4. Anchorage point.
  - 5. Drill steel reactions.
  - 6. Problem areas.
    - a. Defects.
    - b. Recognition.
    - c. Take down.
    - d. Support.
- B. Coal bed.
- C. Bottom.

III. SUPPORT TYPES
- A. Jacks or posts.
- B. Roof bolts.
  - 1. Mechanical.
  - 2. Expansion shell.
  - 3. Resin cartridges.
  - 4. Bearing plate.
  - 5. Block.

IV. INSTALLATION PROCEDURES
- A. Drawing.
- B. Jack locations.
  - 1. Centers.
  - 2. Face.
  - 3. Rib.
- C. Bolt locations.
  - 1. Centers.
  - 2. Face.
  - 3. Rib.
- D. Installation order.

V. SAFETY PRECAUTIONS
- A. Review same.
- B. Emphasize different.

VI. RCP VIOLATIONS
- A. Potential danger.
- B. Legal considerations.

VII. FREQUENT ROOF BOLTER ACCIDENTS AND FALLS
- A. Unsafe act.
- B. Procedure violation.
- C. Correct procedure.
- D. Follow RCP.

VIII. OTHER DUTIES

LESSON 3

ROOF SUPPORT PRINCIPLES

The following topics will be covered in this lesson:
INTRODUCTION
ROOF SUPPORT
ROOF DEFECTS
OTHER ROOF SUPPORTS
REVIEW

INTRODUCTION (Frames 1-8)

1. Your safety depends on you and your buddies.
2. This is the first of ten slide-tape shows.
3. The topics are:
   a. Roof support principles.
   b. Roof bolter controls.
   c. The mining cycle.
   d. Atmospheric checks and materials handling.
   e. Pre-operational check.
   f. Machine operational check and preparation for maintenance.
   g. Tramming and face preparation.
   h. Positioning and drilling.
   i. Bolting and end-of-shift shutdown.
   j. Introduction to on-the-job checklist.
4. Meet the GRINK!

Notes:

ROOF SUPPORT (Frames 9-17)

1. Mine roof consists of two major parts:
   a. Immediate roof.
   b. Main roof.
2. Immediate is made up of thin loose materials.
3. Immediate roof is likely to fall!
4. Immediate roof is supported by:
   a. Temporary supports.
   b. Roof bolts.
5. Roof bolts use two principles:
   a. Suspension.
   b. Beam-building.

Notes:

ROOF DEFECTS (Frames 18-35)

1. Kettle bottoms are heavy smooth rocks.
2. If kettle bottoms are found below the roof line, they should be removed.
3. Kettle bottoms at the roof line should be supported.
   a. Small kettle bottoms may be supported by bolts and bearing plates.
   b. Large kettle bottoms should be planked across.
4. Horsebacks are intrusions of shale materials.
5. Horsebacks are supported in two ways:
   a. By bolts and planks installed along the edge of the horseback.
   b. By drilling and bolting through the horseback.
6. Slips are smooth rock faults.
7. Slips are controlled in two ways:
   a. Diagonal slips are bolted through.
   b. Vertical slips are strapped across.
8. Cracks are larger rock faults.
9. Cracks are controlled in the same two ways slips are controlled.
10. Clay veins are large rock faults filled with mud.
11. Clay veins are controlled in the same manner as slips and cracks.

Notes:

OTHER ROOF SUPPORTS (Frames 36-41)

1. Long headers are long planks connected by several roof bolts.
2. Long headers are used to provide extra support in weak areas.
3. Crossbars are long planks supported by posts at the rib.
4. Crossbars are used in main lines and haulageways.
5. Cribs are stacks of timbers used to support the roof in older mine areas.

Notes:

LESSON 4

BASIC CONTROL FUNCTIONS OF ROOF BOLTING MACHINES

The following topics will be covered in this lesson:
INTRODUCTION
COMMON CONTROLS
UNIQUE CONTROLS
TRAMMING EXAMPLE

INTRODUCTION (Frames 1-4)

1. General control functions are covered in this lesson.
2. There are many variations in types and operation of controls on roof bolters.
3. You will have a chance to become familiar with your mine's machine controls.

Notes:

COMMON CONTROLS (Frames 5-14)

1. Fire suppression system actuator.
   a. Pin must be pulled.
   b. Push or pull actuating button or knob.
2. Tramming controls.
   a. Some machines have one, others have two controls for left and right motors.
   b. Safe operation of two-control tramming takes practice!
3. Pump motor start switch provides hydraulic pressure for operation.
4. Panic bar can be easily reached for emergency shut-off.
5. Split flow control on many machines allows continued operation in case of single motor failure.
6. Diversion control allows one hydraulic system to operate either tramming or drilling, depending on setting.
7. TRS controls.
   a. Extend.
   b. Tilt.
   c. Raise.
8. Boom control allows swing positioning of boom under the drill hole.
9. Safety post control raises and lowers the safety post.
10. Vertical feed control.
    a. Single speed.
    b. Dual speed for drilling (slow) or positioning (fast).

Notes:

UNIQUE CONTROLS (Frames 15-19)

1. Rotation.
   a. Speed.
   b. Torque (force).
2. Keep your eyes on which control you are using!
3. Torque selector.
   a. Standard (drilling).
   b. Low (torqueing mechanical bolts).
4. Remote controls are at the drill station.
   a. Start/panic bar.
   b. Tramming (sometimes called "inch" tramming controls for small adjustments).
5. Stab jack controls extend floor jacks to stabilize the machine.
6. Cable reel control.
   a. Play out.
   b. Take-up.
   c. Some machines have a needle valve which allows you to adjust the power of the reel.
7. Self-centering feature.
   a. Some lever controls automatically return to off as opposed to selection levers or push-pull knobs.
   b. In tramming, this can be hazardous.

Notes:

TRAMMING EXAMPLE (Frames 20-31)

1. Control movements are best learned on individual machines.
2. Left and right tramming controls operate the left and right drive wheels.
3. Both controls forward for straight ahead.
4. Both controls back for reverse.
5. Normal turns.
   a. Right turn - both forward but left farther.
   b. Left turn - both forward but right farther.
   c. Same for reverse turns.
6. Slew turns.
   a. Pushing one control forward and pulling the other back results in a pivot or slew turn.
   b. Slew turn can be hazardous if not done carefully.
   c. Check with your foreman about your mine's policy.
7. REMEMBER
   a. Turning a roof bolter is like turning a lawn mower with a very wide handle.
   b. Push forward the hand opposite from the direction you want to turn.
   c. Push one hand and pull the other and you might be bit by the mower blade.

Notes:

LESSON 5

THE MINING CYCLE

The following topics are covered in this lesson:
THE CONVENTIONAL MINING METHOD
THE CONTINUOUS MINING METHOD

THE CONVENTIONAL MINING METHOD (Frames 3-25)

1. There are six steps in the conventional mining method:
   a. Roof bolting.
   b. Undercutting.
   c. Drilling.
   d. Shooting.
   e. Loading.
   f. Roof bolting.
2. The roof bolting machine is positioned and the operator prepares the area.
3. The roof bolter tests the atmosphere.
4. The cutting machine enters and undercuts the face.
5. The face drill makes a pattern of holes for the blasting materials.
6. Some mines use hand-held drills.
7. Explosives or compressed air shells are placed into the holes.
8. Delaying circuits are used to distribute the blast over the face.
9. The loading machine enters and collects the coal.
10. The loading machine delivers the coal to a shuttle car.
11. The shuttle car delivers the coal to a dump point.
12. The coal is hauled out of the mine by:
    a. Conveyor belt.
    b. Track-mounted cars.
13. Temporary supports are installed and the roof bolting machine returns.

