Seismic Reflection Survey:
Health and Safety Plan

Kansas Geological Survey
Exploration Services Section

Conoco, Inc.
Mason County, Texas
July 1998

Open-file Report #98-26

KANSAS GEOLOGICAL SURVEY EXPLORATION SERVICES
ACCIDENT PREVENTION PLAN

I. PROJECT DESCRIPTION

Project Name: Feasibility of High Resolution 2-D Seismic Reflection to Delineate Faults and Image Stratigraphic Units Within the Upper 200 m in Mason County, Texas

Location: Mason County, Texas

Site Safety Officer: Richard D. Miller

Plan Prepared By: Richard D. Miller

Estimated Duration of Field Work: 5 days

II. STATEMENT OF WORK

A properly designed and executed high resolution seismic reflection survey should be capable of delineating faults and imaging acoustic contrasts/geologic contacts within the upper 200 m in northern Mason County, Texas. This seismic reflection study will focus on: 1) stratigraphic and structural characteristics of this site, 2) feasibility of the technique to delineate faults and other structural features in the upper 140 m, 3) resolution potential (vertical and horizontal), 4) optimum geometries and equipment, 5) near-surface variability and its effects on recorded data, 6) near-surface static effects, and 7) necessary QC to eliminate artifacts and maximize data quality. Proven high resolution techniques will be used to design the data acquisition parameters and determine optimum equipment and methodologies (Steeples and Miller, 1990). Maximizing the resolution potential and signal-to-noise ratio will be an emphasis of this survey. The continuous CDP profile lines will be acquired using either a conventional roll-along technique, resulting in nominal 24-fold or 48-fold stacked sections (Mayne, 1962) or a fixed spread consisting of up to 180 live stations. The seismic source, geophone type, spread geometry, shots/point, and acquisition philosophy used to acquire the CDP profile lines will be based on the results of 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 to detect, delineate, and evaluate local stratigraphy and structural features at this site.

Shallow sandstone aquifer systems such as the Hickory Sandstone in Mason County, Texas, represent field laboratories for the study of fault-influenced fluid behavior. The aquifer system present in this 140 m thick sandstone unit is strongly influenced by both normal and strike slip faulting. Provided fluid characteristics of aquifer/aquiclude systems are analogous to petroleum reservoirs, this faulted sandstone unit provides a low-cost alternative to studying actual petroleum reservoirs when

a large number and diversity of in-situ measurements are necessary to analyze fluid properties. Secondary, but still significant, is the potential at this site for developing and testing a variety of characterization techniques. Shallow, high resolution seismic reflection represents a non-invasive method of imaging faults in two and/or three dimensions. Shallow seismic reflection has effectively extended geometries and characteristics of faulted rock away from boreholes and surface exposures in previous applied research efforts. Enhancing vertical and horizontal resolution and signal-to-noise ratio has become a forefront area of applied shallow seismic reflection research and technique development. This effort will emphasize both effective and accurate imaging of faults present at this site and optimizing resolution and signal-to-noise ratio.

The project will consist of two major acquisition phases: testing and production. The testing phase will commence as soon as a mutually agreed time can be arranged between the Kansas Geological Survey (KGS) and Conoco. A tentative start date of July 13, 1998, has been proposed and mutually agreed upon, forgoing any unforeseen mobilization delays. The testing phase will consist of walkaway tests near planned survey lines. The 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 Conoco agree that the walkaway test data warrants continuation of the project, the production phase will commence.

The production data will fill the remaining portion of the week (3 to 4 days depending on necessary effort dedicated to testing and field conditions) and will follow well established shallow high resolution data acquisition procedures (Hunter et al., 1984; Knapp and Steeples, 1986; Steeples and Miller, 1990). Data acquisition will be roughly structured and designed around the findings of the preliminary testing. Ideally, an uphole or check shot and VSP survey should be acquired in monitor wells along survey lines to enhance confidence, preliminary event identification, and eventual correlation to the stacked data. Step-by-step analysis during the acquisition and processing phases of the survey will be continuous with appropriate modifications made to ensure the quality of the final product.

Outline of Proposed Program

1) An extensive series of walkaway noise tests including a minimum of two unique near-surface settings; several low energy, high frequency seismic sources; a pseudo-continuous spread with 0.5 m receiver spacing spanning source-to-receiver offsets from 0.5 m to over 180 m; comparison of at least two different geophone types; and an analysis of shot gathers incorporating geologic and any borehole information available.

2) Contingent on the walkaway noise tests, 2-D profiles will be acquired approximately along lines proposed by Conoco. The data would be acquired on 96 recording channels (with the exception of any vibroseis data which will be acquired with 95 recording channels, reserving one for the pilot) if a roll-along method is employed, or 180 recording channels if a fixed spread proves optimum. Nominal 48-fold redundancy is anticipated for roll-along profiles and a variable 45- to 90-fold for fixed-spread data.

3) The walkaway noise survey data and possibly the CDP reflection profiles will be analyzed and, if appropriate, brute processed during the field portion of this project (on-site or in motel room). Processing and analysis will be done to ensure project objectives can be met with acquired data.

4) 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.

5) At least one and possibly more VSPs will be acquired (if permitted by Conoco) in monitor wells at key points along the survey lines. The intent of these profiles will be to better correlate the seismic data to both the synthetic seismograms and borehole geology.

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 L40A Mark Products Geophones (180 strings)
- triple 40 Hz L28E Mark Products Geophones (210 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, _" shaft)
- slide hammer impact source
- IVI Minivib (15 to 500 Hz, ~300 lb reaction mass, 8,000 lb hold down)
- 12-gauge auger gun
- RAWD (Rubber band Assisted Weight Drop)
- Geostuff three-component downhole geophone
- Single Mark Products borehole hydrophone

- several linear up-sweeps 30-400 Hz
- optimum vertical stacking
- 0.5 m receiver station spacing
- 0.25 msec sampling interval
- 360-trace, pseudo-continuous walkaway w/source offsets from 0.5 m to 180.5 m
- digital filtering

a) Option #1*
   48-fold, 96-channel roll-along recording
b) Option #2*
   24-fold, 96-channel roll-along recording
c) Option #3*
   45- to 90-fold, 180 channel fixed spread recording

3) VSP
- 3-component hole lock geophone or single hydrophone
- 100 m maximum vertical profile
- 3 m vertical station spacing*
- as many as 3 source offset positions*
- source consistent with production survey

Table 1—continued

4) Planned Field Schedule:

	Approx. Dates
Mobilization	July 6–10
Travel	July 11–12
Walkaway noise testing	July 13
Walkaway noise testing/VSP	July 14
Production Data Acquisition	July 15–17
Travel	July 18–19
Demobilization	July 20–24

5) Data shipped from KGS in 96- or 180-channel SEG-Y format on or by July 24.
Preliminary Report (including all walkaway tests and safety report) approximately August 1, 1998.
Final Report after review and comment by Conoco.

