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Seismic Reflection Survey: Health and Safety Plan

Kansas Geological Survey
Exploration Services Section

Exxon Production Research
Emery County, Utah
June 1999

Open-file Report #99-17

Kansas Geological Survey Exploration Services

Accident Prevention Plan

Project Name: Feasibility of High Resolution 3-D Seismic Reflection to Delineate Faults and Image Stratigraphic Units Within the Upper 100 m in Central Utah

Location: Emery County, Utah

Plan prepared by Richard D Miller (Signature) 6/4/99 (Date)

Plan approved by Kathy Sheldon (KGS Safety Officer) 6/11/99 (Date)

Plan has been reviewed by the following crew members:

Name (printed)	Signature	Date
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DAVID LAFLEN	David Laflen	19 JUNE 99

KANSAS GEOLOGICAL SURVEY EXPLORATION SERVICES
ACCIDENT PREVENTION PLAN

I. PROJECT DESCRIPTION

Project Name: Feasibility of High Resolution 3-D Seismic Reflection to Delineate Faults and Image Stratigraphic Units Within the Upper 100 m in Central Utah

Location: Emery County, Utah

Site Safety Officer: Richard D. Miller

Plan Prepared By: Richard D. Miller

Estimated Duration of Field Work: 12 days

II. STATEMENT OF WORK

A properly designed and executed high resolution seismic reflection survey may be capable of delineating faults and imaging acoustic contrasts/geologic contacts and possibly detecting fault gouge within the upper 100 m at a site along the Green River in central Utah (Figure 1). This seismic reflection study will focus on: 1) stratigraphic and structural characteristics of this site, 2) detecting presence and absence of gouge 0.3 to 1 m thick within fault zone, 3) correlating surface-mapped fault zone geometries with near-surface seismic images, 4) optimizing a minimal deployment ultra-shallow 3-D survey, 5) image a dipping fault plain, 6) adaptations necessary to maximize frequency and penetration depths in this extremely dry and loosely compacted near-surface, 7) resolution potential (vertical and horizontal), 8) analyzing and optimizing equipment, 9) establishing a realistic vertical velocity profile, 10) determining and compensating for near-surface variability (static and coupling) on recorded data, 11) evaluating the effectiveness of 3-D imaging in comparison to 2-D, and 12) identifying pitfalls and artifacts associated with using conventional 3-D designs and approaches to shallow targets. High-resolution techniques established for 2-D surveying will be used in conjunction with strategies for adapting conventional 3-D investigations to shallow targets when designing data acquisition parameters and determining optimum equipment and methodologies (Steeples and Miller, 1990; Büker et al., 1998).

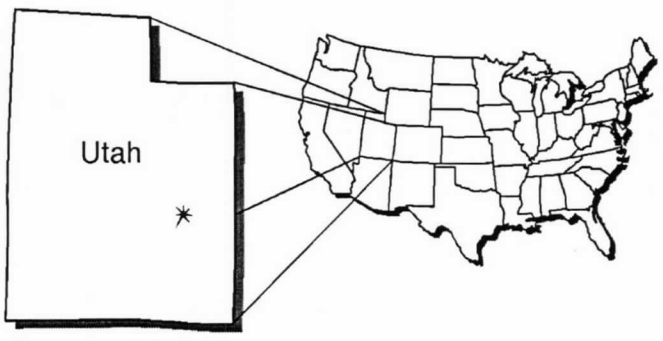

Figure 1

Maximizing the resolution potential, interpretability, and signal-to-noise ratio and maintaining optimum offset traces will be an emphasis of this survey. Shallow 3-D surveying has to date rarely made its way to the refereed literature. A few researchers have presented their findings, which have been full of successes as well as the limitations of the technique when applied to shallow targets (Green et al., 1995; Lanz et al., 1996; Saihkoohi and West, 1996; House et al., 1996). Acquisition and processing philosophies will be consistent with current empirical and theoretical considerations and approaches to high resolution shallow 3-D imaging (Büker et al., 1998). A 216-receiver patch will be deployment with a template that includes 96 shotpoints along three full source lines and six short source line segments. Seismic source configuration, receiver spacing, cross-line distribution, fold, and general acquisition philosophy used to acquire the 3-D data will be based on the results of an uphole velocity survey and initial on-site walkaway noise tests. The primary goal of this study is to determine the utility of state-of-the-art shallow high resolution seismic reflection techniques (3-D) to detect, delineate, and evaluate local stratigraphy and structural features at this site.

Shallow subsurface delineation of complex fault patterns mapped in exposures of the Morrison Formation in central Utah would greatly assist in unraveling the current structural setting and provide insight into the tectonic history of this site. Four unique faults, mapped in surface exposures, possess a variety of orientations and offsets. It is not possible from surface mapping or drill hole data alone to determine the general subsurface geometry of the faults, the "transfer" or bending from one fault to the others, and the linking of these faults at depth.

Previous studies by the Kansas Geological Survey (KGS) in cooperation with Exxon Production Research Company (EPR) in this general area (eastern Utah) have focused on delineation of bar features within an Upper Jurassic succession of siliciclastic depositional systems (Miller and Xia, 1996). The primary target of that study was the 300 to 350 m deep Salt Wash Member of the Morrison Formation. In the proposed research area the depth of burial is significantly less, therefore increasing the effort and expense necessary to delineate features of equivalent size. Complicating this survey even more than previous work within this succession of units is the structural complexity and extreme relief associated with this faulted environment. Seismically imagining structural features along this fault zone would assist in deciphering the geologic history of this site and the seismic signature of the fault zone and resolution requirements for applications to deeper, economically significant targets of similar nature.

The project will consist of three major acquisition phases: velocity validation, feasibility testing, and production. Velocity validation will involve an uphole survey, which will be conducted as soon as a mutually agreed time can be arranged between the KGS and EPR. The feasibility/testing phase will consist of 2-D walkaway tests acquired around the area where survey lines are planned. Walkaway noise tests will be gathered according to common shot station and receiver offset and separated into distinct groups according to recording parameters (source, receiver, recording parameters, etc.). The quality and potential of test data will dictate the acquisition approach taken during the production portion of the project. If both KGS and EPR agree that the walkaway test data warrants continuation of the project, the production phase will commence.

Production data acquisition will require about 10 days to two week to complete (dependent, of course, on access difficulties and site conditions). Data acquisition and processing for the production data will generally follow well established shallow high resolution data acquisition methodologies (Hunter et al., 1984; Knapp and Steeples, 1986; Steeples and Miller, 1990). It will be critical to adhere to specific procedures and guidelines established for 3-D surveys in general (Cordsen and Pierce, 1995) and shallow 3-D surveys in particular (Büker et al., 1998).

Data acquisition will be roughly structured and designed around the findings of the preliminary testing. Step-by-step analysis during the acquisition phase of the survey will be continuous, with appropriate modifications made to insure the quality of the final product.

Outline of Proposed Program

1) Velocity measurements will be made during a preliminary site visit. It will be necessary to establish a realistic velocity function to determine resolution potential and survey geometries. A three-component hole-lock geophone and sledge hammer will be used to record the bore-hole survey. Vertical sampling will likely be on a 1.5 m interval, with several source offsets ranging from around 2 to as much as 30 m offset from the borehole. Velocity data will be downloaded, converted to SEG-Y, and sent to EPR either by e-mail, FTP, or CD as quickly as possible. It will be necessary for all noise associated with drilling to be minimized during data acquisition.
2) Based on the outcome of the velocity survey, an extensive series of walkaway noise tests will be performed designed to evaluate: several low energy, high frequency seismic sources; optimum spread lengths and receiver spacings (requiring a pseudo-continuous spread with 0.25 m receiver spacing spanning source-to-receiver offsets from 0.5 m to over 120 m); at least two different geophone types; and shot gathers that incorporate geologic and any subsurface information available.
3) Contingent on the walkaway noise tests, the 3-D survey data will be acquired within the area proposed by EPR using the template and roll pattern appropriate for the target and KGS equipment limitations. The data would be recorded on a 240-channel seismograph. Design of the fold, azimuthal coverage, and offset distribution will be undertaken by EPR. Changes to the design characteristics of this survey may be necessary after analysis of the velocity measurements and walkaway noise tests.
4) Walkaway noise survey data and possibly some in-line 2-D CMP reflection profiles can be analyzed and, if appropriate, brute processed during the field portion of this project (on-site or in motel room). Based on the current design, several 36-channel in-line, asymmetric split spread 2-D lines with far offsets of around 72 m could be processed into CMP profiles to determine how effectively the fault plain is being imaged. Any processing and/or analysis will be done to insure project objectives can be met with acquired data.
5) If necessary, walkaway noise test data will be processed into final display format with justification for acquisition methods, parameters, and equipment completed at the Kansas Geological Survey in Lawrence, Kansas.

Seismic Reflection Philosophy

Unequivocal identification and verification of reflections on shot gathers is not only necessary, it is mandatory for meaningful interpretations of shallow seismic data. Matching modeled NMO curves with reflection hyperbola interpreted on shot gathers is the most conclusive means to both verify and analyze reflections. This combination incorporates geometric curve fitting (forward and inverse modeling) and event identification (from single-fold shot gather data). Data from this project will go through rigorous verification techniques that include modeling, event verification, and cross comparisons of geologic, borehole, and surface seismic data. Modeling reflection arrivals as interpreted on shot gathers is not only critical, it should be required by law. A pitfall of shallow 3-D reflection on previous surveys has been a lack of understanding of how the reflection hyperbola is distorted by a 2-dimensional geophone spread (Siahkoohi and West, 1996).

Table 1–Summary of Proposed Survey

1. Seismic system to be used – 240-channel R60 StrataView from Geometrics

2. Equipment and testing parameters
   - 100 Hz L-40A Mark Products Geophones (180 strings)
   - double 40 Hz L-28E Mark Products Geophones (315 strings)
   - surface/downhole 30.06 projectile source
   - variety of combinations –hammer (20 lb, 16 lb, 8 lb, 2 lb) and
     –plate (1 sq ft x 1", 0.25 sq ft x 1", 2" shaft, 1" shaft, punch)
   - slide hammer impact source
   - OYO/Geometrics MicroVibrator (50 to 500 Hz, ~60 lb reaction mass, up to 800 lb hold down)
   - 12-gauge auger gun
   - RAWD (Rubber band Assisted Weight Drop)

   Testing will include
   - several different types of linear sweeps within the 50-400 Hz range
   - number of shots or vibrations to obtain optimum vertical stacking
   - optimum receiver station spacing
   - determination of sampling interval based on appropriate oversampling
   - 480-trace, pseudo-continuous walkaway w/source offsets from 0.5 m to 120 m
   - digital filtering

   a. Option 1* — 6 receiver lines spaced 12 m apart, w/36 stations/line spaced 3 m apart; rolling 12 stations after 96 shots along 3 cross-line source lines
   b. Option 2* — 5 receiver lines spaced 12 m apart, w/48 stations/line spaced 2 m apart; rolling 12 stations
      after 96 shots along 3 cross-line source lines

3. Planned field schedule

PHASE 1	Approx. Level of Effort
Mobilization	1 week
Travel (to and from field)	2 days
Velocity survey (acquisition and processing)	2 days
PHASE 2	
Mobilization	2 weeks
Travel (to and from field)	4 days
Walkaway noise testing and analysis	2 days
Demobilization	1 week
PHASE 3	
Production data acquisition (1920 shotpoints)	14 days
Analysis and reporting	2 weeks

4. *Data* shipped from KGS in 240-channel SEG-Y format within 1 month of leaving the field site.
   Preliminary Report (including all walkaway tests and safety report) approximately 3 months after initiation of research agreement.
   Final Report one month after review and comment on preliminary report by EPR.

* Depending on results of testing.

Quality Control (QC)

QC is critical and will be continuous throughout acquisition. Near-surface inconsistencies, extreme topography, an extremely narrow and changing optimum recording window, and poor source/receiver coupling conditions will require strict compliance with QC guidelines and meticulous monitoring of data, an absolutely essential aspect of the data acquisition. The seismograph CRT display, nearly real-time digital filtering, and real-time graphical display of noise levels will permit instantaneous monitoring of cultural, air traffic, vehicle traffic noise, cable-to-ground leakage, and geophone plant quality. After each geophone is planted, it will be tested to insure a cable-to-ground resistance greater than 1000K ohms and individual geophone continuity within 5% of nominal string impedance (including consideration for cable offset). As well, each geophone will undergo a modified tap and twist test. No shot will be recorded if background noise voltage levels on active geophones is greater than 0.05 mV. The ability of the seismograph to real-time monitor noise levels, signal quality (through digital filtering), and unacceptable geophone plants as well as the roll-switch's built-in earth leakage and continuity meters minimize the chances a recorded shot is not maximized for the site and equipment.

Velocity Survey

Velocity measurements will be made using a sledge hammer, downhole three-component hole lock geophone, and StrataView seismograph. Data will be recorded on one vertical and two un-oriented transverse geophones at approximately 1.5 m vertical spacings throughout the interval of interest. It is anticipated that the interval of interest will extend from near the ground surface to a depth not exceeding 100 m. Vertically stacked shot records will be recorded. The number of impacts stacked for each shot gather will be sufficient to allow identification of first break compressional waves. Attenuation resulting from a longer ray path will require the number of impacts per receiver location to increase as a function of increasing geophone depth.

Three-channel seismograms can be made available in SEG-Y format (after conversion from the seismograph's native SEG-2) for transmittal to EPR's Houston office within hours of acquisition in the field. Processing the uphole data will involve gathering traces according to source location and borehole depth. The resulting seismogram will be multi-trace (number of traces dependent on number of depth intervals sampled), resembling an unprocessed VSP record. Processing these data will take several hours after leaving the field and will be available for analysis in SEG-Y format no more than two days after the data has been acquired.

Phase one data will be analyzed to determine if phase two is to commence. If the average velocity is higher than anticipated, the resolution and penetration requirements will not be obtainable with shallow, high resolution seismic techniques. At this point the project will be terminated if the velocity is too high, or the program will proceed to phase two if the velocity is consistent with expectations or slower.

Walkaway Testing

Unique shallow data characteristics expected to be evident during the walkaway testing will exemplify the utility of a good testing program and demonstrate the need to have a sizable repertoire of acquisition equipment available for testing. A shallow seismic reflection program needs to be tuned for the acoustic and logistical conditions at a particular site. As previously stated, identification and confirmation of reflection hyperbola on walkaway noise tests are essential and best accomplished through mathematical curve fitting, matching to borehole-derived velocity structure, and observation of file-to-file consistency. Walkaway noise tests will be designed so the subsurface is oversampled horizontally and the source-to-farthest-receiver-

offset is at least equivalent to the primary depth of interest. This allows all aspects of the complete wavefield (especially the reflections) to be thoroughly appraised.

The primary intent of the walkaway noise test is to allow comparison of various source, receiver, and instrument settings and configurations as they relate to overall improvements in the signal-to-noise ratio and frequency content. Walkaway tests performed on this survey will be designed to optimize the identification of individual events within the full wavefield. Phase velocity and wave type are the most important pieces of information extractable from walkaways. The relationship of velocity and wave type to spread geometries and offsets needs to be completely analyzed and understood for acquisition parameters and equipment to be optimized for shallow reflection surveying (Pullan and Hunter, 1990). Processing of walkaway data for this study will be limited to trace organizing, gain balancing, and digital filtering. Walkaway data from each source configuration or comparison parameter will be displayed in a source-to-receiver offset order.

The evaluation/feasibility portion of the study is designed to allow analysis of acoustic characteristics and, more generally, the reflection method, which in turn permits accurate estimations of resolution and optimization of acquisition equipment and parameters. The walkaways will consist of source-to-receiver offsets ranging from 0.5 m to approximately 120 m or longer, if necessary. The receiver interval will be 0.25 m. The 12-gauge auger gun (Healey et al., 1991) (requiring only class C explosives), an accelerated weight drop (Bison EWG equivalent), OYO/ Geometrics MicroVibrator, various hammer and plate combinations, slide hammer, and 30.06 downhole/surface will be evaluated (if conditions permit) to establish the optimum source for the near-surface conditions, target depth, resolution requirements, and environmental constraints. Each configuration will be evaluated with as near equivalent conditions and parameters as possible (Miller et al., 1986; Miller et al., 1992; Miller et al., 1994; Doll et al., 1998).

Receivers available for testing will include both single Mark Products L-40A 100 Hz geophones and dual 40 Hz Mark Product L-28E geophones wired in series. The 40 Hz geophones will be tested first and, from previous experience with targets of this size and depth range, will probably produce the best response. The need for a strong signal and flat response from geophones with a high spurious noise threshold is paramount to high frequency reflection profiling. Lower quality geophones will not produce the desired output within the desired frequency band. If at any point during the noise testing an optimum parameter or component is identified, the affected portions of the remaining tests at that site will be bypassed.

Data collected during the experimental phase of this survey will be displayed on-site in the appropriate format. Displaying walkaway noise data according to source-to-receiver offset for each source configuration and receiver tested optimizes in-field analysis. Final walkaway sections will be trace balanced and displayed at an appropriate scale. Spectral analysis will be used in conjunction with curve modeling to determine the basic characteristics of reflection data. Determination of source configuration and field parameters for the 3-D production spreads will be based on walkaway tests.

In summary, the walkaway noise testing will be designed and executed to allow evaluation of acoustic signature, optimum acquisition equipment and parameters, near-surface velocity structure, horizontal consistency in reflection character, general resolution potential, signal-to-noise ratio, and impact of cultural noise (i.e., jet aircraft, industrial facility, vehicle traffic, etc.).

3-D Survey Phase

Data Acquisition

Acquisition of the 3-D data will begin as soon as possible after phase two (walkaway noise testing) is completed and both EPR and KGS are satisfied with the parameter design. A total of 10 field days will likely be necessary to acquire the 1,920 3-D shotpoints. Source and receiver selection will be a qualitative choice based on frequency, potential penetration depths, quantity of ground roll relative to body waves, and physical site and near-surface constraints.

Equipment used to acquire these data will be selected based on walkaway tests and site performance. Data will be acquired on a 240-channel (quad 60-channel machines networked) R60 Geometrics StrataView floating-point seismograph. Parameters such as sampling interval and record length will be determined after careful examination of the dominant frequency and usable bandwidth of reflection energy recorded during the walkaway noise tests. Based on experience at sites with a similar near-surface and target interval, the most probable source used for production will be either the OYO/Geometrics MicroVibrator, 30.06 downhole, or some configuration of hammer and plate. Dual L-28E 40 Hz geophones will likely be the preferred choice for the receivers on the production line. Final selections will be made after all survey objectives and economic constraints are thoroughly considered.

Design consideration and acquisition parameters used to acquire the 3-D survey data will be selected based on the results of the velocity survey, individual walkaway tests, EPR's design constraints, target objectives, and commonly accepted shallow 3-D design criteria (Büker et al., 1998). Several rules of thumb will be considered when making final design adjustments. Several key acoustic characteristics of this site will be determined during phases one and two and then used to guide the selection of survey parameters. Preliminary survey designs provide survey data parameters that include:

bin size = 1.5 m
X_{min} between 17 m and 13 m
X_{max} = 58 m
Fold = 24.

Considering the standard rules of thumb for X_{max} and X_{min} (X_{max} = max target depth and X_{min} = 1 to 1.2 times min target depth), preliminary survey designs focus this 3-D survey into a depth interval between about 15 and 60 m. Both fold and bin size are reasonable for the target depth interval, target size, and 2-D appropriate for this target (½ 2-D fold = 3-D fold).

Preliminary survey considerations, estimations, and objectives have allowed the design of an acquisition procedure. A 108 m x 60 m patch will be rolled 33 m in an in-line direction after completing a template which includes 24 shot stations along each of 3 cross-lines and four shot stations along 2 cross-lines on adjacent sides of each major source line for a total of 96 shot stations. A total of 72 receiver stations will be rolled in the positive in-line direction until the completion of each template. After 5 in-line rolls have been completed, three receiver lines will be rolled in a positive cross-line direction to establish another 6 lines of 36 receiver stations at a 3 m x 12 m receiver spacing and 3 m x 12 m source spacing (plus two short source cross-source lines). This patch will then roll in an in-line direction identical to the previous set of 5 in-line rolls. Rolling through the entire survey area in this fashion will result in a three-line overlap with each cross-line roll. Three-dimensional data acquired using this approach will be limited by geometry, but represents a reasonable balance between available recording channels and target objectives.

Several characteristics of these data can be established only after test data have been recorded at this site. Probably the most significant of these relates to the velocity structure of the

site. Contingent on the velocity is maximum usable frequency, maximum receiver spacing, maximum line spacing, and resolution limits. Since maximum usable frequency is a function of interval velocity and maximum dip angles, it will be important to acquire the borehole velocity information in such a way as to allow calculation of both average and interval velocities. Estimation of the optimum bin size is dependent on several criteria including maximum unaliased frequency, interval velocity, and dominant frequency. Resolution, both lateral and vertical, are important considerations in meeting survey objectives. Lateral is related to zero offset time, average velocity, interval velocity, and dominant frequency. Vertical resolution is dependent on dominant frequency and velocity. Receiver and line spacing designations must consider depth of interest, number of recording channels, survey design, velocity structure (hyperbolic moveout as it relates to the optimum recording window), azimuthal distribution, and offset distribution. Optimizing the survey design will require incorporation of several data characteristics which can only be determined after borehole and survey testing is complete.

Surveying x, y, and z will require high resolution. Previous 3-D surveys have used interpolation between surveyed receiver and shot stations to save time and therefore money (Büker et al., 1998). This approach is reasonable if the survey area possesses subtle topographic changes and if the station locations can be established with a common chain to within a few percent of the desired location. The most extreme need for location accuracy is at the longer offsets, which correlate to target depth. Making that assumption, the maximum position error will be less than or equal to the product of the sampling interval, average velocity, and a constant (1.58). Picking a lower than expected average velocity will minimize the acceptable positioning error. With a sampling interval of 0.5 msec and average velocity of 1,000 m/sec the maximum allow positioning error will be about 0.8 m. All station locations will be surveyed with a Trimble 4800 or 4700 GPS with specified post-processed resolution better than 10 cm in x, y, and z.

Final Products

The raw data will be transferred from computer hard drives to CD-ROM at the KGS's Lawrence, Kansas, facility. Data recorded by the 240-channel StrataView is natively stored in a SEG-2 format and as four separate 60-channel files. Each recorded field file will be appropriately grouped and converted to a SEG-Y format. Standard archival procedures at the KGS involve burning the data to a CD. All field notes (OB and survey) will be scanned and loaded onto the CD as well. The KGS will ship the raw digital data in SEG-Y format on CD-ROM with all digital and analog field notes to EPR within one month of leaving the field site.

The acquisition report will provide a chronological and technical accounting of field activities associated with design and collection of these data. Discussions in the report will include dialog and associated figures covering the following topics: walkaway tests, testing procedures, decisions regarding optimization, data acquisition observations, and the full safety plan/report. Walkaway data will be gathered according to unique equipment and/or parameters. Digital filter tests and event identification and analysis will detail and justify parameter and equipment selections. The completed safety plan (with daily signatures) will be consistent with OSHA and DOE standards, with copies of all MSDSs and a detailed description of health/safety risks associated with the environment and equipment.

Overall Project Goal

The goal of this study will be to optimize a shallow high resolution 3-D survey to allow the delineation of a shallow fault zone and investigate the effects of variability in gouge content on the acoustic waveforms. This high resolution 3-D survey will be the first to attempt directly

imaging a shallow fault plain and the materials within the disturbed zone around this fault. Reflections from geologic interfaces altered in close proximity to the fault will provide valuable insight into deeper fault zones acting as traps for petroleum.

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III. RESPONSIBILITIES

The responsibility for employee safety rests with each employee's respective employer. This plan, therefore, applies only to KGS for the survey activities. Each employee of KGS will strive to identify and mitigate any safety hazards encountered. All parties will cooperate in working as safely as possible and will comply with all applicable safety requirements as set forth by EPR as well as those included in this document.

In addition to the safety procedures indicated herein, we will adhere to the following:

1. In the event of electrical storms in the vicinity, all surface operations will cease if lightning strikes are closer than three miles (determined by 15 second count between lightning and thunder).

2. If conditions become excessive (i.e., temperature > 100° < 30° F), continuous day operations will be modified to minimize chances for heat- or cold-related medical problems. Breaks of up to one hour every hour might be necessary in extreme situations.

3. Appropriate field boots will be worn and due caution will be exercised with respect to snakes, ditches, swampy areas, and ground debris. Steel toes will be worn by all field crew members.

4. At least one gallon of fresh water will be on hand at the beginning of each day for each crew member. An ice chest for keeping food stuff cold and an ice chest for medical use in case of injury or overheating will be available on-site.

5. In the case of excessive cold weather, a sheltered area will be available with inside temperatures above 32° F.

6. The seismic crew will operate with an established protocol for initiating seismic sources. The safety plan will be approved by the EPR Representative prior to initiation of field operations.