Notes:

THE CONTINUOUS MINING METHOD (Frames 26-37)

1. The continuous mining method consists of three steps:
   a. Roof bolting.
   b. Continuous mining.
   c. Roof bolting.
2. The roof bolting machine enters the area and is positioned.
3. The roof bolter prepares the area and tests the atmosphere.
4. The continuous mining machine performs four of the steps in conventional mining:
   a. Undercutting.
   b. Drilling.
   c. Shooting.
   d. Loading.

5. The continuous mining machine delivers coal to a shuttle car.
6. The shuttle car delivers the coal to a dump point.
7. The coal is hauled out by conveyor belts or track-mounted cars.
8. The roof bolting machine enters and secures the roof.

Notes:

LESSON 6

ATMOSPHERIC CHECKS AND MATERIALS HANDLING

The following topics will be covered in this lesson:
METHANE
METHANOMETERS
THE FLAME SAFETY LAMP
REACTIONS TO METHANE DANGER
VENTILATION SAFETY
OTHER GAS DANGERS
LIFTING DANGERS
LIFTING PROCEDURES

METHANE (Frames 1-12)

1. Methane is the most common unwanted gas in the mine.
2. Methane is often called "firedamp."
3. Methane was formed by the same process that formed the coal.
4. As coal is mined, methane is released into the mine air.
5. Amounts of methane vary with mine locations.
6. Methane is explosive when it makes up between 5 and 15 percent of the mine air.

Notes:

METHANOMETERS (Frames 13-17)

1. Methanometers are small battery-operated devices that provide accurate readings of the amount of methane in the mine air.
2. The amount of methane is displayed as a percentage.
3. Some methanometers let you sample the mine air under unsupported roofs by the use of long sensing rods.
4. When you test DO NOT go out under an unsupported roof.

Notes:

THE FLAME SAFETY LAMP (Frames 18-28)

1. The flame safety lamp is an older way to measure methane.
2. Two methods of methane detection are used:
   a. The working flame.
   b. The capping flame.
3. In the working flame method, the length of flame indicates the amount of methane.
4. In the capping flame method, the color of the flame indicates amounts of methane.

5. The flame safety lamp is a delicate instrument. Never use a damaged lamp; it could cause a fire or explosion.

Notes:

REACTIONS TO METHANE DANGER (Frames 29-35)

1. Specific actions are required to correct methane dangers prior to the explosive range of 5 - 15%.
2. When 1 to 1-1/2% methane is detected:
   a. Shut off power to face equipment.
   b. Report to the foreman.
   c. Adjust the local ventilation.
3. When 1-1/2% or more is detected:
   a. All power must be cut in the area.
   b. All workers, except those involved in improving the ventilation, must be removed to a safe area.
4. You must test for methane every 20 minutes.

Notes:

VENTILATION DANGERS (Frames 36-40)

1. The mine ventilation system brings in fresh air and removes gases and dust from the mine.
2. Be alert for problems with the ventilation system.
3. Tubing or line brattice in good repair must be installed within 10 feet of the face.
4. If the brattice or tubing needs repair, all work must stop until adequate ventilation is restored.
5. If an auxiliary fan fails, shut off power to face equipment and notify your foreman.
6. Be sure there are no supplies or debris in the path of ventilation air.

Notes:

OTHER GAS DANGERS (Frames 41-50)

1. Carbon monoxide is a colorless, odorless, and tasteless gas that is formed in fires.
2. Carbon monoxide is poisonous and can harm you even in very small quantities.
3. Your self-rescuer will protect you from carbon monoxide.
4. Carbon dioxide is also formed in fires.
5. Carbon dioxide is dangerous in large quantities because it can suffocate you.

6. If you see smoke or flames, get to good air to protect yourself from carbon dioxide. Put on your self-rescuer to protect yourself from carbon monoxide.
7. We require about 21% oxygen in the air we work in to be healthy.
8. You must test for oxygen deficiency at least once during your shift.
9. The flame safety test is used to test for oxygen deficiency; it's best to test near the floor.

Notes:

LIFTING DANGERS (Frames 51-56)

1. Improper lifting is the chief cause of materials handling injuries.
2. Use your legs to lift.
3. Keep your back vertical to protect your spine.

Notes:

LIFTING PROCEDURES (Frames 57-76)

1. The National Safety Council recommends six steps:
   a. Estimate the weight of the object.
   b. Get close to the object.
   c. Spread your feet.
   d. Bend your knees.
   e. Grip the object.
   f. Straighten your legs.
2. Watch your fingers when you get close to the floor.
3. For long objects that are best carried on your shoulder:
   a. Raise the object to waist height with knees bent.
   b. Put the object on your shoulder with knees bent.
   c. Straighten your knees.
4. Keep long objects above eye level.
5. For sacked materials:
   a. Pick up the sack at the corners.
   b. Rest the sack on your hip.
   c. Place the sack on your shoulder and hip.
   d. Swing the sack down.
   e. Keep your back straight.
6. When large objects need to be lifted, you must communicate so all lifters know what to do.
7. In low coal, work on your knees and keep your back straight if you can.
8. In low coal, be sure to get help in moving objects.

Notes:

LESSON 7

PRE-OPERATIONAL CHECKS

The following topics will be covered in this lesson:
SAFETY
PRE-OPERATIONAL CHECKS
ELECTRICAL CHECKS
CABLE INSPECTION
MECHANICAL CHECKS
TOOL CHECKS

SAFETY (Frames 1-7)
1. Injury/death statistics.
2. Injuries due to safety shortcuts.
3. Multiple regulations.

Notes:

PRE-OPERATIONAL CHECKS (Frames 8-12)
1. Explanation of quiz.
2. Personal clothing and gear.
3. Clothing precautions.
4. Four areas to check:
    a. Electrical system.
    b. Cable and travelway.
    c. Mechanical system.
    d. Tools.

Notes:

ELECTRICAL CHECKS (Frames 13-25)
1. Respect ELECTRICITY.
2. Take precautions in wet areas.
3. Insulation required.
4. "AC" checks:
    a. Area of distribution box clear.
    b. Well-coated with rock dust, 240 pounds of rock dust and portable fire extinguisher near.
    c. High voltage switch "on" - if "off," notify foreman.
    d. Low voltage switch - "off."
    e. Trailing cable connector, check for security and proper label.

5. "DC" checks:
    a. Breaker box area.
    b. Rock dust and fire extinguisher.
    c. Ground device.
    d. Trolley wire ground.
    e. Cable nip or tap.
    f. Circuit breaker is "off."

Notes:

CABLE INSPECTION (Frames 26-29)

1. Look for any hazards between power source and bolter machine.
2. Place cable out of the way.
3. Check cable for damage.

Notes:

MECHANICAL CHECKS (Frames 30-51)

1. Is machine under repair?
2. Fire suppression system:
    a. Casing free of dents and corrosion.
    b. Tubing not cut or damaged.
    c. Valve assembly free of debris, in normal condition.
    d. Seals present and in good condition.
    e. Nozzle areas clear.
    f. Machine clean as possible.
3. Operating instructions clean enough to read.
4. Oil checks:
    a. Hoses, adapters, and fittings.
    b. Level.
    c. Add proper oil, checking filter screen.
5. Lift mechanism on canopy, boom, and automatic support.
6. Electrical checks:
    a. Look for bad connections.
    b. Check contactor cases, motor housing, cover and inspection plates.
    c. Condition of electrical connectors and wires.
    d. Inspect electrical items mounted on frame and cable reel.
7. Dust collector:
    a. Collector compartment not full.
    b. Clogged, damaged filters.
    c. Hoses not cracked or cut.
8. All controls in neutral position.
9. All linkages are okay.
10. Report any and all discrepancies to foreman.