*Depending on results of testing.

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 based on borehole velocity information with reflection hyperbola interpreted on shot gathers is the most conclusive means to both verify and analyze reflections. This combination incorporates ground truth (borehole velocity), geometric curve fitting (forward and inverse modeling), and event identification directly 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 borehole and surface seismic. Modeling reflection arrivals as interpreted on shot gathers is not only critical, it should be required by law.

Quality Control (QC)

QC is critical and will be continuous throughout acquisition. Near-surface inconsistencies, vehicle noise, an extremely narrow and changing optimum recording window, and poor receiver coupling conditions will require strict compliance with QC guidelines and meticulous monitoring of data, an absolutely essential aspect of the data acquisition. Based on subtle changes in the near-surface, minor adjustments to some parameters (e.g., source-to-near offset) may be necessary to maintain the optimum recording window (Hunter et al., 1984). 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 minimizes the chances a recorded shot is not maximized for the site and equipment.

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 is 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 over-sampled 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 wave field (especially the reflections) to be thoroughly appraised.

The primary intent of a walkaway noise test is to allow the 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 are ideally suited to the identification of individual events within the full wave field. Phase velocity and wave types are a couple of 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 (Pullan and Hunter, 1990). Assumptions or partial analysis of these key properties could result in artifacts or improperly recorded data. 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 180 m or 225 m, if necessary. The receiver interval will be 0.5 m. The 12-gauge auger gun (Healey et al., 1991) (requiring only class C explosives), an accelerated weight drop (Bison EWG or equivalent), IVI Minivib, various hammer and plate combinations, slide hammer, and 30.06 downhole/surface will be evaluated (if conditions permit) so the optimum source for the near-surface conditions, target depth, resolution requirements, and environmental constraints can be determined. Each source will be evaluated with as near equivalent conditions and parameters as possible. Experience with source testing (Miller et al., 1986; Miller et al., 1992; Miller et al., 1994; Doll et al., 1994) will greatly enhance both the quality and the efficiency of source evaluations at this site.

The receivers available for testing will include both single Mark Products L-40A 100 Hz geophones and triple 40 Hz Mark Product L-28E geophones wired in series. The 40 Hz geophones will be tested first, and from previous experience will probably

produce the best response. The need for a strong signal from geophones with a high spurious noise threshold is paramount and from previous experience, 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 could be by-passed.

Data collected during the experimental phase of this survey will be displayed in the appropriate format on site. All walkaway noise tests will be displayed according to source-to-receiver offset with separate displays for each source, receiver type, and low-cut filter tested. The final walkaway sections will be trace balanced and displayed in a variable-area wiggle trace format. Spectral analysis will be used in conjunction with curve modeling to determine the basic characteristics of reflection data collected with each of the sources tested. Determination of source configuration and field parameters for the CDP production lines will be based on analysis of all 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.). Walkaway noise tests will guide the definitive selection of equipment and parameters as well as optimum station spacing and recording geometries for the production profiles.

Production Phase

The production acquisition phase of this project will begin as soon after the testing phase is completed and both Conoco and KGS are satisfied with the parameter design. A total of 5 field days are available for data acquisition. Time remaining after the VSP/testing will be used to acquire as much production data as possible. 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.

The equipment and parameters used to acquire the production lines will be based on the results of the individual walkaway tests performed at the site during the testing phase of the survey. The 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. The sampling interval will be chosen to insure at least 5 samples/wavelength of the upper corner frequency and 10 samples/wavelength of the dominant reflection energy. The total number of samples will be chosen based on maximum time (depth) of interest as determined by both the sampling interval and the uphole survey (if possible). Once the seismograph's variable settings are selected, the settings will not change for the duration of the particular line being acquired. This is to insure consistency in phase and to avoid confusion relating to plotting scales, alias values, and system response.

Based on experience at sites with a similar near-surface and target interval, the most probable source used for production will be either the IVI Minivib or some configuration of hammer/plate. Triple L-28E 40 Hz geophones with variable damping

capability will likely be the preferred choice for the receivers on the production line. The equipment parameters chosen to record the CDP lines will incorporate the results of both walkaway noise tests and uphole surveys.

The data will be acquired using a standard CDP roll technique with either a constant source/receiver offset, resulting in a nominal 48- or 24-fold CDP stack, or a fixed 180-station spread producing a 45- to 90-fold variable offset section. Geophone station spacing will be confirmed by computations and qualitative judgments made from data acquired during the testing phase. The most probable geophone spacing is 1 m. The data will probably be acquired using an end-on and/or asymmetric split-spread source/receiver geometry, depending on the necessary fold of shallow reflections balanced with the need for continuity, maximum imagable depths, need for velocity control, and the recording technique. The source-to-nearest receiver offset will probably be 0.5 m for the 180-station fixed spread and on the order of 2 m for the rolling spread. The maximum source-to-receiver offset will range from 180.5 m to 90.5 m for the 180-station fixed spread and approximately 96 m for the rolling spread. Modifications to the source/ receiver geometries and offsets will likely be necessary after analysis of the data acquired during the testing phase.

Fine tuning of the field geometries and equipment will be based on analysis of potential (using physical properties derived from the test data) versus required resolution (Miller et al., 1995), balanced with maximum signal-to-noise ratio. The 1/4 wavelength criteria of Widess (1973) will be used to determine the best vertical resolution with equipment and near-surface conditions present during the acquisition of the test data. The potential versus actual horizontal resolution of the production lines will be based on the radius of the theoretical Fresnel zone. Oversampling of the first Fresnel zone will not exceed 15 times (Miller et al., 1990) while a minimum of four times will be maintained throughout the survey (Knapp and Steeples, 1986).

In-hole seismic studies should provide an improved image of structural and stratigraphic features in close proximity to the borehole. Walkaway vertical seismic profile (VSP) techniques will be designed and used to complement and appraise both walkaways and high resolution seismic reflection data, providing information for correlation to geophysical and lithologic logs as well as estimation of some material properties. This VSP survey will be incorporated into and hopefully be used to improve the interpretation of the seismic reflection data through more accurate time-to-depth conversions, correlation with existing electric and geologic logs, and horizontal extrapolation of geologic information from the borehole. A geologic model derived from interpretations that incorporate the geophysical logs, the VSP, the shallow seismic reflection profile, and borehole logs (lithologic), should improve the spatial understanding of structures controlling the hydrology of this area. The design and implementation of the VSP is intended primarily to improve the correlation of reflections recorded during CDP profiling and walkaway surveys to lithology.