7. Appropriate drivers licenses will be held by operators of vehicles at all times (KDOT regulations).

8. All explosive or flammable materials will be properly stored and labeled in accordance with KDOT regulations.

9. High pressure systems will be identified and will be maintained to meet or exceed manufacturer's specifications.

IV. SAFETY PERSONNEL

Safety Personnel and Emergency Contacts

1. Rick Miller (KGS)—Site Safety Officer
2. David Laflen (KGS)—Operations
3. Young Kim (EPR)—Delegated Representative and Site Consultant
4. Greg Landry (EPR)—Safety Coordinator
5. Chad Gratton (KGS)—Line Chief
6. Jianghai Xia (KGS)—Communications and Protocol

Safety Meeting at Survey Site Date: 6/21/99

- ☑ Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- ☑ Environmental hazards (heat, plants, animals [snakes, etc.])
- ☑ Vehicle safety (road travel, warning signs, traffic control)
- ☑ Civilian/bystander safety (safe distances, visitor check-in)
- ☑ Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- ☑ Emergency procedures (injuries, property damage, potential problems)
- ☑ Equipment hazards (safe use of ATV, loader, augers, etc.)
- ☑ First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
DAVID LAFLEN	KGS	
Linda Zimmerman	EPR	
YANG YU	EPR	
Nathan Gaer	KGS	
L.E. STONE	EPR	
Mark Meier	EPR	
Jianghai Xia	KGS	
Jeff Torchia	KGS	
CHAD GRATTON	KGS	
Rick Miller	KGS	

Site Safety Officer

Safety Meeting at Survey Site Date: 6/22/99

- ☑ Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- ☑ Environmental hazards (heat, plants, animals [snakes, etc.])
- ☑ Vehicle safety (road travel, warning signs, traffic control)
- ☑ Civilian/bystander safety (safe distances, visitor check-in)
- ☑ Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- ☑ Emergency procedures (injuries, property damage, potential problems)
- ☑ Equipment hazards (safe use of ATV, loader, augers, etc.)
- ☑ First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
Jeff Torchia	KGS	Jeff Torchia
DAVID LAFFEN	KGS	David Laffen
Linda Zimmerman	EPR	Linda Zimmerman
Jianghai Xia	KGS	Jianghai Xia
Mark Meier	EPR	Mark Meier
J. E. STONE	EPR	J. E. Stone
Yang Yu	EPR	Yang Yu
Nathan Geier	KGS	Nathan Geier
Chad GRATTON	KGS	Chad Gratton
John Kidd	KGS	John Kidd

Site Safety Officer

Safety Meeting at Survey Site Date: 6/23/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
David Laflen	KGS	David Laflen
Chad Gratton	KGS	Chad Gratton
Nathan Geier	KGS	Nathan Geier
Mark Meier	EPR	Mark Meier
L. E. Stone	EPR	L. E. Stone
Yang Yu	EPR	Yang Yu
Jeff Torchia	KGS	Jeff Torchia
Jiangtai Xia	KGS	Jiangtai Xia
Linda Zimmerman	EPR	Linda Zimmerman

Rick Miller
Site Safety Officer

Safety Meeting at Survey Site Date: 6/24/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
David Laflen	KGS	David Laflen
Jiangkai Xia	KGS	J. Xia
Nathan Geier	KGS	Nathan Geier
Chad Gratton	KGS	Chad Gratton
Linda Zimmerman	EPR	Linda Zimmerman
Mark Meier	EPR	Mark Meier
N.E. Stone	EPR	N.E. Stone
Yang Yu	EPR	Yang Yu
Jeff Torchia	KGS	Jeff Torchia

Rick Miller
Site Safety Officer

Safety Meeting at Survey Site Date: 6/25/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
Nathan Geier	KGS	Nat Gei
John Kidd	KGS	John Kidd
David Laflen	KGS	David Laflen
Chad Gratton	KGS	Chad Gratton
Jianghai Xia	KGS	J. Xia
Linda Zimmerman	EPR	L Z
Yang Yu	EPR	Y Yu
Mark Meier	EPR	Mark Meier
Jeff Torchia	KGS	Jeff Torchia

Rick Miller
Site Safety Officer

Safety Meeting at Survey Site Date: 6/26/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
John Kidd	KGS	John Kidd
David Laflen	KGS	David Laflen
Jianghai Xia	KGS	J. Xia
Linda Zimmerman	ERR	
Jeff Ronchia	KGS	
Nathan Geier	KGS	
Chad Gratton	KGS	Chad Gratton

Rick Miller
Site Safety Officer

Safety Meeting at Survey Site Date: 6/27/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	
Jiangha i	KGS	
Nathan Geier	KGS	
Jeff Torchia	KGS	
Yang Yu	EPR	
Mark Meier	EPR	
Linda Zimmerman	EPR	
Chad GRATTON	KGS	
DAVID LAFLEN	KGS	

Rick Miller
Site Safety Officer

Safety Meeting at Survey Site Date: 6/28/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
DAVID LARLEN	KGS	David Larlen
Jianhgi Xia	KGS	
Jeff Torchia	KGS	
Chad GRATTON	KGS	Chad Gratton
Mark Meier	EPR	mark meier
Yang Yu	EPR	
Linda Zimmerman	EPR	
JOHN KIDD	KGS	John Kidd
Nathan Geier	KGS	

Site Safety Officer

Safety Meeting at Survey Site Date: 6/29/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	
David Laflen	KGS	
Jeff Torchia	KGS	
Jing Mi Xia	KGS	
Nathan Geier	KGS	
Linda Zimmerman	EPR	
Mark Meier	EPR	
Yang Yu	EPR	
John Kidd	KGS	
Chad Gratton	KGS	

Site Safety Officer

Safety Meeting at Survey Site Date: 6/30/99

- [x] Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- [x] Environmental hazards (heat, plants, animals [snakes, etc.])
- [x] Vehicle safety (road travel, warning signs, traffic control)
- [x] Civilian/bystander safety (safe distances, visitor check-in)
- [x] Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- [x] Emergency procedures (injuries, property damage, potential problems)
- [x] Equipment hazards (safe use of ATV, loader, augers, etc.)
- [x] First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature
Rick Miller	KGS	Rick Miller
Nathan Geer	KGS	Nathan Geer
DAVID LAFLEUR	KGS	David Lafleur
JOHN KIDD	KGS	John Kidd
Jeff Torchia	KGS	Jeff Torchia
Chad GRATTON	KGS	Chad Gratton
Yang Yu	EPR	Yang Yu
Mark Meier	EPR	Mark Meier
J.E. STONE	EPR	J.E. Stone
Linda Zimmerman	EPR	Linda Zimmerman

Site Safety Officer

Safety Meeting at Survey Site Date: _____

- ❒ Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- ❒ Environmental hazards (heat, plants, animals [snakes, etc.])
- ❒ Vehicle safety (road travel, warning signs, traffic control)
- ❒ Civilian/bystander safety (safe distances, visitor check-in)
- ❒ Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- ❒ Emergency procedures (injuries, property damage, potential problems)
- ❒ Equipment hazards (safe use of ATV, loader, augers, etc.)
- ❒ First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

Safety Meeting at Survey Site Date: _____

- ❒ Gun/explosives safety (handling of ammo, use of sources, cleaning and maintenance)
- ❒ Environmental hazards (heat, plants, animals [snakes, etc.])
- ❒ Vehicle safety (road travel, warning signs, traffic control)
- ❒ Civilian/bystander safety (safe distances, visitor check-in)
- ❒ Site requirements (PPC) (gloves, hats, boots, hearing protector, safety glasses)
- ❒ Emergency procedures (injuries, property damage, potential problems)
- ❒ Equipment hazards (safe use of ATV, loader, augers, etc.)
- ❒ First Aid (heat stroke, frostbite, animal bites, etc.)

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

Specific Safety Requirements

Personnel Safety Equipment: All personnel will be provided hard hats, safety shoes, hearing protection, and eye protection while working in the field during the seismic data acquisition phase of this project. Equipment appropriate for the site will be worn.

Vehicular Safety Equipment: All KGS vehicles will be equipped with a first aid kit and a fire extinguisher. A portable cellular phone will also be available in a KGS vehicle and will be the primary means of communication in the event of an emergency.

Fire/Explosion Prevention: No smoking or open fires are allowed in or around KGS vehicles. The ammunition vehicle will be equipped with a fire extinguisher. The ammunition vehicle will always be in visual contact of a qualified crew member. All ammunition will be kept in steel ammunition cases stored (when not in use) in a locked steel container attached to the ammunition vehicle.

Time of Work: Every effort will be made to expedite all work during clear daylight hours under unrestricted visibility, in good weather conditions.

Accident Prevention Plan Participation: All KGS personnel participating on this project will be required to review this plan prior to arrival on site.

All KGS staff will be required to comply with rules outlined with this plan. Failure or inability of EPR or KGS personnel to comply with the site safety guidelines presented herein will be grounds for suspending all project work until compliance can be assured.

Copies of this Accident Prevention Plan will be available on the dashboard of project vehicles. Emergency call numbers and evacuation routes are included in this safety plan.

Compliance with the following KGS General Health and Safety Rules is required by the KGS of all its staff and any visitors working or present on the job site in all operations.

1. Accidents or injuries must be reported immediately to the site safety officer, no matter how minor they seem.

2. Know how to do your job. Check your work area to determine what problems or hazards may exist. Review the safety requirements of each assigned job with your supervisor. Your activity may endanger other persons or nearby equipment or property. Take necessary steps to safeguard them. Be aware of what others are doing insofar as their actions may affect your safety.

3. Always maintain a safe distance away from any of the explosive seismic materials and devices unless you are specifically authorized or trained to handle these materials. Keep persons not authorized in the use of these materials away from the explosive work area at all times. Those authorized to handle explosives shall use every reasonable precaution, possibly including, but not limited to, visual and audible warning signals, flags, or barricades to ensure safety.

4. Report unsafe equipment, hazardous conditions, and unsafe acts.

5. Use the safety equipment specified for the job.

6. Practice good housekeeping in the work area.

7. For your protection, obey all warning signs such as "Keep Out," "No Smoking," "Eye Protection Required," and "Authorized Personnel Only." Become familiar with site-specific emergency response plans.

8. Do not take shortcuts. Use designated paths.

9. Do not engage in horseplay or roughhousing at any time. To do so may lead to injury and/or be cause for disciplinary action.

10. No KGS staff person is permitted to use intoxicants or to be under the influence of any intoxicant or drug while on the job. This includes any time when operating a company vehicle. Failure to obey this policy may result in immediate termination of employment with KGS. *See Section VII—University Alcohol and Drug Policy.*

11. When in doubt about safety equipment or procedures required to do your job, ask your Supervisor, Department Head, Site Safety Officer, or the Survey Health and Safety Officer.

12. Failure to follow practices relating to your safety or that of fellow staff or failure to properly safeguard equipment, tools, or materials may lead to disciplinary action.

V. EMERGENCY INFORMATION

Police/Ambulance: 911

Green River Medical Center: 435-564-3434

EPR Nurse Practioner
Charlene Lutz: ofc 713-431-7060 / beeper 800-694-4652 / h 281-424-1871

EUSA Medical Emergency
(only if cannot contact CLutz): 713-656-3424

Fire Department: _____

Explosives Unit: _____

State Environmental Agency: _____

Comfort Inn Motel: 435-564-3300

EPR Emergency Contacts

Supervisor	Young Kim Office 713-461-6156 / Home 281-___-____
Industrial Hygienist	Bette Hillman Office 713-431-7233 / Beeper 713-768-2207
Safety Coordinator	Greg Landry Office 713-431-4371 / Beeper 713-768-2199
EPR Nurse	Charlene Lutz Office 713-431-7060 / Beeper 800-694-4652 / Home 281-424-1871
Exxon Risk Management	800-759-7243

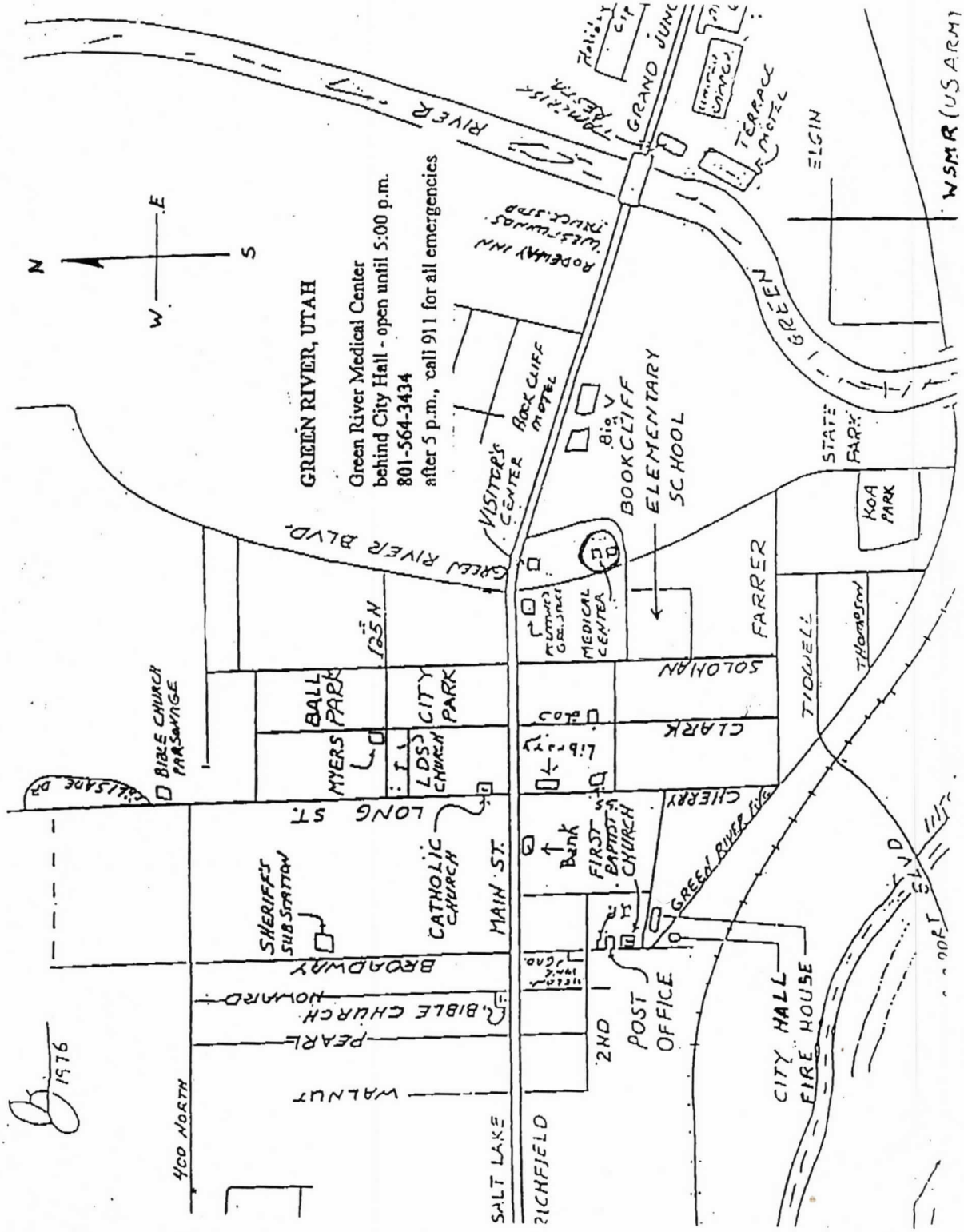
KGS Emergency Contacts

Safety Coordinator and Project Manager
Rick Miller, Kansas Geological Survey
Cellular (in the field): 785-766-8636

KGS Safety Officer
Kathy Sheldon, Kansas Geological Survey
Office: 785-864-3965

Emergency Routes
(Include road or other direction; attach map with routes highlighted. To be filled out by Site Safety Officer.)

A map to the Green River Medical Center is below. Maps and written directions to the Grand County Hospital in Moab are on following pages.



Back

HELP?

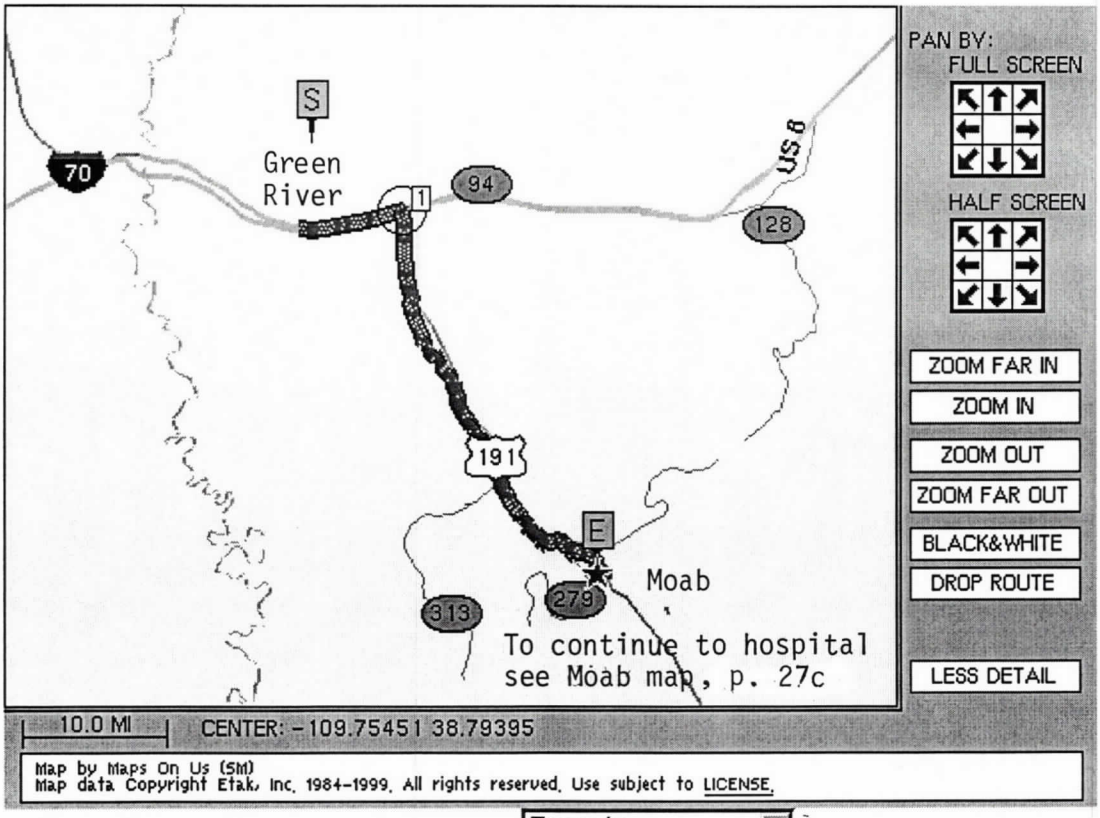
Grand County Hospital
719 W 400 N, Moab, UT 84532-2239
Phone: (435)259-7191

Want directions to this location? click here

Your Map Plan Another Route

Route Summary	
Start:	**Start Point (Green River, UT)**
End:	**Grand County Hospital**
Totals:	**37.9 miles, 45 minutes, 1 turns**

Plan Return Route Jump to Turn-by-Turn Directions Redraw Map to Show Full Route
Hide Large Map



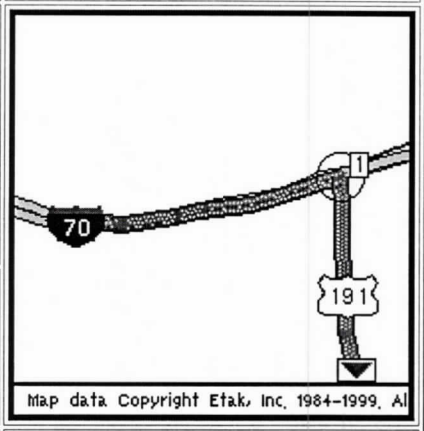
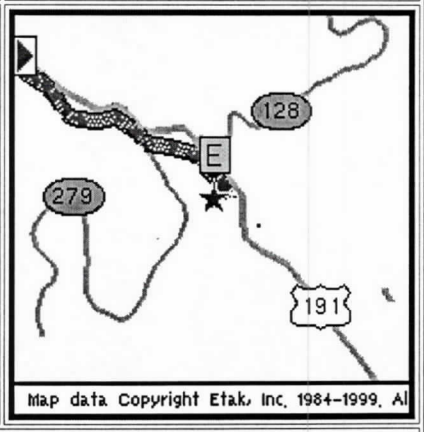
Map-Clicking will: Zoom In

Turn-by-Turn Directions

Page 27a

NOTE: Based on the starting and ending points you selected, we cannot provide door to door directions. Please note that the end points may be shown in the general vicinity rather than the specific address you entered, and the route may not line up exactly with the roads.

For a larger map of a turn, click on the turn number or the detail map.
If you have trouble printing this page, click here for an alternate version.

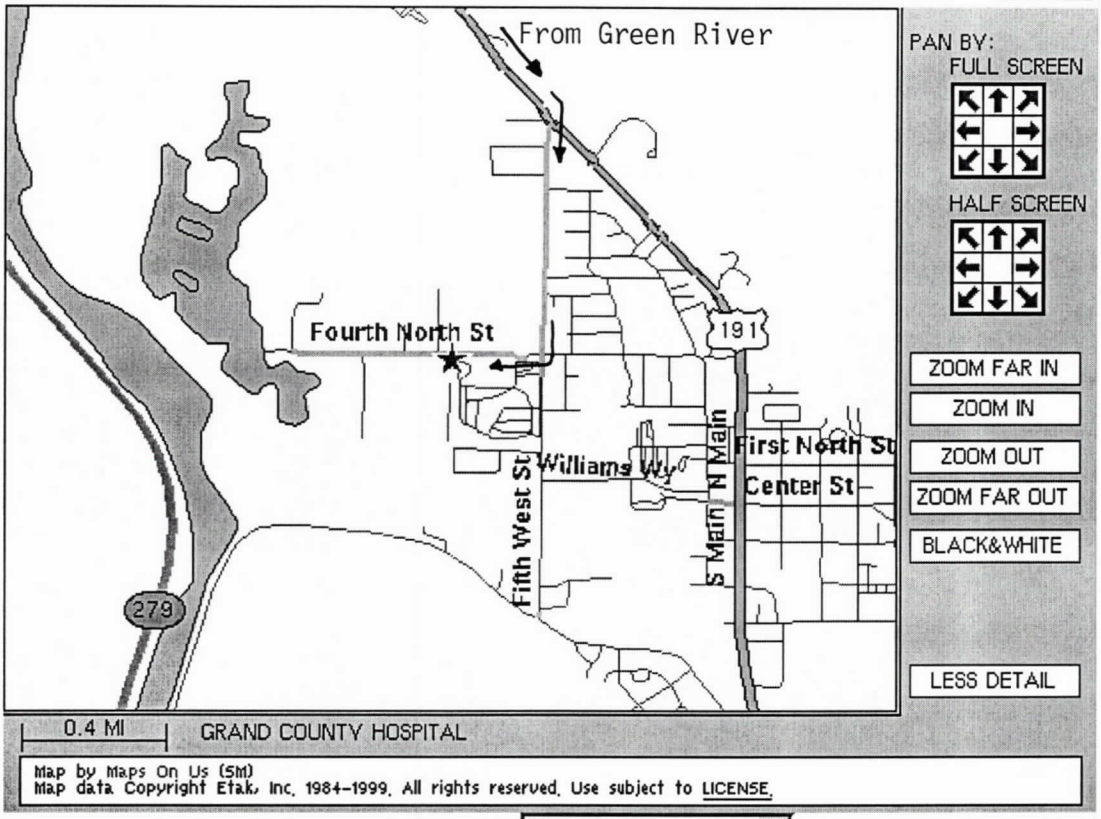
	Go	And Then ...	Total Miles	Detailed Per Turn Maps (Hide These Maps)
Start		Head EAST on I 70 (EAST), From **Start Point (Green River, UT)**	0.0	
1	7.2 mi	TURN RIGHT onto US 191 (SOUTH)	7.2	
End	30.6 mi	**Grand County Hospital**	37.9	

WARNING: Use these directions at your own risk. Switchboard Incorporated is not responsible for their accuracy or for any losses resulting from their use. **Obey all traffic regulations.**

Back HELP?

Grand County Hospital
719 W 400 N, Moab, UT 84532-2239
Phone: (435)259-7191

Want directions to this location? click here



Map-Clicking will: Zoom In

Directions

Plan a route to Grand County Hospital from:

Street: (e.g,, *123 Main St*)

City, State Zip: (e.g,, *Summit, NJ 07901*)

Plan Route Reset

Procedures

Accidents/Injury: If any serious injury does occur, the appropriate authorities shall be notified immediately. All accidents will also be reported.

Several members of the KGS crew have certification in CPR/First Aid through 2/6/01. This certification was received through participation in the "Standard First Aid" and "CPR for the Professional Rescuer" programs presented by the Red Cross of Lawrence, Kansas. These classes are approved by the U.S. Department of Labor, Mine Safety, and Health Administration and meet or exceed OSHA requirements. OSHA certifications are provided by EPIC Training and meet or exceed 29 CFR 1910.120.

The following persons are certified as indicated (please circle area[s] of certification):

Certified in:	First Aid	CPR	40hr OSHA	Rick Miller
Certified in:	First Aid	CPR	40hr OSHA	David Laflen
Certified in:	First Aid	CPR	40hr OSHA	
Certified in:	First Aid	CPR	40hr OSHA	

Fire/Explosion: Upon notification of a fire or accidental explosion on site, the fire department or appropriate first responders shall be notified and all personnel shall leave the area. Since only Class "C" shotgun ammunition will be used as part of the program, local fire, police, and other governing authorities will not be contacted prior to the use of such devices. If Class "A" explosives were used, prior consultation and contact would be made with the appropriate emergency response groups.

At least one KGS vehicle will be on-site during the performance of all work. This vehicle will be used for medical evacuation of project personnel, if necessary.

Permits: All necessary and appropriate permits, fees, and licenses will be obtained by EPR, with copies available on-site for inspection by local authorities.

VI. TASK SPECIFIC HAZARDS

The purpose of the geophysical investigation is to delineate subsurface structures and image significant stratigraphic characteristics at a test site in Emery County, Utah.

Downhole 8-gauge Auger Gun

One of the geophysical tests proposed to be employed requires the use of an auger gun (shotgun type device) to introduce energy into the ground (Healey et al., 1991). This device consists of a small skid-steer loader with an attached auger/screw. The operation consists of (1) screwing the hollow stem auger approximately 3 ft into the ground, (2) retrieving the center bit, (3) loading the shell in the firing tube and lowering the tube until it latches in place, (4) firing the gun by impacting the top of the firing tube with a small hammer, and (5) unscrewing the auger from the ground. The auger gun uses a *blank* 12-gauge shotgun shells fired below the ground surface in a downward direction. The device is built to minimize any danger to persons handling and moving the device, as well as avoid leaving any residual materials in the ground. The shotgun shells will be secured in a specially designed steel, lockable, explosives box attached to a vehicle at all times. The operation/safety rules and regulations for the auger gun are presented as an appendix to this plan.

30.06 Downhole Projectile Source

Experiments will be carried out with a downhole projectile source. This source is a specially modified 30.06 rifle designed to be loaded and fired while secured to the ground in a downward direction. The firing tube is lowered about one foot into a 1" hole. A standard 30.06 rifle shell is loaded in the above-ground breech and then detonated so that air coupled wave (blast), gas, projectile, and shrapnel are contained within the 1" hole. The procedure calls for 1) drilling a 1" x 1' hole, 2) placing the firing tube in the hole (covering the end of the tube with a finger cot), 3) loading a 30.06 round into the above-ground breech, 4) locking the bolt in place, 5) assuming the firing position, 6) detonation, and 7) removal from the hole. The device has successfully and safely fired over 30,000 rounds since 1985. All rounds are stored in a secure steel box.

Sledgehammer

The sledgehammer is a well understood and available source of acoustic energy. The sledgehammer will be used with a hard-wire time break and will be operated by physically capable KGS staff members. An area twice the length of the hammer handle will be cleared prior to use. The hammer will be 1) raised above the operator's head using a two-hand grip, 2) accelerated with full arm extension toward the ground, 3) contact striker plate with hammer, and 4) lifted into split two-hand carry grip. Activities such as changing broken handles and attaching new hammer switches should only be done by experienced KGS staff. A minimum clear area directly in front of the operator of at least 25 ft must be maintained in case operator loses grip on hammer or hammer head breaks free from the handle. Gloves, safety glasses, steel toed boots, and hard hat are required for operating this source.

Weight Drop

The accelerated weight drop is a high energy, hydraulically operated source. All moving parts are shielded and designed to minimize risk of injury to operator and bystanders. By its very nature the weight drop represents a hearing danger. The source is powered by a standard

commercial skid-steer loader. A single operator runs the device from inside a protective cage. Operation simply requires 1) the base plate to be placed on the ground and loader/weight drop weight applied for hold down, 2) idle at low rpm and initiate the hydraulic value (foot control in operator cage), 3) weight is raised against resistive force (rubberband), 4) dropped once maximum pre-set height is reached, and 5) source is hydraulically lifted and carried to next shot point by tracked loader. The source is sufficiently shielded that only in a very unusual situation will pieces of the source come free from the source and represent a threat to safety. By maintaining a minimum 30 ft for hearing safety, the danger of fragments is all but eliminated.

Microvibrator

The microvibrator has no moving parts (on a visible scale) and is self-contained. The oscillatory motion of the vibrator is controlled by an electric circuit with the vibrator itself powered by electricity. The computer control current is located at the seismograph with a 150 ft tether connecting the power supply with the vibrator. The vibrator is attached to the front of a commercial skid-steer loader. The vibrator is 1) carried to the VP by the front loader, 2) it is placed on the ground with pressure applied by the loader, 3) the sweep is activated at the seismograph, and 4) the vibrator is raised and carried to the next VP. A 110V generator provides the power for the system. The primary safety risk is related to the electric power. Proper handling of the power cord and generator mitigates this risk.