Notes:

TOOL CHECKS (Frames 52-59)

1. Have right tools and materials:
   a. Sounding bar.
   b. Slate bar.
   c. Methane tester and flame safety lamp.
   d. Bolt wrench.
   e. Torque wrench.
   f. Drill steel.
   g. Extensions.
   h. Starter bits.
   i. Finishing bits.
   j. Cotter pins or wire.
   k. Jack handle.
   l. Pliers.
   m. Hatchet.
   n. Hammer.
2. Condition of tools.
3. Roof bolting materials.
4. Jacks and temporary supports.

Notes:

LESSON 8

MACHINE OPERATIONAL CHECKS AND PREPARATION FOR MAINTENANCE

The following topics will be covered in this lesson:
INTRODUCTION AND REVIEW
MACHINE START-UP
MACHINE CHECKS
BEFORE TRAMMING CHECKS
PREPARATION FOR MAINTENANCE

INTRODUCTION AND REVIEW (Frames 1-16)

1. Lesson deals with machine checks and preparation for maintenance.
2. Check the atmosphere.
3. AC power checks:
   a. Stand on a mat.
   b. Low voltage "off."
   c. Trailing cable secure.
   d. Low voltage "on."
   e. Do not reset circuit.
   f. Post a danger sign.
4. DC power checks:
   a. Ground connections secure.
   b. Breaker box "off."
   c. Trailing cable secure.
   d. Nip or tap secure.
   e. Wear a glove.
   f. Look away from nip.
   g. Be alert for arcs.
   h. Breaker box "on."

Notes:

MACHINE START-UP (Frames 17-23)

1. Clear the area.
2. Sit entirely in the cab.
3. Yell "clear."
4. Lights on.
5. Press "start."
6. Hit the panic bar.
7. Restart.

Notes:

MACHINE CHECKS (Frames 24-43)

1. Check hydraulic pressure.
2. Raise the canopy or safety post to the roof.
3. Raise the ATRS to the roof.
4. Look for tripping hazard.
5. Operate the boom.
6. Watch for pinch points.
7. Lower the stab jack.
8. Check the chuck.
9. Check the drill steel guide.
10. Check the vacuum system.
11. Check the drill steel.

Notes:

BEFORE TRAMMING CHECKS (Frames 44-53)

1. Center the boom.
2. Raise the stab jacks.
3. Lower the canopy.
4. Remove wheel chocks.
5. Clear the area.
6. Release the parking brake.
7. Turn the lights on.
8. Tram forward and test the brakes.
9. Tram backward and test the brakes.
10. Report problem to the maintenance foreman.

Notes:

PREPARATION FOR MAINTENANCE (Frames 54-73)

1. Park outby the last open crosscut.
2. Set the parking brake.
3. Lower the booms onto crib blocks.
4. Post a danger sign.
5. Turn off the motor and lights.
6. Chock the wheels.
7. Put the trailing cable close to the rib.
8. Turn off both AC and DC at the circuit breaker.
9. Disconnect the trailing cable.
10. For DC, remove the nip and fuse and give them to the maintenance man.
11. Hang the fuse holder in a safe place.
12. Don't be a repairman yourself.

Notes:

LESSON 9

TRAMMING AND FACE PREPARATION

The following topics will be covered in this lesson:
INTRODUCTION
TRAMMING SAFELY
ROOF CONDITION HAZARDS
SCALING AND SOUNDING THE ROOF
SETTING JACKS AND POSTS

INTRODUCTION (Frames 1-4)
1. Check final pre-operational checks.
2. Check atmosphere.

Notes:

TRAMMING SAFELY (Frames 5-14)
1. Stay entirely inside the cab.
2. Watch out for other miners.
3. Watch for debris and bad floor.
4. Sound your warning device at corners.
5. Hang your cable, if necessary.
6. Stop at all check curtains.
7. Park outby the last open crosscut.
8. Check the atmosphere.

Notes:

ROOF CONDITION HAZARDS (Frames 15-18)
1. Check your roof control plan.
2. Look for overhangs, rock on the floor, slips or cracks.
3. Look for clay veins, horsebacks, and kettle bottoms.
4. Install extra bolts for weak areas.

Notes:

SCALING AND SOUNDING THE ROOF (Frames 19-24)

1. Use a scaling bar.
2. Hold the bar firmly.
3. Stand under supported roof.
4. Keep your balance and pry upward.
5. Clean up the floor.
6. Keep an escape route.
7. Use the "sound and vibration" method on the roof.

Notes:

SETTING JACKS AND POSTS (Frames 25-36)

1. Set jacks with one man under supported roof.
2. Set jacks so that you will not hit them with the bolter.
3. Tighten jacks and include cap blocks.
4. Cut post to proper length.
5. Use no more than two wedges.

Notes:

LESSON 10

POSITIONING THE ROOF BOLTER AND BOOMS, AND DRILLING THE ROOF

The following topics are covered in this lesson:
INTRODUCTION
POSITIONING THE BOLTING MACHINE
DRILLING A STARTER HOLE
DRILLING A FINISH HOLE IN HIGH COAL
DRILLING A FINISH HOLE IN LOW COAL
DRILLING A TEST HOLE

INTRODUCTION (Frames 1-3)
1. Remember to set temporary supports.
2. Recall your tramming procedures.

Notes:

POSITIONING THE BOLTING MACHINE (Frames 4-16)
1. Position the chuck under the bolt marking.
2. Raise your ATRS.
3. Be careful when you position the boom; you could hit something, get pinched, pin someone, or trip.
4. Keep one hand on the panic bar.
5. Raise your protective canopy.
6. Wear eye protection.

Notes:

DRILLING A STARTER HOLE (Frames 17-33)
1. A starter hole is at least one foot shorter than the bolt.
2. Verify you are using a starter bit.
3. Line up the steel below the location mark about two inches below the roof.
4. Drill about two inches into the roof but don't hold the steel.
5. Watch out for these danger signs:
   a. Whipping steel.
   b. Too slow penetration.
   c. Too fast penetration.
   d. Dust and cuttings coming out of the hole.
   e. Sticking steel or rotation stopping.
6. Mark your steel prior to drilling to be sure you will drill to the correct depth.

Notes:

DRILLING A FINISH HOLE IN HIGH COAL (Frames 34-47)

1. Resin or combination bolts don't use the same type of finish hole required by a mechanical bolt.
2. The finish hole for a resin or combination bolt should be no more than one inch longer than the bolt.
3. In calculating the depth of any hole, remember to take the thickness of the cap block and bearing plate into account.
4. Don't rest the finish steel on your foot.
5. Mark the depth of the hole on your finish steel.
6. Watch for signs of soft strata or voids in the roof.

Notes:

DRILLING A FINISH HOLE IN LOW COAL (Frames 48-55)

1. Low coal often requires the use of drill extensions.
2. Never use a wrench for an extension.
3. Always couple extensions by hand.
4. Reverse the steps to remove the extensions.
5. Store your steel and extensions in their proper place.

Notes:

DRILLING A TEST HOLE (Frames 56-58)

1. Test holes tell us about the roof strata.
2. Test holes are drilled just like regular holes but are at least one foot deeper.
3. They are often drilled near an intersection.
4. Test holes are often left open. However, paint a circle around the hole to identify it.