The acquisition of VSPs will be consistent and follow well established methodologies (Hardage, 1983). As with all acoustic methods, application of petroleum industry developed methodologies to shallow targets generally require considerable attention to detail and skepticism related to rules-of-thumb and assumptions (Steeples and Miller, 1990). A walkaway VSP oriented perpendicular to any known structural features will be acquired with source offsets ranging from near-vertical to several times

the maximum depth of interest. The near-zero offset VSP (ZVSP) profiles will be used to determine precise ties between log data and reflection events on CDP stacked surface seismic sections. The offset VSP (OVSP) profiles will assist with estimation of lithology and structural changes in geology around the wells. VSPs will help correlate drill/log defined geology with reflections interpreted on CDP stacked sections, allowing verification of reflections on shot gathers.

The 2-D reflection lines will be elevation surveyed, maintaining a relative elevation accuracy of at least ±0.25 m. This level of accuracy is appropriate considering the accuracy with which near-surface velocities can be determined. The line survey will not include x and y. The lines will be laid to insure the station spacing is within ±0.1 m of the selected interval.

Final Products

The raw data will be transferred from computer hard drives to CD-ROM and/or 8 mm tape 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 (either 96 or 180 channel, depending on acquisition method) and converted to a SEG-Y format. Standard archival procedures at the KGS involve burning the data to a CD. If Conoco so chooses, the data can be written to an 8 mm Exabyte tape drive currently integrated into a SGI work-station running ProMax. 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 and/or 8 mm tape with all digital and analog field notes to Conoco within 5 working days after 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: walk-away tests, testing procedures, decisions regarding optimization, data acquisition observations, and the full safety plan/report. Walkaway data will be gathered accord-ing 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 MSDS and a detailed description of Health/Safety risks associated with the environment and equipment. The report will be considered final when review comments and questions provided by Conoco have been addressed.

Overall Project Goal

The goal of this study will be to determine the feasibility of the technique to image and resolve structural and stratigraphic features and characteristics within the upper 200 m at this site. The results of this study will include a thorough comparison of several high resolution seismic sources, an empirically based estimation of horizontal and vertical resolution potential, evaluation of acquisition effort, determination of optimum recording parameters, and several hundred meters of full-fold shallow seismic reflection data.

References

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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 Conoco 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.

3. Appropriate field boots will be worn and due caution will be exercised with respect to snakes, ditches, swampy areas, and ground debris.

4. At least one gallon of fresh water will be on hand at the beginning of each day for each crew member.

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 written 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 (DOT regulations).

IV. SAFETY PERSONNEL

Safety Personnel and Emergency Contacts

1. Rick Miller (KGS)—Site Safety Officer

2. David Laflen (KGS)—Operations

3. Dale Cox and/or Damian Herrick (Conoco)—
   Delegated Representative(s) and Site Consultant(s)

4. John Siceloff (KGS)—Line Chief

Safety Meeting at Survey Site Date: 7/18/98

- ☑ 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, shoes)
- ☑ 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
John Sicciloff	KGS	
Josh Steinlage	KGS	
Anastasia Stroujkova	ConoCo	Anastasia Stroujkova
Dale Cox	CONOCO	Dale Cox
Damian Herrick	Conoco	
Surinder Sahai	Conoco	Surinder K. Sahai
Deidra K Beggy	KGS	Deidra K Beggy
David Laflen	KGS	David Laflen
Cecil Hoffpauir	LBNL	Cecil Hoffpauir

Site Safety Officer

Safety Meeting at Survey Site Date: 7/19/98

- ☑ 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, shoes)
- ☑ 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
David Laflen	KGS	David Laflen
Deidra K Begay	KGS	Deidra K Begay
Joshua Steinlage	KGS	Joshua Steinlage
John Siceloff	KGS	John Siceloff

Site Safety Officer

KDHR

DIVISION OF WORKERS COMPENSATION
KS DEPT OF HUMAN RESOURCES
800 SW JACKSON, STE 600
TOPEKA, KS 66612-1227

EMPLOYER'S REPORT OF ACCIDENT

F

Submit Original Copies Only

OSHA Case of File Number _____
There is a $250 penalty for failure to file Accident Reports within 28 days of the employer's receipt of knowledge of the accident.
This form contains all items requested on OSHA Form Number 101, "Supplementary Record of Occupational Injuries and Illness."

DO NOT WRITE IN THIS SPACE

READ INSTRUCTIONS BEFORE FILLING OUT THIS FORM

1. Federal Employers Identification Number: 486029925
2. Name of Employer: University of Kansas, Lawrence Campus — Telephone Number: (785) 864-3965
3. Mailing Address: Lawrence, KS — Zip Code: 66045
4. Location, if different from mailing address: Moore Hall, 1930 Constant Avenue, Lawrence, KS 66047
5. Nature of Business: Research — S.I.C. Code: 9199 — Dept. or Div.: Kansas Geological Survey
6. Name of Employee: Joshua (First) C (Middle) STEINLAGE (Last) — Age: 23 — Sex: M
7. Home Address: 1111 SW OTTAWA TER, TOPEKA, KS — Zip Code: 66615
8. Soc Sec # — Birth Date: 05-15-75 — Employee's Occupation: ENGR TECH — Home Phone Number: 913 478 3289
9. Date of Injury or Occupational Disease: 07-19-98 — Time of Injury: 1:30 PM — AM/PM
   Date Disability Began — Gross Average Weekly Wage $: NA (8.39/HR no reg sked.)
10. Place of Accident or last exposure: 20 m outside Brady (Katemcy) TX
    (City) (County) (State)
11. Was accident or last exposure on employer's premises? No
12. How did accident occur? Hit hand with hammer while on a KGS geological field team doing research in Texas. (Team returned to Lawrence at 9 pm, 07-23-98.)
13. What was employee doing when injured?. Hammering 12# sledge hammer head onto new handle. Holding sledge hammer head on top of handle with left hand while hammering head onto handle with 2nd hammer in right hand.
14. Name substance or object that directly caused injury: 2nd hammer
15. Describe in detail nature and extent of injury; indicate part of body involved. Flesh on left hand between thumb and index finger severly mashed and lacerated: 5 stiches required.
16. Was worker admitted to hospital? NO — Date: 07-19-98 — Hospital & Address: Heart of TX Mem Hosp
    Emergency Room Only? Yes
17. Name and address of attending physician: Dr. Jeffrey P. Mays, MD, Brady Doctors' Clinic, Brady, TX
    Receipts totalling $34.38 attached for medication & first aid supplies purchased by patient during trip.
18. Has employee returned to regular duty? NO — Light duty ? YES — Date: 07-20-98
19. Is compensation now being paid? NO — Date first/initial payment
20. Weekly compensation rate $ — Is further medical aid needed? Yes, follow-up and stitch removal
21. Did employee die? No — If so, give date of death
    File amended report with 25 days if death subsequently occurs.
22. Name and addresses of dependents (death cases only)