General

Field operations will consist of geophysical investigations to determine the effectiveness of shallow seismic survey methods at this site to delineate the structures and stratigraphy. The introduction of acoustic energy into the ground in a controlled fashion involves equipment or material with the potential to do harm if not properly handled and operated. Good common sense, training, and experience are the rule for seismic field operations. These can usually be easily accomplished if manufacturers' operating and use instructions are followed.

The field investigations will involve project personnel performing geophysical surveys of the study area utilizing the aforementioned explosive, impacting, and vibratory seismic sources. The principal hazards associated with the use of sources mentioned here consist of handling or moving the equipment, improper use, fragments from high velocity impacts, and high sound levels.

VII. ALCOHOL AND DRUG POLICY

The University of Kansas (of which the KGS is a part) is a drug and alcohol free workplace with stringent controls and penalties associated with the use and distribution of controlled substances and alcohol in the workplace regardless of whether it is at a remote field location or on campus. The University of Kansas and Kansas Geological Survey consider alcohol and drug use (non-doctor prescribed) while "on-duty" a health and safety risk. The following section details the University and Survey policy as it relates to drug and alcohol abuse and misuse, enforcement of policies, and penalties for violating those policies.

Policy on Prevention of Illegal Drug and Alcohol Use on Campus and in the Workplace

The University of Kansas prohibits the unlawful possession, use, manufacture, or distribution of alcohol or drugs by students and employees on its property or as part of its activities. The University is committed to a program to prevent the illegal use of drugs and alcohol by students and employees. Any student or employee found to be using, possessing, manufacturing, or distributing controlled substances or alcohol in violation of the law on University property or at University events shall be subject to disciplinary action in accordance with applicable policies of the State of Kansas, the Board of Regents, and the University of Kansas. For employees, the University will take appropriate personnel action for such infractions, up to and including termination. Students who violate this policy will be subject to sanctions which include suspension and expulsion from the University.

As a condition of employment, all employees of the University of Kansas shall abide by the terms of this policy statement and will notify the University of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction. The University will, in turn, notify as appropriate, the applicable federal agency of the conviction within ten days of receipt of notification of the conviction. The University will initiate personnel action, up to and including termination, within thirty days of receiving notice of such conviction. Employees may also be required to satisfactorily participate, at their own expense, in a drug abuse assistance or rehabilitation program before being allowed to return to work. For purposes of this policy, "conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the federal or state criminal drug statutes.

Kansas Law

Students and employees are reminded that illegal possession or use of drugs or alcohol may also subject individuals to criminal prosecution. The University will refer violations or proscribed conduct to appropriate authorities for prosecution. Kansas law provides that any person who violates the criminal statutes on controlled substances by possessing, offering for sale, distributing, or manufacturing opiates and narcotics, such as cocaine and heroin, shall be guilty of a drug severity Level 3 felony. For a conviction of such a felony, the court may sentence a person to a term of imprisonment in accordance with the Kansas Sentencing Guidelines Act and a fine of up to $300,000. Unlawful possession of a depressant, stimulant or hallucinogenic drug is punishable as a Class A nonperson misdemeanor, with a penalty of imprisonment and a fine of $2,500. Depressants include barbiturates, Valium, and barbital. Hallucinogens include LSD, marijuana, and psilocybin. State law classifies amphetamines and methamphetamines as stimulants. Kansas statutes also provide for criminal penalties for conviction of certain alcohol-related offenses. These penalties include imprisonment of up to six months and fines of up to $1,000.

Federal Law

The Federal Controlled Substances Act provides penalties of up to life imprisonment and fines up to $4,000 for intentional unlawful distribution or possession with intent to distribute controlled substances. For unlawful possession of a controlled substance, a person is subject to up to twenty years of imprisonment and fines up to $5,000. Any person who unlawfully distributes a controlled substance to a person under twenty-one years of age or who distributes a controlled substance on or within 1,000 feet of the University may be punished by up to twice the term of imprisonment and fine otherwise authorized by law.

Health Risks

Accidents and injuries are more likely to occur if alcohol and drugs are used on University property or as part of University activities. Every year in the United States, over 200,000 people are treated in hospitals for drug-related accidents and mental and physical illness; another 25,000 die every year from drug-related accidents or health problems. Drug users can lose resistance to disease and destroy their health. Drug tolerance and psychological dependence can develop after sustained use of drugs. More specifically, physical dependency, heart problems, infections, malnutrition, and death may result from continued high doses of amphetamines. Chronic use of narcotics can cause lung damage, convulsions, respiratory paralysis and death. Depressants such as tranquilizers and alcohol can produce slowed reactions, a slowed heart rate, damage to liver and heart, respiratory arrest, convulsions, and accidental overdoses, because the abuser is unaware of how much the drug or alcohol has been taken. Use of hallucinogens may cause psychosis, convulsions, coma, and psychological dependency.

Alcoholism is the number one drug problem in the United States. Alcoholism takes a toll on personal lives by affecting finances, health, social relationships, and families. It can have significant legal consequences. Abuse of alcohol or use of drugs may cause an individual driving a motor vehicle to injure others and may subject the abuser to criminal prosecution. Drunk drivers are responsible for more than half of all traffic fatalities.

Counseling & Treatment Resources

At the University of Kansas, alcohol and drug counseling and treatment are available to students at the University Counseling and Psychological Services, Watkins Health Center, and the Psychological Clinic. The Student Assistance Center and the University Information Center are excellent sources for information about University and community resources for counseling and treatment. The Health Education Department of Watkins Health Center can provide further information about health problems and treatment related to alcohol and drug problems.

University employees may contact the Counseling and Psychological Services and the Psychological Clinic for counseling and treatment. Faculty and staff members may also contact the State LIFEline, a 24-hour toll-free assistance line (1-800-284-7575) for a referral. If referred through the LIFEline program, the first counseling session is paid by the State. Please refer to page 63 for additional resources.

Definitions

The term "controlled substance" as used in this policy means those substances included in Schedules I through V as defined by Section 812 of Title 21 of the United States Code and as further defined by the Code of Federal Regulations, 21 C.F.R. 1300.11 through 1300.15. The term does not include the use of a controlled substance pursuant to a valid prescription or other uses authorized by law.

The term "alcohol" as used in this policy means any product of distillation or a fermented liquid which is intended for human consumption and which is more than 3.2% alcohol by weight as defined in Chapter 41 of the Kansas statutes.

Policy on Substance Abuse

The University recognizes that problems related to the abuse of substances such as alcohol and drugs may be resolved through cooperation between the employer and the affected employee. The policy set forth here for handling substance-abuse problems is intended to enhance cooperation and to protect both the individual and the University.

The University has a right to expect that employees will perform their jobs appropriately and to insist that job-performance standards be met. The University may properly intervene only when impairment affects job performance.

- These problems are defined as those in which an employee's use of alcohol or drugs has become part of a pattern of deteriorating job performance.
- This policy does not supersede any regulations or standard administrative practices applicable to job performance requirements.
- It is the employee's right and responsibility to seek professional assistance for a substance-abuse problem.
- All employees, especially department chairpersons and supervisors, should work to engender an en- lightened attitude toward and a realistic recognition of the nature of substance abuse and to encourage employees to take advantage of available treatments whenever needed.
- Responsibility for implementing this policy rests with all department chairpersons and supervisory personnel. Procedures must be followed to assure that no employee with a substance-abuse problem will have his or her job security or promotional opportunities jeopardized by a request for diagnosis and treatment.
- A chairperson or supervisor may wish to consult with a professional in the treatment of substance-abuse *WITHOUT IDENTIFYING THE CONCERNED EMPLOYEE* before attempting intervention with the employee.
- Before attempting intervention, a supervisor of classified staff should discuss with his or her own supervisor and the Department of Human Resources the rules and requirements protecting the rights of the person believed to be suffering from alcoholism or drug abuse.
- Departmental chairpersons and supervisors should not attempt diagnosis. When an employee's job performance is deteriorating and there is reason to suspect that the source may be the use of alcohol or drugs, the chairperson or supervisor will meet informally with the employee, make an appropriate referral to a professional agency and encourage him or her to seek help for the problem. At this meeting, a date will be set by which improvement in job performance will be assessed.
- The employee is responsible for complying with the referral for diagnosis and for cooperating in any prescribed treatment. He or she should be assured that the referral agency will treat all discussions with strict confidentiality. (Most agencies will, with the consent of their client, report to a super- visor that the client has followed up on a referral.)
- Between the time of the meeting and the date set for assessing improvement in job performance, the chairperson or supervisor will continue to monitor the performance but will in all other respects leave the initiative for further discussions to the employee.

- If, by the date set at the first meeting, the employee's job performance has improved to an acceptable level, no further official action is required.
- The University expects that employees with a possible problem of substance abuse, even in its early stages, will be encouraged to seek diagnosis and treatment. The employee should be assured that seeking help will not interfere with job status, promotional opportunities or other privileges.
- If the job performance remains below accepted standards and the employee has refused to accept diagnosis and treatment, or has failed to respond to treatment, the chairperson or supervisor should suggest that he or she use one of the *options available to any employee with an illness* that interferes with job performance:
  a. *Being placed on sick leave*. This option is for those with accrued leave. It would allow the employee to enter an inpatient treatment center and adopt a treatment program. Under this option, a written plan should be developed between the staff member and the University and properly executed by the chairperson or supervisor in consultation with Human Resources. The plan will spell out specifically the terms of the employee's return to his or her duties at the end of treatment (e.g., how the University is to be informed of the progress made in treatment and the appropriateness of a return to duty and how job performance is to be assessed).
  b. *Being granted a leave of absence without pay for up to twelve months*. This option is for classified employees, upon approval of the Department of Human Resources.
  c. *Taking early retirement*. This option is for those otherwise eligible. It is, of course, a drastic solution for both the individual and the University.
  d. *Resigning*. If a classified employee can make no progress, recommendations to demote or dismiss are to be submitted to the Department of Human Resources for review and action.

Information revealed by the employee while receiving professional services will remain confidential and separate from University employee records. All record-keeping and access procedures will meet the federal regulations governing the confidentiality of patient records and the state law protecting treatment records.

VIII. ACTIVITY HAZARD ANALYSIS

A. Work Item: *Use of Class "C" Shotgun Ammunition* (Auger gun / Buffalo gun)

Specific Hazards–The specific hazards involve injuries to persons or property damage arising from normal or accidental detonation or improper handling of the shotgun ammunition.

Control Measures–All project personnel working with or around the shotgun ammunition, seismic guns, and associated equipment will exercise all appropriate and reasonable precautions to prevent or limit accidents arising from use of explosives. All explosive devices will be Class "C," consisting of fully containerized smokeless black powder in the form of shotgun ammunition. Site work will conform with appropriate and reasonable Class "C" explosives handling, storage, communication, and detonation procedures. All seismic shots will occur in shallow boreholes 2 to 4 feet below ground level.

Rick Miller of the Kansas Geological Survey will be responsible for the safe use of the shotgun ammunition to be used. He will review the blasting communications and safety procedures at the initial site safety meeting and again prior to the initiation of the first seismic shots. All project personnel must become familiar with and abide by these protocols.

Specific shotgun ammunition safety measures are as follows:

- Storage: All shotgun ammunition will be stored in a locked metal container. The storage container will have proper DOT labels for Class "C" shotgun ammunition.

- Transportation: The ammunition vehicle will carry proper DOT labels and will be operated by Rick Miller, David Laflen, or Chad Gratton on or near site. The vehicle will contain a fire extinguisher, First Aid kit, and will be parked far enough off any road to minimize the potential for a collision with other vehicles.

- Handling: Only Rick Miller or qualified alternate, KGS, will be allowed to access, handle, and load the shotguns. Shotgun loading and firing will be conducted in accordance with the attached "Operations/Safety Rules and Regulations for the Auger Gun."

- Firing Communication: Rick Miller, David Laflen, or Chad Gratton shall establish a series of warning signals to be used prior to and following each shot. An audio signal will indicate the beginning of a shot (or prior site specified requirements). He will review the precise warning procedures with all project participants at the initial site safety meeting, and will monitor compliance with these procedures.

- Safe Distances: All project personnel not authorized to handle the shotgun ammunition and guns must stay a distance of 10 feet away from the guns and shot locations. Non-project personnel will not be allowed in the work area.

Blasting shall not commence if any of these protocols is not met.

Transportation. Transportation of the auger guns and ammunition is on a standard 2-ton flatbed truck and enclosed gooseneck trailer. The ammunition is carried in .50-caliber military-style ammo boxes. The ammo boxes are locked in 10-gauge steel boxes that are permanently bolted to the truck bed. The ammunition is classified as "Class C Explosive" by the U.S. Department of Transportation. No more than 2,500 rounds of ammunition will be transported to this project, packed in quantities of around 160 per container.

B. Work Item: *Modified Auger Gun*

Specific Hazards–Detonation outside downhole environment and hand entanglement in moving parts.

Control Measures–Safe gun practices (detailed in supporting documents), care and inspection of firing mechanism, and minimum standoff distance from source when under hydraulic power.

C. Work Item: *Traffic Control*

All regulation concerning right-of-way and traffic directions will be observed.

Specific Hazards–The specific hazard involves accidents with vehicular traffic within the survey area.

Control Measures–All personnel will minimize activity along trafficked roadways to the extent possible. Traffic cones will be used to identify and buffer the work area with respect to on-coming traffic. Care will be used while working on or around driveways. If appropriate, signs and/or flagmen will be used to alert and slow traffic through the survey area.

D. Work Item: *Bolt LSS-6 Land Air Gun* [not used for this survey]

The Bolt Land Air Gun has been in routine use in oil exploration for more than 20 years. The device consists of a 3-cylinder diesel engine, a four-stage air compressor, and an enclosed water filled chamber (housing the "gun"). The safe operation of the gun is well documented in the operator's manual. The entire device is transported as the bed of an F-350 4-wheel drive truck. The 3-cylinder diesel engine powers not only the air compressor but also a hydraulic system designed to raise and lower the gun chamber to the ground. The gun chamber is hydraulically lowered to the ground with the weight of the truck used to hold the device to the ground. The gun is electrically detonated from the cab of the truck with no moving parts exposed during detonation. The engine and air compressor are enclosed in a protective shroud. The gun generates a thump to the ground surface approximately equivalent to 1/8 of a pound of high explosive buried 3 to 4 ft beneath the ground surface.

Control Measures

1) The careful and safe operation of the standard 4 wheel drive truck is well documented in the owners manual.
2) It is critical to always be aware of anyone near the device.
3) The raising of the gun for transport and lowering of the gun just prior to detonation is done with only part of the gun visible to the operator. It is critical that no one comes within

50 ft of the gun while in operation.
4) Hearing protection (down 30 dB) is required by anyone within 50 ft of the truck.

E. Work Item: *MiniVib* [not used for this survey]

The MiniVib is a hydraulically powered vibrator designed to shake the ground in a very controlled fashion over about a 4 to 8 second time duration. The device is hydraulically powered with no moving parts that possess an entanglement potential. Energy is delivered to the ground by this device through a hydraulically powered pad approximately 3 ft in diameter mounted on the belly of the vehicle. The pad is lowered from beneath the vehicle using the vehicle's weight as hold-down pressure. The pad is vibrated by a hydraulic servo delivering frequency-varying energy to the plate over a preset time duration. No moving parts are exposed with the maximum movement of the pad relative to the vehicle less than 2 in.

Control Measures
1) This vehicle is center articulating and requires care when turning that no one is within 20 ft of the vehicle.
2) Safe operation of the vehicle is documented in the operator's manual provided by the manufacturer.
3) Hearing protection is required within 50 ft of the vehicle.
4) All shields are to remain in place while the vehicle is in operation
5) Hydraulic pressures of more than 3000 psi are routine during operation. No maintenance or service will take place while vehicle engine is running.
6) Quick inspection is necessary prior to lowering the pad.

F. Work Item: *Accelerated Weight Drop*

The accelerated weight drop (AWD) generates acoustic energy by accelerating a 50 to 100 lb weight through a 2 ft stroke impacting an 18 in diameter steel plate held to the ground surface by the weight of a skid-steer style loader. The weight is accelerated within an enclosed steel guide. The drive mechanism consists of a hydraulic motor turning a set of sprockets that deliver power to a cycling lift arm that pulls the weight against the resisting force of an industrial rubber band. Simply envisioned, this device is analogous to a sling-shot. All moving parts are shielded, with the contact area between the weight and plate sufficiently enclosed to avoid and possibility of debris becoming airborne and representing a risk to the operator or bystanders.

Control Measures
1) The operator wears hearing protection (30 dB down) while the loader is running.
2) No bystanders can be within 30 ft of the device while it is in operation and within 50 ft without hearing protection.
3) All shields are to remain in place while in operation. Routine maintenance, requiring removing shields, can take place only when the loader engine is off.
4) The operator can exit the vehicle only when the weight drop is in the full down position and solid contact is made with the ground surface.
5) Operation of the loader will be consistent with those published in the owner manual of the Case 1225 UniLoader.

G. Work Item: *All Terrain Vehicles (ATVs)*

ATVs that could be on site include the Yamaha Terra Pro, Kawasaki Mule, and Polaris 4x6. These ATVs all serve a very specific purpose and are critical to smooth and efficient operations. The ATVs never obtain speeds in excess of 15 mph and therefore do not represent risk of injury due to excessive speeds. The tip-over potential is minimized by the 4-wheel design of the vehicles, but tip-over potential does exist. Care is always taken to properly load the vehicles and only traverse grades within the acceptable limits of the vehicle as defined by the manufacturer. Safety helmets will be worn while operating the Yamaha and Polaris ATVs.

1) The Yamaha has a specially designed cable winding device. The Yamaha has a Power Take-Off that is used to power a winding device mounted on the front of the vehicle and is used for the rolling of seismic cable. Operation of the PTO requires the operator to be on the seat and traveling in the lowest speed range (this is controlled by safety overrides that "kill" the engine when these conditions are not met).

2) The Gator is designed to carry the seismograph and 12-volt batteries. This vehicle never travels more than 10 mph and spends over 99% of its time parked along the survey line.

3) The Polaris is the primary work horse of the ATVs. It transports cables and geophones in a 3x3 steel box mounted behind the seat. The vehicle has 6 wheels with 4 drive wheels. The 6-wheel design makes the vehicle very stable with a large safe payload capacity (>700 lbs). This vehicle never travels more than 15 mph and is therefore at low risk of injury from excessive speed.

All ATVs have blinking yellow lights for increased visibility by other traffic.

H. Work Item: *Slide Hammer and Sledgehammers*

Specific Hazards–Uncontrolled swing and fragmenting of hammer or plate.

Control Measures–Only experienced operators, power hammer into ground at a controllable level, no bystanders within the distance of two hammer handle lengths side-to-side and behind and 25 ft in front.

I. Work Item: *Microvibrator*

Specific Hazards–Electric shock.

Control Measures–Operator will have an assistant responsible for moving, untangling, and general care of electric power cord.

IX. TRAINING

At least one KGS personnel working at the site in connection with the project shall have received hazardous waste worker training in accordance with 29 CFR 1910.120(e), be certified in First Aid, and CRP trained. This includes 40-hour initial training and yearly 8-hour refresher training. All KGS personnel will have appropriate experience and training with each source, vehicle, and method used.

X. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) protects employees from the hazards and potential hazards they are likely to encounter as identified during previous site characterization activities. PPE consists of a combination of protective clothing and respiratory protection equipment. Selection of PPE is based on an evaluation of the performance characteristics of the PPE relative to the requirements of the site and the task specific conditions and duration. The level of protection is upgraded when site monitoring or conditions indicate that increased protection is necessary to reduce employee potential for exposure.

Based on the available information assessing the current condition of the sites, minimal skin protection is required for general access. The prescribed working uniform for all personnel engaged in activities related to the project is a modified EPA level D and shall consist of:

Long-sleeved shirts and full-length pants
Leather steel toed safety boots
Hard hat* (only necessary for certain operations)
Eye protection
Hearing protection as required by OSHA for certain tasks (identified by work item)
Orange vests along roadways (unlikely necessary for this project)

No respiratory protection equipment is required. At the present time based on all available information, the atmosphere contains no known hazards. There is no expected potential for inhalation or contact with hazardous levels of any chemical.

Added protection from the sun and insects might be necessary. All workers will be encouraged, but not required, to use sunscreen and insect repellant. These protective chemicals will be available for use on-site.

*When operating sledgehammer, slide hammer, 30.06 projectile, and auger gun.

XI. SAFETY ANALYSIS

The analysis list on the following two pages postulate hazards, consequences of those hazards, and the means of prevention or mitigation of each hazard associated with this survey activity.

XII. ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact of this activity has been evaluated and determined minimal ("small footprint") at more than six U.S. Government facilities (Y-12 ORNL, Oak Ridge, TN; WAG-10, ORNL, Oak Ridge, TN; Paducah Gaseous Diffusion Plant, Paducah, KY; Nevada Test Site, Las Vegas, NV; Fort Ord, CA; INEL, Idaho Falls, ID) as well as BLM and DOD sites.

XIII. HANDLING AND DISPOSAL OF UNEXPLODED ROUNDS

The handling of live ammunition will be in complete compliance with sections VIII.A and B and seismic gun operation procedures (both sections of this report). In the event a round does not detonate using standard operating procedures, the seismic source will be left in place undisturbed for a minimum of 3 minutes. After this initial 3 minutes, the shell will be extracted to insure minimal contact with operators. The unexploded round will be placed in the metal container used for the storage of spent rounds. If the round is an 8-gauge it will remain in the sleeve for a minimum of 20 minutes after placement in the metal can prior to being placed in a metal can and locked in the steel containers attached to the truck. If it is a 50-cal. round it will remain in the can for 20 minutes before it will be removed and re-stored in a metal can in the metal transport boxes attached to the truck. The unexploded rounds will then be transported back to the KGS Lawrence, Kansas, facility where they will be properly disposed of.

XIV. REFERENCES

Applicable portions of the following documents form the basis for this safety plan.

From the United States Department of Energy:

DOE Order 5480.16, *Firearms Safety*.

DOE Report DOE/EV/06194-3, *DOE Explosives Safety Manual*.

ID Appendix 0550, *Standard Operational Safety Requirements,* Part III, Subpart I, "Explosives"

From the United States Department of Defense:

DOD 6055.9-STD, *Ammunition and High Explosive Safety Standards*

AR-385-63, *Safety Policies and Procedures for Firing Ammunition for Training, Target Practice, and Combat*

SAFETY ANALYSIS

Potential Hazard	Consequences	Mitigation/Prevention Mechanism
Lost/Stolen Ammunition	Personal injury or property damage from unauthorized use.	Implementation of system to issue daily ammunition allotment and control inventory, in addition to physical control of ammunition at all times.
During Loading/Unloading:		
Dropped cartridge	Personal injury from accidental discharge.	Assure training of personnel in proper handling of live ammunition.
Introduction of foreign material into breech or barrel	Damage to barrel, breech, or bolt and resulting personal injury.	Assure training of personnel in proper handling of ammunition and in-process inspection of ammunition and seismic gun.
During Firing:		
Muzzle Air Blast	Personal injury from flying rocks, soil, debris.	Close fit of barrel in boreholes suppresses muzzle air blast and its effects.
Ricochet	Personal injury from ricocheting projectile or fragments.	Design and use of seismic gun prevents the escape of projectile or fragments from the borehole with sufficient energy to cause personal injury.
Flashburns	Burns from muzzle flashes	Discharge into earth or containment device suppresses muzzle flash.
Misfire	Personal injury from subsequent accidental discharge of misfired round.	Assure training of personnel in proper handling and disposal of misfired ammunition.

Potential Hazard	Consequences	Mitigation/Prevention Mechanism
Accidental discharge of seismic gun	Injury to unintended target.	Assure that operating procedures prevent transport of loaded seismic gun.
Plugged barrel - dirt	Damage to barrel and resultant personal injury.	Assure that operating procedures include thorough bore sighting between shots and/or probing with dowel after installation in borehole.
Plugged barrel - water	Damage to barrel and resultant personal injury.	Assure that operating procedures require inspection of borehole for water, and sealing of end of barrel with tape or balloon if water is encountered in borehole.
Barrel disengagement from plate	Personal injury to crew member(s) by flying rifle.	Implement an inspection/maintenance procedure for the barrel-to-plate attachment.
Breech disengagement from barrel	Personal injury to crew member(s) by flying breech and bolt groups.	Implement an inspection/maintenance procedure for the breach-to-barrel attachment.
During Transport		
Accidental discharge	Injury to unintended target.	Assure that operating procedures permit loading only after seismic gun is installed in borehole.
Accidental drop or collision	Damage to barrel or firing mechanism	Assure that operating/transportation procedures require thorough inspection of seismic gun after drop or collision incidents. Seismic gun is disassembled and stored in special compartment during vehicular transport.

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

Was anyone injured? Yes ☐ No ☐ If yes, name(s) of injured person(s):

_____

_____

Uninjured person(s) involved in incident: _____

_____

_____

Other witnesses (not involved): _____

_____

_____

Equipment involved in incident: _____

_____

_____

_____

Narrative of what happened (continue on reverse of this page and draw a diagram if it helps explain what happened):

_____

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_____

_____

_____

_____
Site Safety Officer

KGS 05/1999

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

Was anyone injured? Yes ☐ No ☐ If yes, name(s) of injured person(s):

_____

_____

Uninjured person(s) involved in incident: _____

_____

_____

Other witnesses (not involved): _____

_____

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Equipment involved in incident: _____

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Narrative of what happened (continue on reverse of this page and draw a diagram if it helps explain what happened):

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Site Safety Officer

KGS 05/1999

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

Was anyone injured? Yes ☐ No ☐ If yes, name(s) of injured person(s):

_____

_____

Uninjured person(s) involved in incident: _____

_____

_____

Other witnesses (not involved): _____

_____

_____

Equipment involved in incident: _____

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Narrative of what happened (continue on reverse of this page and draw a diagram if it helps explain what happened):

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Site Safety Officer

KGS 05/1999

MEDICAL EVALUATION FORM

Employee Name: RICHARD D. MILLER Date of Exam: 3-20-97

Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047

I have reviewed the results of the medical health history, physical examination, and laboratory tests prescribed for an (initial / annual / exit) exam and certify that the record (is / is not) complete.

Clearance for Hazardous Waste Site Work

As per OSHA Hazardous Waste Operations and Emergency Response Standards (29 CFR 1910.120), this individual was examined for medical conditions that would place him/her at an increased risk of material impairment of health from hazardous waste site work. Based on this examination I certify that this individual:

Y has no medical contraindications to full participation in hazardous waste site work, when conducted under the conditions of adequate training and a health and safety plan.

_____ has medical limitations that restrict full participation in hazardous waste site work. (Describe work function limitations, i.e. lifting, temporary limitation, pending medical follow-up work, etc.)

_____ is medically restricted from any direct work with hazardous waste or hazardous waste sites. (Describe work limitations.)

Comments: _____

Name of Physician: Mary Vernon Signature: MMV
Please Print

Address: 500 Rockledge Rd Date: 3-20-97
Lawrence, KS 66049

TRAINING OUTLINE FOR USE OF SEISMIC GUNS
"GOOD GUN SENSE"

I. Handling (always assume loaded and ready to fire)

A. Transporting (vehicle, on foot, etc.)

1. In field:

   Always point down or away from populated areas
   Always avoid lodging foreign material in barrel
   Never strain to carry, get a second person
   Never assume anything

2. To and from site and storage:

   Must be storage in a metal locked container
   Must be stored with bolt and gun in separate locations
   Must be completely broke down and cleaned prior to storage
   Access to guns and ammo must be limited to trained personnel only
   Live rounds cannot be stored closer than 5 ft from guns

B. Cleaning

1. Daily:

   Must be inspected for unusual wear, signs of metal fatigue, or structural weakness at the beginning and end of each days service
   Bolt and breech must be oiled and check for mechanical operation
   At the end of each 1/2 day service the barrel will be carefully inspected and checked for signs of fatigue.
   The bolts that secure the gun to the protective steel plate are checked at least 3 times a day.