Notes:

LESSON 11

BOLTING THE ROOF AND END-OF-SHIFT SHUTDOWN

The following topics will be covered in this lesson:
INTRODUCTION
BOLT TYPES
INSTALLING A MECHANICAL BOLT
LOW COAL PROCEDURE
INSTALLING A RESIN BOLT
INSTALLING A COMBINATION BOLT
REPOSITIONING THE MACHINE
TORQUE-TESTING MECHANICAL AND COMBINATION BOLTS
TORQUE-TESTING A RESIN BOLT
REMOVING TEMPORARY SUPPORTS
END-OF-SHIFT SHUTDOWN

INTRODUCTION (Frames 1-7)

1. Installing bolts is the most dangerous part of your job.
2. The most common injuries are:
   a. Crushed fingers.
   b. Tripping and falling.

Notes:

BOLT TYPES (Frames 8-13)

1. Three types of bolts are discussed:
   a. Mechanical.
   b. Resin.
   c. Combination.
2. Mechanical bolt is similar to a molly bolt.
3. Resin bolts use a glue approach.
4. Combination bolts have both mechanical and resin sections.

Notes:

INSTALLING A MECHANICAL BOLT (Frames 14-28)

1. Install the bolt wrench in the chuck.
2. Select the proper parts.
3. Put the assembled bolt in the hole and lower it into the chuck.
4. Raise the bolt with the boom until the bearing plate or block just touches the roof.
5. WATCH YOUR FINGERS!
6. Torque the bolt with rotation only.
7. Look away to avoid eye injuries.

8. You may get a spinner; if so, remove the bolt and install a new one.
9. Re-torque the bolt and inspect the bearing plate.
10. Check the atmosphere every 20 minutes.

Notes:

LOW COAL PROCEDURE (Frames 29-30)

1. In low coal, you may have to bend the bolt to get it in the hole.
2. Bend the bolt to a 45 degree angle before you put it in the hole.
3. Insert it to bend and straighten it out, then insert it to its full length.

Notes:

INSTALLING A RESIN BOLT (Frames 31-41)

1. Resin is very irritating; be careful not to get it in your eyes or on your skin.
2. Install the bolt wrench and select your supplies.
3. Install the resin and rebar in the hole (be sure to check the date on the resin).
4. Lower the bolt head into the chuck.
5. Now raise the bolt to about 2 inches below the roof.
6. Spin the bolt with no thrust for the recommended period of time. This is usually about 20 seconds.
7. Stop rotation and give the bolt maximum thrust for 1 minute to "cure" the bolt.
8. Check to see if resin is released from about half the bolts.

Notes:

INSTALLING A COMBINATION BOLT (Frames 42-52)

1. Install the bolt wrench in the chuck and gather your supplies.
2. Assemble the bolt.
3. Insert the resin and follow the resin with the bolt.
4. Raise the bolt to about 1/2-inch below the roof and spin the bolt.
5. Hold the bolt still for at least 1 minute to cure the bolt.
6. Torque the mechanical section.

Notes:

REPOSITIONING THE MACHINE (Frames 53-54)

1. Raise the stab jacks and lower the canopy.
2. Move the boom under the next bolt position.
3. Lower the stab jacks and raise the canopy.

Notes:

TORQUE-TESTING MECHANICAL AND COMBINATION BOLTS (Frames 55-64)

1. Select the torque wrench with a pounds-of-force indicator.
2. Set the indicator to zero.
3. Apply pressure until the bolt moves or the pressure given in the roof control plan is reached.
4. If the bolt moves before the pressure is reached, then re-torque the bolt.
5. If the bolt cannot be tightened, install another.

Notes:

TORQUE-TESTING RESIN BOLTS (Frames 65-69)

1. Select a "click-type" torque wrench.
2. Set the value given in the roof control plan.
3. Apply pressure until you hear a click.
4. If the bolt moves before the click, test it again. Replace it if it moves a second time.

Notes:

REMOVING TEMPORARY SUPPORTS (Frames 70-73)

1. Know your escape route.
2. Remove jacks, lowering the top extension.
3. Remove posts by pounding the top.
4. Stow supplies in their proper place.

Notes:

END-OF-SHIFT SHUTDOWN (Frames 74-78)

1. Remember to test the atmosphere every 20 minutes.
2. Clear your path.
3. Park outby the last open crosscut, set the brake, lower the booms, and shut off the motor and lights.
4. Chock the wheels, move the cable, turn off the power at the source.
5. Disconnect the cable for AC power; disconnect the nips for DC power.
6. Follow the same procedure for any occasion when you leave the machine for 30 minutes.

Notes:

LESSON 12

ON-THE-JOB CHECKLIST

The following topics are covered in this lesson:
INTRODUCTION
KEY WORDS
EXAMPLES
CHECKLIST

INTRODUCTION (Frames 1-4)
1. Checklists are very common for operators of complex equipment.
2. You will have two - a long, more detailed review checklist and a short on-the-job checklist.
3. Both will concentrate on exactly what you are to do.

Notes:

KEY WORDS (Frames 5-11)
1. The key words for checklist items are:
   a. Presence.
   b. Condition.
   c. Setting.
   d. Response.
2. "Presence" should key us to ask if the item is there and if it's in the right place.
3. "Condition" should key us to ask if the item is in the proper condition.
4. "Setting" should key us to question the condition of the item.
5. "Response" should key us to any response we are looking for from the item or event.

Notes:

EXAMPLES (Frames 12-15)
1. Check the fire suppression system. What do our key words mean here?
2. How about a nip?
3. What about a fuse?

Notes:

CHECKLIST (Frames 16-25)

1. Look at each major heading on your short checklist.
2. Look at pre-operational checks and apply the four key words.
3. Check each major heading with the key words in mind.
4. Don't forget to check the atmosphere.
5. Now review the show one more time.

Notes:

LESSON 13

LECTURE GUIDE

- HANDS-ON TRAINING ON THE SURFACE OR AWAY FROM PRODUCTION -

This section discusses hands-on training with a surface roof bolter machine or one underground away from production. The basic approach is for you to demonstrate each task in the checklist, stating each step of the task and what the trainee should see and do. Then each trainee will perform all tasks correctly and safely. You should observe trainee performance and correct it, if needed. Safety training should be emphasized on the more hazardous tasks.

An outline is attached for exercises with a machine on the surface or away from production. Note that the exercises proceed in the same order as the phases of the checklist. Trainees should use their checklists during this training.

1.0 Pre-Operational Checks

You should demonstrate each step of pre-operational checks in the order in which they appear in the checklist. Call out each step and what you see and do. Have each trainee perform each task at the distribution center or breaker box, and observe their performance.

Correct any incorrect procedures or safety precautions. The other tasks should be demonstrated, but not performed by the trainees.

2.0 Control Functions and Machine Operation Checks

After you energize the machine, demonstrate the function of each control. Then demonstrate the steps in machine operation checks.

3.0 Preparation for Maintenance

Demonstrate the tasks in preparation for maintenance. Observe trainee performance in disconnecting power at the distribution center or breaker box. Correct errors in procedures or safety precautions. Re-energize the machine for the next task.

4.0 Tramming

Demonstrate the procedures and safety precautions in tramming. Have trainees tram at least 200 feet and around a left and right turn. Have them tram through a check curtain, if you use them in your mine. Correct any errors in procedure or safety precautions.

5.0 Face Preparation

Demonstrate the procedures and safety precautions of face preparation at a bolted entry. Emphasize safety precautions. Review major causes of

injuries and falls, as well as the safety precautions in Table 1. Scaling of roof should be demonstrated later at a production face.