NOTE: HOSPITAL REPORT ATTACHED

23. Insurance Carrier: STATE SELF INSURANCE FUND (785) 296-2364
    Address: 900 SW JACKSON, RM 951 SOUTH, TOPEKA, KS 66612-1251
    Policy Number — Name of Agent
    Claim Number — Name of Claim Representative
24. Date of Report: 07-24-98 — Completed by: SHARON COX — Title: PERSONNEL COORDINATOR

Sharon Cox

AGE

OD Y N

CAUSE

NATURE

SEVERITY
0 - NO TIME LOST
1 - TIME LOST
2 - MEDICAL
3 - FATAL

SOURCE

MEMBER

DO NOT WRITE IN THIS SPACE

K-WC 1101-a (Rev 7-97) -- SUBMISSION DOES NOT CONSTITUTE ADMISSION OF LIABILITY

Safety Meeting at Survey Site Date: 7/20/98

- ☑ 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)
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- ☑ Site requirements (PPC) (gloves, hats, shoes)
- ☑ 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
DAVID LAFLEN	KGS	David Laflen
Deidra K. Begay	KGS	Deidra Begay
Joshua Steinlage	KGS	Joshua Steinlage
John Sicelloff	KGS	John Sicelloff

Site Safety Officer

Safety Meeting at Survey Site Date: 7/21/98

- ☑ 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, shoes)
- ☑ 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
Deidra K Beyay	KGS	Deidra K Beyay
Joshua Steinlage	KGS	
DAVID LAFLEN	KGS	David Laflen
John Siceloff	KGS	John Siceloff

Site Safety Officer

Safety Meeting at Survey Site Date: 7/22/98

- ☑ 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, shoes)
- ☑ 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	
Deidra McBegay	KGS	
Joshua Steinpage	KGS	
David Laflen	KGS	
John Siceloff	KGS	

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 and the ammunition vehicle 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 the vehicle carrying the blasting ammunition. The blasting vehicle will be equipped with a fire extinguisher. The blasting vehicle will not be left running and unattended. The shotgun ammunition will be kept in steel ammunition cases which will be stored in a locked steel container inside the ammunition vehicle.

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

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

All 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 on the dashboard of project vehicles. Emergency call numbers and evacuation routes are included in the safety plan available in the seismic trailer.

The following are the General Health and Safety Rules required by KGS for all staff and subcontractors 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 prepare explosives shall use every reasonable precaution 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 ladders, ramps, stairways, and 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 discharge.

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.

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 discharge.

V. EMERGENCY INFORMATION

Ambulance: _____

Hospital Emergency Room: _____

Poison Control Center: _____

Police: _____

Fire Department: _____

Airport: _____

Explosives Unit: _____

State Environmental Agency: _____

Client: _____

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.)

Hospital:

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.

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

Certified in:	First Aid	CPR	Rick Miller
Certified in:	First Aid	CPR	David Laflen
Certified in:	First Aid	CPR	_____
Certified in:	First Aid	CPR	_____
Certified in:	First Aid	CPR	_____

Fire/Explosion: Upon notification of a fire or accidental explosion on site, the fire department shall be notified and all personnel shall leave the area. Since only Class "C" shotgun ammunition may 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. In the case Class "A" explosives are used, prior consultation and contact will 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.

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 Mason County, Texas.

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. This device consists of a small skid-steer loader with an attached auger/screw. The operation consists of (1) screwing the auger, which houses the shotgun device, approximately 3 ft into the ground, (2) loading and firing the gun, and (3) unscrewing the auger from the ground. The auger gun uses a *blank* 12-gauge shotgun shell fired under the ground surface in a downward direction. The device is built to minimize any danger to the person handling the device, and avoid any residue materials left in the ground. The shotgun shells will be secured in a specially designed steel, lockable, explosives box in a vehicle at all times. The operation/safety rules and regulations for the auger gun are presented as an appendix to this plan.

Experiments will be carried out with a downhole projectile source. This source is a modified 30.06 rifle which has been designed to be loaded and fired while secured to the ground in a downward direction. The firing tube is lowered down a 1" hole about one foot. A standard 30.06 rifle shell is loaded in an above-ground breech and then detonated in such a way that all 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) covering the bolt, 5) securing firing position, and 6) detonation. The device has successfully and safely fired over 20,000 rounds since 1985. All rounds are stored in a secure steel box.

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 other non-intrusive seismic sources. These sources include a vehicle mounted vibrator, accelerated weight drop, and hand operated hammers. The principal hazards associated with this type testing would consist of handling or moving the equipment, fragments from high velocity impacts, and high sound levels.

ACTIVITY HAZARD ANALYSIS

A. Work Item: *Use of Class "C" Shotgun Ammunition*

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 Society 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 Joe Anderson 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, 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 Joe Anderson shall establish a series of warning signals to be used prior to and following each shot. One short horn blast, whistle blow, or other audio signal will indicate the beginning of a blast (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 25 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 50-cal., auger guns and ammunition is on a standard one-ton flat-bed four-wheel drive truck and 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 2,000 rounds of ammunition will be transported to this project, packed in quantities of 160 per ammo can.

B. 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.

C. Work Item: ***Bolt LSS-6 Land Air Gun***

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.

D. Work Item: *MiniVib*

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 1500 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.

E. 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 Uni-Loader.

F. 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.

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.

VII. 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.

VIII. 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 (when site requires)
Eye protection
Hearing protection as required by OSHA
Orange vests along roadways

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.

IX. SAFETY ANALYSIS

The attached analysis list postulated hazards, consequences of those hazards, and the means of prevention or mitigation of each hazard associated with this survey activity (Attachment 4).

X. ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact of this activity has been evaluated and determined minimal 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.

XI. HANDLING AND DISPOSAL OF UNEXPLODED ROUNDS

The handling of live ammunition will be in complete compliance with sections VI.A. 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 5 minutes. After this initial 5 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.

XII. 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.

Potential Hazard	Consequences	Mitigation/Prevention Mechanism
Misfire	Personal injury from subsequent accidental discharge of misfired round.	Assure training of personnel in proper handling and disposal of misfired ammunition.
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.

Potential Hazard	Consequences	Mitigation/Prevention Mechanism
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.

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.

5/1?/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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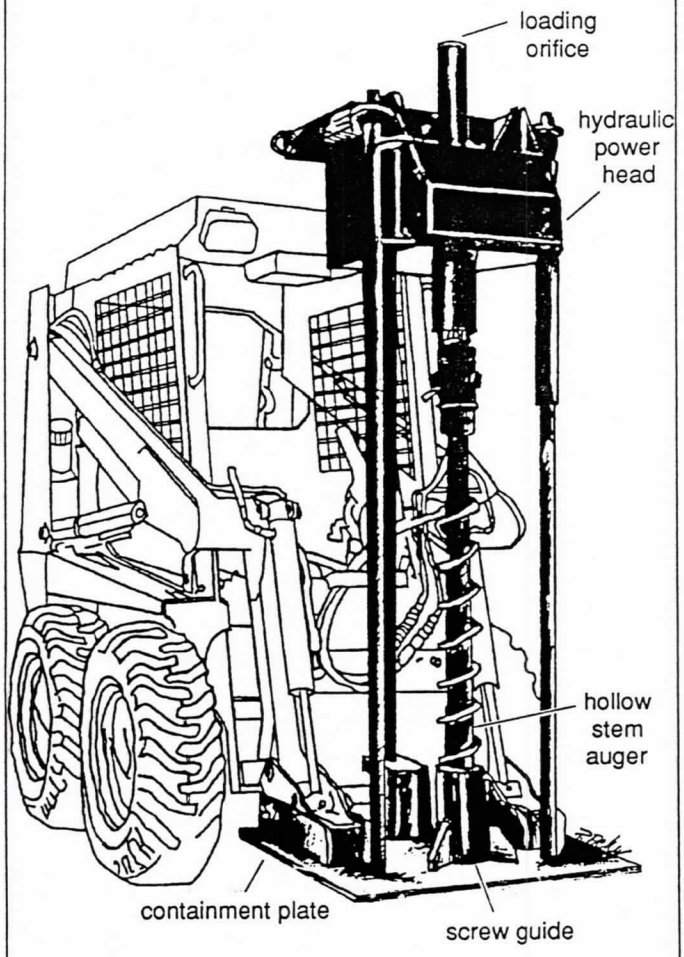

Fig. 1 Diagram represents the auger gun in above-ground position. Modified buffalo-gun portion of the auger gun is not shown, but is conceptually the same as previously documented (Pullan and MacAulay, 1987).

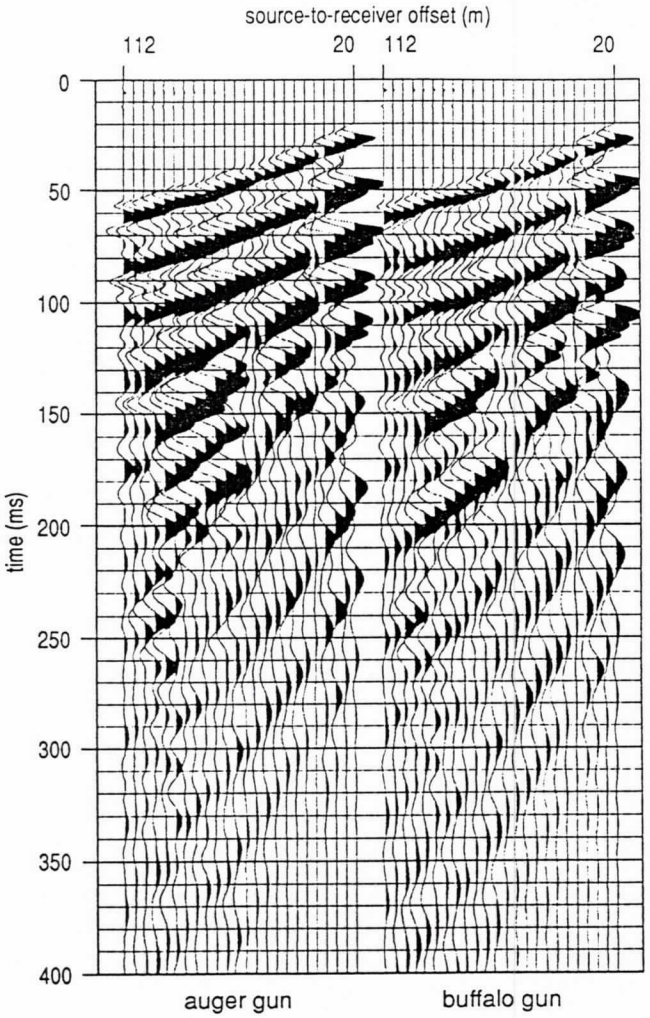

Fig. 2 Auger gun field file (left) compared to the buffalo gun (right).

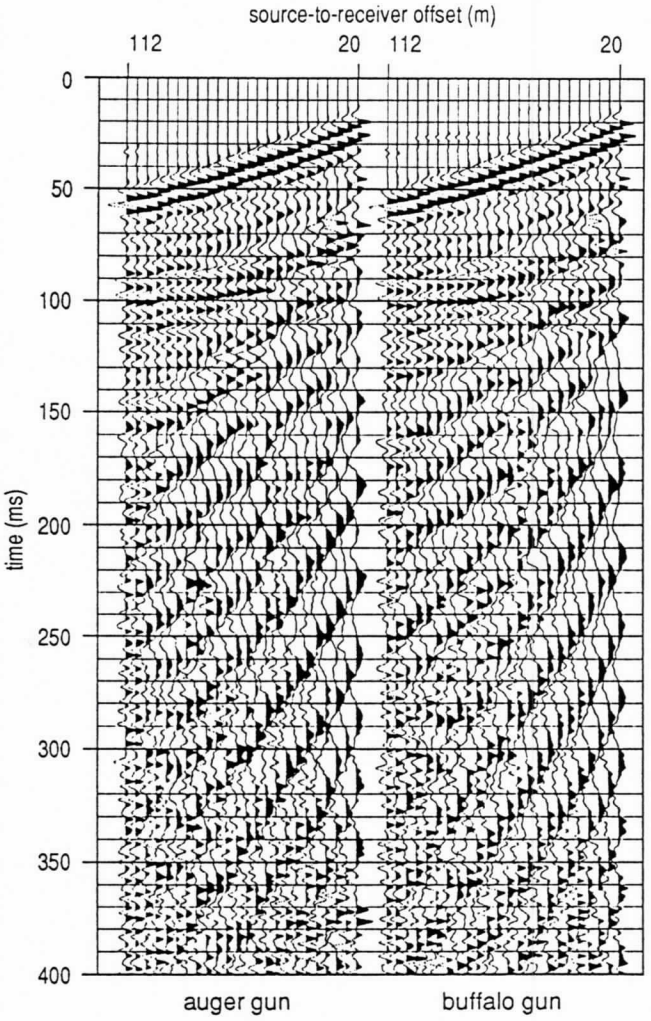

Fig. 3 A 150 Hz digital low-cut filter enhanced the 80 ms reflection event on both the auger (left) and buffalo (right) guns.

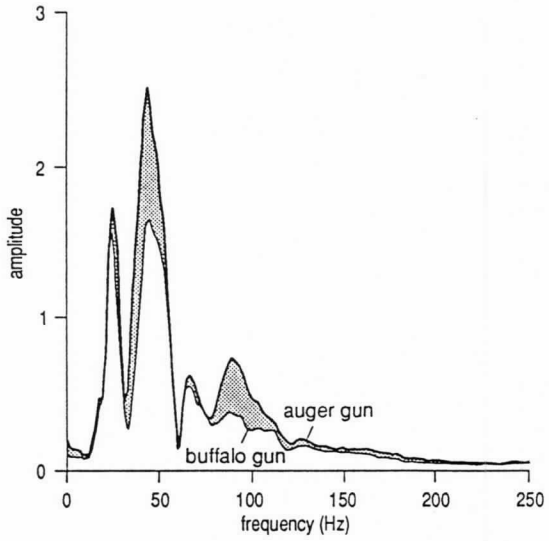

Fig. 4 The darkened area represents the difference between the lower curve (buffalo gun) and the upper curve (auger gun).

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

Funding for this research was provided in part by National Science Foundation Grant No. EAR-8218735. We appreciate Esther Price's efforts in manuscript preparation and Marla Adkins-Heljeson's editorial suggestions.

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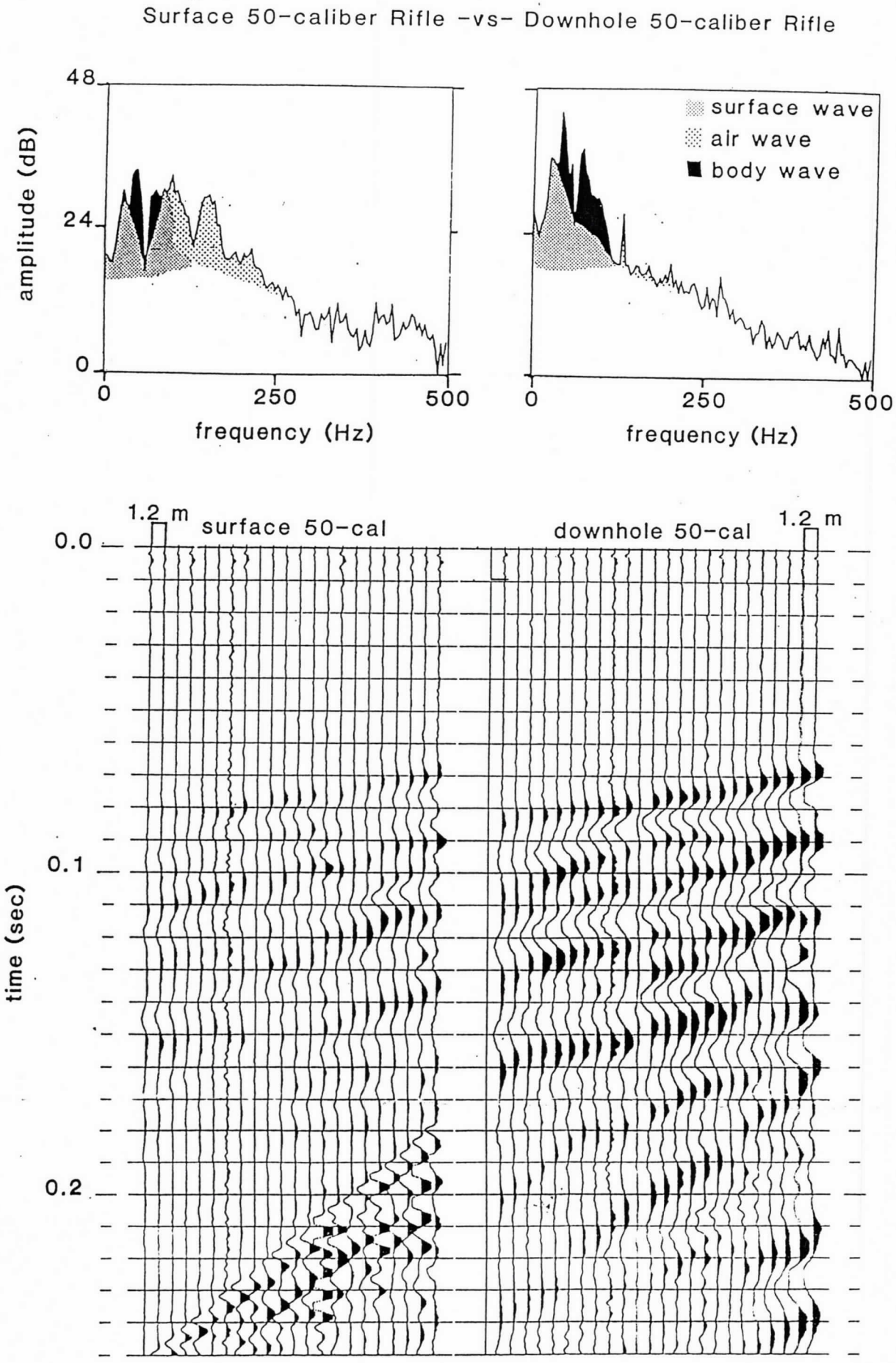


Figure captions:

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

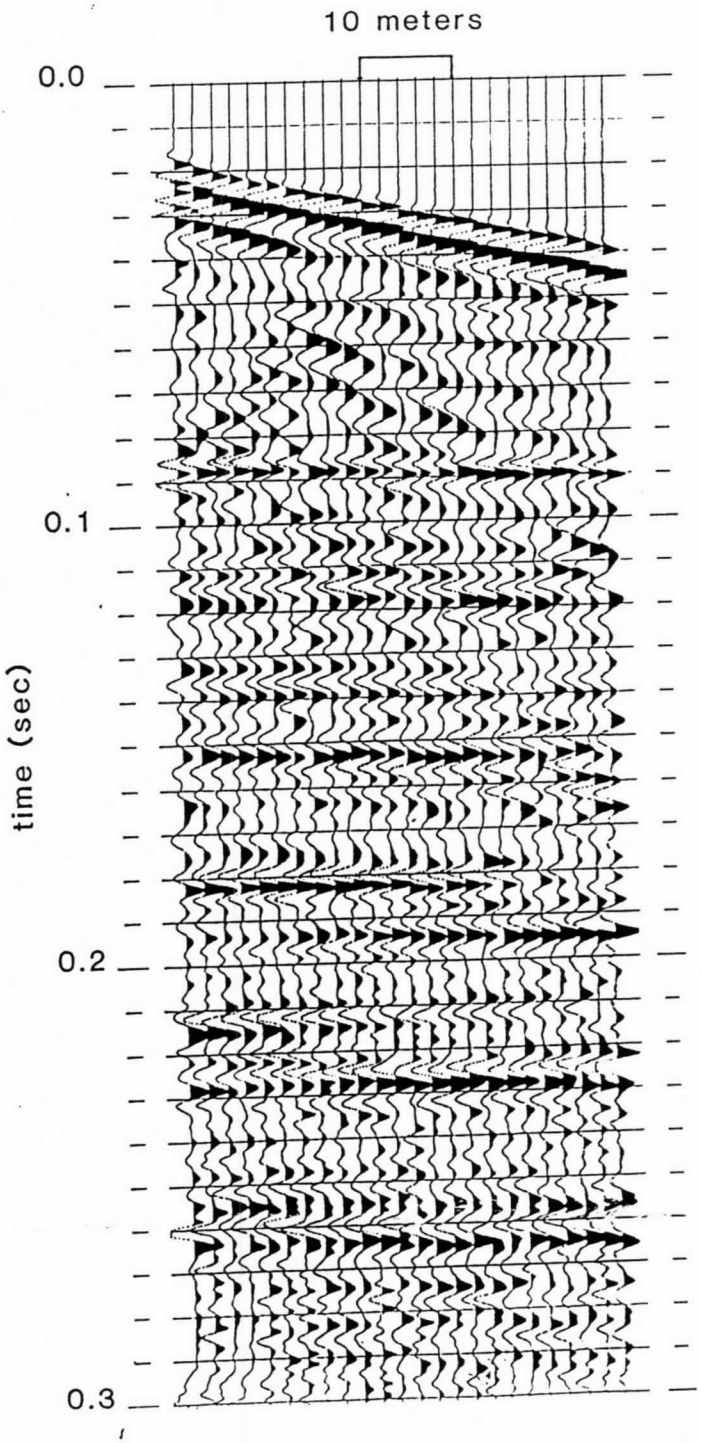


FIG. 2. —This single-shot field file with an AGC applied illustrates the high frequencies and therefore the resolution easily obtainable with a downhole .50-cal.

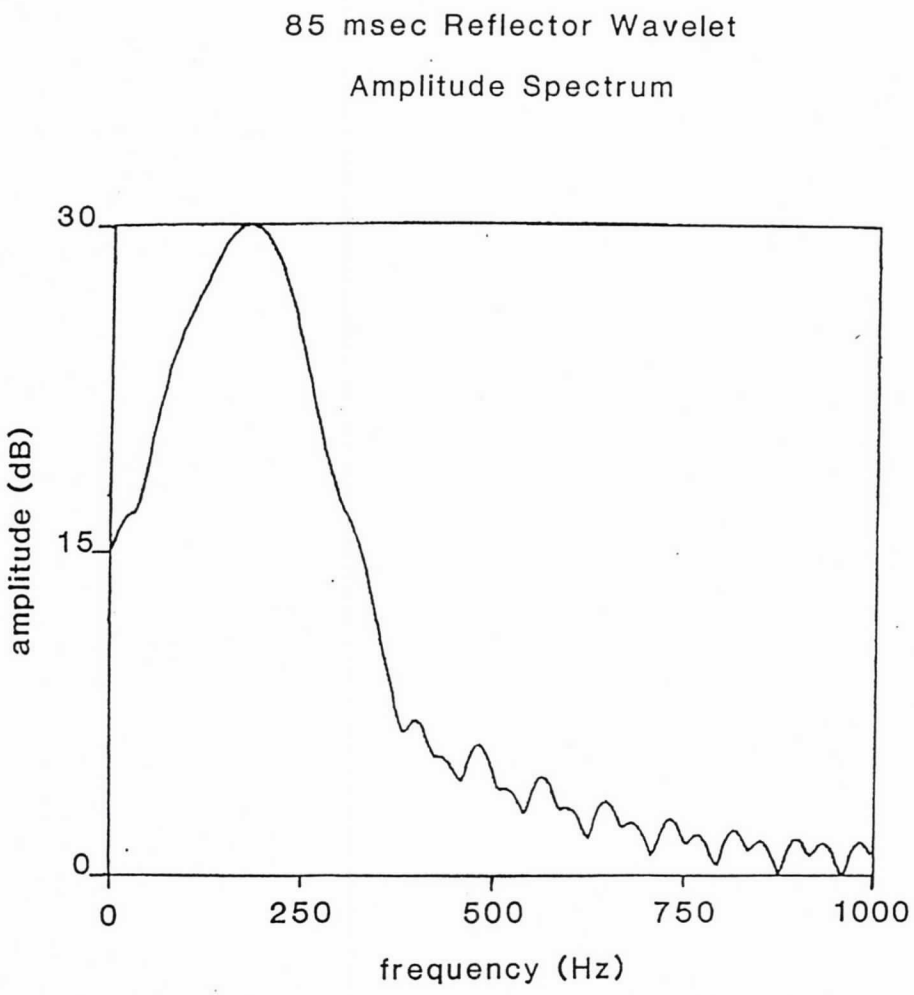


FIG. 3. -The amplitude spectrum of the reflection pulse at 85 msec is almost 3 octaves

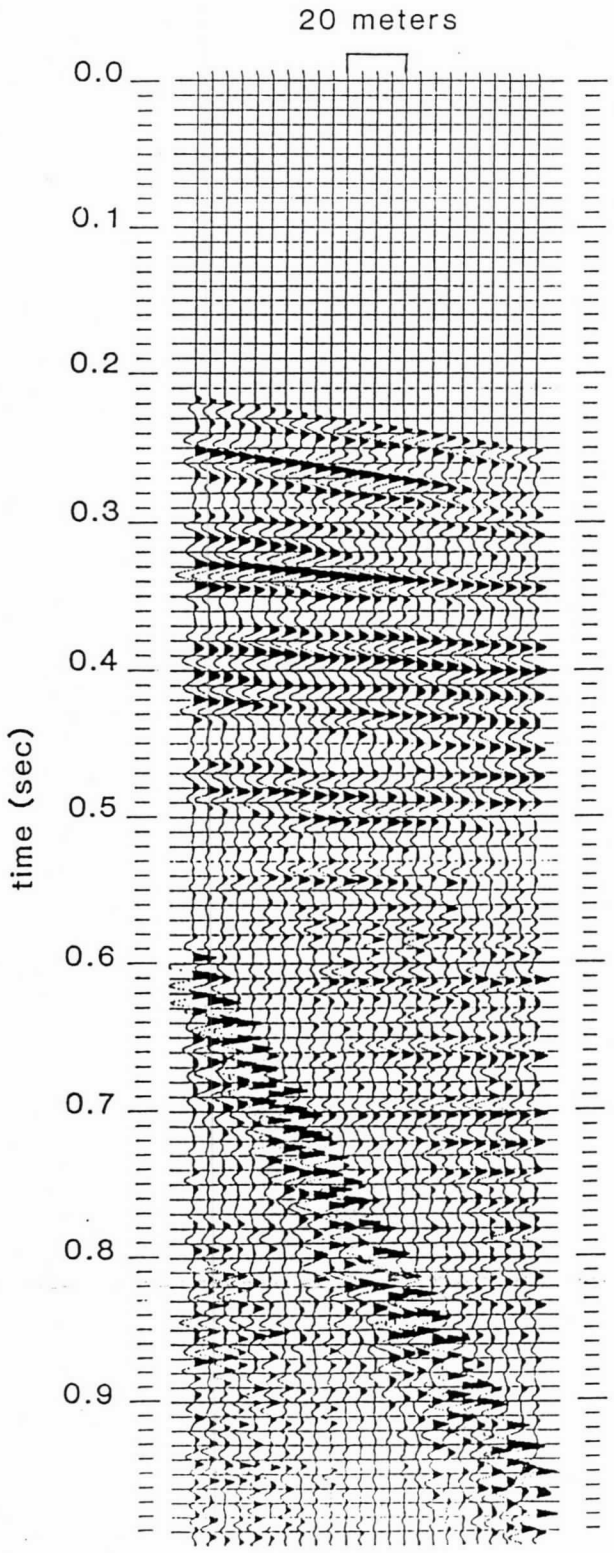


FIG. 4. —This stacked field file has 100 Hz reflection energy as deep as 1100 meters.

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.

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_2O = 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 Toxic
(203) 789

1475

Olin CORPORATION
120 Long Ridge Road, Stamford, Connecticut 0690
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			Conditions to Avoid
	Unstable		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			Conditions to Avoid
	May Occur		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 - Particles Ingestion?

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

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?
Not known 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		Eye Protection	
	Not applicable		Safety glasses when shooting

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

Work/Hygenic Practices Wash hands after skin contact with cartridges.

• USGPO: 1988-491-529/63773

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 - H_2SO_4

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 (@ 77 °F 25 °C) 2.730 ☒ 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: GAS ☐ LIQUID ☒ PASTE ☐ SOLID ☐ 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

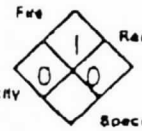
Date May 8, 1991

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 (913) 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

5 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: Neglicible

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 (1)

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 C.O.C. 190 °C 374 °F

27 FLAMMABLE LIMITS %: NDA
LOWER ____ UPPER ____

EXTINGUISHING AGENTS
28
☒ 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

EMERGENCY FIRST AID PROCEDURES

32 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

MATERIAL SAFETY DATA SHEET

PRODUCT SA 825 0012

SECTION V — SPECIAL PROTECTION INFORMATION

VENTILATION TYPE REQUIRED (LOCAL, MECHANICAL, SPECIAL) 36: None Required	PROTECTIVE GLOVES 38: Rubber or plastic oil resistant
RESPIRATORY PROTECTION (SPECIFY TYPE) 37: None Required	EYE PROTECTION 39: 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

44 UNREGULATED BY D.O.T. [X]	U.S. D.O.T. PROPER SHIPPING NAME 47
45 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 46	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 [signature] 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

PRODUCT SA 825 0012

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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

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, Chebanse, 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	UNSTABLE		CONDITIONS TO AVOID: 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	MAY OCCUR		CONDITION TO AVOID
	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

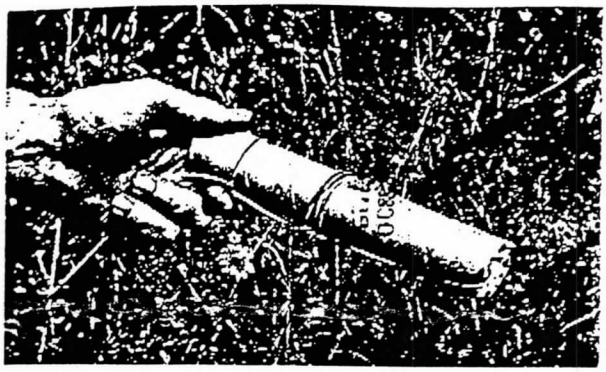
OTHER PROTECTIVE EQUIPMENT

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

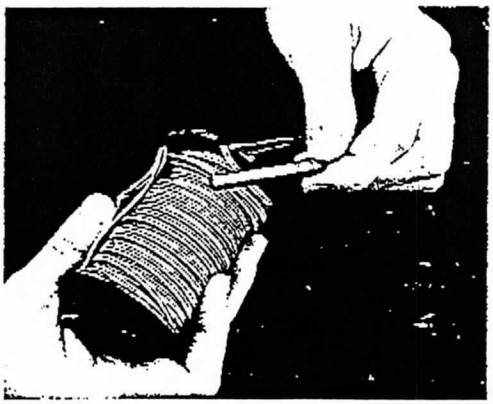
PACKAGING

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.

INVOICE

Van Amburgh/Alamo, Inc.
12900 Preston Road
1220 North Dallas Bank Tower
Dallas, TX 75230
(214) 233-9666

INVOICE DATE	INVOICE NO.	PAG
11/18/91	40649	1

MSDS

SOLD TO
Soc. of Explor. Geophysic
c/o Ks. Geological Survey
1930 Constant Ave.
Lawrence, KS 66046

SHIP TO
Fort Bend Co. Delivery

OPEN NO.	ORDER DATE	CUSTOMER NO.	SALES PERSON	PURCHASE ORDER NO.	SHIP VIA	SHIP DATE	TERMS
40649	11/15/91	S30			Our Truck	11/15/91	Net 30 Days

ITEM NO. / QUANTITY ORDERED	ITEM DESCRIPTION / QUANTITY SHIPPED	STK UNIT	UNIT PRICE	PRICE UNIT	DISCOUNT	EXTENDED PRICE
550408000 12.000	80' SW STATICMASTER 12.000	EACH	816.50	CU		97.98
10812533 4.000	SEISPRIME E 1-1/8 X 1/3 4.000	LB	164.00	CLB		6.56
000000051 1.000	HAZARDOUS MATRL HNDLG CHG 1.000	%SAL	3.14	%SAL		3.14
900000001 4.000	E.R.C.C.- HIGH EXPLOSIVES 4.000	LB	6.50	CLB		.26
000000006 12.000	E.R.C.C. - DETONATORS 12.000	EACH	6.50	CU		.78

DATE 12/5/91
GOODS RECD 11/91
INVOICE RECD 12/91

SALES AMOUNT	108.72
MISC. CHARGES	.00
FREIGHT	.00
SALES TAX	~~6.80~~
TOTAL	~~115.52~~
PAYMENT REC'D	