2. Seasonal:

   R/R springs in extraction system and those associated with the firing rod
   R/R bolts and nuts that attach to protective steel plate.
   R/R mounting bracket as necessary

C. Firing

1. Assumptions

NONE

2. Never Do's

Move from downhole placement with shell in chamber
Gun loaded with no one standing on plate
With one person on plate
With knees locked
Extract a shell in less than 2 minutes that does not detonate
Without both operators aware of detonation
Drop a loaded round
Return a mis-fire to live round canisters

March 24, 1987

MANDATORY SAFETY RULES FOR USE OF THE .50-CALIBER SEISMIC GUN

The .50-cal seismic gun is powerful and must be securely positioned when fired. Danger exists not only with the bullet projectile, but also with the recoil of a loose gun. Be sure that all mounting bolts are tight. Never strike the gun or bolt with a metal object. If the gun is jamming or sticking, clean it thoroughly with WD-40. Wiping down cleaned parts will help avoid the cohesion of dirt and sand to the parts.

Operational Safety Rules

1. Each day the Party Chief must make sure all personnel are fully trained in safety rules.
2. Arm the gun ONLY when the gun is in position to be fired.
3. ALWAYS unlock the bolt when moving the gun (disarm it).
4. NEVER move the gun with a live round loaded.
5. ALWAYS remove the bolt completely from the gun for transportation and storage.
6. ALWAYS double check safety procedures.
7. Use common gun sense.

Downhole Mode

Be sure all mounting bolts are tight. Do not force the gun down an augered hole. Re-auger the hole, if necessary. Be sure that the base plate rests on the ground. Have two people stand on the plate when firing (flex knees to absorb the shock).

If the hole has water in it, seal the muzzle of the gun with tape or a balloon to keep water from seeping into the barrel. Avoid this situation, if possible. Water in the barrel may seriously damage the gun when fired. Injury is possible.

Surface Mode

Be sure all mounting bolts are tight. Carefully protect the breech, trigger, and bolt when moving the apparatus. THE TRIGGER IS EASILY BROKEN.

5/10/92

OPERATION/SAFETY RULES AND REGULATIONS
FOR THE

AUGER GUN

The auger gun is a multi-component shallow seismic source which is designed for safe operation. The auger gun can detonate up to a 400 grain black powder load (approximately equivalent to one-twelfth of a pound of high explosive). Improper handling or operation of the auger gun or any of its components can potentially result in serious injury. Proper use of the auger gun includes not only safe operation and handling of the gun mechanism (firing rod) itself but also the skid-steer loader that transports and powers the device. The auger gun is not intended to fire projectiles but it has been designed to do so safely with no damage to the gun or operators. Proper maintenance is critical to the longevity and smooth operation of the auger gun. As with operating any firearm or explosive device, maintenance, transportation, and storage handlers must always assume the firing rod is loaded and the safety is off.

Operation and Safety Regulations

1) Each day the Site Safety Officer (SSO) must brief all members of the seismic crew on the proper operation and maintenance of the auger gun.

2) Prior to set-up on any location the site must be cleared of all potential underground hazards and utilities. The 'tip-over' potential of a site (directly related to topography) must also be considered prior to access with the loader.

3) The firing rod is never transported or stored loaded or in firing mode (locked into the auger) prior to downhole placement of the auger.

4) The firing rod is stored unloaded (no sleeve snapped onto the bottom) in the left side storage holster during downhole placement and in-field movement.

5) Only after the auger has been screwed into the ground and the center bit extracted and placed in the right side storage holster will the firing rod be removed from the left side storage holster. The shells should be pre-loaded into metal sleeves and ready for loading prior to removing the firing rod from the storage holster. Once the firing rod has been removed from the holster, the firing rod should be pointed toward the ground and the loaded sleeve snapped into place making certain that nothing (hand, finger, etc) is covering the powder end of the sleeve. The firing rod should then be immediately lowered downhole and locked into place.

6) Firing of the device should only take place after the hole has been water flooded and the firing rod handles securely locked in the J notches. If after a sharp blow with a hammer the shell does not detonate wait for at least 5 min. prior to removing the firing rod from its locked position. Once the firing rod is removed from the auger, the unfired round should be released from the firing rod and dropped into the empty shell casing can on the right side of the devise making certain not to touch the sleeve itself. The unfired round should not be removed from the metal sleeve for at least 20 minutes after placement in the empty shell casing can.

7) The skid-steer loader should be operated with good common sense taking no chances that would compromise the safety of either the operator or any other crew member. No one should be allowed to operate the loader without proper training.

8) The firing rod should always be handled as if it is loaded. The firing rod has an automatic safety that will only allow the firing pin to travel through the rod if the gun is locked into place in the auger.

Improved Shallow Seismic-Reflection Source: Building a Better Buffalo

John Healey, Joe Anderson, Richard Miller, Dean Keiswetter, Don Steeples, and Brett Bennett, Kansas Geological Survey

SUMMARY

An improved design of the buffalo gun, incorporating hole drilling and shooting into one operation with almost total blast containment, provided nearly 50 percent more recordable seismic signal than the traditional buffalo gun. The 'auger gun' is designed to optimize field efficiency, source couple, and safety. The auger gun consists of three main parts: power source, auger/screw, and modified buffalo gun. Amplitude spectra indicate the auger gun delivers approximately 20 percent more total energy and 50 percent more reflection energy with no noticeable increase in recorded ground roll at a test site in Lawrence, Kansas. Subtle changes in source environment, such as a 15 cm gap between the detonation point and the base of the hole or inclusion of water as opposed to air at the detonation point, have a significant effect on the quality of the recorded data. The auger gun should increase field efficiency by over 50 percent on most shallow surveys, while improving the signal-to-noise ratio and total energy in comparison to the buffalo gun.

INTRODUCTION

Increasing environmental and engineering applications of reflection seismology have spurred research and development of shallow high-resolution reflection techniques and equipment. Resolution on the order of a meter is necessary to detect ultrashallow targets—generally the goal of most environmental and engineering studies (Steeples and Miller, 1990). Resolution can be increased by boosting the recorded frequency and the signal-to-noise ratio of reflection wavelets. Recent advances in engineering seismographs have made possible cost-effective acquisition of 15-bit or greater floating point data. Generating a high-frequency seismic source pulse has been accomplished in a multitude of different ways in the past (Miller et al., 1986).

The most commonly used seismic sources on shallow engineering surveys have fallen under two main categories: explosives or weight drops. The explosive category includes both high explosives and 'guns'. Weight-drop sources include everything from mechanically assisted vertical mass impacts (usually >20 kg mass) to human-assisted vertical mass impacts (sledge hammers, malls, and thors). Recent advances in high-frequency engineering sources have come predominantly under the 'gun' classification. Development of a downhole shotgun capable of generating a consistently high frequency source wavelet with only minimal increase in expense and effort over hammers, spurred the shallow seismic-reflection industry. Downhole shotgun sources possess significantly more energy in the 200 to 600 Hz range in comparison to hammer sources (Pullan and MacAulay, 1987).

DESIGN AND TECHNIQUE

The auger gun is designed to optimize field efficiency, source couple, and safety. A measure of success with the downhole shotgun source (as with any downhole explosive source) can be related to efficiency in generation of broad-band, high-frequency energy. Improved energy transfer is obtained when downhole placement of the shotgun shell includes a water stem and restricted recoil (Miller et al. 1989). Containment of the air-coupled wave has been at least partially accomplished for downhole projectile sources with a steel containment plate (Steeples et al., 1987). To obtain proper downhole placement of existing gun sources, a minimal diameter pilot hole (generally 6 cm, or so) approximately 80 cm deep must be bored. The auger gun described here incorporates all the previous operations and configurations into a single pass source.

The auger gun consists of three main parts: power source (skid-steer loader), auger/screw, and modified buffalo gun (Figure 1). The power source for testing described here is a 25 hp, 4-wheel drive, 1.2 m wide, hydraulic loader. The auger/screw is a modified hydraulic auger that receives its hydraulic drive power from the loader. The buffalo gun used for these tests was elongated to slightly over 2 m in length, is designed for bottom loading (as opposed to the standard screw-on head), solenoid firing, time break from a downhole sensor. The firing pin has an automatic (spring-loaded) safety. These components when assembled represent approximately 1500 kg and are transportable in the bed of a standard pick-up truck.

Operation of the auger gun is a three-step process: (1) screwing the auger flight into the ground, (2) loading and firing the gun, and (3) unscrewing the auger flight from the ground. Once the 4-wheel-drive loader is in place, the containment plate is lowered to the ground surface with the weight of the loader placed on the plate. The hollow-stem auger flight is then screwed into the ground using a gaging device designed to ensure the flight is screwed into the ground at a fixed rate and no material is removed from the hole. Screwing the auger flight into the ground accomplishes both exceptional blast containment and minimal residual borehole. After the auger flight is securely screwed into the ground 80+ cm, the modified buffalo gun is loaded (by sliding the gun over a shotgun shell), lowered down the center of the hydraulic drive head, through the hollow stem auger flighting, and seated into a sleeve at the base of the auger flight. Water can be poured through the hollow stem auger prior to downhole

placement of the buffalo gun to improve source couple. Once positioned, the gun can be fired by either a hammer impact on the top of the firing pin or with an electric solinoid.

Safety must be of the utmost concern in any operation involving seismic sources. Designed into the auger gun are several critical safety improvements over the traditional buffalo gun. First, is the improved loading design that does not require the operator's hand to come any closer than a meter from the shell either during loading or while the live shell is in the firing chamber. Another improvement is related to containment of the entire gun mechanism in its downhole position throughout the firing operation. Finally, the firing-pin lock or safety is spring-loaded and does not require operator intervention prior to firing. The entire design and operation of the auger gun revolves around maximizing the recorded reflection energy without compromising the safety of the operator or bystanders.

The auger gun incorporates several key characteristics designed and previously shown to enhance high-frequency seismic signal at the expense of air-coupled wave and ground roll while maximizing mobility, operator safety, field efficiency, and ground coupling. Containment of the explosion is optimized by screwing the auger into the ground and positioning most of the loader weight on the gun. Field efficiency is maximized by incorporating the borehole preparation with the gun placement and detonation. The massive nature of the design and improved shell-loading procedure minimizes risk to the operator. Mobility is only restricted by the 1.2 m wide, 4-wheel-drive loader. Environmental impact is minimal with remnants of the operation restricted to a nominal 4 cm corkscrew hole approximately 80 cm deep.

RESULTS

Data acquired for this test were recorded on an Input/Output DHR-2400 seismograph with no analog low-cut filtering. The sampling interval was 1/2 ms and record length was 500 ms. The receivers were three L-28E Mark Products 40-Hz geophones wired in series and arranged in a 1 m in-line array. The source-to-closest-receiver was 20 m with a geophone station interval of 4 m. The shells used for this test were 8 gauge, 400 grain black powder blanks. The recording environment was consistent throughout the comparison.

Auger gun and buffalo gun field files acquired under identical conditions allows for comparison of several key source characteristics (Figure 2). The amplitude of the data is noticeably higher with the auger gun with very little difference in the dominant frequency on either field file. Reflection information is not directly interpretable on these shot gathers. A 150 Hz digital low-cut filter reveals a strong reflection present on both files at approximately 80 ms (Figure 3). The low-cut filter does a good job of removing the ringy refraction arrival clearly dominating the upper 120 ms of the unfiltered files. Some subtle indications of 50 Hz ground roll are still present on filtered files. The general characteristics of the 80 ms reflection seem to be consistent for both sources.

Amplitude spectra suggest the auger gun produces more useable seismic energy per grain of explosive than the traditional buffalo gun (Figure 4). Almost 25 percent more energy is present on the auger gun spectra in the 30- to 70-Hz range than the equivalent buffalo gun spectrum. Little or no observable increase in the amount of recorded ground roll can be observed on spectra of unfiltered data. Peaks in the spectra around 90 Hz represent reflection energy at this site. The auger gun delivers almost double the recordable high-frequency reflection energy of the buffalo gun.

Subtle changes in source environment make considerable difference in the amplitude spectrum of auger gun data. Leaving a 15-cm air-filled space between the base of a shell loaded in the auger gun and the bottom of the screw hole reduced total recorded reflection energy almost an order of magnitude. A water column placed in the hollow stem auger flight just prior to loading the shell tight against the base of the screw hole increased recorded reflection energy by over 50 percent. Significant variability in frequency and amplitude of the recorded energy resulted from slight changes in the downhole environment. These subtle changes and their resulting effect on the seismic data are indicative of how the near surface acoustically responds to gun powder explosions.

CONCLUSION

The auger gun should represent a 50 percent improvement in acquisition rates and recorded reflection energy at most sites when compared to the traditional buffalo gun. The auger gun is a modification of the original buffalo gun design (Pullan and MacAulay, 1987), and at some sites will represent an improvement. As with all seismic equipment and techniques, site characteristics dictate relative effectiveness. One characteristic of the auger gun that is not site-dependent and does represent an improvement over the buffalo gun is overall safety. The massive nature of the auger gun should allow detonation of series charges totally as much as 1000 grains of black powder. Preliminary testing indicates that at some sites it may be possible to acquire over 500 shotpoints a day when station spacings are 5 m or less.

ACKNOWLEDGMENTS

We wish to thank Esther Price for her work on manuscript preparation and Pat Acker for her quality graphics.

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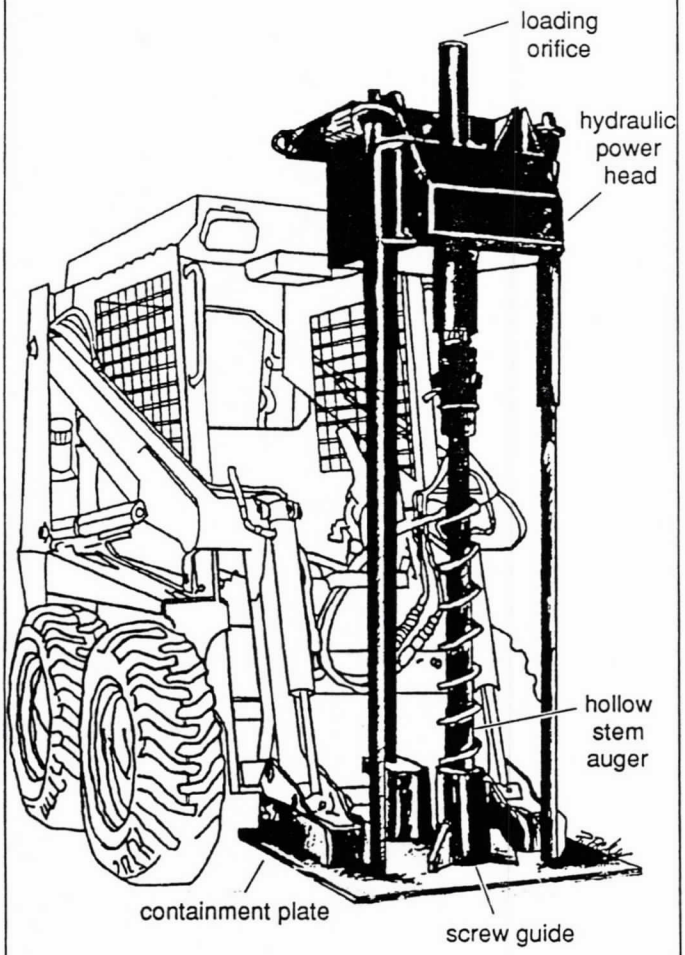

Fig. 1 Diagram represents the auger gun in above-ground position. Modified buffalo-gun portion of the auger gun is not shown, but is conceptually the same as previously documented (Pullan and MacAulay, 1987).

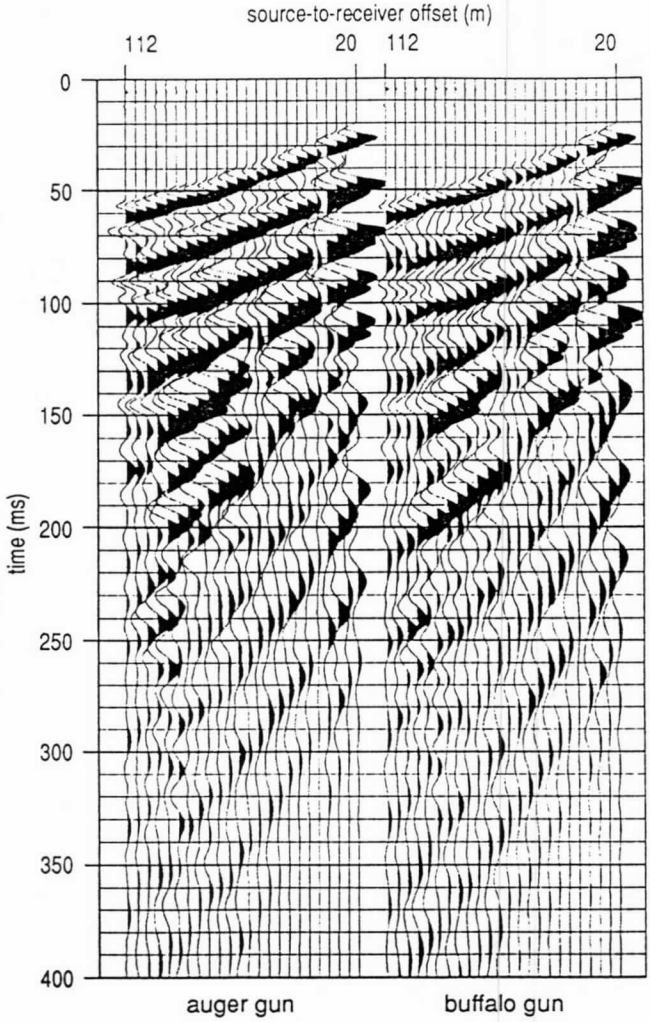

Fig. 2 Auger gun field file (left) compared to the buffalo gun (right).

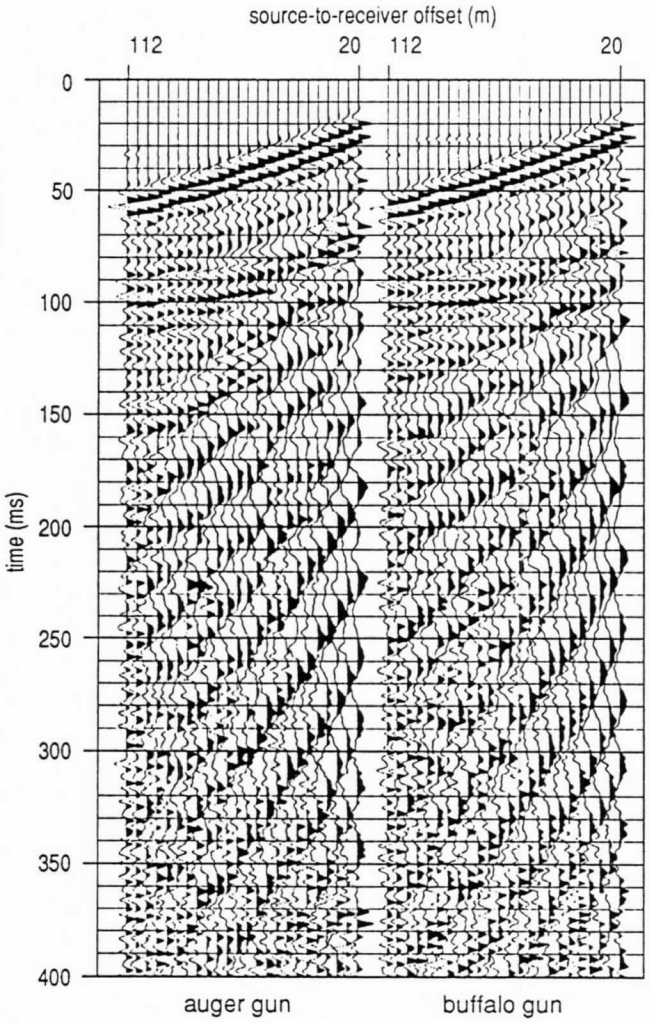

Fig. 3 A 150 Hz digital low-cut filter enhanced the 80 ms reflection event on both the auger (left) and buffalo (right) guns.

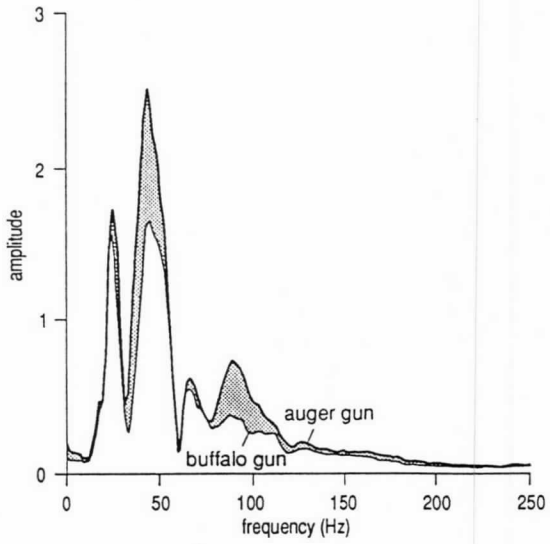

Fig. 4 The darkened area represents the difference between the lower curve (buffalo gun) and the upper curve (auger gun).

Downhole .50-caliber Rifle—an Advance in High-resolution Seismic Sources

Don W. Steeples, Richard D. Miller, Ralph W. Knapp,
Kansas Geological Survey.

SUMMARY

In a direct comparison, the downhole .50-caliber seismic source produced more seismic energy, a broader body-wave frequency spectrum, an amplitude drop in the air-coupled wave, and a higher dominant frequency of the recorded body-wave energy than the silenced surface .50-caliber source. The recorded seismic energy of the downhole rifle showed an increased amplitude of 6 to 12 dB over that recorded by the silenced surface rifle. The dominant frequency of the recorded reflection energy was consistently 20 to 40 Hz higher than the surface rifle. The air-coupled wave amplitude was decreased over 12 dB by subsurface firing of the rifle. The frequency spectrum of the body-wave pulse was broadened by almost a half octave on the high end. The safety of operation of the source is not compromised. Reflectors with a dominant frequency in excess of 180 Hz can be easily identified on field files at depths of less than 30 m using the downhole .50-caliber rifle. Identification of 100-Hz reflectors from 1,100 m is possible on field files of multiple vertically stacked downhole .50-caliber shots. The source will operate in an efficient manner collecting CDP data, common-offset data, or spot-correlation data.

INTRODUCTION

Increasing environmental and engineering applications of reflection seismology have spurred research and development of shallow high-resolution reflection techniques and equipment. Resolution on the order of a meter is necessary to detect ultra-shallow targets which are generally the goal of most environmental and engineering studies. This increased resolution can be obtained by boosting the frequency of the source pulse which, in turn, increases the dominant frequency of the recorded seismic-reflection energy. Generating the high-frequency seismic source pulse necessary for shallow applications has been accomplished in a multitude of different ways in the past (Miller et al., 1986).

Recent seismic source advances at the Kansas Geological Survey (KGS) have mainly revolved around surface projectile-type sources (Steeples and Knapp, 1982; Miller and Steeples, 1986; Seeber and Steeples, 1986). A .50-caliber rifle, which was designed and built to safely fire a 750-grain bullet vertically into the ground, has more recently been adapted to operate partially underground with only the firing apparatus above ground. This allows safe operations, a higher-frequency source pulse, and an increased signal-to-noise ratio.

DESIGN AND TECHNIQUE

The general design centers around optimizing the conversion of energy produced by a .50-caliber rifle bullet into seismic (acoustic) waves. The majority of the energy produced by a .50-caliber round goes into accelerating the projectile and into exhaust gases. Previously, with above-ground sources, we have silenced and dispersed the exhaust gases in hopes of eliminating or at least greatly reducing the effects of the air-coupled wave on seismic data. The downhole .50-caliber rifle nearly simultaneously excites the earth with a projectile and with exhaust gases while containing most of the air-coupled wave, resulting in increased frequency and signal-to-noise ratio on seismic record sections.

The downhole .50-caliber seismic source consists of a .50-caliber rifle bolted to a 0.6-cm-thick steel plate. The rifle itself is a standard .50-caliber breech and bolt, built by Texas Gun and Machine Company, attached to a standard .50-caliber machine-gun barrel. Machined grooves in the barrel are used in conjunction with a pressure clamp to attach the rifle to a 30-cm by 90-cm steel plate. The rifle barrel is lowered into a 60- to 80-cm-deep borehole 4 cm in diameter until the plate is flush with the ground surface. This steel plate acts as a ground seal and a platform to stand on while firing the gun. The weight of the shooter on the plate and the snug fit of the barrel to the borehole walls help seal the gun to the ground. The rifle can be equipped with a source sensor or closure switch to generate a time break. Firing can be done either electrically by solenoid or manually by pulling the trigger. The downhole .50-caliber weighs about 30 kg and is easily two-person portable.

FREQUENCY AND AMPLITUDE

The downhole .50 caliber produces from 6 to 12 dB greater recordable seismic energy at equivalent offsets than the silenced surface .50 caliber (fig. 1). The increased recorded energy boosts the signal-to-noise enough to substantially clean up the record section. The source-to-closest geophone offset in fig. 1 is 43 m. Besides this noticeable increase in recorded seismic energy, a consistent 20-40 Hz boost in the dominant frequency of the source wavelet is characteristic.

In previous shallow-source comparisons (Miller et al., 1986), the surface .50-caliber performed comparably to Mini-Primacord and a 10-gauge Buffalo gun in total energy and frequency spectrum. The noted increase in frequency and energy would make the downhole .50-caliber rifle comparable to the 8-gauge Buffalo gun which was among the best sources tested for reflection energy versus ground roll, total energy, and frequency content.

SAFETY

Safety should be of the utmost concern in any operation involving seismic sources. The rifle is

mounted on a 0.6-cm-thick steel plate to protect the operator from fragments and to help hold the gun securely in place. Since the projectile is fired from a bolt and breech, originally designed as a standard firearm, the utmost in safety has already been designed into the actual firing mechanism. The bolt and breech manufacturer designed the apparatus not to fragment even if the barrel was completely obstructed. The barrel is in standard use by the U. S. military on .50-caliber machine guns. The extra thickness of a machine-gun barrel serves to dissipate heat and, especially in our case, protects from blow-out if foreign material gets into the barrel. This makes continuous operations safe and consistent.

CASE STUDY

Silenced surface .50-caliber vs Downhole .50-caliber.

The direct comparison of the surface and the downhole .50-caliber rifles was performed near Winter Park, Colorado, in an attempt to detect the Moffat railroad tunnel, 85 m below the surface. The receivers were single 100-Hz geophones with a 1.2-m station interval. The sources were 43 m from the closest receiver station. The resulting recorded field files plotted, using true amplitude, clearly show the increased amplitude and the increased signal-to-noise ratio of the downhole rifle as compared to the surface source (fig. 1). A glaring difference is the absence of air-coupled wave on the field file using the downhole rifle. The frequency difference is obvious on the amplitude spectra (fig. 1).

Downhole .50-caliber Field Files and Spectrum

The downhole .50-caliber rifle can produce a source pulse with a dominant reflection frequency in excess of 180 Hz (fig. 2) when used with analog low-cut filters that have a -3 dB point of 220 Hz and a 24 dB/octave rolloff. Clean minimum-phase reflection wavelets, easily in excess of 150 Hz, can be identified down to 270 msec directly off the field file (fig. 3). The spectrum of the reflector at 85 msec is almost 3 octaves across with corner frequencies of 40 and 290 Hz (fig. 3).