TABLE 1. - Face Preparation Accidents and Procedures

PRIMARY CAUSES OF ROOF FALL ACCIDENTS
Failure to comply with adopted roof control plan
Failure to use or improper use of temporary supports
Failure to take down or secure loose roof
Failure to examine roof or incorrect analysis
Failure to follow adopted rules or instructions

SAFETY PROCEDURES
No one beyond supported roof unless setting temporary supports
Test atmosphere every 20 minutes
Watch and listen to roof
Pry upward when scaling
Face working face
Maintain clear line of retreat

Separate the trainees into teams of two and have them conduct face preparation tasks at two or three entries around an unused intersection. Post warning signs to keep other vehicles out. Observe trainee performance and correct errors in procedures or safety precautions.

Emphasize gas checks, roof sounding, and setting temporary supports. Do not emphasize speed.

6.0 Positioning

Demonstrate the procedures and safety precautions of positioning at the same fully-bolted entry. Emphasize both safety and productivity. Review the most important safety precautions in Table 2. Demonstrate safe and correct positioning procedures. Then have each trainee perform the tasks and correct any errors in safety precautions or procedures.

TABLE 2. - Machine and Boom Positioning Safety Practices

Stay Clear of:	Boom
	Stab Jack
	Rib
	Pinch Points
	Temporary Supports

Watch Out for:	Other Workers
	Poor Footing

7.0 Drilling

Demonstrate the procedures and safety precautions of drilling at the same fully-bolted entry. Emphasize both safety and productivity. Review the major causes of injuries, as well as safety precautions in Table 3. Demonstrate safe and correct drilling procedures. Comment on drill steel reactions and what they mean. Have each trainee perform the tasks and correct any errors in safety procedures or precautions.

TABLE 3. - Drilling Accidents and Procedures

Accidents:	Particles in Eyes
	Wrench Slipped
	Mashed Fingers
	Wrong Control
	Hit by Rock
	Hit by Lowered Boom
	Lost Balance
	Holding Rotating Steel

Safety Procedures:	Wear Safety Glasses
	Do Not Use Wrench
	Watch for Pinch Points
	Watch Controls
	Stay Under Canopy
	Watch Lowering Boom
	Watch Poor Footing
	Do Not Hold Rotating Steel

8.0 Bolting

Since roof bolts are expensive, your trainees probably cannot practice installing one bolt after another until they do it correctly. However, most bolting injuries occur before torqueing. The most efficient practice approach will be to remove the expansion shell on mechanical bolts and leave out the resin cartridges for resin bolts. They can practice inserting, raising, and applying torque to the bolts until they can do it safely and efficiently. Then they can practice the full operation with shells and resin for two bolts apiece.

Demonstrate the procedures and safety precautions of bolting at the same fully-bolted entry. Emphasize safety and productivity. Discuss the major causes of injuries, as well as safety precautions in Table 4. Demonstrate safe and correct bolting procedures. Have each trainee perform the tasks and correct any errors in safety procedures and precautions.

TABLE 4. - Bolting Accidents and Procedures

Accidents:	Hand Between Plate and Roof
	Fell or Tripped
	Struck by Bolt or Plate
	Wrong Control
	Struck by Wrench
	Fingers in Pinch Points
	Cuts Bending Bolts
	Particles in Eyes

Safety Procedures:	Do Not Hold Bolt
	Watch Footing
	Handle Bolts Carefully
	Check Control
	Clamp/Guide Wrench
	Watch Pinch Points
	Wear Safety Glasses

9.0 End-of-Shift Shutdown

Demonstrate the procedures and safety precautions of end-of-shift shutdown as you leave the mine at the end of each shift. Call out each step and what you see and do. Have each trainee perform each task at the distribution center or breaker box and observe their performance.

Correct any incorrect procedures or safety precautions. The other tasks should be demonstrated, but not performed by the trainees.

EXERCISE OUTLINE

Activity

- Pre-Operational Checks
  - Demonstrate
  - Observe trainee performance (inspect electrical system)
    - Correct as needed
- Machine Operation Checks
  - Discuss control functions
  - Demonstrate
- Preparation for Maintenance
  - Demonstrate
  - Observe trainee performance (power)
    - Correct as needed
- Reenergize Machine
- Tramming (some productivity emphasis)
  - Demonstrate
  - Observe trainee performance
    - Tram at least 200 feet
    - Around right and left turn
    - Through check curtain
    - Correct as needed
  - Skills and Raising
- Face Preparation (emphasize safety)
  - Under permanently supported roof
  - No scaling
  - Demonstrate
  - Review safety precautions
  - Observe trainee performance
    - Teams of two
    - Correct as needed
- Positioning (emphasize safety and productivity)
  - Demonstrate - safe procedures
  - Review safety precautions
  - Observe trainee performance
    - Correct as needed
  - Skills training
    - Bolt line-up
    - Instruction and practice

Drilling (emphasize safety and productivity)
- Demonstrate - safe procedures
- Review safety precautions
- Observe trainee performance
  - Correct as needed
- Skills training
  - Instruction and practice

Bolting (emphasize safety and productivity)
- Demonstrate - safe procedures
- Review safety precautions
- Observe trainee performance
  - No shell or resin
  - Correct as needed
- Skills training
  - No shell or resin
  - Instruction and practice
- Observe trainee performance and skill with shell and resin
  - Correct as needed

End-of-Shift Shutdown
- Demonstrate - safe procedures
- Observe trainee performance
  - Correct as needed

LESSON 14

LECTURE GUIDE

- HANDS-ON TRAINING ON THE SURFACE OR AWAY FROM PRODUCTION -

This section discusses hands-on training with a surface roof bolter machine or one underground away from production. The basic approach is for you to demonstrate each task in the checklist, stating each step of the task and what the trainee should see and do. Then each trainee will perform all tasks correctly and safely. You should observe trainee performance and correct it, if needed. Safety training should be emphasized on the more hazardous tasks. One the trainee can do the task correctly and safely, you should give additional skills training on job phases with high impact on productivity. Interview experienced roof bolter machine operators at your mine to determine what techniques they use to do the tasks quickly while following correct procedures. Teach these techniques to the trainees and supervise their practice until they can do tasks in twice the average time required for an experienced operator. These times should be available from your production department.

An outline is attached for exercises with a machine on the surface or away from production. Note that the exercises proceed in the same order as the phases of the checklist. Trainees should use their checklists during this training.

1.0 Pre-Operational Checks

You should demonstrate each step of pre-operational checks in the order in which they appear in the checklist. Call out each step and what you see and do. Have each trainee perform each task at the distribution center or breaker box, and observe their performance.

Correct any incorrect procedures or safety precautions. The other tasks should be demonstrated, but not performed by the trainees.

2.0 Control Functions and Machine Operation Checks

After you energize the machine, demonstrate the function of each control. Then demonstrate the steps in machine operation checks.

3.0 Preparation for Maintenance

Demonstrate the tasks in preparation for maintenance. Observe trainee performance in disconnecting power at the distribution center or breaker box. Correct errors in procedures or safety precautions. Reenergize the machine for the next task.

4.0 Tramming

Demonstrate the procedures and safety precautions in tramming. Have trainees tram at least 200 feet and around a left and right turn. Have

them tram through a check curtain, if you use them in your mine. Correct any errors in procedure or safety precautions.

Once the trainees can perform the tasks correctly and safely, give them some skills training in tramming quickly from place to place. Teach them any techniques experienced roof bolter operators use to get the job done quickly (if they do not violate correct procedures). Give them supervised practice until they can tram correctly from place to place in no more than twice the time it takes an experienced machine operator.