The downhole .50-caliber rifle has not only been proven to be a useful shallow high-resolution reflection-seismic source, it also possesses the capability to penetrate as much as 1,100 m of sedimentary veneer overlain by 15 to 30 m of weathered alluvium (fig. 4). The reflection at 720 msec on the field file is Arbuckle dolomite at a depth of 1,100 m in central Kansas. This eight-shot stack was recorded with 30-Hz low-cut filters and ten 40-Hz geophones. The dominant frequency of the reflection energy is about 100 Hz.

ACKNOWLEDGMENTS

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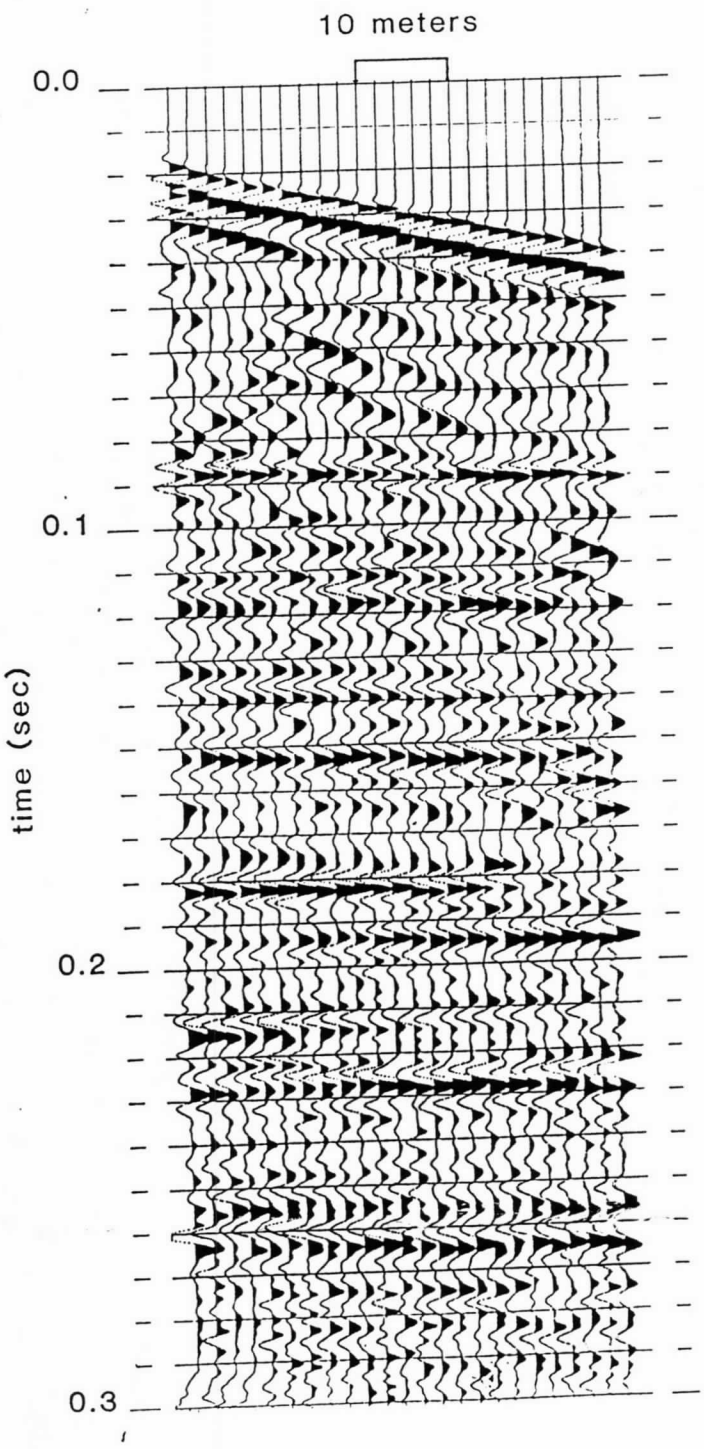

FIG. 2. This single-shot field file with an AGC applied illustrates the high frequencie and therefore the resolution easily obtainable with a downhole .50-cal.

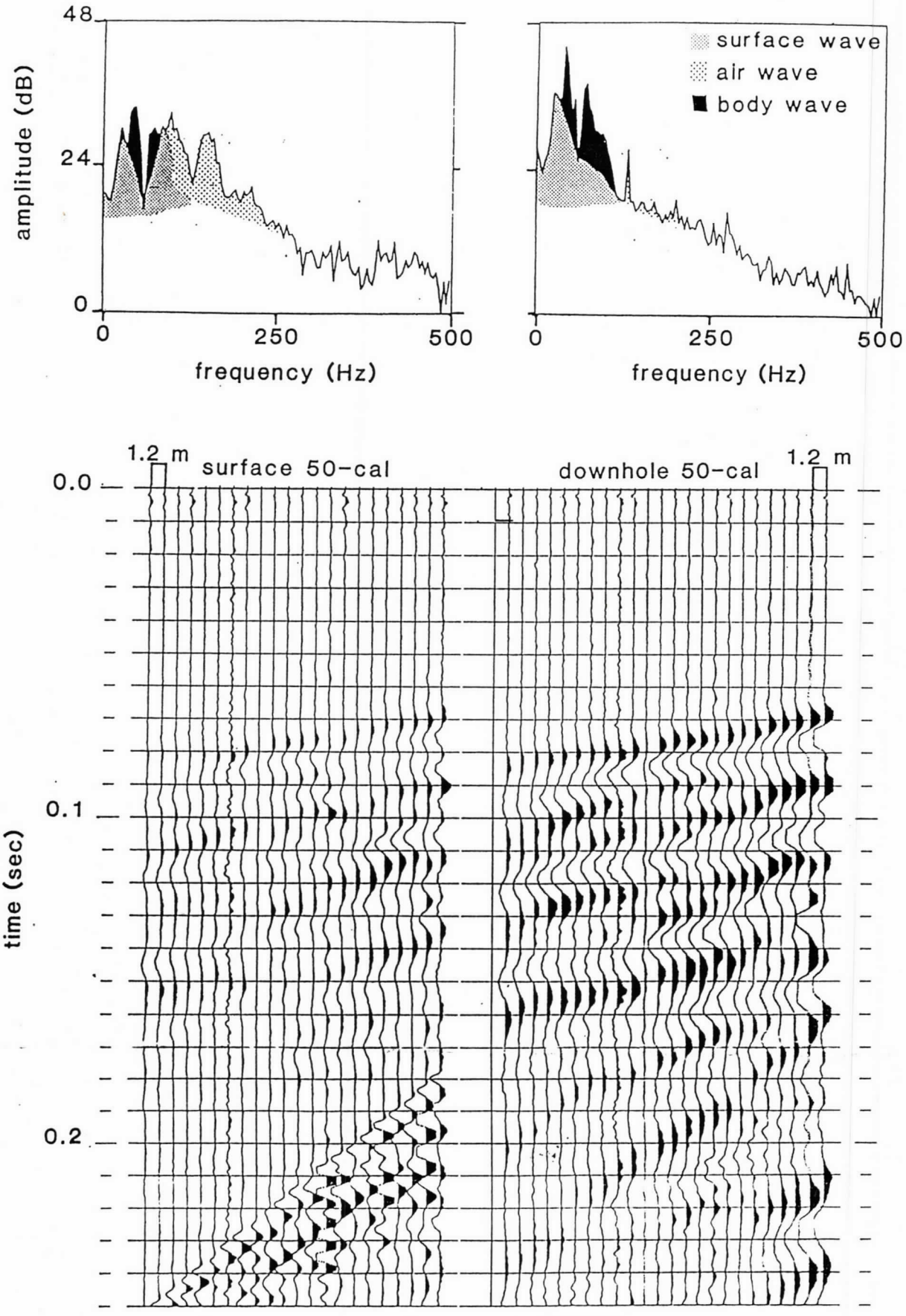

Figure captions.

-This single shot comparison plotted true amplitude with identical recording parameters clearly shows the increased signal-to-noise and the improved frequ

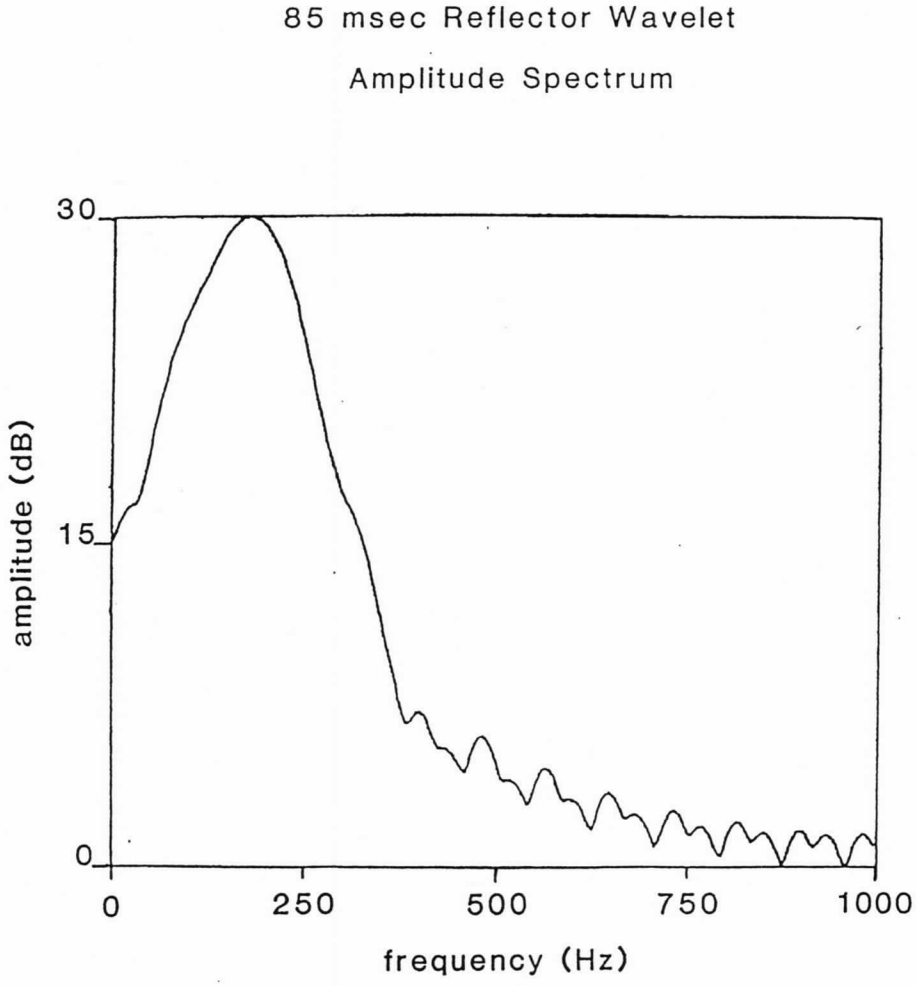

FIG. 3. -The amplitude spectrum of the reflection pulse at 85 msec is almost 3 octaves

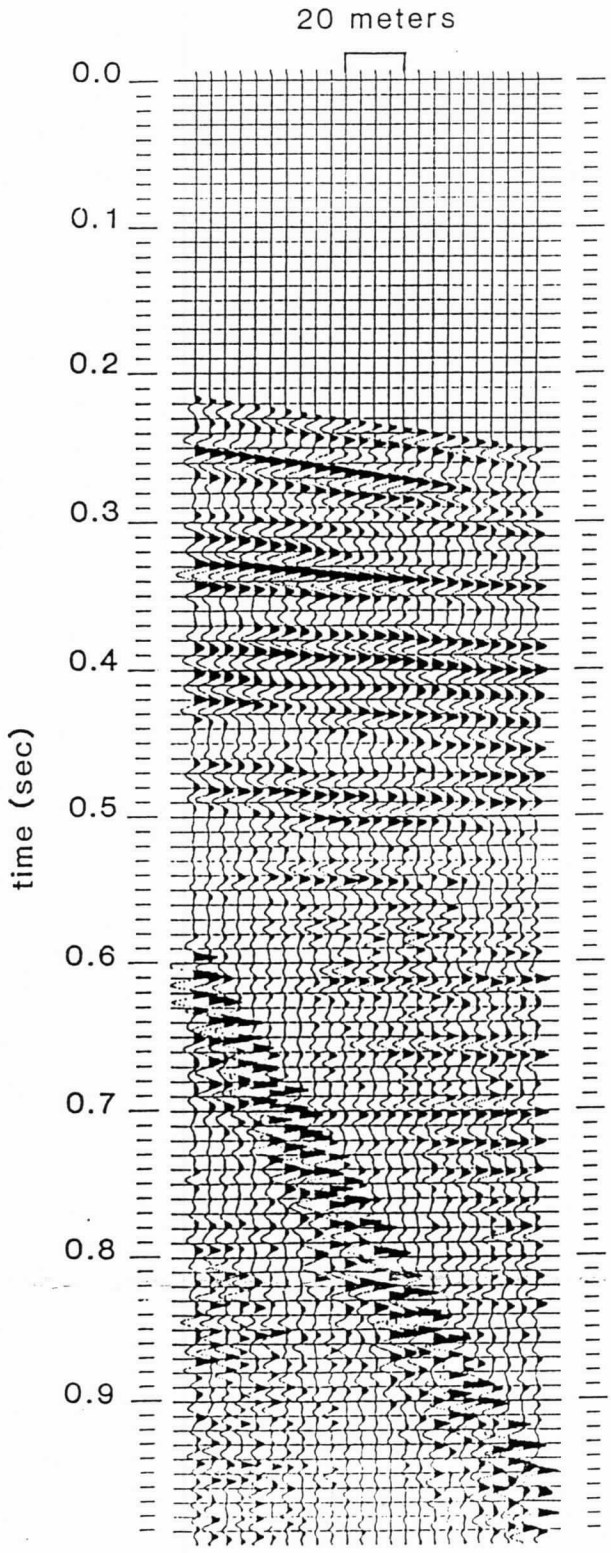

FIG. 4. This stacked field file has 100 Hz reflection energy as deep as 1100 meters.

Olin MATERIAL SAFETY DATA

OCEAN® Network
EMERGENCY PHONE 1-800-OLIN-911

SECTION I - IDENTIFICATION

CHEMICAL NAME & SYNONYMS		
Industrial Ammunition 8 Gauge (Small Arms Ammunition)		
CHEMICAL FAMILY	**FORMULA**	**TRADE NAME**
Not applicable	Mixture	Not applicable
DESCRIPTION		**CAS NO.**
Container with powders and projectile		Not assigned

SECTION II - NORMAL HANDLING PROCEDURES

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Store in a cool, well-ventilated place away from all sources of ignition. If damaged, do not get dust in eyes, on skin or on clothing. Do not take internally. Avoid breathing dust or fumes. Upon contact with skin or eyes wash off with water. Avoid breathing fumes during discharge.

PROTECTIVE EQUIPMENT		VENTILATION REQUIREMENTS
Eyes	Safety glasses or goggles	Local mechanical exhaust ventilation recommended during confined space discharge.
Gloves	None necessary	
Other	Hearing protection recommended during discharge	

SECTION III - HAZARDOUS INGREDIENTS

BASIC MATERIAL	OSHA PEL	LD 50	LC 50	SIGNIFICANT EFFECTS
Lead	50 ug/m^3	No Data	No Data	Eye irritation, fatigue disturbance of sleep

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT METHOD	OSHA CLASSIFICATION	FLAMMABLE EXPLOSIVE LIMITS	LOWER	UPPER
Not Applicable	Explosive		-	-

EXTINGUISHING MEDIA

Deluge with water, material is self-oxidizing. Flood with water to fight fire and to cool shells.

SPECIAL FIRE HAZARD & FIRE FIGHTING PROCEDURES

Evacuate area. Fight fire from an explosion resistant location.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

None established. (Inorganic recm. std.-air: TWA 0.15 mg (Pb)m^3 (ACGIH 1984-85)

SYMPTOMS OF OVER EXPOSURE

Eye irritation, fatigue, disturbance of sleep.

EMERGENCY FIRST-AID PROCEDURES

SKIN	Contact of skin with shells presents no health hazard.
EYES	Flush thoroughly with water. If an irritation occurs, call a physician.
INGESTION	Ingestion of shells not a possible route of exposure.
INHALATION	Remove victim to fresh air.

Chemical Industrial Ammunition 8 Gauge CAS No. Not assigned

SECTION VI - TOXICOLOGY (Product) (Small Arms Ammunition)

ACUTE ORAL LD 50	Not applicable	CARCINOGENICITY	Not carcinogenic
		MUTAGENICITY	May be mutagenic
ACUTE DERMAL LD 50	> 2 g/kg	EYE IRRITATION	May be an irritant
		PRIMARY SKIN IRRITATION	Not an irritant
ACUTE INHALATION LC 50	Not known		

PRINCIPAL ROUTES OF ABSORPTION
Inhalation, dermal

EFFECTS OF ACUTE EXPOSURE
Fatigue, disturbance of sleep, eye irritation.

EFFECTS OF CHRONIC EXPOSURE Anemia, central nervous system depression, toxicity to kidneys, reproductive system and fetus.

SECTION VII - SPILL AND LEAKAGE PROCEDURES (Control Procedures)

ACTION FOR MATERIAL RELEASE OR SPILL

Remove all sources of ignition. Wear goggles and gloves. Use non-sparking utensils during cleanup. If containers are damaged, wear NIOSH/MSHA approved dust respirator. Follow OSHA regulations for respirator use. (See 29 CFR 1910.134). Minimize powder contamination. Clean up and place in an approved DOT container. Isolate and do not seal. Label "Small Arms Ammunition". Wash all contaminated clothing before reuse.

In the event of a large spill use the emergency telephone number shown on the front of this sheet.

TRANSPORTATION EMERGENCY, CONTACT CHEMTREC 800-424-9300

WASTE DISPOSAL METHOD

Dispose of contaminated product, empty containers and materials used in cleaning up spills or leaks in a manner approved for this material. Consult appropriate federal, state and local regulatory agencies to ascertain proper disposal procedures.

SECTION VIII - SHIPPING DATA

D.O.T. CLASS	Class C Explosive ORM-D

SECTION IX - REACTIVITY DATA

STABLE X UNSTABLE AT ____ °C ____ °F	HAZARDOUS POLYMERIZATION	MAY OCCUR	
		WILL NOT OCCUR	X
CONDITIONS TO AVOID	Open flame, heat, sparks, shock or percussion, pressure		
INCOMPATIBILITY (Material to Avoid)	Acids, alkalis, oxidizing materials (contents)		
HAZARDOUS DECOMPOSITION PRODUCTS	Lead fume, carbon monoxide		

SECTION X - PHYSICAL DATA

MELTING POINT	N/A	VAPOR PRESSURE	N/A	VOLATILES	N/A
BOILING POINT	N/A	SOLUBILITY IN WATER	N/A	EVAPORATION RATE	N/A
SPECIFIC GRAVITY (H,O = 1)	N/A	pH	N/A	VAPOR DENSITY (Air = 1)	N/A

INFORMATION FURNISHED BY: C. C. Noonan (203) 789-5436 **DATE** November 16, 1985

Department of Environmental Hygiene and Toxicology
(203) 789-5436

Olin CORPORATION
120 Long Ridge Road, Stamford, Connecticut 06904
OCEAN® Network
EMERGENCY PHONE 1-800-OLIN-911

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List)	Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.
All Shotshell Ammunition	

Section I "Small Arms Ammunition"

Manufacturer's Name	Emergency Telephone Number
Remington Arms Co., Inc.	(501) 676-3161
Address (Number, Street, City, State, and ZIP Code)	Telephone Number for Information
I-40 & Highway 15	(501) 374-2246
Lonoke, Arkansas 72086	Date Prepared 8-12-86
	Signature of Preparer (optional) W.G. Bell, Chem Lab - Technical Section

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Lead, Inorganic and lead compounds	50mg/M^3			
Arsenic and compounds	10mg/M^3			
Antimony and compounds	500 mg/M^3			
Barium and compounds	500 mg/M^3			
Nitroglyerin (0.05 ppm skin) 500 micrograms/M^3 of air				

DOT - "Small Arms Ammunition"
Class C Explosive

UPS ORM-D

Section III — Physical/Chemical Characteristics

Boiling Point		Specific Gravity (H_2O = 1)	
Not applicable		Not applicable	
Vapor Pressure (mm Hg.)		Melting Point	
Not applicable		Not applicable	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	
Not applicable		NOT Applicable	

Solubility in Water
Lead & Lead Styphnate - Insoluble; Lead Nitrate - 127 gm/100cc Water - 100°C

Appearance and Odor
Grayish, Gray, Silvery Material - No odor

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
Not applicable	Not applicable	NA	NA

Extinguishing Media
Material is self oxidizing; flood with water to fight fire and cool shells.

Special Fire Fighting Procedures
Evacuate immediate area and deluge with water. Wear protective clothing for shrapnel.

Unusual Fire and Explosion Hazards
Shells will detonate when exposed to flame and high temperatures.

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid: Flames, sparks, percussion or shock and high
	Stable	X	temperatures (130°C)

Incompatibility (*Materials to Avoid*): Strong mineral acids and alkalis

Hazardous Decomposition or Byproducts: Oxides of carbon, nitrogen and lead fumes.

Hazardous Polymerization	May Occur		Conditions to Avoid: Heat, fire, static, friction and percussion.
	Will Not Occur	X	

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? Fumes Skin? Cuts or abrasions - Ingestion? Particles

Health Hazards (*Acute and Chronic*)
Anemia, fatigue, noctoria, embryotoxin, malnutrition, weakness, mental confusion, pallor - treat per general lead exposure; headache and nausea

Carcinogenicity: Not known NTP? IARC Monographs? OSHA Regulated? Lead - Yes

Signs and Symptoms of Exposure: Refer to health hazard above.

Medical Conditions Generally Aggravated by Exposure: Gastrointestinal tract; kidneys, blood and central nervous system. (CNS)

Emergency and First Aid Procedures: Skin - flush with water; if swallowed seek medical attention immediately.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled

Use non-sparking equipment to cleanup and store shells - avoid ignition sources.

Waste Disposal Method
Material may be burned per appropriate federal, state and local regulatory agency - contact

Precautions to Be Taken in Handling and Storing

Refer to released or spilled data above.

Other Precautions

Label containers - "Small Arms Ammunition" wear gloves and shrapnel protection.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*): OSHA SA/HiE/SCBA

Ventilation	Local Exhaust: Not required	Special: Not applicable	
	Mechanical (General): Not required	Other: Not applicable	

Protective Gloves: Not applicable Eye Protection: Safety glasses when shooting

Other Protective Clothing or Equipment: Use hearing protection when discharging cartridges.

Work/Hygienic Practices: Wash hands after skin contact with cartridges.

• USGPO: 1988-491-529/45775

MATERIAL SAFETY DATA SHEET

SMALL ARMS AMMUNITION
CENTERFIRE RIFLE & PISTOL AMMUNITION

Federal Cartridge Company
900 Ehlen Drive
Anoka, Minnesota 55303

TELEPHONE: 612-323-2300
PRODUCT SERVICE: 612-323-3706
EMERGENCY PHONE NUMBER: 800-424-9300 (CHEMTREC)

Issue Date: January 4, 1999

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SECTION #1 - PRODUCT IDENTIFICATION:

CENTERFIRE PRODUCT FAMILY		
Centerfire Metallic Cartridge Including The Following:		
.222 Remington	.30-30 Winchester	.300 Savage
.22-250 Remington	.32 Automatic	.32 Winchester Special
.223 Remington	.32 S&W Long	.338 Winchester Magnum
6mm Remington	.32 H&R Magnum	.35 Remington
.243 Winchester	.380 Automatic	8mm Mauser
.257 Roberts +P	.38 Special	.45-70 Government
.25-06 Remington	.357 Magnum	.280 Remington
.270 Winchester	9mm Luger Auto	7-30 Waters
7mm Remington Magnum	9mm Ball (M-822)	7.62X39 Soviet
7mm Mauser	9mm Federal	.303 British
.300 Winchester Magnum	.41 Rem Magnum	.375 H&H Magnum
.308 Winchester	.44 S&W Special	.300 H&H Magnum
.30-06 Springfield	.44 Rem Magnum	.458 Winchester Magnum
.30 Caliber Carbine	.45 Automatic	.416 Rigby
.25 Automatic	.45 Colt	.470 Nitro Express
10mm Automatic	9mm Subsonic	.38 Special +P+
.40 S&W	6.5X55 Swedish	7X64 Brenneke
5.56 Limited Range	9mm Limited Range	.38 Special +P
356 TS&W	.270 Weatherby Magnum	.300 Weatherby Magnum
7mm Weatherby Magnum	.357 SIG	.38 Super

CENTERFIRE PRODUCT FAMILY		
Centerfire Metallic Cartridge Including The Following:		
9X18 Makarov	.257 Weatherby Magnum	.416 Remington Magnum
.220 Swift	.35 Whelen	.340 Weatherby Magnum
7mm STW	7mm-08 Remington	.260 Remington

SECTION #2 - CHEMICAL COMPOUNDS:

CHEMICAL COMPOUNDS			
		TWA UNLESS OTHERWISE NOTED	
	CAS NUMBER	OSHA PEL	ACGIH TLV
Bullet - Lead or Lead Core	7439-92-1	.05 mg/m^3	.05 mg/m^3
Copper Jacket	7440-50-8	1 mg/m^3 Fume: .1 mg/m^3	1 mg/m^3 Fume: .2 mg/m^3
Zinc (As Zinc Oxide)	7440-66-6 1314-13-2	10 mg/m^3 (5 mg/m^3 as respirable dust) Fume: 5 mg/m^3	10 mg/m^3 Fume: 5 mg/m^3
Tin	7440-315	.1 mg/m^3	2 mg/m^3
Nyclad Coating	Not Established	Not Established	Not Established
Cartridge Case - Brass, (As Zinc & Copper) (See Above)			
Nickel Plated Brass (As Nickel)	7440-02-0	1 mg/m^3	1 mg/m^3
Propellant - Nitrocellulose	9004-70-0	Not Established	Not Established
Nitroglycerine	55-63-0	2 mg/m^3 Ceiling	0.46 mg/m^3 (Skin)
Graphite	7782-42-5	15 mg/m^3 (5 mg/m^3 as respirable dust)	2 mg/m^3
Primer - Lead Styphnate (As Lead)	12403-82-6	.05 mg/m^3	.05 mg/m^3
Barium Nitrate (As Barium)	7440-39-3	.5 mg/m^3	.5 mg/m^3
Antimony Sulfide (As Antimony)	7440-36-0	.5 mg/m^3	.5 mg/m^3
Aluminum	7429-90-5	15 mg/m^3 (5 mg/m^3 as respirable dust)	10 mg/m^3

DEFINITIONS OF ACRONYMS

OSHA PEL: Occupational Safety and Health Administration's Permissible Exposure Limit.

ACGIH TLV: American Conference of Governmental Industrial Hygienists' Threshold Limit Values.

TWA: Time Weighted Average.

STEL: Short Term Exposure Limit, the 15 minute exposure which should not be exceeded at any time during a workday.

CEILING: The concentration which is not to be exceeded at any time during a workday.

CAS: Chemical Abstracts Service number.

SECTION #3 - PHYSICAL DATA

Boiling Point:	Not Applicable
Melting Point:	Not Applicable
Vapor Pressure:	Not Applicable
Density:	3.1 - 8.0 grams/cc
Solubility (Water):	None
Evaporation Rate:	Not Applicable
Percent Volatiles:	Not Applicable
Vapor Density (Air = 1):	Not Applicable
Appearance:	Brass or nickel plated brass case with plastic, lead, copper jacketed lead or nylon clad lead bullet.
Odor:	None
Odor Threshold:	None

SECTION #4 - FIRE FIGHTING & EXPLOSION DATA:

Flash Point (F):	Not Applicable
Auto Ignition Temperature (F):	Not Applicable
Upper Explosive Limits (Percent):	Not Applicable
Lower Explosive Limits (Percent):	Not Applicable
Fire & Explosion Hazards:	May ignite if heated to 250 degrees F, independent of air. Unconfined ignited cartridges can produce low velocity metallic fragments which may cause eye injury or superficial skin wounds if unprotected by standard fire-fighter turnout gear.
Extinguishing Media:	Water

Special Fire Fighting Instructions: Wear full fire-fighter protective gear including face shield or SCBA. Use wide fog pattern nozzle to stop any low velocity fragments. Use water to cool ordinary combustibles below ignition temperature.

SECTION #5A - EXPOSURE & EFFECTS -- INHALATION

ROUTE OF EXPOSURE & EFFECTS - INHALATION

Acute: Inhalation of gases and particulates produced while firing ammunition may result in mild throat, eye, upper respiratory and lung irritation. The irritant effects may lead to lung symptoms such as bronchitis. An over exposure to gases or particulates may also cause: anemia; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness, muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as vomiting, colic, diarrhea or constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage.

Chronic: Prolonged repeated over exposure to fired cartridge gases and particulates may result in elevated blood lead levels and elevated zinc protoporphyrin levels. Symptoms of chronic overexposure to lead may include: anemia; lead lines on the gums; nervous system symptoms which may include irritability, headache, restlessness, fatigue, muscle weakness (i.e. wrist drop), muscle tremor, convulsions, loss of memory, visual and hearing disturbances, loss of coordination; gastrointestinal effects such as weight loss, vomiting, colic, diarrhea, constipation; circulatory symptoms such as a drop in blood pressure; reproductive effects including fertility problems, birth defects, miscarriages and possible kidney damage.

If acute or chronic symptoms should appear, contact a physician. Blood lead and zinc protoporphryn levels are recommended and should be monitored as per OSHA 1910.1025.

First Aid: Remove person to fresh air. Seek medical attention.

SECTION #5B - EXPOSURE & EFFECTS -- SKIN

ROUTES OF EXPOSURE & EFFECTS - SKIN

Acute: Elemental and inorganic lead compounds are not absorbed through the skin. Certain organic lead compounds, however, can be absorbed through the skin.

Chronic: Elemental and inorganic lead compounds are not absorbed through the skin. Certain organic lead compounds, however, can be absorbed through the skin.

First Aid: Wash exposed areas thoroughly with soap and water.

SECTION #5C - EXPOSURE & EFFECTS -- EYES

ROUTES OF EXPOSURE & EFFECTS - EYES

Acute: Contact with large volumes of smoke may cause minor eye irritation.

Chronic: None reported

First Aid: Remove person to fresh air. If foreign body is suspected, wash eyes in fresh water for 15 minutes, contact physician.

SECTION #5D - EXPOSURE & EFFECTS -- INGESTION

ROUTE OF EXPOSURE & EFFECTS -- INGESTION

Acute: Acute ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under acute inhalation in addition to gastrointestinal irritation.

Chronic: Chronic ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under chronic inhalation.

Note: Wash hands thoroughly with soap and water before eating or smoking.

First Aid: Ingestion is not a likely route of exposure. In case of ingestion, contact physician.

SECTION #5E - EXPOSURE & EFFECTS -- CARCINOGENESIS DATA

N.T.P. No

I.A.R.C.: Group 2B, possibly carcinogenic in humans.

OSHA: No

SECTION #5F - EXPOSURE & EFFECTS -- COMMENTS

Lead and barium are toxic metals, which may be released during the firing of modern ammunition. Care should be taken in the cleaning of range facilities to minimize the exposure potential to lead and barium. Persons engaged in these activities should wear protective clothing with an appropriate respirator. Range operators should consult OSHA 1910.1025 for details pertaining to the handling of lead in the work environment.

Severe lead intoxication has been associated in the past with sterility, abortion, and stillbirth. Modern information confirming that lead poisoning affects birth rates or causes injury to the fetus in man is not conclusive.

SECTION #5G - AGGRAVATION OF PRE-EXISTING HEALTH CONDITIONS

AGGRAVATION TO PRE-EXISTING HEALTH CONDITIONS

Exposure to lead can aggravate pre-existing anemia, cardiovascular and respiratory diseases and conditions related to the gastrointestinal, reproductive, renal (kidney), and central nervous systems.

Reference: Industrial Toxicology, Safety and Health Applications in the Workplace; Williams/B.

SECTION #6 - REACTIVITY & POLYMERIZATION

Stability:	Stable under normal use conditions
Conditions to Avoid:	Individual cartridges may ignite if the primer is struck or if the cartridge is exposed to excess heat
Incompatible Materials:	Oils, acids, Alkalies, Ammonia, and other corrosive materials
Hazardous Decomposition Materials:	Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fume may also be produced.
Polymerization:	Will not occur

SECTION #7 - SPILLS, LEAKS & DISPOSAL PROCEDURES

STEPS TO BE TAKEN - SPILLS:

Avoid conditions detailed in Section #6. If container should rupture, place all loose cartridges from broken shipping cases into a sturdy container. Secure container carefully.

Waste Disposal Methods: Contact Manufacturer - Product Service (612) 323-3706

SECTION #8 - SPECIAL PROTECTIVE EQUIPMENT

Ventilation: Use in a well-ventilated area. Consult the current addition of ACGIH Industrial Ventilation Manual and/or NRA ventilation recommendations.

Protective Equipment:

Eyes: Recommend protective eyewear conforming to ANSI Z-87

Gloves: Not generally required

Respirators: Use an approved respirator while cleaning range facilities. Consult OSHA 1910.1025 for exact requirements.

Hearing Protection: Hearing protection recommended while discharging cartridges

SECTION #9 - SPECIAL PRECAUTIONS -- STORAGE & HANDLING

Store in a dry, cool area in the original container to assure performance. Keep out of the reach of children. Avoid striking the primer of unchambered cartridges. Remove ammunition from service if any of the following conditions have occurred:

1. Prolonged storage at or above 200 degrees F
2. Evidence of corrosion
3. Physical damage
4. Exposure to oil or spray type lubricants

Avoid prolonged storage in leather cartridge carriers. Cartridges can ignite if heated to 250 degrees F independent of air.

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Remington Arms Material Safety Data Sheet

This Material Safety Data Sheet has been prepared in compliance with Federal OSHA Hazard Communication Standard 29 CFR 1910.1200. ANSI Z400.1-1993 and the ISO Safety Data Sheet Standard. This product may be considered to be a hazardous chemical under 29 CFR 1910.1200. This information is required to be disclosed for safety in the workplace. ***This MSDS is applicable only to the product identified herein and only when used properly.***

NOTE: Refer to Section XVII for *List of Acronyms.*

I. PRODUCT IDENTIFICATION

Product: Cartridges, Small Arms

Trade Name: **CENTERFIRE RIFLE, PISTOL & REVOLVER LOADED ROUND**

CAS Registry No.: N/A
CAS Name: N/A
Formula: N/A
Molecular Weight: N/A
Grade: N/A

HMIS Rating
Health: 2
Flammability: 0
Reactivity: 1

IN EVENT OF EMERGENCY
(Spill, Leak, Fire, Exposure, Accident)
CALL CHEMTREC DAY OR NIGHT
(800) 424-9300
In Washington, D.C. 483-7616
Outside Continental U.S.A. (202) 483-7616

II. HAZARDOUS COMPONENT INFORMATION

NOTE

This list includes, but is not limited to, those hazardous materials which comprise greater than 1% (0.1% if carcinogenic) of the total component weight per 29 CFR 1910.1200.

A Centerfire Rifle, Pistol and Revolver Loaded Round is comprised of the following four (4) components. The hazardous chemicals contained in each are listed.

1. **Projectile** Lead, Copper, Zinc, Antimony
2. **Brass Shellcase** Copper, Zinc, Nickel
3. **Propellant** Nitrocellulose, Nitroglycerin, Dibutyl Phthalate, Graphite
4. **Primer** Copper, Zinc, Lead, Antimony, Barium, Lead Styphnate, Tetrazene

LIST OF HAZARDOUS CHEMICALS
(In Alphabetical Order)

CAS or Chemical Name: **ANTIMONY**
CAS Registry Number: 7440-36-0
Exposure Standards:
PEL (OSHA)..... TWA 0.5 mg/m^3
TLV (ACGIH) ..... TWA 0.5 mg/m^3

CAS or Chemical Name: **BARIUM**
CAS Registry Number: 7440-39-3
Exposure Standards:
PEL (OSHA)..... TWA 0.5 mg/m^3
TLV (ACGIH) ..... TWA 0.5 mg/m^3

CAS or Chemical Name: **COPPER**
CAS Registry Number: 7440-50-8
Exposure Standards:
PEL (OSHA)..... TWA (fume) 0.1 mg/m^3
TWA (dust, mist) 1.0 mg/m^3
TLV (ACGIH) ..... TWA (fume) 0.2 mg/m^3
TWA (dust, mist) 1.0 mg/m^3

CAS or Chemical Name: **DIBUTYL PHTHALATE**
CAS Registry Number: 84-74-2
Exposure Standards:
PEL (OSHA)..... TWA 5 mg/m^3
TLV (ACGIH) ..... TWA 5 mg/m^3

CAS or Chemical Name: **GRAPHITE**
CAS Registry Number: 7440-44-0
Exposure Standards:
PEL (OSHA) ..... (Natural Graphite) (Transitional: TWA 50 mppcf) TWA 2.5 mg/m^3
(Synthetic Graphite) (Transitional: TWA Total Dust: 15 mg/m^3 ; Respirable Fraction: 5 mg/m^3)
TWA Total Dust: 10 mg/m^3; Respirable Fraction: 5 mg/m^3
TLV (ACGIH) ..... TWA 2 mg/m^3 (respirable dust)

CAS or Chemical Name: **LEAD**
CAS Registry Number: 7439-92-1
Exposure Standards:
PEL (OSHA)..... TWA 0.05 mg/m^3
TLV (ACGIH) ..... TWA 0.15 mg/m^3
BEI 50/L in blood, 150/g creatinine in urine

Trade Name: **LEAD STYPHNATE**
CAS or Chemical Name: **LEAD TRINITRORESORCINATE**
CAS Registry Number: 63918-97-8
Exposure Standards: None established.

CAS or Chemical Name: NICKEL
CAS Registry Number: 7440-02-0
Exposure Standards:
PEL (OSHA)..... TWA Soluble Compounds: 0.1 mg/m^3
TWA Insoluble Compounds 1.0 mg/m^3
TLV (ACGIH) ..... TWA 1.0 mg/m^3
(Proposed: TWA 0.05 mg/m^3 ; human carcinogen)

Trade Name: NITROCELLULOSE
CAS or Chemical Name: CELLULOSE TETRANITRATE
CAS Registry Number: 9004-70-0
Exposure Standards: None Established

CAS or Chemical Name: NITROGLYCERIN
CAS Registry Number: 55-63-0
Exposure Standards:
PEL (OSHA)..... Transitional; TWA CL 0.2 ppm (skin)
STEL 0.1 mg/m^3 (skin)
TLV (ACGIH) ..... TWA 0.05 ppm (skin)

CAS or Chemical Name: TETRAZENE
CAS Registry Number: 109-27-3
Exposure Standards: None established.

CAS or Chemical Name: ZINC
CAS Registry Number: 7440-66-6
Exposure Standards: None established.

III. HAZARDS IDENTIFICATION

Emergency Overview: Accidental fire or explosion may cause severe injury or death.

Potential Human Health Effects:

Skin Contact: May cause allergic reaction (sensitization) in susceptible individuals.

Eye Contact: Lead dust and fumes can irritate the eyes causing redness and discharge.

Inhalation: Inhalation of lead dust or fumes may cause irritation to nose, throat, upper respiratory tract and lungs. Irritation may lead to bronchitis, headache, lowering of blood pressure and weakness.

Ingestion/Absorption: Ingestion may cause severe headache, nausea, vomiting, abdominal pain, fatigue, diarrhea, trembling, ringing in ear and salivation.

Carcinogenicity Information: This product is not classified a carcinogen by IARC, OSHA, NTP or EPA. Lead is classified a carcinogen by IARC.

IV. FIRST AID MEASURES

Skin Contact: Wash affected area thoroughly with soap and water. Remove contaminated clothing. Wash clothing thoroughly prior to reuse. Discard any contaminated leather items (i.e. shoes, etc.).

Eye Contact: If wearing contacts, immediately remove contact lenses. Hold eyelids apart and flush eyes thoroughly with water for at least 15 minutes. Obtain medical attention immediately.

Inhalation: Immediately remove to fresh air. Administer artificial respiration, if necessary. If breathing is difficult, administer oxygen. Obtain medical attention immediately.

Ingestion/Absorption: If conscious, drink large amounts of water. Induce vomiting. Immediately contact a physician or Poison Control Center. ***Never*** induce vomiting or give anything by mouth to an unconscious person.

V. FIRE HAZARDS

Flammable Properties: Refer to *HMIS Rating*. May ignite if heated to 250°F. Will ignite when exposed to flame and high temperatures. Be cautious of shrapnel.

Extinguishing Media: Flood fire with water to fight fire and cool shells. If no water is available, use carbon dioxide, dry chemical or earth.

Fire-Fighting Instructions: Evacuate area immediately. Deluge area with water. Wear full fire-fighting protective gear including face shield or SCBA to protect from shrapnel.

VI. ACCIDENTAL RELEASE MEASURES

Safeguards: Remove from all sources of ignition.

Spill Cleanup: Use non-sparking equipment to clean up spill. If disposal is necessary, refer to *XIII. DISPOSAL CONSIDERATIONS*.

Accidental Release: See above.

VII. HANDLING AND STORAGE

Personnel Handling: Handle with care. Do not strike or crush the rounds.

Storage: Store in original containers in a cool, dry, well-ventilated area away from all sources of ignition. Do not subject to mechanical shock. Keep out of reach of children. This product ***must not be stored*** with acids, strong oxidizers or caustics.

VIII. PERSONAL PROTECTION/EXPOSURE CONTROLS

Engineering Controls: N/A

Personal Protective Equipment:
- Safety glasses recommended when handling or firing rounds.
- Hearing protection recommended when firing rounds.
- Use of NIOSH/MSHA-approved respirator required when exposed to fumes and/or dust in an enclosed or poorly-ventilated area.

Exposure Guidelines:
- Keep product away from sources of accidental ignition.

Exposure Limits:
- Exposure limits listed with each hazardous chemical.

IX. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DATA

Appearance: Projectile: cylindrical; grayish, silvery color
Case: cylindrical; bronze color

Form:	Solid	**Evaporation Rate:**	N/A
Color:	Variable	**Melting Point:**	N/A
Odor:	None	**Solubility in Water:**	N/A
Boiling Point:	N/A	**pH:**	N/A
Specific Gravity:	N/A		
Vapor Density:	N/A		

X. STABILITY AND REACTIVITY

Chemical Stability: Stable under normal use conditions. Will not react with water.

Other Hazards:
Incompatibility: Incompatible with acids, strong oxidizers and caustics.
Polymerization: Will not occur.

Conditions to Avoid: Flames, sparks, percussion, shock, static, high temperatures (266°F or 130°C)

XI. TOXICOLOGICAL INFORMATION

Oral LD 50: No available data.
Dermal LD 50: No available data.
Inhalation LC 50: No available data.
Irritation: Not a skin or eye irritant.

XII. ECOLOGICAL INFORMATION

Aquatic Toxicity:
Lead (LC 50) to Bluegill: 2-5 mg/l
Barium to Stickleback: 400 mg/l
Barium Nitrate to Stickleback: 760 mg/l

Environmental Impact:

When used and disposed of properly, there is no known environmental impact.

XIII. DISPOSAL CONSIDERATIONS

This product is considered a characteristic hazardous waste per 40 CFR 261.24 ***for disposal purposes only***. Dispose of as required by local, state and federal laws and regulations.

EPA Hazardous Waste Code: D008 (lead)

XIV. TRANSPORTATION INFORMATION

SHIPPING INFORMATION

Proper Shipping Name:	Cartridges, Small Arms
Hazard Class:	ORM-D
UN/NA No:	N/A
Packing Group:	N/A
Shipping Label:	None required.
Special Information:	**May be reclassified internationally as:**
	Hazard Class: 1.4S
	UN/NA No.: UN0012
	Packing Group: II
	Shipping Label: 1.4S label

XV. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

TSCA Inventory Status: Included on list.

HAZARD CLASSIFICATION

Chronic Health:	Headache, nausea, weakness
Acute Health:	Anemia, embryotoxin.
Fire Hazard:	0 (per *HMIS Rating*)
Pressure Hazard:	Sudden release of pressure.
Reactivity Hazard:	1 (per *HMIS Rating*)

XVI. OTHER INFORMATION

NFPA Rating: Not established.

NPCA-HMIS Ratings:

Health:	2
Flammability:	0
Reactivity:	1

References:

Code of Federal Regulations, Monthly Summary, CFR 1910.1200(g) and Appendix E (B.), Regulations Management Corporation, Bloomington, Indiana, July 1, 1994.

Hazardous Chemical Desk Reference: Third Edition, Richard J. Lewis, Sr., Van Nostrand Reinhold, Copyright 1993.

American National Standards Institute, Z400.1-1993

International Standards Organization Safety Data Sheet Standard.

XVII. LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA WEEL	American Industrial Hygienists Association-Workplace Environmental Exposure Level
ANSI	American National Standard Institute
BEI	Biological Exposure Indexes
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
CL	Ceiling Limits (not to be exceeded)
DSL	Domestic Substances List
EPA	Environmental Protection Agency
HMIS	Hazardous Materials Identification System
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Standards Organization
MITI	Ministry of International Trade and Industry (Japan)
MSHA	Mine Safety and Health Appliance
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NTA	National Transportation Agency (Canada)
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
ORM	Other Regulated Materials
PEL	Permissible Exposure Limit (OSHA)
SCBA	Self-contained Breathing Apparatus
STEL	Short-Term Exposure Limit
TLV	Threshold Limit Values (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average
UN/NA	United Nations/North American (Identification number)

For additional information, please contact:

Remington Arms Company, Inc.
Consumer Information
Wilmington, DE 19805

(800) 243-9700

GENERAL MOTORS CORPORATION
MATERIAL SAFETY DATA SHEET

SECTION I

PRODUCT NAME OR NUMBER (as it appears on label): ALL MODELS OF DELCO BATTERIES

GM COMMON CODE:

MANUFACTURER'S NAME: Delco Remy Division, GMC

EMERGENCY TELEPHONE NO.: (317) 646-3080

ADDRESS (Number, Street, City, State and Zip Code): 2401 Columbus Avenue, Anderson, IN 46018

MANUFACTURER'S D-U-N-S NO.:

HAZARDOUS MATERIAL DESCRIPTION, PROPER SHIPPING NAME, HAZARD CLASS, HAZARD ID NO. (49 CFR 172.101): Battery, Wet, Filled with Acid, (Corrosive Material) Class 8 - UN2794

ADDITIONAL HAZARD CLASSES (as applicable):

CHEMICAL FAMILY: Liquid Content • Sulfuric Acid

FORMULA: Liquid Content - H2SO4

SECTION II — INGREDIENTS (list all ingredients)

CAS REGISTRY NO.	%W	%V	CHEMICAL NAME(S)	Listed as a Carcinogen in NTP, IARC or OSHA 1910(z) (specify)
7664939		37	Sulfuric Acid	NA
7732185		Bal.	Water	NA
7439921	>	90	Lead	NA
			Separator:	
			Daramic	
			Case and Cover: Polypropylene (Plastic)	

SECTION III — PHYSICAL DATA

BOILING POINT 233 °F ___ °C		SPECIFIC GRAVITY (H_2O = 1) Varies with battery size	Average 1.280 ± .01
VAPOR PRESSURE 2,730 @ 77 °F 25 °C [X] mm Hg [ ] psi		PERCENT VOLATILE BY VOLUME (%) NA	PERCENT SOLID BY WEIGHT (%) NA
VAPOR DENSITY (AIR = 1)	NA	EVAPORATION RATE (= 1) NA	
SOLUBILITY IN WATER Miscible		pH = < 1.0	
APPEARANCE AND ODOR Water - white liquid (acid content)			IS MATERIAL: LIQUID SOLID GAS PASTE POWDER

SECTION IV — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT NA °F ___ °C method used

FLAMMABLE LIMITS: LEL NA; UEL NA

EXTINGUISHING MEDIA

SPECIAL FIRE FIGHTING PROCEDURES: Recommended self-contained breathing apparatus if batteries are involved in fire due to toxic fumes from burning plastic and acid fumes and vapors.

UNUSUAL FIRE AND EXPLOSION HAZARDS: While batteries are being charged, hydrogen gas is generated. Avoid open flames, spark or lighted matches. Acid, powerful oxidizers, can ignite combustible upon contact.

SECTION V-HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE — Conditions to Avoid Contact with sulfuric acid results in rapid destruction of body tissue (burns).	THRESHOLD LIMIT VALUE ☒ TLV=1 mg/m3 PERMISSIBLE EXPOSURE LIMIT ☐ Sulfuric Aci OTHER LIMIT ☐

PRIMARY ROUTES OF ENTRY Inhalation ☒ Skin Contact ☐ Other (specify) Ingestion

EMERGENCY AND FIRST AID PROCEDURES Do not exceed 1 mg/m3 TWA. Remove to fresh air. Get medical attention. EYE or SKIN CONTACT: Flush with large volumes of water. Get medical attention. INGESTION: DO NOT induce vomiting. Give milk mixed with egg whites if conscious.

SECTION VI-REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATIBILITY (materials to avoid) Oxidizing or reducing materials.

HAZARDOUS DECOMPOSITION PRODUCTS: When heated, can emit highly toxic fumes.

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	XX	

SECTION VII-SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Lime or soda may be used to neutralize and/or flush with large volumes of water. Contain spill.

WASTE DISPOSAL METHOD
According to local, state, and federal regulations for acid or lead scrap.

CERCLA (Superfund) REPORTABLE QUANTITY (in lbs) 1,000 lbs.

RCRA HAZARDOUS WASTE NO. (40 CFR 261.33) D002

VOLATILE ORGANIC COMPOUND (VOC) (as packaged, minus water) NA

☒ Theoretical 4 lb/gal ☐ Analytical NA lb/gal

SECTION VIII-SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type)
Use NIOSH approved respiratory protection if 1 mg/m3 TWA is exceeded (acid).

VENTILATION	LOCAL EXHAUST (Specify Rate) Yes at charging stations	SPECIAL	NA
	MECHANICAL (General) (Specify Rate)	OTHER	NA

PROTECTIVE GLOVES (specify type) Rubber	EYE PROTECTION (specify type) Splash-proof safety g

OTHER PROTECTIVE EQUIPMENT
Use rubber boots and acid-proof clothing for major spills.

SECTION IX-SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Avoid skin contact. When charging batteries, avoid placing in areas where hydrogen can build up. DO not place near open flames, sparks, or lighted matches.

OTHER PRECAUTIONS

Seller agrees not to assert any claim (other than a claim for a patent infringement) against General Motors Corporation for any use or disclosure of any technical data or information disclosed in connection with this questionnaire.

PLEASE COMPLETE QUESTIONNAIRE AND RETURN TO:	Name (print) Robert A. Chisman Signature Robert A. Chisman Title Senior Industrial Hygienist Date May 8, 1991

ANSUL®

ANSUL FIRE PROTECTION
MARINETTE, WI 54143-2542

MATERIAL SAFETY DATA SHEET

FORAY
QUICK IDENTIFIER (In Plant Common Name)

Manufacturer's Name:	ANSUL FIRE PROTECTION	Emergency Telephone No.:	CHEMTREC (800) 424-9300
Address:	One Stanton Street, Marinette, WI 54143-2542	Other Information Calls:	(715) 735-7411
Prepared By:	Safety and Health Department	Date Prepared:	April 22, 1994

SECTION 1 — IDENTITY

Common Name: (used on label) (Trade Name and Synonyms)	FORAY Dry Chemical Extinguishing Agent	CAS No.:	N/A
Chemical Name:	N/A This is a Mixture	Chemical Family:	Mixture
Formula:	N/A		

SECTION 2 — INGREDIENTS

PART A — HAZARDOUS INGREDIENTS

Principal Hazardous Component(s) (chemical and common name(s)):	Wt. %	CAS No.	ACGIH TLV	Acute Toxicity Data
Magnesium Aluminum Silicate (Attapulgite Clay)	5-7	8031-18-3	10 mg/M^3	NDA

PART B — OTHER INGREDIENTS

Other Component(s) (chemical and common name(s)):	Wt. %	CAS No.		Acute Toxicity Data
Proprietary Mixtures of: Monoammonium Phosphate	65-82	7722-76-1		Oral (Rat) LD_{50} 5750 mg/kg
Ammonium Sulfate	12-22	7783-20-2		Oral (Rat) LD_{50} 3000 mg/kg
Calcium Carbonate	<2	1317-65-3	10 mg/M^3	NDA
Methyl Hydrogen Polysiloxane	<1	63148-57-2		NDA
Yellow Pigment	<.05	5468-75-7		NDA

SECTION 3 — PHYSICAL AND CHEMICAL CHARACTERISTICS (Fire and Explosion Data)

Boiling Point:	N/A			Specific Gravity (H_2O = 1):	N/A	Vapor Pressure (mm Hg):	N/A
Percent Volatile by Volume (%):	N/A	Vapor Density (Air = 1):	N/A	Evaporation Rate (= 1):	N/A		
Solubility in Water:	Slight			Reactivity in Water:	Unreactive		
Appearance and Odor:	Yellow colored powder, no characteristic odor						
Flash Point:	None	Flammable Limits in Air % by Volume:	N/A	Extinguisher Media:	N/A	Auto-Ignition Temperature:	N/A
Special Fire Fighting Procedures:	NONE – THIS IS AN EXTINGUISHING AGENT						
Unusual Fire and Explosion Hazards:	None						

SECTION 4 – PHYSICAL HAZARDS

Stability:	Unstable ☐ Stable ☒	Conditions to Avoid:	N/A
Incompatibility (Materials to Avoid):	Strong alkalis, Mg, oxidizers that can release chlorine per NFPA 43A		
Hazardous Decomposition Products:	NH_3 and/or PO_x may be evolved		
Hazardous Polymerization:	May Occur ☐ Will Not Occur ☒	Conditions to Avoid:	N/A

FORAY (Continued)

SECTION 5 — HEALTH HAZARDS

Threshold Limit Value:	OSHA nuisance dust limit of 15 mg/M3 or ACGIH nuisance dust value of 10 mg/M3 for the eight hour time-weighted average.
Routes of Entry: Eye Contact:	Mildly irritating for a short period of time.
Skin Contact:	May be mildly irritating.
Inhalation:	Treat as a mineral dust. Irritant to the respiratory tract.
Ingestion:	Not an expected route of entry.
Signs and Symptoms: Acute Overexposure:	Transient cough, shortness of breath.
Chronic Overexposure:	Chronic fibrosis of the lung, pneumoconiosis.
Medical Conditions Generally Aggravated by Exposure:	Reactive airway
Chemical Listed as Carcinogen or Potential:	National Toxicology Program: Yes ☐ No ☒ I.A.R.C. Monographs: Yes ☐ No ☒ OSHA: Yes ☐ No ☒

SECTION 6 — EMERGENCY AND FIRST AID PROCEDURES

Eye Contact:	Flush with large amounts of water; if irritation persists, seek Medical attention.
Skin Contact:	Wash with soap and water; if irritation persists, seek Medical attention.
Inhalation:	Remove victim to fresh air. Seek Medical attention if discomfort continues.
Ingestion:	If patient is conscious, give large amounts of water and induce vomiting. Seek Medical help.