5.0 Face Preparation

Demonstrate the procedures and safety precautions of face preparation at a bolted entry. Emphasize safety precautions. Review major causes of injuries and falls, as well as the safety precautions in Table 1. Scaling of roof should be demonstrated later at a production face.

Separate the trainees into teams of two and have them conduct face preparation tasks at two or three entries around an unused intersection. Post warning signs to keep other vehicles out. Observe trainee performance and correct errors in procedures or safety precautions.

Emphasize gas checks, roof sounding, and setting temporary supports. Do not emphasize speed.

6.0 Positioning

Demonstate the procedures and safety precautions of positioning at the same fully-bolted entry. Emphasize both safety and productivity. Review the most important safety precautions in Table 2. Demonstrate safe and correct positioning procedures. Then have each trainee perform the tasks and correct any errors in safety precautions or procedures.

TABLE 1. - Face Preparation Accidents and Procedures

PRIMARY CAUSES OF ROOF FALL ACCIDENTS
Failure to comply with adopted roof control plan
Failure to use or improper use of temporary supports
Failure to take down or secure loose roof
Failure to examine roof or incorrect analysis
Failure to follow adopted rules or instructions

TABLE 1 (Continued). - Face Preparation Accidents and Procedures

SAFETY PROCEDURES
No one beyond supported roof unless setting temporary supports
Test atmosphere every 20 minutes
Watch and listen to roof
Pry upward when scaling
Face working face
Maintain clear line of retreat

TABLE 2. - Machine and Boom Positioning Safety Practices

Stay Clear of:	Boom Stab Jack Rib Pinch Points Temporary Supports

Watch Out for:	Other Workers Poor Footing

After they can position the machine safely, give them skills training in rapid and correct positioning. Teach them techniques experienced roof bolter operators use at your mine to line up parts of the machine with bolts in the last row so they can drill holes with a minimum number of movements. Teach them final machine and boom positioning techniques that minimize positioning time. Trainees should practice these tasks under your coaching until they can position the machine in no more than twice the time it takes an experienced machine operator.

7.0 Drilling

Demonstrate the procedures and safety precautions of drilling at the same fully-bolted entry. Emphasize both safety and productivity. Review the major causes of injuries, as well as safety precautions in Table 3. Demonstrate safe and correct drilling procedures. Comment on drill steel reactions and what they mean. Have each trainee perform the tasks and correct any errors in safety procedures or precautions.

TABLE 3. - Drilling Accidents and Procedures

Accidents:	Particles in Eyes
	Wrench Slipped
	Mashed Fingers
	Wrong Control
	Hit by Rock
	Hit by Lowered Boom
	Lost Balance
	Holding Rotating Steel

Safety Procedures:	Wear Safety Glasses
	Do Not Use Wrench
	Watch for Pinch Points
	Watch Controls
	Stay Under Canopy
	Watch Lowering Boom
	Watch Poor Footing
	Do Not Hold Rotating Steel

After they can drill safely, give them skills training in rapid and correct drilling. Teach them techniques experienced roof bolter operators use to drill a hole quickly without abusing the machine or drill bits. Trainees should practice these tasks under your coaching until they can drill a hole in no more than twice the time it takes an experienced operator. Check with your roof control department and see if there are any restrictions on drilling extra holes in an already bolted roof. You may be required to plug each hole or install bolts in them.

8.0 Bolting

Since roof bolts are expensive, your trainees probably cannot practice installing one bolt after another until they do it correctly. However, most bolting injuries occur before torqueing. The most efficient practice approach will be to remove the expansion shell on mechanical bolts and leave out the resin cartridges for resin bolts. They can practice inserting, raising, and applying torque to the bolts until they can do it safely and efficiently. Then they can practice the full operation with shells and resin for two bolts apiece.

Demonstrate the procedures and safety precautions of bolting at the same fully-bolted entry. Emphasize safety and productivity. Discuss the major causes of injuries, as well as safety precautions in Table 4. Demonstrate safe and correct bolting procedures. Have each trainee perform the tasks and correct any errors in safety procedures or precautions.

After they can bolt safely, give them skills training in rapid and correct bolting. Teach them techniques experienced roof bolter operators

TABLE 4. - Bolting Accidents and Procedures

Accidents:	Hand Between Plate and Roof
	Fell or Tripped
	Struck by Bolt or Plate
	Wrong Control
	Struck by Wrench
	Fingers in Pinch Points
	Cuts Bending Bolts
	Particles in Eyes

Safety Procedures:	Do Not Hold Bolt
	Watch Footing
	Handle Bolts Carefully
	Check Control
	Clamp/Guide Wrench
	Watch Pinch Points
	Wear Safety Glasses

use to install bolts quickly without violating safety procedures. Trainees should practice these tasks under your coaching until they can install a bolt in no more than twice the time it takes an experienced operator.

9.0 End-of-Shift Shutdown

Demonstrate the procedures and safety precautions of end-of-shift shutdown as you leave the mine at the end of each shift. Call out each step and what you see and do. Have each trainee perform each task at the distribution center or breaker box and observe their performance.

Correct any incorrect procedures or safety precautions. The other tasks should be demonstrated, but not performed by the trainees.

EXERCISE OUTLINE

Activity

- Pre-Operational Checks
  - Demonstrate
  - Observe trainee performance (inspect electrical system)
    - Correct as needed
- Machine Operation Checks
  - Discuss control functions
  - Demonstrate
- Preparation for Maintenance
  - Demonstrate
  - Observe trainee performance (power)
    - Correct as needed
- Reenergize Machine
- Tramming (some productivity emphasis)
  - Demonstrate
  - Observe trainee performance
    - Tram at least 200 feet
    - Around right and left turn
    - Through check curtain
    - Correct as needed
  - Skills and Raising
- Face Preparation (emphasize safety)
  - Under permanently supported roof
  - No scaling
  - Demonstrate
  - Review safety precautions
  - Observe trainee performance
    - Teams of two
    - Correct as needed
- Positioning (emphasize safety and productivity)
  - Demonstrate - safe procedures
  - Review safety precautions
  - Observe trainee performance
    - Correct as needed
  - Skills training
    - Bolt line-up
    - Instruction and practice

Drilling (emphasize safety and productivity)
- Demonstrate - safe procedures
- Review safety precautions
- Observe trainee performance
  - Correct as needed
- Skills training
  - Instruction and practice

Bolting (emphasize safety and productivity)
- Demonstrate - safe procedures
- Review safety precautions
- Observe trainee performance
  - No shell or resin
  - Correct as needed
- Skills training
  - No shell or resin
  - Instruction and practice
- Observe trainee performance and skill with shell and resin
  - Correct as needed

End-of-Shift Shutdown
- Demonstrate - safe procedures
- Observe trainee performance
  - Correct as needed

LESSON 15

LECTURE GUIDE

- HANDS-ON TRAINING AT THE FACE -

This lesson outlines hands-on training with a roof bolter machine at the face in production. It assumes that trainees have already received training with a machine on the surface or away from production. If this is not the case, you should use the procedures in Lesson 14 for all tasks except scaling the roof. For scaling, use the procedures in this lesson.

The basic approach of hands-on training at the face is to review the tasks learned away from the face, learn roof inspection and scaling, and practice all roof bolter operator tasks under production conditions. An outline of "at the face exercises" is attached. Trainees should use their checklist during this training.