SECTION 7 — SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify Type):	Dust mask where dustiness is prevalent, or TLV exceeded. Mechanical filter respirator if exposure is prolonged.			
Ventilation:	Local Exhaust:	Discretionary	Mechanical (General):	Recommended
Protective Gloves:	N/A		Eye Protection:	Recommended as mechanical barrier for prolonged exposure.
Other Protective Clothing or Equipment:	If irritation occurs, long sleeves and impervious gloves should be worn.			

SECTION 8 — SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

Precautions to be Taken in Handling and Storage:	Should be stored in original container or Ansul fire extinguisher.
Other Precautions:	Do not mix agents.
Steps to be Taken in Case Material is Released or Spilled:	Sweep up.
Waste Disposal Methods:	Dispose of in compliance with local, state, and federal regulations.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS

HAZARD INDEX:	
4 Severe Hazard	1 HEALTH
3 Serious Hazard	
2 Moderate Hazard	0 FLAMMABILITY
1 Slight Hazard	0 REACTIVITY
0 Minimal Hazard	

N/A = Not Applicable NDA = No Data Available

DEERE & COMPANY
John Deere Road, Moline, IL 61265
1-800-822-8262

Material Safety Data Sheet

JOHN DEERE PRODUCT NAME: **Hy-Gard Transmission and Hydraulic Oil**

DATA SHEET NO: 8503-40,100
LATEST REVISION DATE: 15 Feb. 1989
DEERE CODE: Y3, Y38, XN, Y4
JDM PART NO: TY6237, TY6238,TY6278, TY6354, AR69444, AR69445, TY22028, TY22062, TY22077, TY22078, TY22079, TY22080, TY22092

SECTION I - PRODUCT IDENTIFICATION

CHEMICAL NAME AND SYNONYMS: Lubricating Oil; Hydraulic Fluid; J20C
CHEMICAL FAMILY: Hydrocarbon FORMULA: Complex

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT	TLV/PEL	V.P.	CAS.#
Solvent refined, hydrotreated, heavy paraffinic distillate	50-60	5 mg/m^3*	-	64742547
Solvent refined, hydrotreated, middle distillate	0-25	5 mg/m^3*	-	64742467
Severely hydrotreated light naphthenic distillate	0-25	5 mg/m^3*	-	64742536
Polymeric additive in oil (poly-methacrylate)	10-15	None	-	None
Additive containing zinc dialkyl dithiophosphate	5- 6	None	-	Mixture

*for oil mists

SECTION III - PHYSICAL DATA

BOILING POINT: N.A.
% VOLATILE VOLUME: N.A.
VAPOR DENSITY: N.A.
APPEARANCE/ODOR: dark amber/slight odor
SP. GRAVITY (WATER=1): 0.89
EVAPORATION RATE: N.A.
SOLUBILITY IN WATER: Insoluble
N.A. - not available

SECTION IV - FIRE & EXPLOSION HAZARD DATA

FLASH POINT: 390° F C.O.C.
FLAMMABLE LIMIT - LEL: N.A.
EXTINGUISHING MEDIA: Water fog, foam, dry chemical, carbon dioxide, or halogenated agents.
SPECIAL FIRE FIGHTING PROCEDURES: Do not use a direct stream of water. Product will float and can be reignited on surface of water. Cool fire exposed containers with water. Use NIOSH approved self-contained breathing apparatus.
UNUSUAL FIRE & EXPLOSION HAZARDS: None

SECTION V - HEALTH HAZARD DATA

EXPOSURE LIMIT: See Section II - Hazardous Ingredients
EFFECTS OF OVEREXPOSURE: Exposure to vapors or mists of this product may cause mild upper respiratory tract irritation. Prolonged or repeated contact may cause various skin disorders such as dermatitis, oil acne, or folliculitis. Eye contact is minimally irritating. Effects of ingestion are expected to be relatively non-toxic. Exposure to product may aggravate preexisting skin and respiratory conditions.
EMERGENCY & FIRST AID: Eyes - flush with water 15 minutes. Skin - remove contaminated clothing; wash skin with soap and water; if material is injected under the skin, do not wait for symptoms to develop - get medical attention promptly to prevent serious damage. Inhalation - remove victim to fresh air and provide oxygen if breathing is difficult. Ingestion - do NOT induce vomiting. In all cases seek medical attention.

SECTION VI - REACTIVITY DATA

STABILITY: Stable
INCOMPATIBILITY: Avoid open flame, and oxidizing materials
HAZARDOUS POLYMERIZATION: Will not occur
DECOMPOSITION PRODUCTS: Dependent on combustion conditions. A complex mixture of airborne solid, liquid, and gas will evolve when this material undergoes pyrolysis or combustion. Oxides of carbon, sulfur, phosphorous, and other unidentified organic compounds may be formed.

SECTION VII - SPILL OR LEAK PROCEDURE

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Dike and contain. Use vacuum or an absorbent such as clay or sand to pick up. Flush area with water to remove trace residue. NOTE: This product is classified as an oil under the Clean Water Act. Spills, entering surface waters or any watercourse or sewer leading to surface waters, must be reported to the National Response Center 800-424-9802.
WASTE DISPOSAL METHOD: In accord with federal, state, and local regulations

SECTION VIII - PROTECTIVE EQUIPMENT INFORMATION

VENTILATION: Local exhaust to keep TLV/PEL below acceptable levels
RESPIRATOR: NIOSH approved as needed EYE WEAR: Recommended
GLOVES: Recommended to minimize skin contact OTHER:

SECTION IX - SPECIAL PRECAUTIONS

Minimize skin contact. Wash with soap and water before eating, smoking, or using toilet facilities. Launder contaminated clothing before reuse. Properly dispose of contaminated articles including shoes that cannot be cleaned. Store in a cool, dry place with adequate ventilation. Keep away from open flames. Keep away from children.

SECTION X - DATA PREPARATION

NAME: T. M. Snyder, CIH TITLE: Industrial Hygienist

SIGNATURE: DATE: January 29, 1998

CITGO Petroleum Corporation
P. O. Box 3758
Tulsa, Oklahoma 74102

Material Safety Data Sheet

Trade Name:	**CITGO No. 2 Fuel Oils, All Grades**	Date: September 26, 1997	
CAS No.:	68476-30-2	Commodity Code:	AG2FO
Synonyms:	Fuel Oil, No. 2	Technical Contact:	(918) 495-5933
		Medical Emergency:	(918) 495-4700
CITGO Index No.:	5388	CHEMTREC Emergency:	(800) 424-9300

MATERIAL HAZARD EVALUATION

(Per OSHA Hazard Communication Standard [29 CFR 1910.1200])

Health Precautions: **DANGER:** Harmful or fatal if swallowed; can enter the lungs and cause damage. Contains Petroleum Distillates. If swallowed, do not induce vomiting. Call a physician immediately. Keep out of reach of children.

Safety Precautions: Combustible Liquid. Keep away from heat, flame and other potential ignition sources.

HMIS Rating[1]: Health: 1* Flammability: 2 Reactivity: 0

1.0 GENERIC COMPOSITION / COMPONENTS

Components	CAS No.	%	Hazard Data	
Petroleum Distillates (A complex mixture of hydrocarbons, having a viscosity range of 32.6 SUS to 37.9 SUS at 37.7° C (100°F).)	68476-30-2	100	Oral LD_{50} (rat):	9.0 ml/kg
			Dermal LD (rabbit):	> 5 gm/kg
			Dermal Sensitization:	Nonsensitizing
			Skin (rabbit):	Irritant
			Eye (rabbit):	Mild irritant
			Teratogenesis (rat):	Negative

2.0 PHYSICAL DATA

PHYSICAL HAZARD CLASSIFICATION (Per 29 CFR 1910.1200)

Combustible	Yes	Flammable	No	Pyrophoric	No
Compressed Gas	No	Organic Peroxide	No	Reactivity	No
Explosive	No	Oxidizer	No	Stable	Yes

[1]Hazard Rating: least-0; slight-1; moderate-2; high-3; extreme-4.
CITGO assigned these values based on an evaluation conducted pursuant to NPCA guidelines. Use of an asterisk (*) indicates that the material may present chronic health effects.

2.0 PHYSICAL DATA (continued)

Boiling Point, 760 mm Hg, °C (°F):	160 - 360 (320 - 680)
Specific Gravity (0 °F) (H_2O = 1):	0.84
Vapor Density (Air = 1):	> 1
% Volatiles by Volume:	ND
Melting Point, °C (°F):	-29 (-20)
Vapor Pressure, mm Hg (25 °C):	2 - 26
Solubility in Water:	Negligible
Evaporation Rate:(n-butyl acetate = 1):	< 1
pH of Undiluted Product:	NA
Appearance and Odor:	
Dyed:	Red liquid, petroleum odor.
Undyed:	Water white to yellow tinted liquid, petroleum odor.

3.0 FIRE AND EXPLOSION DATA

Flash Point, OC, °C (°F):	ND
Flash Point, CC, °C (°F):	52 - 85 (125 - 185)
Autoignition Temperature, °C (°F):	254 - 285 (489 - 545)
NFPA Rating[2]:	Health: 0 Flammability: 2 Reactivity: 0
Flammable Limits (% by volume in air):	Lower: 0.6 Upper: 7.0
Extinguishing Media:	CO_2, dry chemical, foam, water fog
Special Fire Fighting Procedure:	Wear self-contained breathing apparatus when in a confined area. Structural firefighter's protective equipment will only provide limited protection.
Unusual Fire or Explosion Hazard:	Fires involving the products represented by this MSDS may release irritating fumes.

4.0 REACTIVITY DATA

Stability:	Stable.
Conditions Contributing to Instability:	Heat, flame.
Incompatibility:	Oxidizing agents.
Hazardous Decomposition Products: (thermal, unless otherwise specified)	Carbon dioxide (CO_2), smoke, fumes, hydrocarbons, carbon monoxide (CO) and oxides of nitrogen.
Hazardous Polymerization:	Hazardous polymerization is not expected to occur.

5.0 SPILL, LEAK AND DISPOSAL PROCEDURES

Procedure if Material is Spilled:

- Remove sources of heat or ignition; provide ventilation; contain leak.
- **Small Spills:** Absorb released material with non-combustible absorbent. Place into containers for later disposal. (See Waste Disposal section below.)

[2]Hazard Rating: least-0; slight-1; moderate-2; high-3; extreme-4.
CITGO assigned these values based on an evaluation conducted pursuant to NFPA guidelines.

5.0 SPILL, LEAK AND DISPOSAL PROCEDURES (continued)

- **Large Spills:** Evacuate area in the event of significant spills. Adequately ventilate area and determine potential exposure conditions. Exposure potential may require the use respiratory protection. Use protective clothing. Contain spill in temporary dikes to avoid product migration and to assist in recovery. Do not allow material to escape into sewers, ground water, drainage ditches or surface waters.
- Control ignition sources around spill area. Use of a fire fighting foam blanket on spilled material will reduce vapor release and fire potential.
- Administer first aid, as needed.
- OSHA regulations may require establishing a regulated area with site control.
- Report spills as required to appropriate federal, state and local authorities.

Waste Disposal:

- It is the responsibility of the user to determine if the material is a hazardous waste at the time of disposal.
- Transportation, treatment, storage and disposal of waste material must be conducted in accordance with RCRA regulations (see 40 CFR 260 through 40 CFR 271).
- State and/or local regulations may be more restrictive.
- Contact the RCRA/Superfund Hotline at (800) 424-9346 or your regional US EPA office for guidance concerning case specific disposal issues.

Protective Measures During Repair and Maintenance of Contaminated Equipment:

- Refer to Section 7.0 - Special Protection Information.
- Keep unnecessary persons from hazard area.
- Drain and purge equipment, as necessary, to remove material residues
- Use gloves constructed of impervious materials such as heavy nitrile and protective clothing if direct contact is anticipated.
- Provide ventilation to maintain exposure potential below applicable exposure levels.
- Eliminate heat and ignition sources.
- Remove contaminated clothing.
- Wash exposed skin thoroughly with soap and water.

6.0 HEALTH HAZARD DATA

Health Hazard Classification (Per 29 CFR 1910.1200):

Highly Toxic	No	Sensitizer	No
Toxic	No	Reproductive Effects	No
Corrosive	No	Mutagen	No
Irritant	Yes	Target Organ (skin)	Yes

Carcinogen:

Product/Component	CAS No.	Conc. (%)	NTP	IARC	OSHA	Other
No. 2 Fuel Oil	68476-30-2	100	No	Group 3	No	ND

Toxicity Summary: If swallowed, this material can enter the lungs and cause severe damage. This material can cause skin irritation.

6.0 HEALTH HAZARD DATA (continued)

Major Route(s) of Entry: Inhalation of mists or vapors. Skin contact.

Acute Exposure Symptoms:

Inhalation: Inhalation of mists or vapors above applicable workplace exposure levels can cause transient euphoria, respiratory tract irritation, gastrointestinal irritation, headache, dizziness, or central nervous system depression. Studies with laboratory animals suggest that bronchoconstriction and respiratory impairment are associated with inhalation of high concentrations of fuel oil mists.

Dermal: This material can cause skin irritation.

Eye: This material can cause transient eye irritation including stinging, tearing and swelling.

Ingestion: Symptoms of fuel oil ingestion can include burning of mouth and upper gastrointestinal tract, stomach cramps, coughing, drowsiness, restlessness, irritability, vomiting, diarrhea and unconsciousness. In addition, breathing difficulty may develop. Coughing, pneumonia and painful breathing can suggest that the product has entered the lungs. Ingestion of large concentrations of product can cause convulsions, coma and death.

Injection: Injection under the skin, in muscle or into the blood stream can cause irritation, inflammation, swelling, fever, and systemic effects, including pulmonary edema, pneumonia and mild central nervous system depression. Injection of pressurized hydrocarbons can severe, permanent tissue damage.

Chronic Exposure Symptoms:

The products represented by this MSDS contain a mixture of petroleum hydrocarbons commonly referred to as "middle distillates." Laboratory data have associated some middle distillates with skin cancer when the material is applied repeatedly over the lifetime of the test animal.

Middle distillates similar to the products represented by this MSDS have been associated with liver and kidney damage in subchronic (90 day) inhalation studies of male rats. The relevance of these findings to human health is unclear.

Prolonged or frequent contact can cause the skin to dry or crack. Also, long term dermal exposure can cause an inflammation of the skin marked by redness, pain or itching (dermatitis).

Other Special Effects:

None.

Medical Conditions Aggravated by Exposure:

Individuals with chronic respiratory disorders, liver dysfunction or kidney disease can have these conditions aggravated by elevated exposure to vapors, mists or aerosols of this material.

First Aid and Emergency Procedures for Acute Effects:

Inhalation: Move victim to fresh air. If victim is not breathing, immediately begin cardiopulmonary resuscitation (CPR). If breathing is difficult, 100 percent humidified oxygen should be administered by a qualified individual. Seek medical attention immediately.

Dermal: Remove contaminated clothing. Wash exposed skin with soap and water. Launder clothing before use. Seek medical attention if tissue appears damaged or if irritation persists.

Eyes: Flush eyes with cool water while occasionally lifting and lowering eyelids. Remove contact lenses if worn. Seek medical attention if excessive tearing, irritation or pain persists.

6.0 HEALTH HAZARD DATA (continued)

Ingestion: Do not induce vomiting. If spontaneous vomiting is about to occur, place victim's head below knees. Never give anything by mouth to a person who is not fully conscious. Seek medical attention immediately.

Injection: Injection under the skin, in muscle or into the blood stream is a medical emergency. Seek medical attention immediately.

Notes to Physician:

Inhalation: If cough or difficulty in breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. Administer 100 percent humidified supplemental oxygen with assisted ventilation as required. In symptomatic patients (coughing, choking, tachypnea, etc.), monitor blood gases to assure adequate ventilation. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Ingestion: The viscosity at of this material is approximately 32 SUS at 100° F. Accordingly, upon ingestion, there is a high risk of pulmonary aspiration. Aspiration can result in chemical pneumonitis or lipoid pneumonia. Removal by careful gastric lavage with tight fitting, cuffed endotracheal tube may be considered.

Pulmonary edema can be managed with PEEP and supplemental oxygen. Antibiotics are indicated only if bacterial superinfection of the lungs occurs. Steroids have not been shown to be of benefit for hydrocarbon pneumonitis.

7.0 SPECIAL PROTECTION INFORMATION

Ventilation Requirements:

Use in well ventilated area. In confined spaces or when hot, mechanical ventilation may be required to maintain airborne concentrations below applicable work place exposure levels as evaluated by designated and properly trained individuals.

Applicable Workplace Exposure Levels:

Chemical Component	ACGIH TLV TWA ppm (mg/M^3)	ACGIH TLV STEL/ Ceiling (C) ppm (mg/M^3)	ACGIH TLV Skin notation?	OSHA PEL TWA ppm (mg/M^3)	OSHA PEL STEL/ Ceiling (C) ppm (mg/M^3)	OSHA PEL Skin notation?
Petroleum Distillates	NE	NE	NE	NE	NE	NE

Specific Personal Protective Equipment:

Personal protective equipment should be selected based upon the conditions under which this material is used. A hazard assessment of the work area for PPE requirements should be conducted by a qualified professional pursuant to OSHA regulations.

Respiratory: Only NIOSH or MSHA approved equipment should be used. Use of an organic vapor and dust/mist filter dual cartridge respirator is required when vapor and mist concentrations exceed the applicable workplace exposure levels. Respiratory protection should be selected on the basis of the maximum expected air concentration.

Eyes: Use safety goggles or chemical splash goggles if splashing is anticipated.

Dermal: Use gloves constructed of impervious materials such as heavy nitrile rubber if frequent or prolonged contact is expected.

Clothing or Equipment: Wear body-covering work clothes to avoid prolonged or repeated exposure. Remove contaminated clothing and launder before reuse.

8.0 TRANSPORTATION AND SPECIAL PRECAUTIONS

Storage: Do not use or store this product near heat, flame or other potential ignition sources. Do not store with oxidizers. Do not store this product in unlabeled containers. Keep container closed.

Danger: **Flammable or Combustible Liquid.** Vapors are heavier than air and may travel to an ignition source and flash back. Use only in a well ventilated area. Never siphon by mouth. Empty containers may contain product residues which can ignite with explosive force. Consult appropriate federal, state and local authorities before reusing, reconditioning, reclaiming, recycling or disposing of empty containers and/or waste residues of this product.

DOT Information:

Proper Shipping Name:	Fuel Oil, No.2
Hazard Class:	3
Hazard Identification No.:	UN 1202
Placard:	Flammable liquid

9.0 ENVIRONMENTAL DATA

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA)

Section 313 - Toxic Chemicals:

This product is not known contain any components in concentrations above *de minimis* levels that are listed as toxic chemicals in 40 CFR Part 372 pursuant to the requirements of Section 313 of SARA.

Section 311/312 - Hazard Categories:

This product may meet one or more of the criteria for the hazard categories defined in 40 CFR Part 370 as established by Sections 311 and 312 of SARA as indicated below:

Immediate (Acute) Health Hazard:	Yes	Sudden Release of Pressure Hazard:	No
Delayed (Chronic) Health Hazard:	Yes	Reactive Hazard:	No
Fire Hazard:	Yes		

Section 302 - Extremely Hazardous Substances:

This product is not known to contain any components in concentrations greater than one percent that are listed as Extremely Hazardous Substances in 40 CFR Part 355 pursuant to the requirements of Section 302(a) of SARA.

Clean Water Act (CWA):

Under the CWA, discharges of crude oil and petroleum products to surface water without proper Federal and State permits must be reported immediately to the National Response Center at (800) 424-8802.

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA) Section 102 Hazardous Substances:

As defined by CERCLA, the term "hazardous substance" does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance.

9.0 ENVIRONMENTAL DATA (continued)

California Proposition 65 (The Safe Drinking Water and Toxics Enforcement Act):

Warning: This material contains the following chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm, and are subject to the requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5):

Component:	Effect:
Diesel Engine Exhaust	Cancer

New Jersey Worker and Community Right-to-Know Act:

Fuel Oil (68476-30-2)

Toxic Substances Control Act (TSCA):

Reported in TSCA Inventory as:	Product	Components
No. 2 Fuel Oils	X	

10.0 LABELING

DANGER:

HARMFUL IF SWALLOWED - CAN ENTER LUNGS AND CAUSE DAMAGE
CONTAINS PETROLEUM DISTILLATES
COMBUSTIBLE LIQUID
CAUSES SKIN IRRITATION
MAY CAUSE CANCER BASED ON ANIMAL DATA
TARGET ORGAN(S): Skin

HANDLING:

Keep away from heat, sparks and flames. Keep container closed.
Avoid breathing vapor or mists.
Avoid direct dermal contact.

FIRST AID:

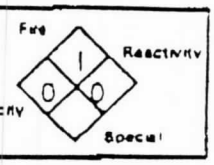
If swallowed, do not induce vomiting.
Call a physician immediately.
In case of contact, remove contaminated clothing immediately and wash thoroughly with soap and water.

MATERIAL SAFETY DATA SHEET

PRODUCT SA 825 0012

ELL-BEE LITHIUM M-P GREASE

NFPA HAZARD RATING
4 – EXTREME
3 – HIGH
2 – MODERATE
1 – SLIGHT
0 – INSIGNIFICANT



SECTION I

1 WITCO MANUFACTURING DIVISION OR SUBSIDIARY

2 ADDRESS (NUMBER, STREET, CITY, STATE, ZIP CODE)

EMERGENCY TELEPHONE
MANUFACTURER (915) 782-5800
CHEM TREC 1-(800) 424-9300

3 CHEMICAL NAME OR FAMILY: Petroleum Hydrocarbon

4 FORMULA: NA

SECTION II — CHEMICAL AND PHYSICAL PROPERTIES

CHEMICAL

6 HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide

6 INCOMPATIBILITY (KEEP AWAY FROM): Strong oxidizing agents such as: hydrogen peroxide, chromic acid, bromine

7 LIST ALL TOXIC AND HAZARDOUS INGREDIENTS: None

PHYSICAL

8 FORM: Semi-solid

9 ODOR: Mineral Oil

10 APPEARANCE: Grease

11 COLOR: Amber

12 SPECIFIC GRAVITY (WATER = 1) RT: 0.924

13 BOILING PT.: NDA °C / °F

14 MELTING PT.: NA °C / °F

15 SOLUBILITY IN WATER AT 25 °C: Negligible

16 % VOLATILE (BY WT %): NA

17 EVAP. RATE (= 1): NA

18 VAPOR PRESSURE (mm Hg at 20 °C): NA

19 VAPOR DENSITY (AIR = 1): NA

20 pH AS IS: NA

pH ( )

21 STRONG ACID ___ STRONG BASE ___ STABLE X UNSTABLE ___

22 VISCOSITY SUS AT 100 °F: <100 / 100 OR >XX

23 NA

SECTION III — FIRE AND EXPLOSION DATA

24 SPECIAL FIRE FIGHTING PROCEDURES: Fire fighters should wear an approved self contained breathing apparatus.

25 UNUSUAL FIRE AND EXPLOSION HAZARDS: Dense smoke

26 FLASH POINT (METHOD USED): Above 190 °C 374 °F C.O.C.

27 FLAMMABLE LIMITS %: NDA LOWER ___ UPPER ___

28 EXTINGUISHING AGENTS
☒ DRYCHEMICAL ☒ CO_2
☐ WATERSPRAY ☒ FOAM
☒ WATERFOG ☒ SAND/EARTH
☐ OTHER ___

SECTION IV — HEALTH HAZARD DATA

29 PERMISSIBLE CONCENTRATIONS (AIR): NDA

30 EFFECTS OF OVEREXPOSURE: May cause skin & eye irritation with prolonged contact.

31 TOXICOLOGICAL PROPERTIES: NDA

32 EMERGENCY FIRST AID PROCEDURES
EYES: Flush with large amounts of water for at least 15 min. Call a physician immediately.
33 SKIN CONTACT: Wash thoroughly with soap and water.
34 INHALATION: NDA
35 IF SWALLOWED: Call a physician immediately.

NA = NOT APPLICABLE NDA = NO DATA AVAILABLE < = LESS THAN > = MORE THAN

FORM NO. 851

MATERIAL SAFETY DATA SHEET

PRODUCT SA 825 0012

SECTION V — SPECIAL PROTECTION INFORMATION

VENTILATION TYPE REQUIRED (LOCAL, MECHANICAL, SPECIAL) 36: None Required	PROTECTIVE GLOVES 36: Rubber or plastic oil resistant
RESPIRATORY PROTECTION (SPECIFY TYPE) 37: None Required	EYE PROTECTION 38: Safety goggles and full face shield
	OTHER PROTECTIVE EQUIPMENT 40: None Required

SECTION VI — HANDLING OF SPILLS OR LEAKS

PROCEDURES FOR CLEAN-UP 41:

Transfer bulk of material into another container. Absorb remaining residue with proper absorbents such as sand, earth, vermiculite. Sweep up and dispose as solid waste in accordance to local, state and federal regulations.

WASTE DISPOSAL 42:

By methods consistent with local, state and federal regulations.

SECTION VII — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE 43:

Keep containers closed.

SECTION VIII — TRANSPORTATION DATA

33 UNREGULATED BY D.O.T. [X]	U.S. D.O.T. PROPER SHIPPING NAME 47:
35 REGULATED BY D.O.T [ ]	U.S. D.O.T. HAZARD CLASS 48: — I.D. NUMBER 49:
TRANSPORTATION EMERGENCY INFORMATION: CHEM TREC 1-(800) 424-9300 44:	RQ 50: — LABEL(S) REQUIRED 51:
	FREIGHT CLASSIFICATION 52: Petroleum Lubricating Grease
	SPECIAL TRANSPORTATION NOTES 53:

SECTION IX — COMMENTS

54:

KEEP OUT OF REACH OF CHILDREN!!

SIGNATURE Ray G. Thornton TITLE Manager Technical Compliance

REVISION DATE _____ SENT TO ATTN: _____ DATE 3/05/94

SUPERSEDES _____

We believe the statements, technical information and recommendations contained herein are reliable, but they are given without warranty or guarantee of any kind, express or implied, and we assume no responsibility for any loss, damage, or expense, direct or consequential, arising out of their use.

MATERIAL SAFETY DATA SHEET

Tox no. : 042840

Print Date : 04/02/90
Last Reviewed : 05/03/89

Part Type and Number	Part name
Ford - U.S. BATTERY - ALL	BATTERY ELECTROLYTE
Motorcraft - U.S. BATTERY - ALL	BATTERY ELECTROLYTE

CHEMICAL AND PHYSICAL PROPERTIES

Material type	LIQUID
Specific Gravity	1.250
Boiling Point	>135 C
Flash Point	Not Applicable
pH	2.0

HAZARDOUS AND OTHER DISCLOSED INGREDIENTS

Percent Range	Exposure Limits - TWA ACGIH/OSHA (where est.)	CAS number	Chemical Name
>30-60	1/1 mg/m3	7664-93-9	SULFURIC ACID

Exposure Limit Abbreviations

TWA=Time Weighted Average C=Ceiling
S=Short Term Exposure Sk=Skin
Sol=Soluble Compounds Fu=Fumes
Insol=Insoluble Compounds Du=Dust

REGULATORY INFORMATION

This product contains a toxic chemical or chemicals subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

SIGNAL WORD

DANGER -- CORROSIVE

HAZARDS

Contact with this material will cause burns to the skin, eyes and mucous membranes.
When this material comes into contact with the eyes, serious damage may occur.
This product is harmful by inhalation, when in contact with the skin and if it is swallowed.
This product is irritating to the eyes, respiratory system and skin.
This product may be fatal if it is swallowed.