1.0 Pre-Operational Checks, Machine Operation Checks, Preparation for Maintenance

Review the procedures and safety precautions in the first four phases. Have one trainee perform each task on a rotating basis as you proceed through the checklist. Observe their performance and correct as needed.

2.0 Face Preparation

Review face preparation procedures. Demonstrate testing the atmosphere, then have one trainee perform the test and correct his errors. Perform visual inspection of the roof and ribs. Point out any defects, such as slips, cracks, or clay veins. Point out normal roof sounds and describe those sights and sounds that indicate an impending fall.

Demonstrate procedures and safety precautions of scaling. Have each trainee perform the scaling tasks and correct any errors. Do not emphasize speed.

Demonstrate sounding of the roof and ribs. Point out the sounds of good roof and rib, and describe the sound of bad roof or rib. Observe the performance of all trainees in this task and correct any errors in procedures or safety precautions. Again, do not emphasize speed.

Review the steps in setting temporary supports. Have teams of two set temporary supports under your close supervision. Observe trainee performance and correct any errors. Do not emphasize speed.

Review the steps in marking bolt locations. Have one trainee mark bolt locations while you correct any errors in procedures or safety precautions.

3.0 Positioning, Drilling, and Bolting

Review positioning, drilling, and bolting. After each review, have a team of two trainees perform the task under your close supervision. Correct any errors in procedures or safety precautions.

4.0 Full Cycle

Have a team of two trainees tram to the next face, position the machine, prepare the face, and drill and bolt the roof. Observe trainee performance and correct errors in procedures or safety precautions. If the trainees are operating safely, continue skills training and practice. Have a new team bolt each new face.

5.0 End-of-Shift Shutdown

Review end-of-shift shutdown at the end of the shift. Have one team perform the tasks while you observe and correct errors.

Any observed unsafe acts should be corrected immediately. Less critical procedural errors and low productivity can be discussed with the trainee during production delays.

EXERCISE OUTLINE

Activity

- Pre-Operational Checks
  - Review procedures
  - One trainee perform each task
    - Rotating
    - Correct as needed
- Machine Operation Checks
  - Review procedures
  - One trainee perform each task
    - Rotating
    - Correct as needed
- Preparation for Maintenance
  - Review procedures
  - One trainee perform each task
    - Rotating
    - Correct as needed
  - Reenergize machine
- Tramming
  - Review procedures
  - One trainee perform each task
    - Correct as needed
- Face Preparation
  - Review procedures
  - Demonstrate atmospheric check
  - Observe trainee performance
    - One trainee
    - Correct as needed
  - Demonstrate roof and rib inspection
    - Point out defects
    - Point out normal sounds
    - Describe warning sights and sounds
  - Demonstrate scaling
  - Observe trainee performance
    - All trainees
    - Correct as needed
  - Demonstrate roof and rib sounding
    - Point out normal sounds
    - Describe bad sounds
  - Observe trainee performance
    - All trainees
    - Correct as needed

Face Preparation (Continued)
- Review setting temporary supports
- Observe trainee performance
  - Teams of two
  - Correct as needed
- Review marking bolt locations
- Observe trainee performance
  - One trainee
  - Correct as needed
- Review positioning
- Observe trainee performance
  - Teams of two
  - Correct as needed
- Review drilling
- Observe trainee performance
  - Teams of two
  - Correct as needed
- Review bolting
- Observe trainee performance
  - Teams of two
  - Correct as needed

Observe Trainee Performance
- Teams of two
- Tram, prepare, position, drill, bolt
- Correct as needed
- Continue skills training

New Team of Two Each Face

Review End-of-Shift Shutdown

Observe Trainee Performance
- One team
- Correct as needed

CHECKLIST

FOR

ROOF BOLTER
MACHINE OPERATORS

Allen Corporation
of America

TABLE OF CONTENTS

PRE-OP CHECKS - Continued

CABLE

1. Connections - Secure
2. Insulation - Worn : Cuts : Splices
3. Location - Near Rib (Hang, If Necessary)

TRAVELWAY

1. Clear - No Debris
2. Water - None
3. Roof - Secure

MECHANICAL SYSTEM

Caution: Check for Danger Sign

1. Boom - Secure
2. Oil - Full : Filter Screen - OK
3. Hoses - Tight : Leaks : Insulation
4. Lift Mechanism - Leaks : Damage : Secure
5. Electrical Components - Secure : Connection : Insulation
6. Cable Reel - Secure

MECHANICAL SYSTEM - Continued

Fire Suppression System

1. Tamper Indicator - In Place
2. Casing - Dents : Corrosion
3. Tubing - Kinks : Cracks
4. Connections - Secure
5. Nozzles - Clear

Dust System

1. Tubing - Secure : Cuts
2. Collection Box - Clean

Controls

1. Movement - Free
2. Position - Neutral

Provisions

1. Tools
2. Steel
3. Bolts
4. Test Equipment

MACHINE OPERATION

Caution: Check Atmosphere Every 20 Minutes

1. Electrical - Recheck
2. Power to Machine - ON
3. Area - Clear of Personnel
4. Enter Cab - Yell "Clear"
5. Starter Button - Push ON
6. Panic Bar - Push OFF
7. Starter Button - Push ON (Restart)
8. Lights - ON

HYDRAULIC COMPONENTS

1. Pressure Gauge - Correct Reading
2. Canopy - Raise : Lower Slightly
3. TRS - Raise : Lower Slightly
4. Boom(s) - Check All Positions

Caution: Avoid Pinch, Squeeze : Hand on Panic Bar

5. Lower Stab Jacks

Caution: Feet Clear

MACHINE OPERATION - Continued

DRILL COMPONENTS

1. Chuck - Rounded Edges : Cracks : Burrs
2. Guide - Secure
3. Speeds - Check
4. Vacuum - Suction

TRAM

1. Boom(s) - Position
2. Stab Jacks - Raise
3. Canopy - Lower
4. Cable - Position
5. Chocks - Remove
6. Area - Clear of Personnel
7. Body - Position in Cab

Caution: Warn Personnel Before Moving

8. Brake - Release
9. Tram - Move Forward & Reverse
10. Brakes - Check

NOTE: Report All Malfunctions

PREPARATION FOR MAINTENANCE

1. Position - Outby Crosscut
2. Brakes - Set
3. Boom(s) - Lower to Cribbing

Caution: Attach DANGER Sign

4. Chocks - Insert
5. Cable - Position (Near Rib)

ELECTRICAL - A/C Power

1. Power - OFF (At Box)
2. Cable - Disconnect
3. Danger Sign - Attach (End of Cable)

ELECTRICAL - D/C Power

1. Power - OFF (At Circuit Breaker)
2. Nip - Disconnect
3. Fuse - Remove : Give to Repairman
4. Danger Sign - Attach (To Nip)

TRAMMING

PREPARE MACHINE

1. Boom(s) - Position
2. Stab Jacks - Raise
3. Canopy - Lower
4. Cable - Position
5. Area - Clear of Personnel
6. Body - Position in Cab

Caution: Keep Entire Body in Cab

TRAM

1. Area - Clear of Personnel
2. Brake - Release
3. Machine - Tram

   NOTE: Be Alert for Hazards and Personnel

4. Park - Outby
5. Brake - Set
6. Machine - OFF
7. Atmosphere - Test

   NOTE: Test at a Maximum of 5 Feet Beyond Permanent Support

8. Tram - Inby (To Workplace)

FACE PREPARATION

1. Atmosphere - Test

   NOTE: Test Under Supported Roof
   Every 20 Minutes

2. Roof & Ribs - Inspect
3. Scale - Loose Material
4. Temporary Supports - Set

   NOTE: 2 Supports, 5 Foot Centers
   Within 5 Feet of Rib & Face

5. Roof - Sound (If Bad, Scale)
6. Jacks - Set (RCP)
7. Posts - Set (RCP)

   NOTE: Use a Maximum of 2 Wedges

8. Rows - Set All
9. Bolt - Mark Position (RCP)

   NOTE: Use RCP to Determine Positions

POSITIONING

POSITION MACHINE

NOTE: Recheck Atmosphere Every 20 Minutes

TRAM TO WORKPLACE

1. Area - Clear of Personnel
2. Body - Position in Cab

Caution: Keep Entire Body Inside Cab

3. Machine - Energize
4. Signal - Yell "Clear"
5. Brake - Release
6. Machine - Tram (Be Alert for Hazards)
7. Machine - Position
8. ATRS - Raise (If Equipped)
9. Boom(s) - Position

Caution: Avoid Pinch Points, Squeeze : Watch Temporary Supports : Hand on Panic Bar

10. Stab Jacks - Lower (Feet Clear)
11. Canopy - Raise

DRILLING

TEST HOLE

1. First Hole
2. One Each Entry
3. 1' Longer

DRILL STARTER HOLE

1. Starter Steel - Select (Length : Diameter : Straight : Unplugged)
2. Starter Steel - Insert in Chuck (Engage Clamp : Secure Guide)
3. Boom(s) - Raise (Bit 2" from Roof)
4. Boom(s) - Position
5. Drill - Start (Slow)

Caution: Do Not Hold Drill Steel

6. Feed - Apply Rotation & Release Guide
7. Drill Reactions - Observe
8. Drill - To Proper Depth

   NOTE: Mechanical Bolt - 1" Shorter
   Resin Bolt - 1" Longer

9. Boom(s) - Lower (Slow Rotation)
10. Rotation - Stop : Remove Steel
11. Steel : Stow

DRILLING - Continued

DRILL FINISHING HOLE

1. Finishing Steel - Select
2. Finishing Steel - Insert in Chuck
3. Rotation - Start (Slow)
4. Boom(s) - Raise (Slow)
5. Feed - Apply : Release
6. Guide - Release
7. Steel Reactions - Observe
8. Drill - To Proper Depth
9. Boom(s) - Lower
10. Rotation - Stop
11. Finishing Steel - Remove : Stow

DRILL WITH EXTENSIONS

1. Lead Extensions - Select
2. Driver - Select : Insert in Chuck
3. Lead Extensions - Insert in Hole :
   Couple with Driver

Caution: Keep Fingers Clear of Coupling

4. Drill - To Proper Depth
5. Boom(s) - Lower
6. Rotation - Stop

   NOTE: Add Lead Extensions (As Needed)

7. Steel Extensions - Remove : Stow

BOLTING

INSTALL MECHANICAL BOLT

1. Wrench - Select (Proper Size)
2. Wrench - Install in Chuck : Engage Clamp
3. Bolt - Select (Length : Threads OK)
4. Washer, Plate, Block - Add
5. Expansion Shell - Add : Remove Band

   NOTE: Check Easy Rotation

6. Bolt - Insert in Hole
7. Bolt - Lower to Wrench

Caution: Do Not Rotate or Raise Chuck, Rotate Bolt by Hand

8. Bolt - Raise (Plate Loosely Against Roof)

TORQUE BOLT

1. Torque Control - Engage
2. Torque - Engage (Slow : Full Speed : No Thrust)
3. Torque - Release (Reapply : Release)
4. Boom(s) - Lower
5. Wrench - Remove : Stow
6. Plate - Inspect (Tight Installation)

   NOTE: For Low Coal Bolt Installation
   a. Bend Bolt at 45^{o} Angle
   b. Insert Bolt Into Hole
   c. Straighten Bolt

BOLTING - Continued

INSTALL RESIN BOLT

1. Wrench - Select
2. Wrench - Install in Chuck : Engage Clamp
3. Bolt - Select (Correct Length)
4. Plate, Block - Add
5. Resin - Select (Size : Type : Shelf Life)
6. Resin - Insert
7. Bolt - Insert
8. Bolt - Lower to Wrench

Caution: Do Not Rotate or Raise Chuck, Rotate By Hand

9. Bolt - Raise (1" to 2" From Roof)
10. Resin - Mix

Caution: Use Eye Protection

11. Bolt - Rotate

    NOTE: Use High Speed for Specified Time

12. Bolt - Thrust (Against Roof)

    NOTE: Hold for Specified Time

13. Boom(s) - Lower
14. Wrench - Remove : Stow
15. Plate - Inspect (Tight : Excess Resin)

    NOTE: For Low Coal Installation, Bend Bolt as Mechanical

BOLTING - Continued

INSTALL COMBINATION BOLT

1. Wrench - Select
2. Wrench - Install in Chuck : Engage Clamp
3. Mechanical Section - Prepare
4. Washer, Plate, Block - Add
5. Resin Section - Prepare (Mate Rebar Coupler Hand-Tight)
6. Resin - Insert in Hole
7. Resin Section - Insert in Hole
8. Mechanical Section - Insert in Hole (Couple to Resin Section)
9. Bolt - Lower to Wrench

Caution: Do Not Rotate or Raise Chuck, Rotate By Hand

10. Bolt - Raise (¼" to ½" From Roof)
11. Resin - Mix

TORQUE BOLT

1. Torque Control - Engage
2. Torque - Engage (Slow : Full Speed : No Thrust)
3. Torque - Release (Reapply : Release)
4. Boom(s) - Lower
5. Wrench - Remove : Stow
6. Plate - Inspect (Tight : Excess Resin)

REPOSITIONING

1. Stab Jacks - Raise
2. Canopy - Lower
3. Machine - Position

Caution: Warn Others Before Moving Machine

4. Boom(s) - Position
5. Stab Jacks - Lower
6. Canopy - Raise

TORQUE-TEST BOLT

Mechanical & Combination Bolt

1. Torque Wrench - Select (Set to Zero)
2. Torque Wrench - Mate to Bolt
3. Torque - Turn Clockwise (Until Bolt Turns)
4. Torque - To RCP Specifications
5. Torque Wrench - Remove : Stow

Resin Bolt

1. Curing Time - To Manufacturer's Specifications
2. Torque Wrench - Select (Click Type)
3. Indicator - Set (To RCP Specifications)
4. Torque Wrench - Mate to Bolt
5. Bolt - Torque (Until Indicator Clicks)
6. Wrench - Remove : Stow

REMOVE SUPPORTS

1. Atmosphere - Test
2. Roof & Ribs - Inspect
3. Scale - Loose Material
4. Roof - Sound (If Bad, Scale)
5. Extra Bolts - Install (If Needed)
6. Supports - Remove : Stow

Caution:	*Face Working Face : Maintain Clear Line of Retreat*

TRAM AWAY

Provisions

1. Tools - Gather : Stow
2. Supplies - Gather : Stow
3. Cable - Position
4. Tram - Away from Work Area

Caution:	*Before Tramming, Warn Others : When Tramming, Be Alert for Hazards & Obstructions*

END-OF-SHIFT SHUTDOWN

1. Machine - Park (Outby Crosscut)
2. Travelway, Airway - Clear
3. Curtains - Park Away From
4. Brakes - Set
5. Boom(s) - Lower
6. Motor - OFF
7. Lights - OFF
8. Chock Blocks - Insert
9. Cable - Position (Near Rib)
10. Power - OFF (At Box or Breaker)
11. Cable - Disconnect