M S D S
(CONTINUED)

Tox no. : 042840

TARGET ORGANS AND MEDICAL CONDITIONS

Overexposure to some hazardous ingredients in this product has been found to affect certain body organs and systems in experimental animals and/or humans. These include:

Lungs
Teeth
Skin, Eyes, and Respiratory System

ACUTE TOXICITY INFORMATION

Based on the composition of the product identified by the supplier, selected portions of the acute toxicity information from RTECS are as follows:

7664-93-9 SULFURIC ACID
Inhalation, adult rat, LC50 = 510 mg/m3 (2 Hours)
Oral, adult rat, LD50 = 2140 mg/kg

SAFE HANDLING AND STORAGE

Do not breathe gas/fumes/vapor/spray.
Use this product with adequate ventilation.
Do not get this material in your eyes, on your skin, or on your clothing.
This is an oxidizing agent - avoid bringing it into contact with an organic material.
Store this product in air-tight containers away from sources of heat and light.

FIRE, EXPLOSION AND REACTIVITY INFORMATION

Bringing this product into contact with combustible material may cause a fire.
EXTINGUISHER INFORMATION: Dry chemical, foam, carbon dioxide.
Use water to cool fire-exposed containers and to protect personnel.
Wear self-contained breathing apparatus.
This product can react violently with reducing agents and organic materials.
Explosive HYDROGEN GAS may be released if aqueous solutions of this material come into contact with reactive metals (IRON, ZINC, ALUMINUM).
Irritating and/or toxic fumes and gases may be emitted upon heating of this product.
The decomposition of this product will release toxic gases.

M S D S
(CONTINUED)

Tox no. : 042840

PROTECTIVE MEASURES AND TREATMENTS

Use of an impervious apron is recommended.
Use general ventilation and use local exhaust, where possible, in confined or enclosed spaces.
Wear chemical goggles and face shield.
The use of neoprene gloves is recommended.
In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Immediately take off all contaminated clothing.
If the material is swallowed, get immediate medical attention or advice -- Give several glasses of water or milk.
If gas/fume/vapor/dust/mist from the material is inhaled, remove the affected person immediately to fresh air.
For skin contact flush with large amounts of water.
Wash thoroughly after handling.

NOTES TO PHYSICIANS

If the product is ingested, probable mucosal damage may contraindicate the use of gastric lavage. Treat the affected person appropriately.

SPILLS, LEAKS AND DISPOSAL

Eliminate all sources of ignition or flammables that may come into contact with a spill of this material.
Avoid skin contact and inhalation of vapors during disposal of spills.
Dispose of waste material according to Local, State, and Federal Environmental Regulations.
In case of large spills, follow all facility Emergency Response Procedures.

SPECIAL REMARKS

This is an acidic material.

U. S. DEPARTMENT OF TRANSPORTATION INFORMATION

Shipping name: BATTERY FLUID, ACID UN: 2796
Hazard Class: Corrosive material Hazard Label: Corrosive

The chemical name(s) appearing below under "NAME" must appear as part of shipping name IF the amount being shipped in each container exceeds the quantity shown under "RQ" below. The letters "RQ" must also appear as part of the shipping name, in the form:
shipping name, chemical name, RQ.
For U.S. shipments from Ford Facilities, consult the "Ford Hazardous Material Transportation Control Program" Manual, otherwise consult 49CFR172.

------CAS--	RQ(lbs)	-NAME----------
7664-93-9	2777	SULFURIC ACID

M S D S
(CONTINUED)

Tox no. : 042840

Print Date : 04/02/90

PREPARATION INFORMATION

Health and safety information has been evaluated by:

Environmental & Occupational Toxicology, Occupational Health & Safety,
Ford Motor Company
900 Parklane Towers West, Dearborn, MI 48126

For emergency call: (313) 337-3182 -or- (313) 323-0045 (for 24 hour service)

This is the last page of this MSDS.

MATERIAL SAFETY
DATA SHEET

AMOCO REGULAR LEAD-FREE GASOLINE

MSDS NO: 02003992

MANUFACTURER/SUPPLIER:
Amoco Oil Company
200 East Randolph Drive
Chicago, Illinois 60601

EMERGENCY HEALTH INFORMATION: (800) 447-8735
EMERGENCY SPILL INFORMATION: (800) 424-9300
CHEMTREC, U.S.A.
OTHER PRODUCT SAFETY INFORMATION: (312) 856-3907

IMPORTANT COMPONENTS: Gasoline (CAS 8006-61-9) ACGIH TLV 300 ppm, STEL 500 ppm; OSHA PEL 300 ppm, STEL 500 ppm.
Benzene (CAS 71-43-2) ACGIH TLV 10 ppm; OSHA PEL 1 ppm (8-hr. TWA), STEL 5 ppm (15 min.).
*See Supplemental Information Section.

WARNING STATEMENT: Danger! Extremely flammable. High vapor concentrations can cause headaches, dizziness, drowsiness and nausea. Harmful if swallowed and/or aspirated into lungs. Can produce skin irritation on prolonged or repeated contact. Use as motor fuel only. Long-term exposure to vapors has caused cancer in laboratory animals.

HMIS/NFPA CODES:(HEALTH;1)(FLAMMABILITY;3)(REACTIVITY;0), Chronic health hazard

APPEARANCE AND ODOR: Clear, bright liquid. Characteristic odor.

HEALTH HAZARD INFORMATION

EYE

EFFECT: High concentrations of vapor/mist may cause eye discomfort.

FIRST AID: Flush eyes with plenty of water. Get medical attention if irritation persists.

PROTECTION: None required; however, use of eye protection is good industrial practice.

SKIN

EFFECT: Prolonged or repeated contact can defat the skin and lead to irritation and/or dermatitis.

FIRST AID: Wash exposed skin with soap and water. Remove contaminated clothing, including shoes, and thoroughly clean and dry before reuse. Get medical attention if irritation develops.

PROTECTION: Avoid prolonged or repeated skin contact. Wear protective clothing and gloves if prolonged or repeated contact is likely.

INHALATION

EFFECT: Vapour harmful. High vapor concentrations can cause headaches, dizziness, drowsiness and nausea. See Toxicology Section.

FIRST AID: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. Get medical attention.

PROTECTION: Use with adequate ventilation. Avoid breathing vapor and/or mist. If ventilation is inadequate, use NIOSH/MSHA certified respirator which will protect against organic vapor/mist.

HEALTH HAZARD INFORMATION - CONTINUED

INGESTION

EFFECT: Low viscosity product. Harmful or fatal if aspirated into lungs.

FIRST AID: If swallowed, do NOT induce vomiting. Get immediate medical attention.

FIRE AND EXPLOSION INFORMATION

FLASHPOINT: -45°F

FLAMMABLE LIMITS: UPPER: 7.6% LOWER: 1.3%

AUTOIGNITION TEMPERATURE: 495°F

EXTINGUISHING MEDIA: Agents approved for Class B hazards (e.g., dry chemical, carbon dioxide, halogenated agents, foam, steam) or water fog.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Extremely flammable vapor/air mixtures form. Extinguishment of fire before source of vapor is shut off can create an explosive mixture in air.

PRECAUTIONS: Keep away from ignition sources (e.g., heat, sparks and open flames). Keep container closed. Use with adequate ventilation.

REACTIVITY INFORMATION

DANGEROUS REACTIONS: Avoid chlorine, fluorine and other strong oxidizers.

HAZARDOUS DECOMPOSITION: Burning can produce carbon monoxide and/or carbon dioxide and other harmful products.

STABILITY: Burning can be started easily.

CHEMICAL AND PHYSICAL PROPERTIES

BOILING POINT: 80°F TO 430°F, Range

SOLUBILITY IN WATER: Negligible, below 0.1%.

SPECIFIC GRAVITY (WATER = 1): 0.75

VAPOR PRESSURE: 7-15 lb RVP (ASTM D-323)

VAPOR DENSITY (AIR = 1): 3 TO 4

STORAGE AND ENVIRONMENTAL PROTECTION

STORAGE REQUIREMENTS: Store in flammable liquids storage area. Keep container closed. Store away from heat, ignition sources, and open flame in accordance with applicable federal, state, or local regulations.

SPILLS AND LEAKS: Remove or shut off all sources of ignition. Use water spray to disperse vapors. Increase ventilation, if possible. Contain on an absorbent material (e.g., sand, sawdust, dirt, clay). Keep out of sewers and waterways.

WASTE DISPOSAL: Residues and spilled material are hazardous waste due to ignitability. Disposal must be in accordance with applicable federal, state, or local regulations. Enclosed-controlled incineration is recommended unless directed otherwise by applicable ordinances.

SPECIAL PRECAUTIONS: Keep out of sewers and waterways. Avoid strong oxidizers. Report spills to appropriate authorities. USE AS MOTOR FUEL ONLY.

TOXICOLOGICAL INFORMATION

EYE: Primary eye irritation score 0.0/110.0 (rabbits).

SKIN: Primary dermal irritation score 1.1/8.0 (rabbits). Acute dermal LD50 greater than 5ml/kg (rabbits). Practically nontoxic for acute exposures by this route.

INHALATION: Acute LC50 20.7mg/l (rats).

INGESTION: Acute oral LD50 18.8ml/kg (rats). Practically nontoxic for acute exposures by this route.

Excessive exposure to vapors may produce headaches, dizziness, nausea, drowsiness, irritation of eyes, nose and throat and central nervous system depression.

In a long-term inhalation study of whole unleaded gasoline vapors, exposure-related kidney damage and kidney tumors were observed in male rats. Similar kidney effects were not seen in female rats or in mice. At the highest exposure level (2056 ppm), female mice had an increased incidence of liver tumors. Results from subsequent scientific studies suggest that the kidney damage and probably the kidney tumor response are unique to the male rat. The significance of the mouse liver tumor response in terms of human health is questionable.

Inhalation of whole unleaded gasoline vapors did not produce birth defects in laboratory animals.

Gasoline is a complex mixture of hydrocarbons and contains benzene (up to 4 volume %), toluene and xylene. Chronic exposure to high levels of benzene has been shown to cause cancer (leukemia) in humans and other adverse blood effects (anemia). Benzene is considered a human carcinogen by IARC, NTP and OSHA. Overexposure to xylene and toluene can cause irritation to the upper respiratory tract, headache and narcosis. Some liver damage and lung inflammation were seen in chronic studies on xylene in guinea pigs but not in rats.

Aspiration of this product into the lungs can cause chemical pneumonia and can be fatal. Aspiration into the lungs can occur while vomiting after ingestion of this product.

REGULATORY INFORMATION

CERCLA REPORTABLE QUANTITY:
This product is exempt from the CERCLA reporting requirements under 40 CFR Part 302.4. However, if spilled into waters of the United States, it may be reportable under 40 CFR Part 153 if it produces a sheen.

DOT PROPER SHIPPING NAME: Gasoline, Flammable Liquid, UN1203.

OSHA HAZARD COMMUNICATION STANDARD: Flammable liquid. Irritant. Contains components listed by ACGIH. Contains components listed by OSHA. Contains a carcinogenic component.

RCRA STATUS:
This product is subject to the 40 CFR Part 268.30 land ban on the disposal of certain hazardous wastes because it contains the following substance(s):

COMPONENT/CAS NUMBER
Ethylbenzene (100-41-4)
Toluene (108-88-3)
Xylene (1330-20-7)

SARA STATUS:
This product is regulated under the following section(s) of SARA Title III, 42 USC 9601. Spills or releases of the product may be reportable as determined by the information given below:

SECTIONS 311 AND 312 OF SARA AND 40 CFR PART 370:
This product is defined as hazardous by OSHA under 29 CFR Part 1910.1200(d).

SECTION 313 OF SARA AND 40 CFR PART 372:
This product contains the following substances, which are on the Toxic Chemicals List in 40 CFR Part 372:

COMPONENT/CAS NUMBER	WEIGHT PERCENT
Benzene (71-43-2)	4
Ethylbenzene (100-41-4)	2
Toluene (108-88-3)	22
Cyclohexane (110-82-7)	5
Xylene (1330-20-7)	10
MTBE (1634-04-4)	7

TSCA STATUS: All of the components of this product are listed on the TSCA Inventory.

SUPPLEMENTAL INFORMATION

Gasoline is a complex mixture of hydrocarbons. Those major components having occupational exposure limits are:

Butane (CAS 106-97-8) ACGIH TLV 800 ppm; OSHA PEL 800 ppm.

Cyclohexane (CAS 110-82-7) ACGIH TLV 300 ppm; OSHA PEL 300 ppm.

Ethylbenzene (CAS 100-41-4) ACGIH TLV 100 ppm, STEL 125 ppm; OSHA PEL 100 ppm, STEL 125 ppm.

SUPPLEMENTAL INFORMATION - CONTINUED

n-Heptane (CAS 142-82-5) ACGIH TLV 400 ppm, STEL 500 ppm; OSHA PEL 400 ppm, STEL 500 ppm.

n-Hexane (CAS 110-54-3) ACGIH TLV 50 ppm; OSHA PEL 50 ppm.

Pentane (CAS 109-66-0) ACGIH TLV 600 ppm, STEL 750 ppm; OSHA PEL 600 ppm, STEL 750 ppm.

Toluene (CAS 108-88-3) ACGIH TLV 100 ppm, STEL 150 ppm; OSHA PEL 100 ppm, STEL 150 ppm.

Trimethyl benzene (CAS 25551-13-7) ACGIH TLV 25 ppm; OSHA PEL 25 ppm.

Xylene (CAS 1330-20-7) ACGIH TLV 100 ppm, STEL 150 ppm; OSHA PEL 100 ppm, STEL 150 ppm.

ISSUE INFORMATION

BY:

R. G. Farmer, Director,
Product Safety & Toxicology

ISSUED: June 09, 1989
SUPERSEDES: March 18, 1988

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME: Clifton Chemical Co.	EMERGENCY TELEPHONE NO.: (815) 697-2123
ADDRESS (Number, Street, City, State, and ZIP Code): 160 So. Locust St. Ohebanse, Il. 60922	
CHEMICAL NAME AND SYNONYMS	TRADE NAME AND SYNONYMS: Windshield Washer
CHEMICAL FAMILY	FORMULA: Mixture

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS	N/A		BASE METAL	N/A	
CATALYST	N/A		ALLOYS	N/A	
VEHICLE	N/A		METALLIC COATINGS	N/A	
SOLVENTS	N/A		FILLER METAL PLUS COATING OR CORE FLUX	N/A	
ADDITIVES	N/A		OTHERS	N/A	
OTHERS	N/A				

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
Methyl Alcohol	38	200ppm
Nonylphenol Surfactant CAS # 68412-54-4	.001	
Triphenylmethane CAS # 2650-18-2 EPA TSCA List- Yes	Tr.	

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	N/A	SPECIFIC GRAVITY (H2O=1)	.951
VAPOR PRESSURE (mm Hg)	N/A	PERCENT VOLATILE BY VOLUME (%)	N/A
VAPOR DENSITY (AIR=1)	N/A	EVAPORATION RATE (=1)	N/A
SOLUBILITY IN WATER	Complete		
APPEARANCE AND ODOR	Blue-aromatic		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) T.C.C. 112 F	FLAMMABLE LIMITS	LEL	UEL
EXTINGUISHING MEDIA Dry chemical, CO_2 or Alcohol foam			
SPECIAL FIRE FIGHTING PROCEDURES Wear self-contained breathing apparatus			
UNUSUAL FIRE AND EXPLOSION HAZARDS Vapor is heavier than air and may travel considerable distance to an ignition source.			

(Continued on reverse side)

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE
Methyl Alcohol- 200ppm, 8 hour time- weighted average

EFFECTS OF OVEREXPOSURE
Ingestion- Poisonous, causes blindness, perhaps death. Inhalation- Narcosis, headache, nausea, loss of consciousness. Skin- Drying, irritation. Eye- Burning.

EMERGENCY AND FIRST AID PROCEDURES
Ingestion- Induce vomiting of conscious person, call M.D. Inhalation- Remove person to fresh air. Skin- Remove contaminated clothing and wash with water. Eyes- Flush eyes with water for at least 15 min. Contact a physician immediately.

SECTION VI REACTIVITY DATA

STABILITY			CONDITIONS TO AVOID
	UNSTABLE		Sparks, heat and flames.
	STABLE	X	

INCOMPATABILITY (Materials to avoid)
None

HAZARDOUS DECOMPOSITION PRODUCTS
Thermal decomposition may produce carbon dioxide and/or carbon monoxide.

HAZARDOUS POLYMERIZATION			CONDITION TO AVOID
	MAY OCCUR		
	WILL NOT OCCUR	X	

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Place leaking container in well ventilated areas, eliminate ignition sources. Avoid run-off into storm sewers and ditches which lead to natural waterways

WASTE DISPOSAL METHOD
Incineration, biological treatment of dilute solution.

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

VENTILATION		
	LOCAL EXHAUST: When appropriate to control employee exposure.	SPECIAL
	MECHANICAL (General)	OTHER

PROTECTIVE GLOVES: Neoprene or rubber gloves

EYE PROTECTION: Chemical safety goggles

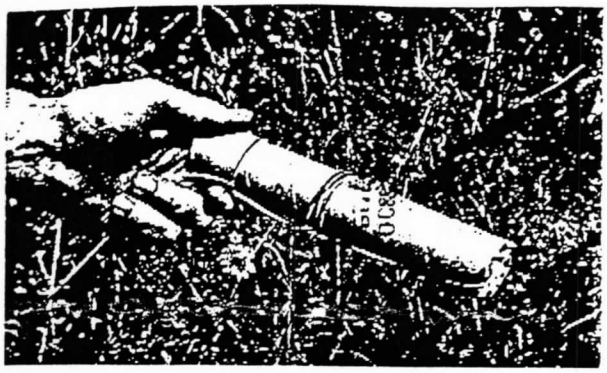
OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Cannot be made non-poisonous.

OTHER PRECAUTIONS

seisPRIME/E® Emulsion Seismic Explosive



EXCELLENT FOR "MINI-HOLES" AND VERTICAL STACKING

These non-nitroglycerin emulsion products are packaged in convenie one-pound, one-half, one-third, and one-quarter pound cartridges ar formulated to provide a seismic pulse equal to dynamite for clear, sha seismic records.

Although classified as high explosive, seisPRIME/E emulsions are no headache and have excellent resistance to accidental detonation by friction impact.

Spiral-wound 1/4 to 1/2-pound paper cartridges are easily capped a waxed to sleep well.

PROPERTIES AND SPECIFICATIONS

PRODUCT	E-1	E-1/2	E-1/3	E-1/4
Weight	One Pound	1/2 Pound	1/3 Pound	1/4 Pound
Size	2 1/4 x 8 1/2	1 1/2 x 8	1 1/8 x 8	1 x 8
Style	49	SW	SW	SW
Density (gm/cc)	1.18	1.15	1.15	1.15
Velocity (fps) (unconfined)	16,500	16,000	15,000	14,500
Detonation pressure (kilobars)	100	100	100	100
Absolute Bulk Strength (cal/cc)	885	775	775	775
Relative Bulk Strength (ANFO=100)	120	105	105	105

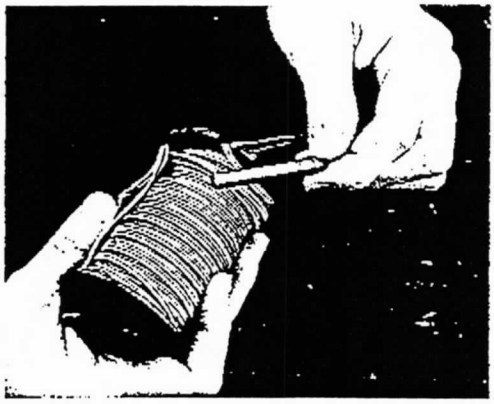
PACKAGING

Available in four sizes to meet vertical stacking a "mini-hole" applications. seisPRIME/E in the one-pou size is packaged in thin-walled, easy couplir cartridges for vertical stacking or larger downho shots.

In the 1/2 to 1/4-pound sizes, seisPRIME/E packaged in spiral-wound paper cartridges.

All sizes have excellent water resistance and can initiated with a #8 strength STATICMASTER detonato

STATICMASTER® Electric Detonators for Seismic Exploration



DESIGNED FOR SEISMIC WORK - Exclusive Atlas electric match provides reliat detonation with minimum lag time and scatter. Full #8 strength explosive output to he insure initiation of the seismic charge, even under severe conditions.

UNEXCELLED PERFORMANCE - Rigid statistical quality control tests are perform on all components and on the completed detonator to assure reliable and consiste performance. A tough, hard enamel coating under the plastic outer insulation provid additional protection against shorting of legwires under extreme conditions.

WATER AND WEATHER-PROOF - Legwire insulation is designed to withsta extremes of heat and cold and the severe conditions encountered in deep-hole loadir All detonators contain a double-crimped rubber plug to provide a water-tight se Excellent firing characteristics permit use in single-hole or multiple-hole pattern shootin

PROPERTIES AND SPECIFICATIONS

- Detonator strength - #8
- Functioning time scatter - Less than 0.001 second; even lower as firing current is increased
- Recommended firing current - 3 to 10 amps DC, 4 to 10 amps AC
- Water immersion depth (max. tested) - 500 feet
- Bridgewire resistance - 0.9 Ohms
- Detonator shell - Gilding metal

REDUCED SENSITIVITY TO EXTRANEOUS ELECTRICITY

A special bridgewire and the SF feature in the electric match provide reduced sensitivity to static electricity.

OPERATING AIDS

With recommended firing currents, STATICMASTER elect detonators meet all requirements for series firing.

WARNING - Do not use STATICMASTER electric detonators the same circuit with other types or brands of electric detonators

PACKAGING

STATICMASTER electric detonators come with **spoole** duplex copper lead wires (yellow color) in lengths of 40', 60', 8 100', 120', 150', 160', 200', 250', 300', and 400'; and in short legwire lengths (**folded** duplex wires, yellow) measuring 12', 2 and 24'.

HAZARDOUS CHEMICAL MATERIAL SAFETY DATA SHEET

(Conforms to the Requirements of 29 CFR 1910.1200)

PRODUCT CATEGORY: EMULSIONS AND EMULSION / ANFO BLENDS - BLASTING AGENTS, ALL GRADES

1. NAME AND ADDRESS OF MANUFACTURER:

ATLAS POWDER COMPANY
15301 DALLAS PARKWAY
SUITE 1200
DALLAS, TEXAS 75248
TWX 910-860-5237

2. PREPARED BY: P.E. Therriault DATE: 06-24-88 REVISION: One

3. MEDICAL EMERGENCY TELEPHONE NUMBERS:

EAST OF THE MISSISSIPPI: 717 - 386 - 4121
WEST OF THE MISSISSIPPI: 417 - 624 - 0212

4. THE MATERIALS DESCRIBED IN THIS DATA SHEET ARE:

HAZARDOUS CHEMICAL INGREDIENTS

5. CHEMICAL AND COMMON NAME(S) OF HAZARDOUS CHEMICAL MIXTURE/INGREDIENTS:

Apex-All Grades, RXL 614, RXL 615, PowerAN-All Grades, Bulk Emulsions-All Grades

Major Hazardous Ingredients Include:	TSCA LISTED	CAS NO.	RTECS NO.
Ammonium Nitrate	Y	6484-52-2	BR9050000
Diesel Oil (In Some Formulas)	Y	68334-30-5	No Listing

Note: See MSDS for Ammonium Nitrate Plus Fuel Oil

6. PHYSICAL AND CHEMICAL CHARACTERISTICS:

	Vapor Pressure	Flash Point	Melting Point°C	Boiling Point°C	Specific Gravity	Mol. Wt.	Odor	Appearance
Ammonium Nitrate	0	d	155	190	1.725	83	None	White Solid
Diesel Oil	nd	nd	nd	147.371	0.87	nd	Pungent	Brown Liqui
Mixture	Neg.	nd	nd	125	1.1 to 1.3	NA	None	White Greas

nd = No Data d = Dissociates na = Not Applicable

7. PHYSICAL HAZARDS:

Ammonium Nitrate - DOT: Oxidizer Diesel Oil: Flammable
Mixture DOT Explosive, Blasting Agent

8. HEALTH HAZARDS:

	A.N.	D.O.
Carcinogen	N	N
Corrosive	N	N
Highly Toxic	N	N
Irritant	N	N
Sensitizer	N	N
Toxic	N	N
Target Organ Effects	N	N

Ref: Registry of Toxic Effects of Chemical Substances (RTECS)
N = No Criteria Match
Y = Positive Criteria Match per RTECS
nd = No Data

9. PRIMARY ROUTE(S) OF ENTRY: No Data

10. PERMISSIBLE EXPOSURE LIMITS: No Data

11. LISTINGS:

MATERIAL	NTP ANNUAL REPORT ON CARCINOGENS	IARC MONOGRAPHS	OSHA CARCINOGEN
AN	No	No	No
SN	No	No	No
SP	No	No	No
EDDN	No	No	No
DO	No	No	No

12. GENERALLY APPLICABLE PRECAUTIONS FOR SAFE HANDLING AND USE:

HYGIENIC PRACTICES:

Avoid Skin and Eye Contact. Avoid Breathing Blasting Fumes.

PROTECTIVE MEASURES DURING REPAIR AND MAINTENANCE OF CONTAMINATED EQUIPMENT:

Use non sparking tools, avoid open flame, wear normal safety equipment, such as safety glasses and hard hat.

PROCEDURES FOR CLEANUP OF SPILLS AND LEAKS:

Bulk Product: Isolate and contain spilled material. Contact Distributor or Atlas Powder for Spill Response Assistance.
The disposal of damaged or deteriorated explosives must be carried out in accordance with all Federal and State Regulations.
In the event of a major spill, contact the National Response Center (800-424-8802) and the local Police.

13. CONTROL MEASURES:

ENGINEERING: Follow BATF standards for storage (27 CFR 151 Subpart 3)
Except for Bulk products, see "Do's and Don'ts - Instructions and Warnings" - found in every shipping case.
See Institute of Makers of Explosives Publications.

WORK PRACTICES: Follow OSHA Standards for Storage and Use (29 CFR 1910.109)
Except for Bulk products, see "Do's and Don'ts - Instructions and Warnings" - found in every shipping case.
See Institute of Makers of Explosives Publications.

PERSONAL PROTECTIVE EQUIPMENT:

Avoid toxic fumes from blasting, wear normal protective equipment, such as safety glasses, hard hats, etc.

14. EMERGENCY AND FIRST AID PROCEDURES:

Do not attempt to fight fires involving explosives.
Immediately evacuate the area. Avoid toxic fumes from fires.
In case of skin contact, wash affected area with water. Eye contact - flush eyes for at least 15 minutes and consult a Physician.

15. DISCLAIMER: The above information taken from various published and unpublished sources is believed to be accurate and represents the best information currently available to us. However, we make no warranty of the accuracy of such information, express or implied, and assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes.