Seismic Reflection Survey: Health and Safety Plan

Kansas Geological Survey
Exploration Services Section

Ash Grove Cement Company
Omaha, Nebraska
April 2003

Open-file Report #2003-18

Kansas Geological Survey Exploration Services

Accident Prevention Plan

Project Name: Feasibility of High Resolution Seismic Reflection to Map a Drill Inferred Irregularity in Pennsylvanian/Mississippian Contact and Delineate Bedding within a Massive Limestone over 600 ft Deep

Location: Omaha, Nebraska

Plan prepared by _____ _____
Signature Date

Plan approved by _____ _____
KGS Safety Officer Date

Plan has been reviewed by the following crew members:

Name (printed)	Signature	Date

KANSAS GEOLOGICAL SURVEY EXPLORATION SERVICES
ACCIDENT PREVENTION PLAN

I. PROJECT DESCRIPTION

Project Name: Feasibility of High Resolution Seismic Reflection to Map a Drill Inferred Irregularity in Pennsylvanian/Mississippian Contact and Delineate Bedding within a Massive Limestone over 600 ft Deep

Location: Omaha, Nebraska

Site Safety Officer: Richard D. Miller

Plan Prepared by: Richard D. Miller

Estimated Duration of Field Work: 5 days

II. STATEMENT OF WORK

This high-resolution seismic reflection study will attempt to image the feature responsible for a discrepancy of more than 400 ft in the top of the Mississippian between two boreholes located less than a half-mile apart (Figure 1). The primary goal of this study will be to map the uppermost Mississippian limestone and the basal Pennsylvanian contact. It is critical that this contact be mapped with sufficient detail to allow a reasonable description of the feature and likely process responsible for the apparent inconsistency between coreholes 02-17D and 02-18D. Of secondary interest is the delineation of any thin chert, quartz, and shale stringers that might be present within the massive (over 100 ft thick) Mississippian limestone encountered in hole 02-17D around 650 below the ground surface. With the Midcontinent Geophysical Anomaly (MGA), also called the Midcontinent Rift, immediately west of the study area and the northern edge of the Nemaha Ridge immediately south of the study area, extreme structural and depositional features are locally possible. State-of-the-art shallow high-resolution seismic reflection techniques possess the potential to detect, delineate, and evaluate the locally complex structures and stratigraphies suggested by borings and possibly associated with the two major structural features (MGA and Nemaha Ridge) mapped in this area.

The project will consist of two major 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 the Ash Grove Cement Company (AGC). The testing phase will consist of walkaway tests near the planned survey lines. Walkaway noise test data 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 the test data will dictate if the project proceeds to the next phase and the acquisition approach taken during the production portion of the project. Both KGS and AGC will jointly determine if the production phase will commence.

Seismic images and the resulting geologic interpretations of those seismic images will be optimized to include the entire Mississippian limestone of interest and the bottom several hundred feet of the Pennsylvanian section in this area. This optimization requires the high-resolution reflection data correlate to existing ground truth (borings 02-17D and 02-18D) with a high degree of confidence. Shallow, high-resolution seismic reflection techniques have been successful delineating stratigraphic and structural features associated with a variety of tectonic and depositional features throughout the Midcontinent (Miller et al., 1990b; Geier, 1999; Miller et al., 1995b).

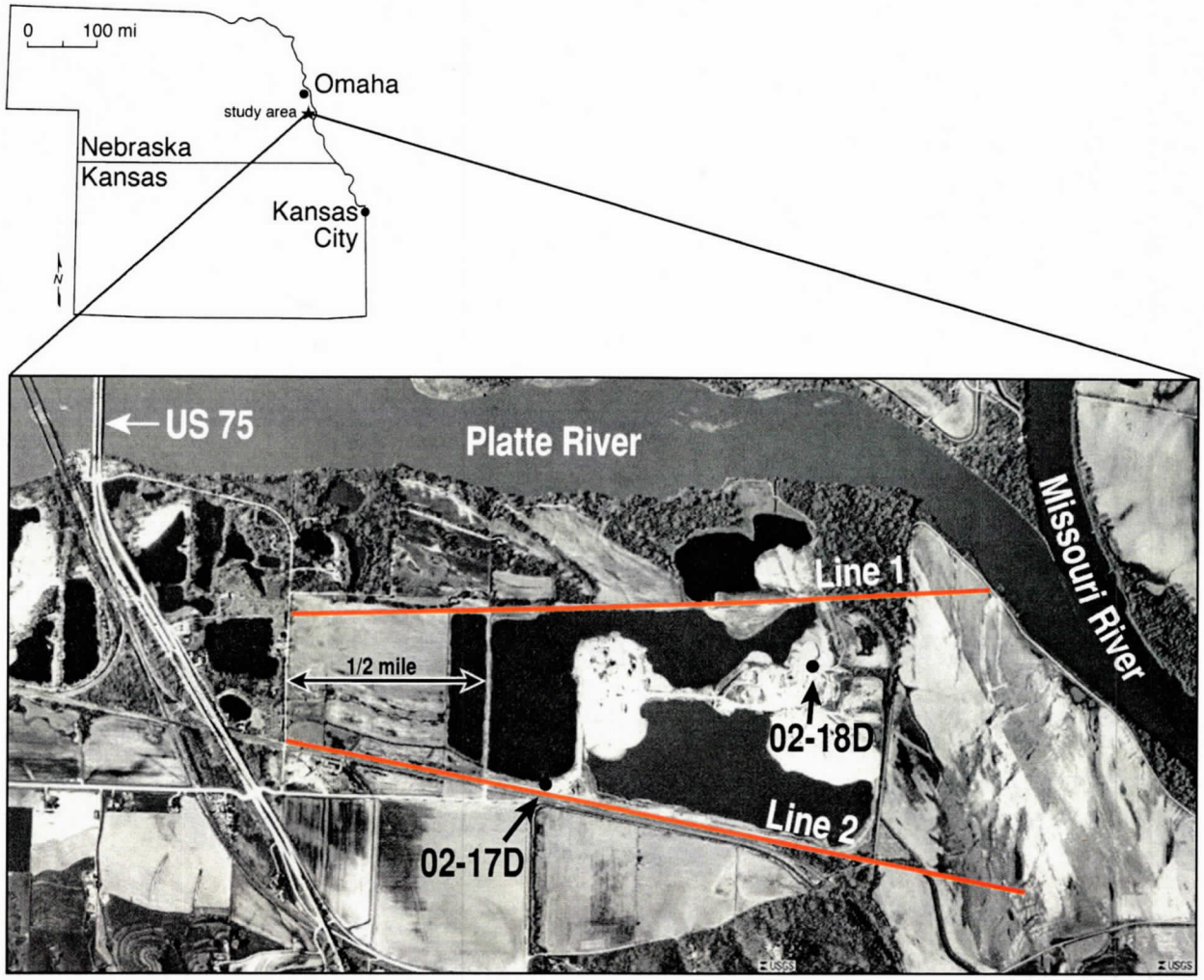

Figure 1. Site map with proposed lines along the north and south property boundaries of the Lyman-Richey Plant #8.

Seismic data from this study could play an important role in improving the overall understanding of the nature and consistency of regional-scale structures and stratigraphies as observed on the high-resolution seismic reflection profile acquired over the Nemaha Ridge between St. Marys and Manhattan, Kansas. Correlating the findings of this survey with the Kansas data could help establish extent, timing, and regional consistency of tectonic features observed on seismic data and inferred in Kansas from drill data.

Accurate time-to-depth conversions of CMP stacked seismic reflection data is critical to accurate geologic interpretations in highly altered or geometrically complex subsurface setting. Uphole velocity surveys may be important add-ons for future drilling programs.

This study will focus on: 1) application of minimal to noninvasive, high-resolution seismic techniques in this alluvial near-surface setting, 2) maximizing the resolution potential (both horizontal and vertical) in this potentially complex structural setting, 3) optimizing source and acquisition geometries for resolution and survey economics, 4) correlating seismic data with borehole data, 5) delineating intra-limestone beds as thin as a few feet at over 700 ft below ground surface, 6) 3-D geometry of the feature responsible for the discontinuity between the two coreholes on the Lyman-Richey Plant #8, and 7) establish analogies and possible chronologies as they relate to structures observed on seismic profiles studying faulting near the Nemaha Ridge in north-central Kansas.

The production data will require 4 to 6 days (depending on conditions) and will follow well-established shallow high-resolution data acquisition procedures (Hunter et al., 1984; Knapp and Steeples, 1986; Steeples and Miller, 1990). The basic structure of both the acquisition and processing flow will be roughly designed around the findings of the preliminary testing. Production data will be acquired in a standard CDP format (Mayne, 1962) using roll-along acquisition techniques similar to conventional petroleum exploration data acquisition. Ideally, an uphole or check shot survey should be acquired in a nearby borehole to enhance confidence and preliminary event identification. Step-by-step analysis during the acquisition and processing phases of the survey will be continuous with appropriate modifications made if deemed necessary to ensure the quality of the final product. The geophone spacing, seismic source, source spacing, optimum fold, geophone type, spread geometry, sampling interval, total samples, shots/point, and acquisition philosophy will be based on extensive pre-production tests.

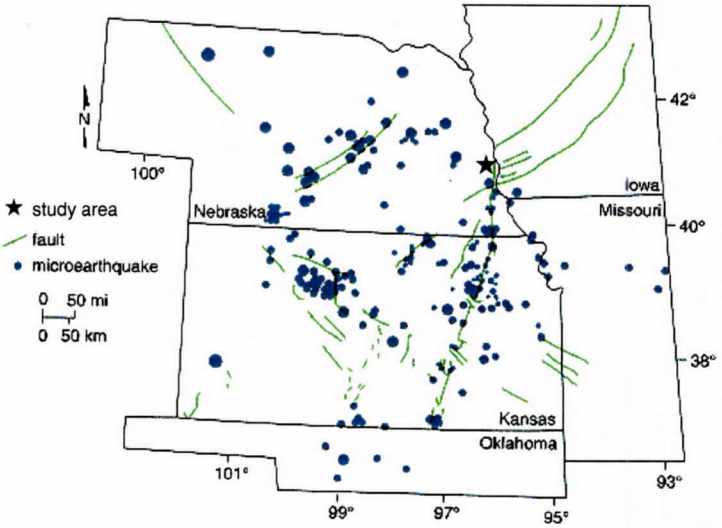

Figure 2. Microearthquakes recorded by the Kansas Geological Survey between August 1977 and August 1989 are size-coded by local magnitude. The largest event had a magnitude of 4.0 and the smallest had a magnitude of 0.8 on the Richter Scale (from Steeples, 1995).

Geologic and Geophysical Setting

The study area lies immediately north of the Nemaha Uplift (Ridge) and within an area that has been strongly influenced by the tectonic activity associated with the Precambrian Midcontinent Rift System (MGA) (Steeples, 1995) (Figure 2). The Nemaha Ridge is a buried granite mountain range that formed about 300 million years ago near the end of the Mississippian and beginning of the Pennsylvanian. From subsurface data alone it is currently interpreted to extend from roughly Omaha to Oklahoma City (Figure 3). In some places along the eastern front of this mountain range elevation changes of over 2000 ft in less than three miles horizontal have been documented (Cole, 1976; Geier, 1999). The faults that bound the Ridge are still slightly active today, especially the Humboldt fault zone that forms the eastern boundary of the Nemaha Ridge.

About 50 miles west of the Nemaha Ridge in Kansas is the MGA, a zone of the earth's continental crust that was ripped apart and filled with oceanic-type crust (basaltic rocks) about 1.1

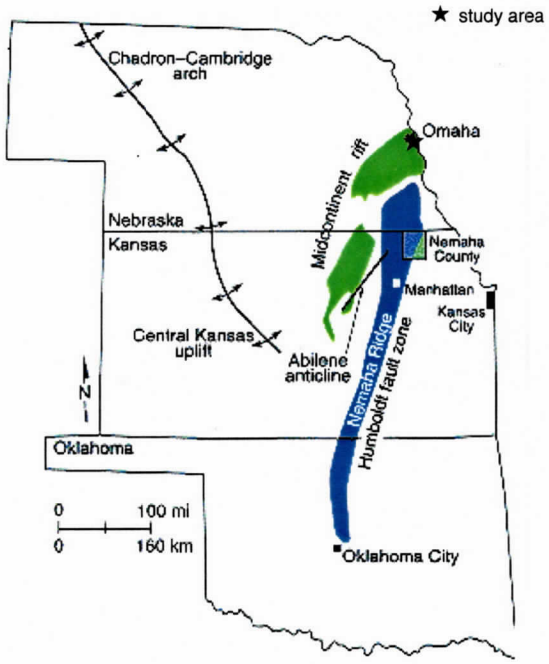

Figure 3. Major regional tectonic features that are apparently related to earthquake activity. Nemaha County is the locality where the Nemaha Ridge was discovered by drilling in the early 1900's (Kansas Geological Survey, 1989, Bulletin 226).

billion years ago. This rift zone extends from central Kansas northeast across Nebraska, Iowa, and Minnesota, and into the Lake Superior region. Why the rifting stopped after only spreading about 30 to 50 miles is not known; but if it had not stopped, the United States would have likely separated into two different continents with the present day Kansas split by an ocean which would have provided beach front property near present day Salina, Kansas.

Considering the proximity of the study area to the intersection of the MGA and Nemaha Ridge, regional faulting, folding, and fracturing of mid-Pennsylvanian and early rock layers would not be unexpected. Two coreholes located within a half-mile of each other and reported to be less than 2 miles from a basement granitic intrusion (suggested to be part of the MGA) were drilled by AGC and provide the essential ground truth for this study (Figure 3). Rocks encountered in the two boreholes were interpreted to be dramatically different below about 400 ft. This difference is most clearly seen contrasting the lithologies below the thick Pennsylvanian shale that rests unconformitably on a Mississippian limestone in hole 02-17D at about 570 ft (Figure 4) with the same Pennsylvanian shale in a second hole 02-18D immediately northeast where the thick Mississippian limestone is replaced by at least 400 ft of cyclic Pennsylvanian sequences.

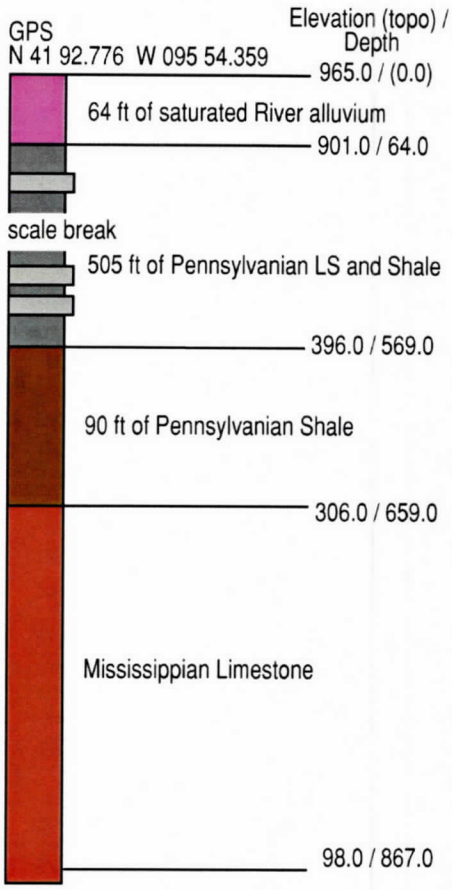

Figure 4. General log of hole 02-17D.

Indicative of the unique evolution of this rift/ridge area is the presence of Pennsylvanian clastic basal strata near the eastern Nebraska-Kansas border on the eastern flank of the Nemaha Uplift. The coarse, feldspathic sandstones and conglomerates derived from Proterozoic granitic basement of the Nemaha Uplift that make up these strata show upward transitions from coarse, poorly-sorted, clay-cemented, feldspathic sandstones into shales and/or mudstones with paleosols (Joeckel et al., 2002). Once the lithologic interpretation of the core from 02-18D is complete, the number of possible scenarios relating to geologic setting, lithologies, and structures should be reduced.

Experimental (Testing) Phase

Experimentation will focus on a series of tests designed to evaluate a variety of acquisition methods and parameters. These experiments will revolve around walkaway noise tests, which involve recording data from a variety of sources and source locations, using various configurations, into a fixed spread of receivers. These data will be recorded on a 24-bit, 240-channel Geometrics StrataView seismograph. The test spread needs to be located in an area with a uniform, relatively undisturbed subsurface, far enough away from the highway to minimize the recorded vehicle noise and the known geologic anomaly to avoid wavefield abnormalities. Considering the drill data from this site, testing will best be accomplished in the northwest corner of the site (Figure 1). It will likely take around half a day to complete this aspect of the program.

At some time during this seismic program it may prove beneficial to acquire a vertical velocity survey in an open borehole. Since seismic methods measure earth response in time, to make direct correlations and comparisons to drill data (which is measured in depth) a relationship between time and depth must be established. Borehole velocity surveys are designed to measure the acoustic travel time from the ground surface to specific layers at various depths in the subsurface. The resulting measured velocity function would be used to establish the accuracy of the estimated velocity function, which will

be derived from curve fitting and semblance routines during the processing of the CMP data. Defining the earth's velocity function using one-way travel times greatly enhances the correlation of reflections to reflectors and therefore greatly improves interpretations of depth and bed thickness on CMP stacked section. Vertical velocity measurements provide a measure of true average velocity for establishing a realistic time-to-depth conversion for two-way travel time CMP stacked sections.

A walkaway spread will be deployed along the west end of line 1. The walkaway will consist of source-to-receiver offsets ranging from 8 ft to approximately 1900 ft. The receiver interval for this testing will likely be 8 ft. The 8-gauge Auger Gun (Healey et al., 1991) (requiring only class C explosives), 50-cal downhole, and IVI Minivib high-frequency vibrator will be available for testing (Figures 5a, 5b, and 5c). This testing will determine which source is optimum for the near-surface conditions, target depth, resolution requirements, and environmental constraints. Each source tested 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 double 40 Hz Mark Products L-28E geophones and triple 10 Hz Mark Product U2w geophones wired in series (Figures 6a and 6b). The 10 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 it is known that 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 could be bypassed.

Data collected during the experimental phase of this survey will be reduced to the appropriate final display format on site. All walkaway noise tests will be displayed according to source-to-receiver

Figure 5a. Auger gun (12 gauge and 8 gauge).

Figure 5c. IVI minivib.

Figure 5b. Vehicle-mounted 50 cal. downhole source.

Figure 6a. Double 40 Hz geophones with 14 cm spikes.

Figure 6b. 10 Hz UltraPhones with 14 cm spikes.

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 forward 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 CMP production lines at each site will be based on analysis of all walkaway tests.

Production Acquisition

Optimally, two sub-parallel profiles will be collected along the north and south property boundary of the Lyman-Richey Plant # 8 (Figure 1). This line orientation will provide the optimum subsurface coverage for a minimum of cost and time commitment. A 240-channel rolling spread compressional wave survey will be acquired along and through the tree line near the northern property boundary and in the north railroad ditch along the south property line. Both profiles will extend into the State land located immediately east of the eastern Lyman-Richey property line. The two profiles will each be approximately 2 miles long with the boreholes located between and in the eastern one-third of the survey area.

Based on previous experience, the IVI Minivib will be the source of choice to acquire data along the northern boundary and either the 8-gauge auger gun or 50-cal downhole projectile source the source of choice in the railroad ditch. The minivib is a non-invasive high frequency vibrator that puts less than 3 psi pressure on the ground surface, thereby minimizing ground deformation and optimizing mobility while providing over 4000 lbs of force at 200 Hz. The downhole sources on the other hand are small, maneuverable, minimally invasive (2" hole, 3 ft deep), and if they deliver sufficient energy to depth, will provide a very high frequency repeatable energy pulse in most alluvial settings with a shallow water table.

A source spacing of around 32 ft seems most reasonable to efficiently achieving the goals of this program. Receiver spacing will likely be 16 ft; this determination is based on experienced analysis of a 15 mile long CMP profile across the Nemaha Ridge near Wamego, Kansas, that was acquired in the summer of 1997 by the KGS. As at this site, the near-surface material along the Wamego, Kansas, profile was river valley alluvial (Figure 7). These Kansas data were acquired with 55 ft source and receiver spacings and do not possess sufficient detail, sampling, and resolution to confidently map key features that might be observed at this site. Therefore, reducing the receiver spacing to 16 ft and source spacing to 32 ft should best match the seismic data characteristics with the local geology and borehole data. The equipment parameters chosen to record the CMP lines will incorporate the results of both walkaway noise tests and previous experience studying similar targets at similar depths.

The fold (redundancy) and sampling frequency (spatial and temporal) proposed here should provide sufficient split-spread source/receiver geometries and trace separations to produce velocity maps at accuracy levels of 10% or better and detect bed offsets or material changes at horizontal and vertical resolutions on the order of 40 ft and 15 ft, respectively. Of key interest will be the geometry of layers

that can (above 660 ft) and cannot (below 660 ft) be correlated between the two boreholes. Recently developed conceptual geological models for this site explain the discontinuity observed in the two boreholes as either indicative of Late Mississippian or Early Pennsylvanian faulting or erosion (large incised valley).

The production acquisition phase of this project will begin after the testing phase is completed and KGS and AGC are satisfied with the parameter design. The data should be acquired in four days or less. Acquisition equipment in general and source and receiver selection in particular 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 data will be acquired using a CMP fixed rolling spread technique, which will result in nominal 30-fold CMP stack sections with trace or subsurface sample spacing of 8 ft. Parameters such as sampling interval, record length, and sweep settings will be determined after careful examination of the dominant frequency and usable bandwidth of reflection energy on walkaway data. The production data will probably be acquired using an asymmetric split spread source/ receiver geometry to enhance continuity and increase velocity and dip control. The source-to-nearest receiver offset will likely be on the order of 12 ft with a maximum source-to-receiver offset range from about 1000 ft to approximately 2900 ft (optimum range is between 50 and 1200 ft). Modifications to the source/receiver geometries and offsets may be necessary after analysis of the data acquired during the testing phase.

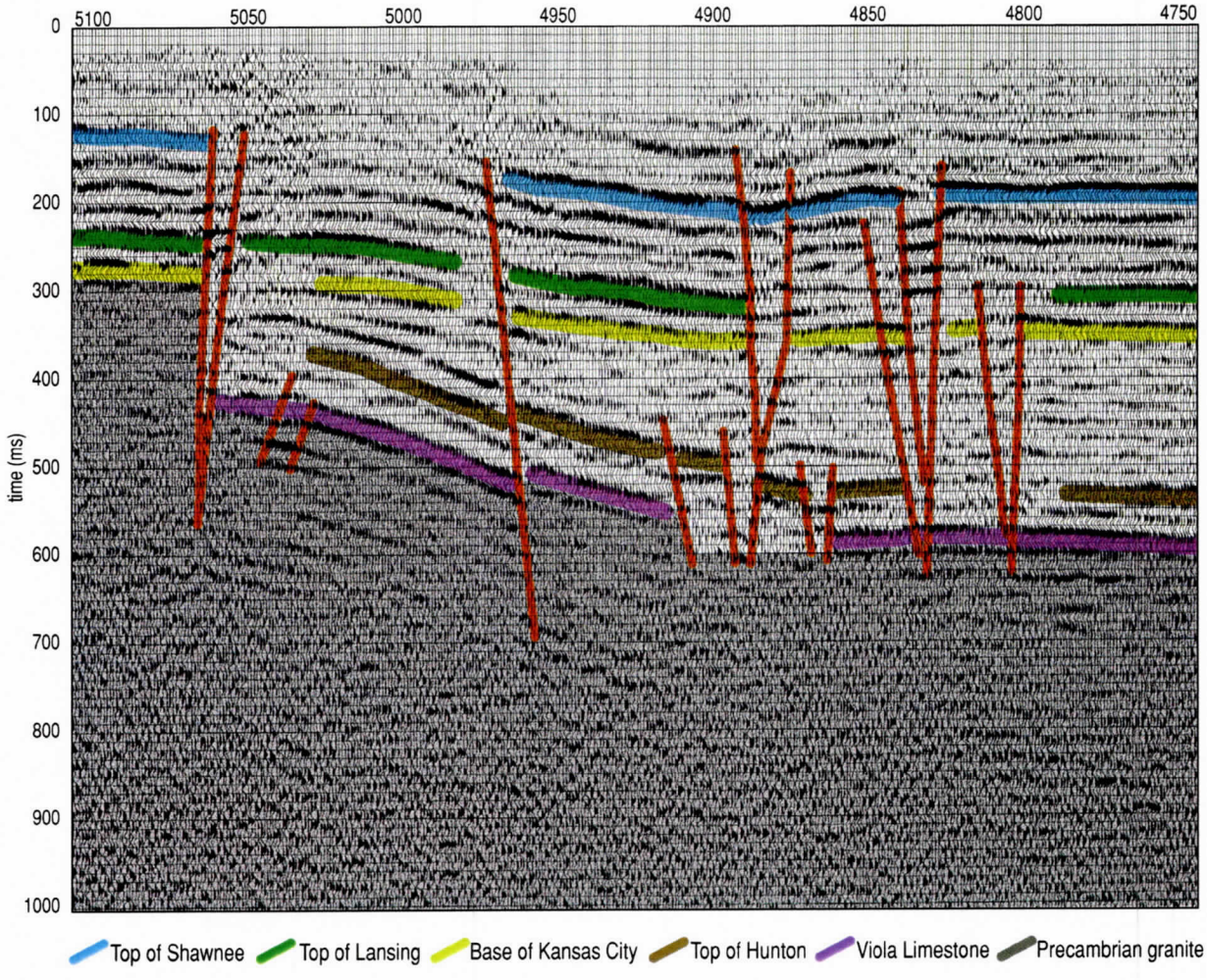

Figure 7. Humboldt fault zone interpreted on seismic data collected between St. Marys and Manhattan, Kansas.

Final design of the field geometries will be based on analysis of potential (using physical properties derived from the test data) versus required resolution (Miller et al., 1995a). The quarter-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 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., 1990a) while a minimum of four times will be maintained throughout the survey (Knapp and Steeples, 1986).

QA/QC

The data acquired and processed on this survey will be managed to ensure the highest quality and most accurate acoustic representation of the geologic setting possible. Current state-of-the-art techniques will be used in a fashion that is appropriate and verified with step-by-step QA/QC. The most important (possibly even essential) information provided (besides the CDP stacked section itself) will be samples of shot gathers after passing through key intermediate processing steps. This information allows the geophysicist and geologist to make determinations as to the authenticity of processed seismic sections. Seismic processing software and techniques are very power tools that, if not used properly, can and most likely will result in unrealistic interpretations.

The equipment and recorded data will be continuously monitored during acquisition to ensure the highest quality CMP stacked section. The response amplitude of receivers will be monitored using a modified tap test performed after the planting of each geophone or group of geophones. The continuity and leakage of each active station will be meter-monitored prior to each shot. The system will be subject to a series of pre-acquisition tests designed to insure the integrity of analog filters, consistency in system noise, and precision in digitally stored data. Visual analysis of general signal-to-noise ratio, environmental noise, DC bias, and variations in the optimum recording window will be performed on at least every fifth field plot.

Production Processing

High-resolution seismic reflection data, by its very nature, lends itself to over-processing, inappropriate processing, and minimal involvement processing. Interpretations of high-resolution shallow reflection data must take into consideration not only the geologic information available, but also each step of the processing flow and the presence of reflection events on raw unprocessed data. Processing for the reflection portion of this study will include only operations or processes that enhance signal-to-noise-ratio and/or resolution as determined by evaluation of high confidence reflections interpreted directly on shot gathers (Figure 8). For the most part, processing of high resolution shallow reflection data is a matter of scaling down conventional processing techniques and methods; however, without extreme attention to details, conventional processing approaches will produce undesirable artifacts. In-field processing of the reflection data will result in a brute stack used to insure the data acquired are of sufficient quality to provide meaningful interpretations and to permit the merging of the different modes when final processing is completed several months after leaving the field. In-field processing will be coincident with data acquisition and will not impact the full day field schedules.

The basic architecture and sequence of processing steps to be followed during the generation of the final stacked sections will be similar to conventional petroleum exploration flows (Yilmaz, 1987). The primary exceptions relate to the step-by-step QC necessary for the highest confidence interpretations of shallow features and realization of full resolution potential (Miller et al., 1989; Miller et al., 1990a; Miller and Steeples, 1991) (Figure 8). Specific distinctions relate to the emphasis placed on velocity analysis (Miller, 1992), lack of extensive wavelet processing, care and precision placed on muting, step-by-step analysis of effects of each operation on reflected energy, limiting statics operations to maximum shifts no greater than one-quarter wavelength of the dominant reflection energy with large correlation windows, and coincident iterative velocity and statics analysis.

Each analysis step in the processing flow will be available for critique. Any additional information requested during the processing flow will be generated within a reasonable amount of time (amount of time determined jointly). All digital information will be delivered on the requested magnetic media

(if readily available). All hardcopy displays of analysis steps as well as any specially requested data displays will be delivered on 300 dpi plots. Horizontal and vertical scale on hard-copy displays will be set to maximize the analysis potential of these and existing data.

Special emphasis will be placed on all the analysis portions of the processing flow. It has been proved necessary and most effective to do velocity, spectral, and on certain occasions deconvolution analysis on every CMP (Steeples and Miller, 1990). Many times variability in near-surface materials and/or conditions require changes in processing parameters over distances of less than 20 m. To insure the highest quality geologically representative stacked section, velocity analysis on every CMP is necessary. In association with point-by-point analysis, care must be taken to ensure that all coherent events interpreted on stacked sections as reflections are indeed reflections. Biasing processing parameters to enhance events interpreted as reflections that are actually coherent noise must be avoided at all cost. Differentiating reflections from direct wave, refractions, air wave, and ground roll in the early portion of a stacked section is an extremely difficult task and must not be taken lightly.

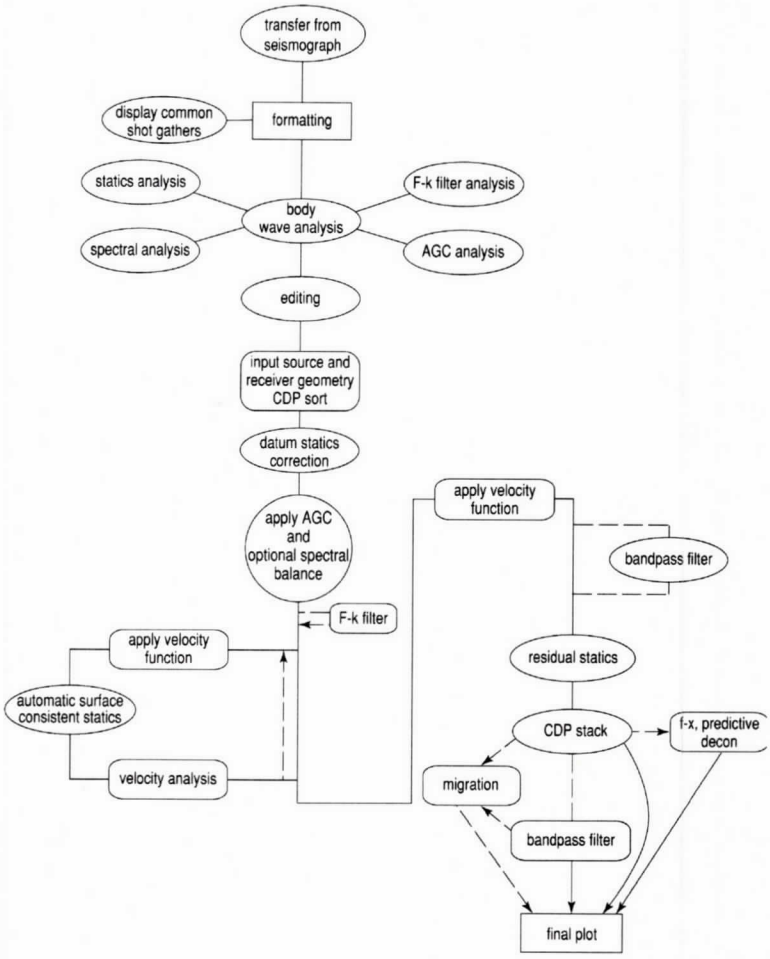

Figure 8. Processing flow.

As much effort as possible will be made during processing of this data to interact with AGC staff to insure the most accurate stacked seismic reflection sections. The interpretation stage of this project will be critical and should involve integration of geophysical with geologic models. Interpretation of the resulting CMP stacked section and generation of associated geophysical models will require a cooperative effort to produce a representative cross-section.

Geologic Interpretation

Geological interpretations will, for the most part, be consistent with well-established concepts and practices with particular emphasis being placed on velocity analysis, layer resolution, and reasonable bed variability when making geologic inferences. Based on the proposed acquisition and processing plan it should be possible to coincidently interpret both seismic profiles and the corehole data in such a way as to produce a pseudo 2½-D section of the subsurface at this site. Faults and folds, as well as major depositional or erosional features that have been proposed based on corehole samples from this site, should be correlatable between the two planned seismic sections.

It will be the intent of this survey to provide a geologic interpretation of the subsurface, loosely correlating major reflections with reflectors and identifying any disturbance in the otherwise uniform bedding expected in this part of the mid-continent. Extrapolation of areas interpreted to have folding, faulting, or depositional/erosional variations beyond the survey lines will depend on degree and apparent consistency of interpreted features on seismic profiles. Intra-bed variability in layers identified in core

data will be interpreted if the survey resolution permits. Changes in average material concentrations (i.e., thickening of a chert or shale layer within a thick limestone unit) will be studied and estimations made if data quality permit.

Overall Project Goal

The goal of this study is to determine the feasibility of imaging and resolving structural and stratigraphic features within the upper 1000 ft consistent with interpretations guided corehole samples taken within a quarter-mile of the proposed seismic lines. The results of this study will include: an overall appraisal of the high-resolution seismic method (resolution/signal-to-noise); time-to-depth converted interpreted CMP stacked sections focusing on sitewide correlation of geologic units; an empirically based geologic cross-section correlating layers between boreholes and across the site; structural features and potential mechanisms associated with this localized feature; evaluation of confidence in extrapolations between stacked section and boreholes; comparison and contrast with seismic data along the eastern side of the Nemaha Ridge; and evaluation of current equipment and methodologies addressing these kinds of geologic problems in this type of setting.

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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 USACE as well as those included in this document.

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

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

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

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

4. Safety glasses will be worn by crew members when operating vehicles or sources.

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

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

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

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

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

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

IV. SAFETY PERSONNEL

Safety Personnel and Emergency Contacts

1. Rick Miller (KGS)—Site Safety Officer
2. David Laflen (KGS)—Operations
3. Jeff Beech (AGC)—Delegated Representatives and Site Supervisor

Safety Meeting at Survey Site Date: _____

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

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

Safety Meeting at Survey Site Date: _____

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

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

Safety Meeting at Survey Site Date: _____

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

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

Safety Meeting at Survey Site Date: _____

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

The following people were present today:

Name (PRINT)	Company	Signature

_____
Site Safety Officer

V. EMERGENCY INFORMATION

Nebraska State Patrol	1-800-525-5555 (or *55 on cellular)
Cass County Sheriff (AGC site)	(402) 296-9370 (in Plattsmouth, NE)
Sarpy County Sheriff (BW motel)	(402) 593-2288 (in Papillion, NE)
Emergency Medical–Ambulance	911
Midlands Community Hospital	(402) 593-3300 (1111 S 84th Street, Papillion, NE)
Alegent Health	(402) 593-1700 (8074 S 84th Street, LaVista, NE)

Lodging—BW White House Inn: (402) 293-1600 (305 Fort Crook Road N, Bellevue, NE)

DIRECTIONS: Coming North on US75, exit on Cornhusker Rd, turn right, go ~½ mi to Fort Crook, left on Fort Crook ~½ mi, is on right side of the road. See map next page.

AGC Emergency Contacts

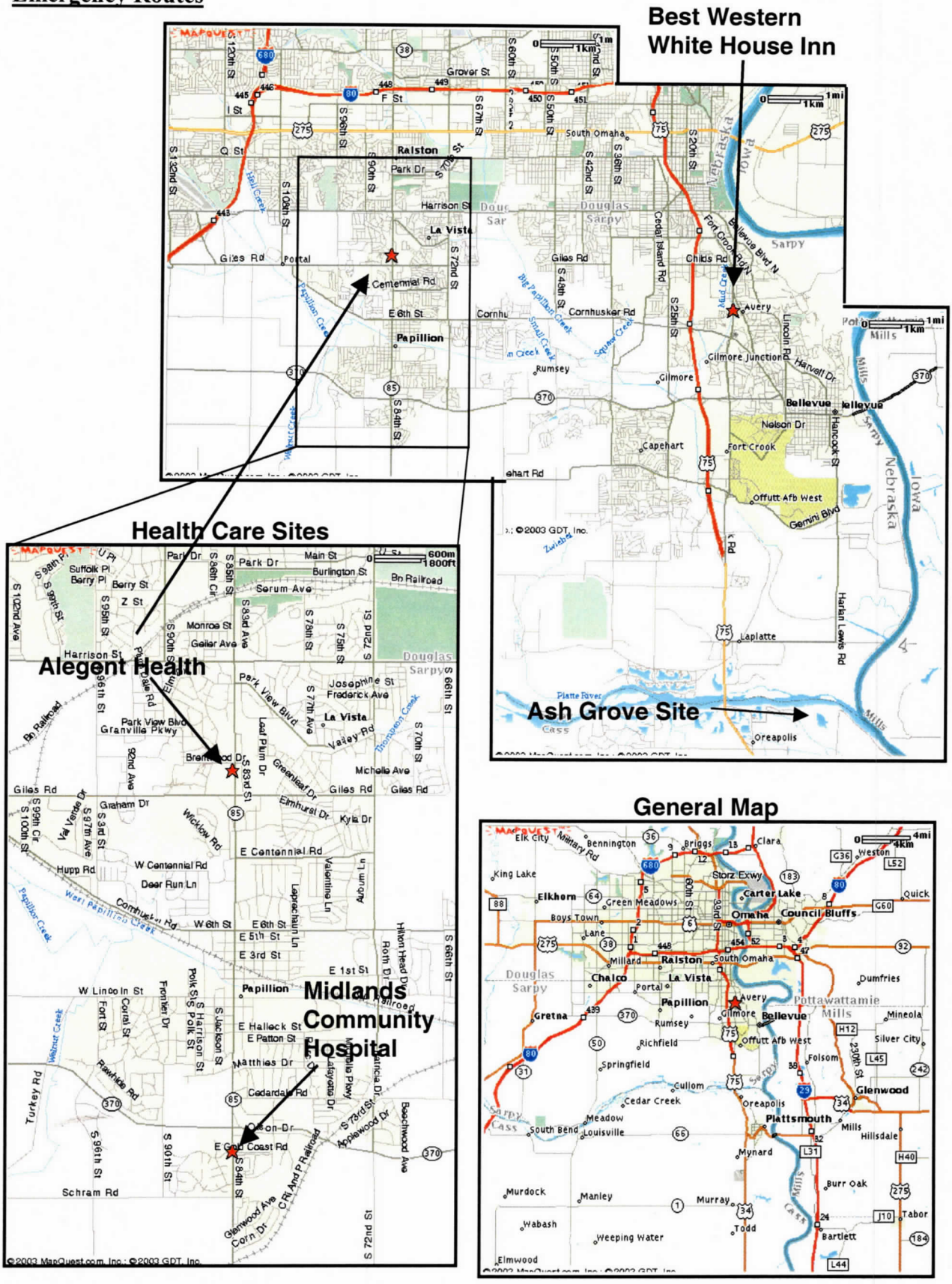
AGC Plant (402) 234-3415
Jeff ext. 271
Howard ext. 266
Operator for paging, dial 0

KGS Emergency Contacts

Safety Coordinator and Project Manager
Rick Miller, Kansas Geological Survey
Cellular (in the field): 785-766-8638

KGS Safety Officer
Kathy Sheldon, Kansas Geological Survey
Office: 785-864-2109

Emergency Routes



Procedures

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

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

The following persons are certified as indicated (strikethrough denotes no certification):

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

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

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

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

VI. TASK SPECIFIC HAZARDS

The purpose of the geophysical investigation is to acquire seismic data that can be used to extract key physical properties of the near surface.

Downhole Auger Gun

One of the geophysical tests proposed to be employed requires the use of an auger gun (shotgun type device) to introduce energy into the ground (Healey et al., 1991). This device consists of a small skid-steer loader with an attached auger/screw. The operation consists of (1) screwing the hollow stem auger approximately 3 ft into the ground, (2) retrieving the center bit, (3) loading the shell in the firing tube and lowering the tube until it latches in place, (4) firing the gun by impacting the top of the firing tube with a small hammer, and (5) unscrewing the auger from the ground. The auger gun uses a *blank* 8-gauge or 12-gauge shotgun shells fired below the ground surface in a downward direction. The device is built to minimize any danger to persons handling and moving the device, as well as avoid leaving any residual materials in the ground. The shotgun shells will be secured in a specially designed steel, lockable, explosives box attached to a vehicle at all times. The operation/safety rules and regulations for the auger gun are presented as an appendix to this plan.

Sledgehammer

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

IVI 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.

50-cal. Downhole

The downhole .50-caliber seismic source consists of a .50-cal. rifle bolted to a 0.6 cm thick steel plate. The rifle itself is a standard .50-cal. breech and bolt, built by Texas Gun and Machine Company, attached to a standard .50-cal. 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 cm 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-cal. weighs about 30 kg and is easily two-person portable. Safety rules for the use of the .50-cal. seismic gun are presented as an appendix to this plan.

General

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

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

VII. ALCOHOL AND DRUG POLICY

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

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

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

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

Kansas Law

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

Federal Law

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

Health Risks

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

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

Counseling & Treatment Resources

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

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

Definitions

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

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

Policy on Substance Abuse

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

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

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

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

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

VIII. ACTIVITY HAZARD ANALYSIS

A. Work Item: *Use of Class "C" Shotgun Ammunition* (Auger gun / Buffalo gun / 50 cal. / 30.06)

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

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

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

Specific shotgun ammunition safety measures when KGS is managing ammo 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 or qualified alternate, KGS, will be allowed to access, handle, and load the shotguns. Shotgun loading and firing will be conducted in accordance with the attached "Operations/Safety Rules and Regulations for the Auger Gun."

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

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

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

Ammunition safety measures on-site are the responsibility of YPG demo staff. The previous protocols are KGS minimums and can serve as fall-back measures if YPG demo staff are so inclined.

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

B. Work Item: ***Modified Auger Gun***

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

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

C. Work Item: ***Downhole 50-cal.***

The downhole .50-caliber seismic source consists of a .50-cal. rifle bolted to a 0.6 cm thick steel plate. The rifle itself is a standard .50-cal. breech and bolt, built by Texas Gun and Machine Company, attached to a standard .50-cal. 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 cm 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-cal. weighs about 30 kg and is easily two-person portable. Safety rules for the use of the .50-cal. seismic gun are presented as an appendix to this plan.

D. 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.

E. 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 3000 psi are routine during operation. No maintenance or service will take place while vehicle engine is running.
6) Quick inspection is necessary prior to lowering the pad.

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

ATVs that could be on site include the 4x6 John Deere Gator and three Polaris 4x6s. 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 6-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 (not used for this survey). 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.

Safety Specifics:

Every ATV operator shall possess a valid state driver's license and shall have completed an ATV training course prior to operation of the vehicle.

The manufacturer's recommended payload shall not be exceeded at any time.

Gloves and an approved motorcycle helmet with full face shield or goggles shall be worn at all times while operating an ATV.

ATVs are to be used off-road only (no paved road use).

ATVs shall be driven during daylight hours only.

Only ATVs with four or more wheels are permitted to be used.

Passengers are prohibited on ATVs.

All ATVs shall be equipped with a warning signal device (horn).

IX. TRAINING

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

X. PERSONAL PROTECTIVE EQUIPMENT

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

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

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

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

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

XI. SAFETY ANALYSIS

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

XII. ENVIRONMENTAL IMPACT ANALYSIS

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

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

XIII. 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.
<u>During Loading/Unloading</u>:		
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.
<u>During Firing</u>:		
Muzzle Air Blast	Personal injury from flying rocks, soil, debris.	Close fit of barrel in boreholes suppresses muzzle air blast and its effects.
Ricochet	Personal injury from ricocheting projectile or fragments.	Design and use of seismic gun prevents the escape of projectile or fragments from the borehole with sufficient energy to cause personal injury.
Flashburns	Burns from muzzle flashes	Discharge into earth or containment device suppresses muzzle flash.
Misfire	Personal injury from subsequent accidental discharge of misfired round.	Assure training of personnel in proper handling and disposal of misfired ammunition.

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

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

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

_____

_____

Uninjured person(s) involved in incident: _____

_____

_____

Other witnesses (not involved): _____

_____

_____

Equipment involved in incident: _____

_____

_____

_____

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

_____

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Site Safety Officer

KGS 05/1999

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

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

_____

_____

Uninjured person(s) involved in incident: _____

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Other witnesses (not involved): _____

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Equipment involved in incident: _____

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

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Site Safety Officer

KGS 05/1999

Kansas Geological Survey
Incident Report Form

Date of incident: _____

Location of incident: _____

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

_____

_____

Uninjured person(s) involved in incident: _____

_____

_____

Other witnesses (not involved): _____

_____

_____

Equipment involved in incident: _____

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

_____

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_____
Site Safety Officer

KGS 05/1999

MEDICAL EVALUATION FORM

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

Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047

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

Clearance for Hazardous Waste Site Work

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

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

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

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

Comments: _____

Name of Physician: Mary Vernon Signature: MMV
Please Print

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

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

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

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

1. In field:

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

2. To and from site and storage:

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

B. Cleaning

1. Daily:

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

2. Seasonal:

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

C. Firing

1. Assumptions

NONE

2. Never Do's

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

March 24, 1987

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

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

Operational Safety Rules

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

Downhole Mode

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

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

Surface Mode

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

3/10/92

OPERATION/SAFETY RULES AND REGULATIONS
FOR THE

AUGER GUN

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

Operation and Safety Regulations

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

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

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

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

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

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

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

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

Improved Shallow Seismic-Reflection Source: Building a Better Buffalo

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

SUMMARY

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

INTRODUCTION

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

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

DESIGN AND TECHNIQUE

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

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

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

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

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

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

RESULTS

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

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

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

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

CONCLUSION

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

ACKNOWLEDGMENTS

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

REFERENCES

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Miller, R. D., Steeples, D. W., and Mazzella, A., 1990,

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Pullan, S. E., and MacAulay, 1987, An in-hole shotgun source for engineering seismic surveys: Geophysics, 52, 985-996.

Steeples, D. W., Miller, R. D., and Knapp, R. W., 1987, Downhole .50-caliber rifle—an advance in high-resolution seismic sources [Exp. Abs.]; *in* Technical Program Abstracts and Biographies: Soc. Explor. Geophys. 57th Ann. Mtg., 76-78.

Steeples, D. W., and Miller, R. D., 1990, Seismic-reflection methods applied to engineering, environmental, and ground-water problems: *in* Geotechnical and Environmental Geophysics, v. I, Review and Tutorial, Ward, S. H. (ed.), Soc. Explor. Geophys., Tulsa, OK, 1-30.

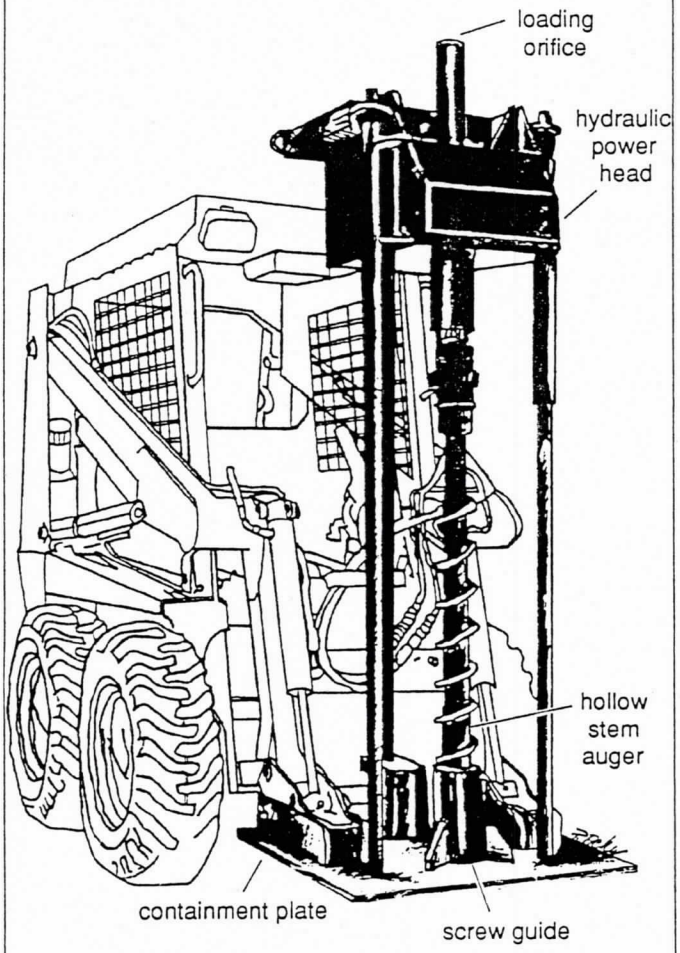

Fig. 1 Diagram represents the auger gun in above-ground position. Modified buffalo-gun portion of the auger gun is not shown, but is conceptually the same as previously documented (Pullan and MacAulay, 1987).

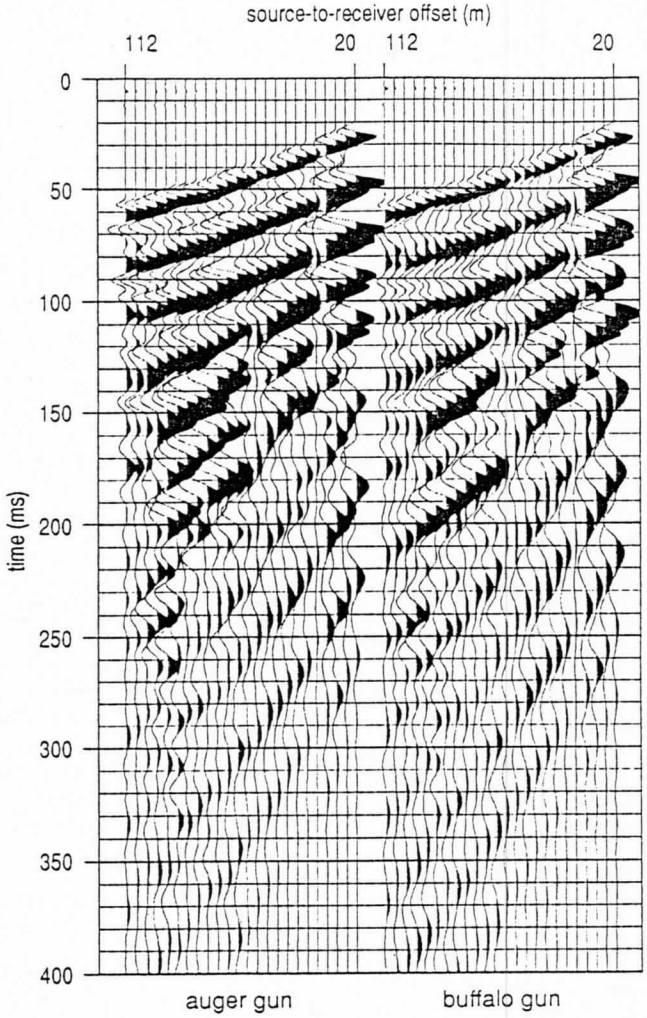

Fig. 2 Auger gun field file (left) compared to the buffalo gun (right).

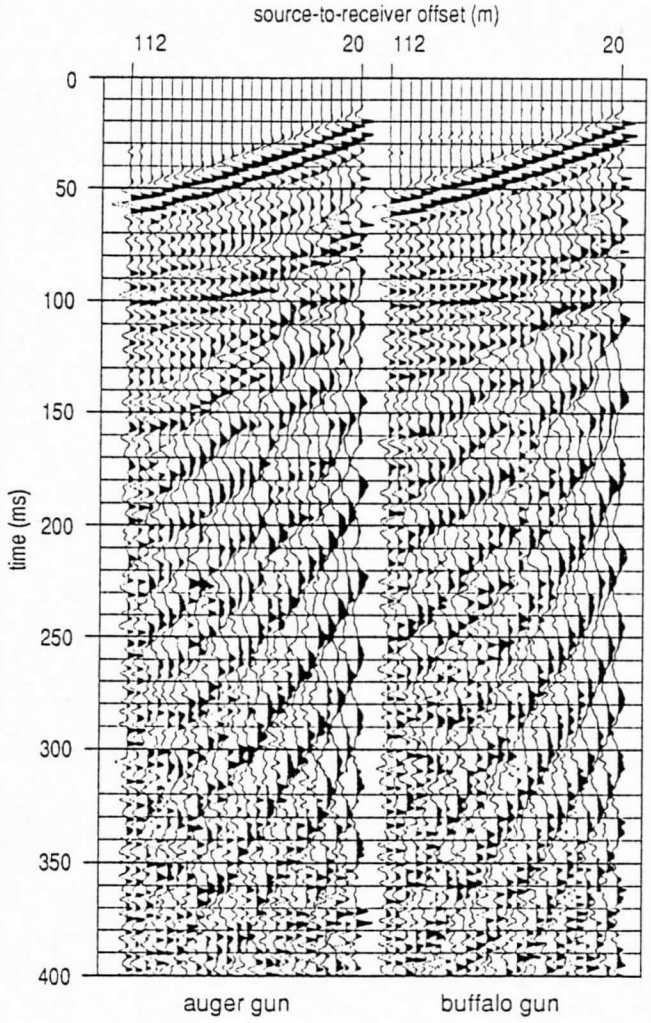

Fig. 3 A 150 Hz digital low-cut filter enhanced the 80 ms reflection event on both the auger (left) and buffalo (right) guns.

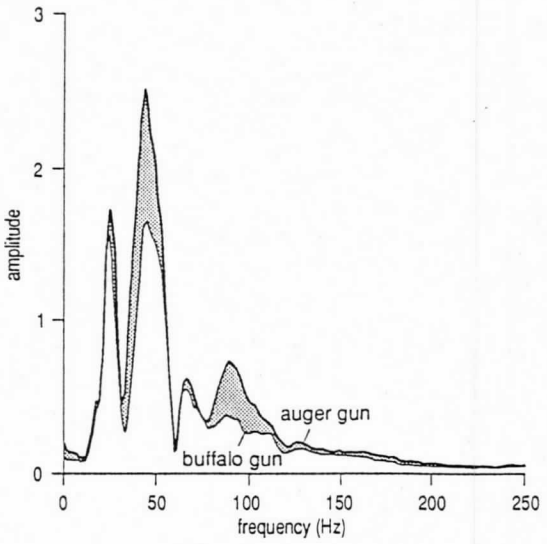

Fig. 4 The darkened area represents the difference between the lower curve (buffalo gun) and the upper curve (auger gun).

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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Seeber, M.D., and Steeples, D.W., 1986, Seismic data obtained with a .50-caliber machine gun as a high-resolution seismic source: AAPG Bull., v. 70, p. 970-976.

Steeples, D.W., and Knapp, R.W., 1982, Reflections from 25 feet or less: Paper presented at 1982 SEG Convention (Exp. Abs.), SEG program volume, p. 469-471.

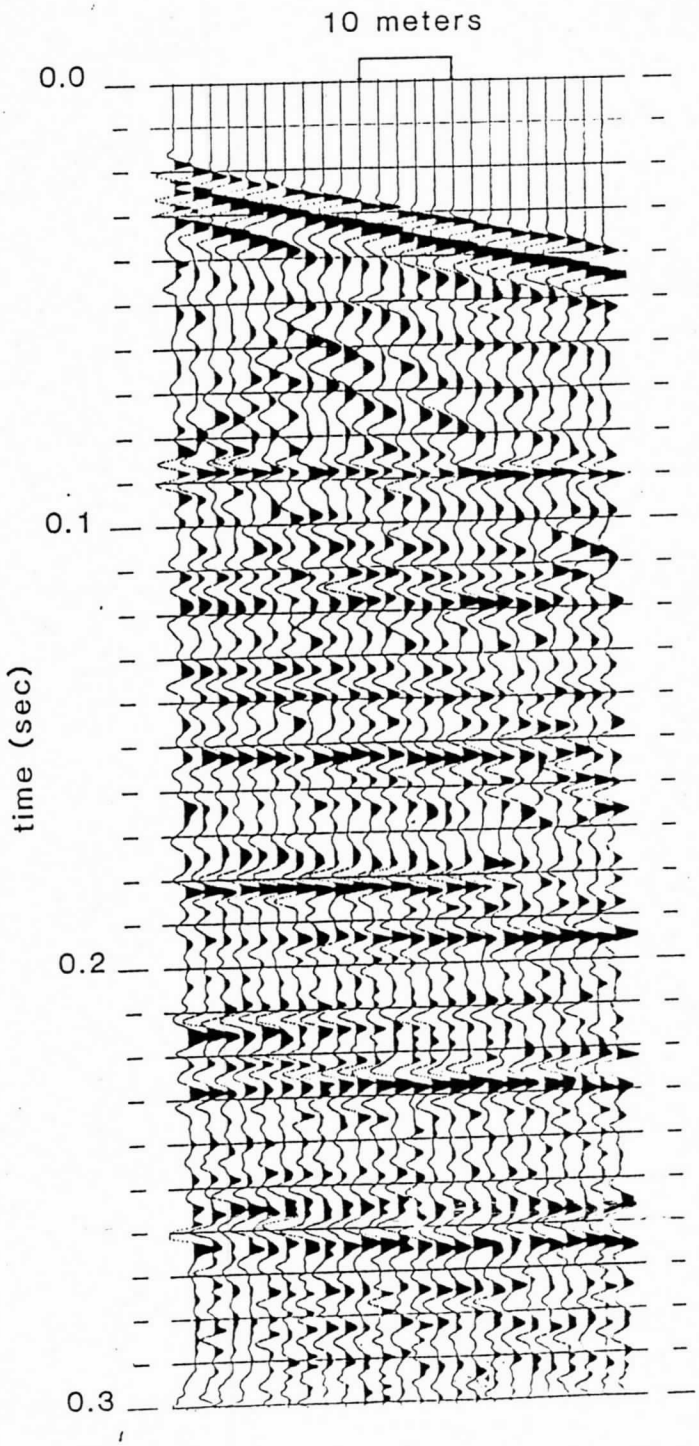
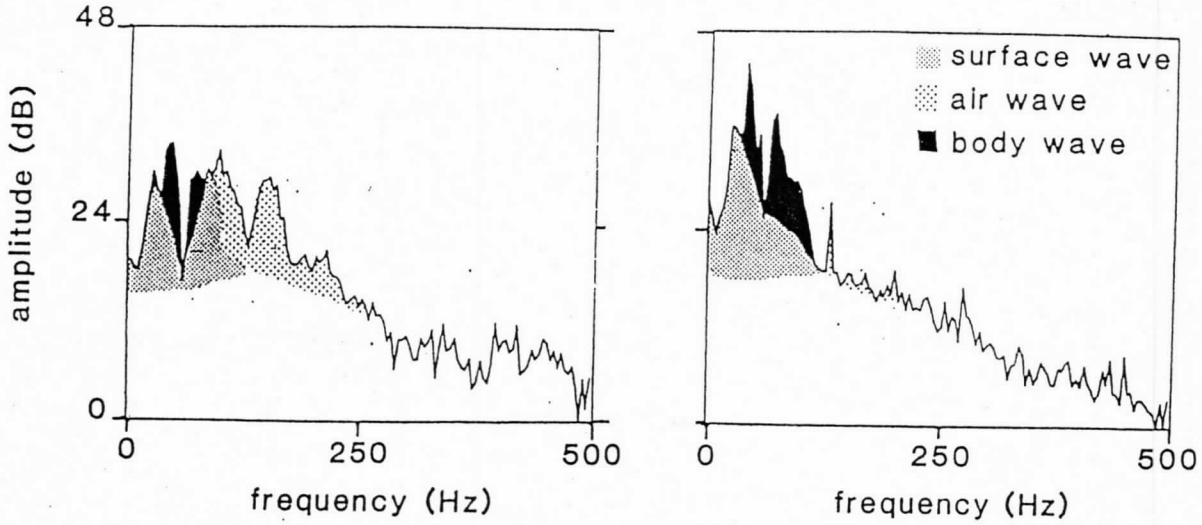


FIG. 2. —This single-shot field file with an AGC applied illustrates the high frequencies and therefore the resolution easily obtainable with a downhole .50-cal.



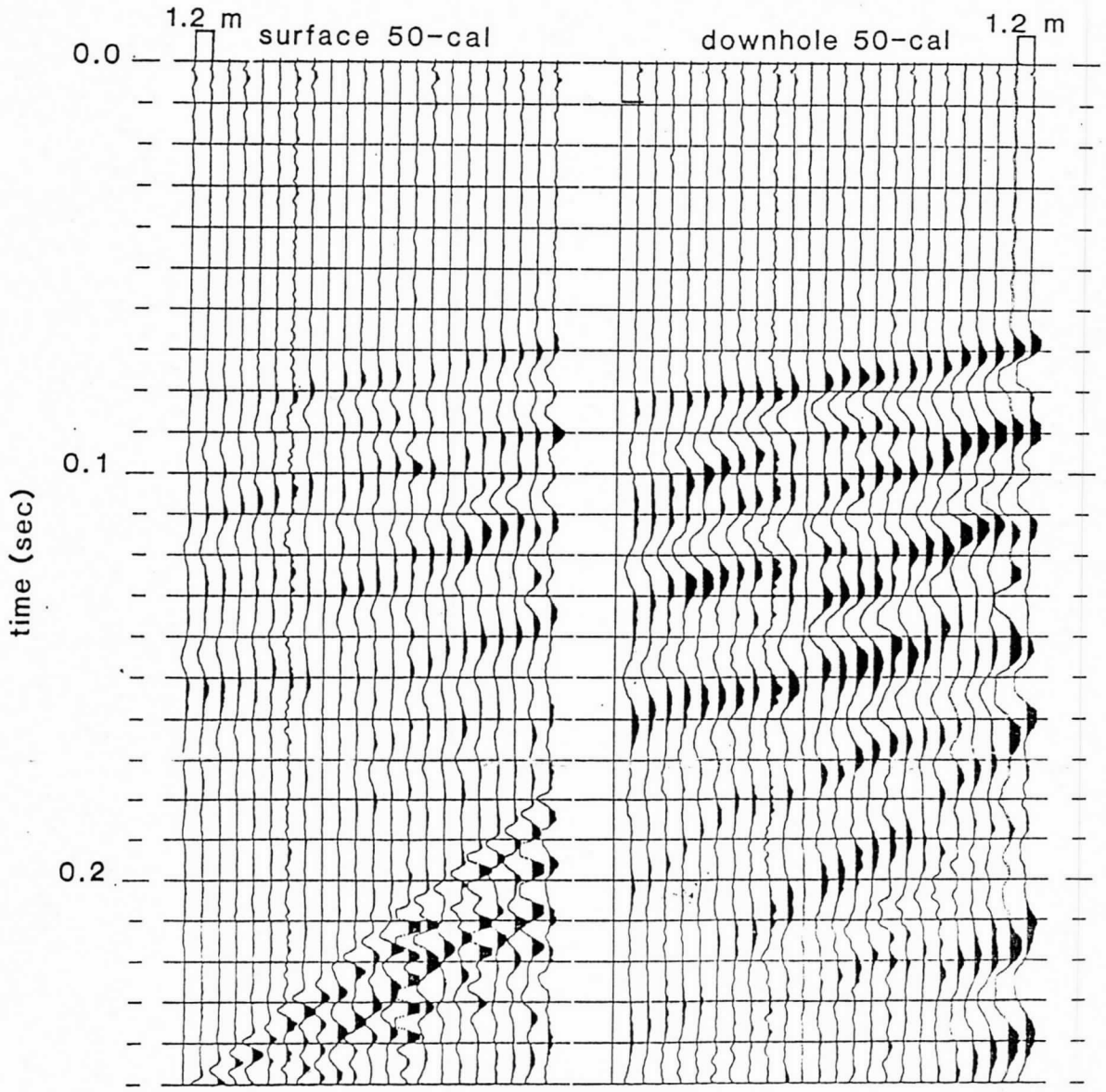


Figure captions:

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

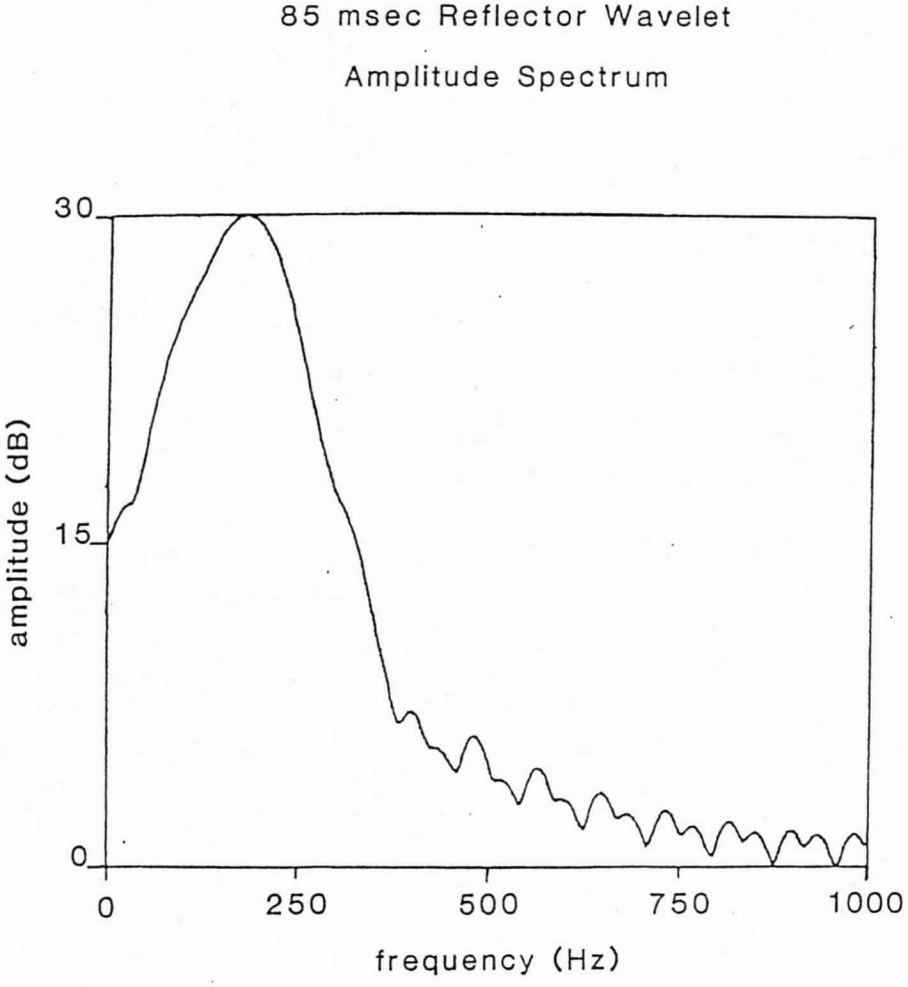


FIG. 3. -The amplitude spectrum of the reflection pulse at 85 msec is almost 3 octaves

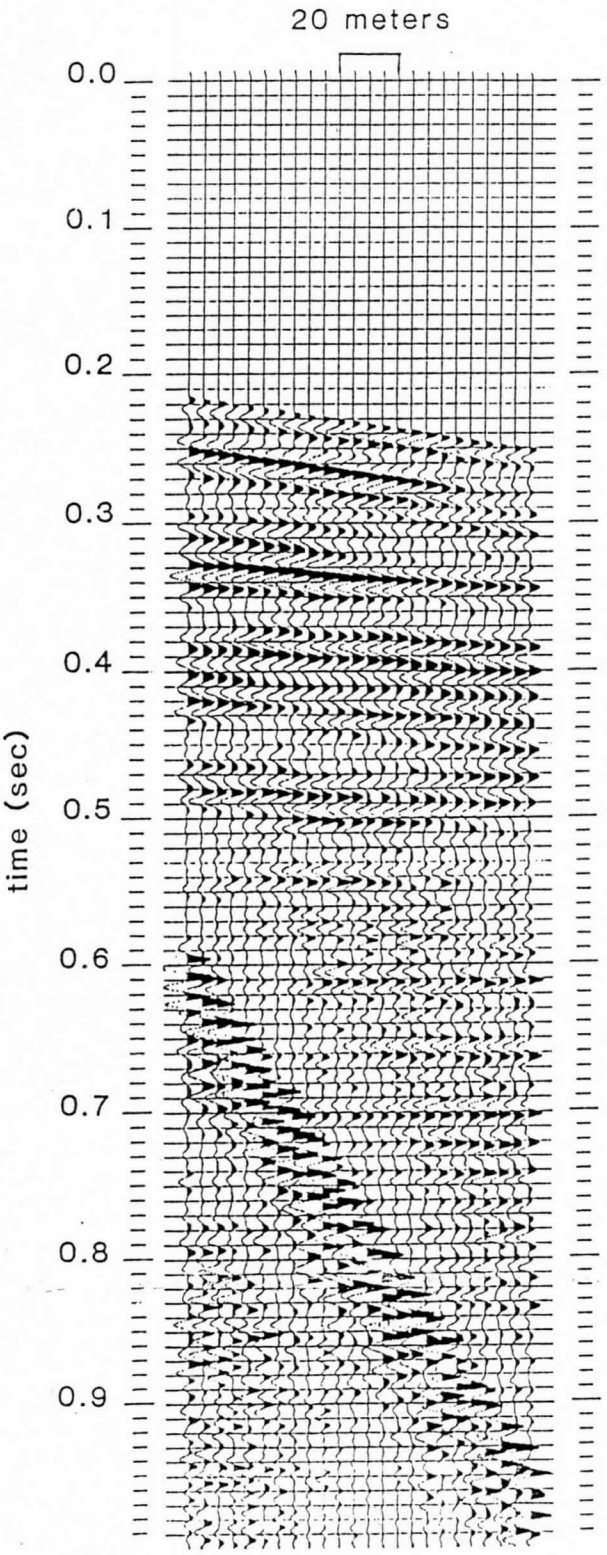


FIG. 4. This stacked field file has 100 Hz reflection energy as deep as 1100 meters.

Olin MATERIAL SAFETY DATA

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

SECTION I - IDENTIFICATION

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

SECTION II - NORMAL HANDLING PROCEDURES

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

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

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

SECTION III - HAZARDOUS INGREDIENTS

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

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

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

EXTINGUISHING MEDIA

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

SPECIAL FIRE HAZARD & FIRE FIGHTING PROCEDURES

Evacuate area. Fight fire from an explosion resistant location.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

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

SYMPTOMS OF OVER EXPOSURE

Eye irritation, fatigue, disturbance of sleep.

EMERGENCY FIRST-AID PROCEDURES

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

Chemical Industrial Ammunition 8 Gauge

CAS No. Not assigned

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

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

PRINCIPAL ROUTES OF ABSORPTION
Inhalation, dermal

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

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

SECTION VII - SPILL AND LEAKAGE PROCEDURES (Control Procedures)

ACTION FOR MATERIAL RELEASE OR SPILL

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

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

TRANSPORTATION EMERGENCY, CONTACT CHEMTREC 800-424-9300

WASTE DISPOSAL METHOD

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

SECTION VIII - SHIPPING DATA

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

SECTION IX - REACTIVITY DATA

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

SECTION X - PHYSICAL DATA

MELTING POINT	N/A	VAPOR PRESSURE	N/A	VOLATILES	N/A
BOILING POINT	N/A	SOLUBILITY IN WATER	N/A	EVAPORATION RATE	N/A
SPECIFIC GRAVITY (H_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 Toxicology
(203) 789-5436

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

Material Safety Data Sheet

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

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

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

Section I "Small Arms Ammunition"

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

Section II — Hazardous Ingredients/Identity Information

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

DOT - "Small Arms Ammunition"
Class C Explosive

UPS ORM-D

Section III — Physical/Chemical Characteristics

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

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

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

Section IV — Fire and Explosion Hazard Data

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

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

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

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

Section V — Reactivity Data

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

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

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

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

Section VI — Health Hazard Data

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

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

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

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

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

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

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

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

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

Precautions to Be Taken in Handling and Storing

Refer to released or spilled data above.

Other Precautions

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

Section VIII — Control Measures

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

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

Protective Gloves: Not applicable

Eye Protection: Safety glasses when shooting

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

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

• U.S.G.P.O.: 1988-491-529/45775

MATERIAL SAFETY DATA SHEET

SMALL ARMS AMMUNITION
CENTERFIRE RIFLE & PISTOL AMMUNITION

Federal Cartridge Company
900 Ehlen Drive
Anoka, Minnesota 55303

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

Issue Date: January 4, 1999

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SECTION #1 - PRODUCT IDENTIFICATION:

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

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

SECTION #2 - CHEMICAL COMPOUNDS:

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

DEFINITIONS OF ACRONYMS

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

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

TWA: Time Weighted Average.

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

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

CAS: Chemical Abstracts Service number.

SECTION #3 - PHYSICAL DATA

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

SECTION #4 - FIRE FIGHTING & EXPLOSION DATA:

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

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

SECTION #5A - EXPOSURE & EFFECTS – INHALATION

ROUTE OF EXPOSURE & EFFECTS - INHALATION

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

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

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

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

SECTION #5B - EXPOSURE & EFFECTS – SKIN

ROUTES OF EXPOSURE & EFFECTS - SKIN

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

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

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

SECTION #5C - EXPOSURE & EFFECTS – EYES

ROUTES OF EXPOSURE & EFFECTS - EYES

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

Chronic: None reported

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

SECTION #5D - EXPOSURE & EFFECTS – INGESTION

ROUTE OF EXPOSURE & EFFECTS – INGESTION

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

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

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

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

SECTION #5E - EXPOSURE & EFFECTS – CARCINOGENESIS DATA

N.T.P. No

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

OSHA: No

SECTION #5F - EXPOSURE & EFFECTS – COMMENTS

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

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

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

AGGRAVATION TO PRE-EXISTING HEALTH CONDITIONS

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

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

SECTION #6 - REACTIVITY & POLYMERIZATION

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

SECTION #7 - SPILLS, LEAKS & DISPOSAL PROCEDURES

STEPS TO BE TAKEN - SPILLS:

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

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

SECTION #8 - SPECIAL PROTECTIVE EQUIPMENT

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

Protective Equipment:

Eyes: Recommend protective eyewear conforming to ANSI Z-87

Gloves: Not generally required

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

Hearing Protection: Hearing protection recommended while discharging cartridges

SECTION #9 - SPECIAL PRECAUTIONS – STORAGE & HANDLING

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

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

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

==========

Remington Arms Material Safety Data Sheet

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

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

I. PRODUCT IDENTIFICATION

Product: Cartridges, Small Arms

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

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

HMIS Rating
Health: 2
Flammability: 0
Reactivity: 1

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

II. HAZARDOUS COMPONENT INFORMATION

NOTE

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

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

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

LIST OF HAZARDOUS CHEMICALS
(In Alphabetical Order)

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

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

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

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

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

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

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

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

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

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

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

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

III. HAZARDS IDENTIFICATION

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

Potential Human Health Effects:

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

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

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

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

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

IV. FIRST AID MEASURES

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

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

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

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

V. FIRE HAZARDS

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

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

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

VI. ACCIDENTAL RELEASE MEASURES

Safeguards: Remove from all sources of ignition.

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

Accidental Release: See above.

VII. HANDLING AND STORAGE

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

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

VIII. PERSONAL PROTECTION/EXPOSURE CONTROLS

Engineering Controls: N/A

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

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

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

IX. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DATA

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

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

X. STABILITY AND REACTIVITY

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

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

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

XI. TOXICOLOGICAL INFORMATION

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

XII. ECOLOGICAL INFORMATION

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

Environmental Impact:

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

XIII. DISPOSAL CONSIDERATIONS

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

EPA Hazardous Waste Code: D008 (lead)

XIV. TRANSPORTATION INFORMATION

SHIPPING INFORMATION

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

XV. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

TSCA Inventory Status: Included on list.

HAZARD CLASSIFICATION

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

XVI. OTHER INFORMATION

NFPA Rating: Not established.

NPCA-HMIS Ratings:

Health:	2
Flammability:	0
Reactivity:	1

References:

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

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

American National Standards Institute, Z400.1-1993

International Standards Organization Safety Data Sheet Standard.

XVII. LIST OF ACRONYMS

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

For additional information, please contact:

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

(800) 243-9700

GENERAL MOTORS CORPORATION
MATERIAL SAFETY DATA SHEET

SECTION I

PRODUCT NAME OR NUMBER (as it appears on label) ALL MODELS OF DELCO BATTERIES	GM COMMON CODE
MANUFACTURER'S NAME Delco Remy Division, GMC	EMERGENCY TELEPHONE NO. (317) 646-3080
ADDRESS (Number, Street, City, State and Zip Code) 2401 Columbus Avenue, Anderson, IN 46018	MANUFACTURER'S D-U-N-S NO.
HAZARDOUS MATERIAL DESCRIPTION, PROPER SHIPPING NAME, HAZARD CLASS, HAZARD ID NO. (49 CFR 172.101) Battery, Wet, Filled with Acid, (Corrosive Material) Class 8 - UN2794	
ADDITIONAL HAZARD CLASSES (as applicable)	
CHEMICAL FAMILY Liquid Content - Sulfuric Acid	FORMULA Liquid Content - 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 2,730 (@ 77 F 25 °C ☒ mm Hg ☐ psi		PERCENT VOLATILE BY VOLUME (%)	NA	PERCENT SOLID BY WEIGHT (%)	NA
VAPOR DENSITY (AIR = 1)	NA	EVAPORATION RATE (= 1)	NA		
SOLUBILITY IN WATER Miscible		pH =	< 1.0		
APPEARANCE AND ODOR Water - white liquid (acid content)			IS MATERIAL: LIQUID SOLID GAS PASTE POWDER		

SECTION IV — FIRE AND EXPLOSION HAZARD DATA

FLASH POINT NA °F ___ °C	method used	FLAMMABLE LIMITS	LEL NA	UEL NA
EXTINGUISHING MEDIA				

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

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

SECTION V-HEALTH HAZARD DATA

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

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

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

SECTION VI-REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATIBILITY (materials to avoid) Oxidizing or reducing materials.

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

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	XX	

SECTION VII-SPILL OR LEAK PROCEDURES

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

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

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

RCRA HAZARDOUS WASTE NO. (40 CFR 261.33) D002

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

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

SECTION VIII-SPECIAL PROTECTION INFORMATION

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

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

PROTECTIVE GLOVES (specify type) Rubber

EYE PROTECTION (specify type) Splash-proof safety g

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

SECTION IX-SPECIAL PRECAUTIONS

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

OTHER PRECAUTIONS

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

PLEASE COMPLETE QUESTIONNAIRE AND RETURN TO:

Name (print) Robert A. Chisman

Signature Robert A. Chisman

Title Senior Industrial Hygienist

Date May 8, 1991

ANSUL®

ANSUL FIRE PROTECTION
MARINETTE, WI 54143-2542

MATERIAL SAFETY DATA SHEET

FORAY
QUICK IDENTIFIER (In Plant Common Name)

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

SECTION 1 — IDENTITY

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

SECTION 2 — INGREDIENTS

PART A — HAZARDOUS INGREDIENTS

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

PART B — OTHER INGREDIENTS

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

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

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

SECTION 4 — PHYSICAL HAZARDS

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

FORAY (Continued)

SECTION 5 — HEALTH HAZARDS

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

SECTION 6 — EMERGENCY AND FIRST AID PROCEDURES

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

SECTION 7 — SPECIAL PROTECTION INFORMATION

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

SECTION 8 — SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

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

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS

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

1 HEALTH
0 FLAMMABILITY
0 REACTIVITY

N/A = Not Applicable NDA = No Data Available

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

Material Safety Data Sheet

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

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

SECTION I - PRODUCT IDENTIFICATION

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

SECTION II - HAZARDOUS INGREDIENTS

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

*for oil mists

SECTION III - PHYSICAL DATA

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

SECTION IV - FIRE & EXPLOSION HAZARD DATA

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

SECTION V - HEALTH HAZARD DATA

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

SECTION VI - REACTIVITY DATA

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

SECTION VII - SPILL OR LEAK PROCEDURE

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

SECTION VIII - PROTECTIVE EQUIPMENT INFORMATION

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

SECTION IX - SPECIAL PRECAUTIONS

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

SECTION X - DATA PREPARATION

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

SIGNATURE: DATE: January 29, 1998

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

Material Safety Data Sheet

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

MATERIAL HAZARD EVALUATION

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

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

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

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

1.0 GENERIC COMPOSITION / COMPONENTS

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

2.0 PHYSICAL DATA

PHYSICAL HAZARD CLASSIFICATION (Per 29 CFR 1910.1200)

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

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

2.0 PHYSICAL DATA (continued)

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

3.0 FIRE AND EXPLOSION DATA

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

4.0 REACTIVITY DATA

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

5.0 SPILL, LEAK AND DISPOSAL PROCEDURES

Procedure if Material is Spilled:

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

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

5.0 SPILL, LEAK AND DISPOSAL PROCEDURES (continued)

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

Waste Disposal:

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

Protective Measures During Repair and Maintenance of Contaminated Equipment:

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

6.0 HEALTH HAZARD DATA

Health Hazard Classification (Per 29 CFR 1910.1200):

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

Carcinogen:

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

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

6.0 HEALTH HAZARD DATA (continued)

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

Acute Exposure Symptoms:

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

Dermal: This material can cause skin irritation.

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

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

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

Chronic Exposure Symptoms:

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

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

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

Other Special Effects:

None.

Medical Conditions Aggravated by Exposure:

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

First Aid and Emergency Procedures for Acute Effects:

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

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

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

6.0 HEALTH HAZARD DATA (continued)

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

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

Notes to Physician:

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

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

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

7.0 SPECIAL PROTECTION INFORMATION

Ventilation Requirements:

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

Applicable Workplace Exposure Levels:

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

Specific Personal Protective Equipment:

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

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

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

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

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

8.0 TRANSPORTATION AND SPECIAL PRECAUTIONS

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

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

DOT Information:

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

9.0 ENVIRONMENTAL DATA

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

Section 313 - Toxic Chemicals:

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

Section 311/312 - Hazard Categories:

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

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

Section 302 - Extremely Hazardous Substances:

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

Clean Water Act (CWA):

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

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

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

9.0 ENVIRONMENTAL DATA (continued)

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

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

Component:	Effect:
Diesel Engine Exhaust	Cancer

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

Fuel Oil (68476-30-2)

Toxic Substances Control Act (TSCA):

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

10.0 LABELING

DANGER:

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

HANDLING:

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

FIRST AID:

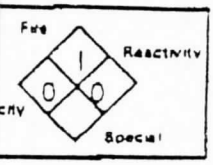
If swallowed, do not induce vomiting.
Call a physician immediately.
In case of contact, remove contaminated clothing immediately and wash thoroughly with soap and water.

MATERIAL SAFETY DATA SHEET

PRODUCT SA 825 0012

ELL-BEE LITHIUM M-P GREASE

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



SECTION I

1 WITCO MANUFACTURING DIVISION OR SUBSIDIARY

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

EMERGENCY TELEPHONE
MANUFACTURER (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

6 HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide

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

7 LIST ALL TOXIC AND HAZARDOUS INGREDIENTS: None

PHYSICAL

8 FORM: Semi-solid

9 ODOR: Mineral Oil

10 APPEARANCE: Grease

11 COLOR: Amber

12 SPECIFIC GRAVITY (WATER = 1) RT: 0.924

13 BOILING PT.: NDA °C / °F

14 MELTING PT.: NA °C / °F

15 SOLUBILITY IN WATER AT 25 °C: Negligible

16 % VOLATILE (BY WT %): NA

17 EVAP. RATE (= 1): NA

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

19 VAPOR DENSITY (AIR = 1): NA

20 pH AS IS: NA
pH ( )

21
STRONG ACID ☐
STRONG BASE ☐
STABLE ☒
UNSTABLE ☐

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

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 ____

28 EXTINGUISHING AGENTS
☒ DRYCHEMICAL ☒ CO2
☐ 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 36: Rubber or plastic oil resistant
RESPIRATORY PROTECTION (SPECIFY TYPE) 37: None Required	EYE PROTECTION 38: Safety goggles and full face shield
	OTHER PROTECTIVE EQUIPMENT 40: None Required

SECTION VI — HANDLING OF SPILLS OR LEAKS

PROCEDURES FOR CLEAN-UP 41:

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

WASTE DISPOSAL 42:

By methods consistent with local, state and federal regulations.

SECTION VII — SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE 43:

Keep containers closed.

SECTION VIII — TRANSPORTATION DATA

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

SECTION IX — COMMENTS

54:

KEEP OUT OF REACH OF CHILDREN!!

SIGNATURE Ray G. Thornton TITLE Manager Technical Compliance

REVISION DATE _____ SENT TO ATTN: _____ DATE 3/05/84

SUPERSEDES _____

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

MATERIAL SAFETY DATA SHEET

Tox no. : 042840

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

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

CHEMICAL AND PHYSICAL PROPERTIES

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

HAZARDOUS AND OTHER DISCLOSED INGREDIENTS

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

Exposure Limit Abbreviations

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

REGULATORY INFORMATION

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

SIGNAL WORD

DANGER -- CORROSIVE

HAZARDS

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

M S D S
(CONTINUED)

Tox no. : 042840

TARGET ORGANS AND MEDICAL CONDITIONS

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

Lungs
Teeth
Skin, Eyes, and Respiratory System

ACUTE TOXICITY INFORMATION

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

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

SAFE HANDLING AND STORAGE

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

FIRE, EXPLOSION AND REACTIVITY INFORMATION

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

M S D S
(CONTINUED)

Tox no. : 042840

PROTECTIVE MEASURES AND TREATMENTS

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

NOTES TO PHYSICIANS

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

SPILLS, LEAKS AND DISPOSAL

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

SPECIAL REMARKS

This is an acidic material.

U. S. DEPARTMENT OF TRANSPORTATION INFORMATION

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

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

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

M S D S
(CONTINUED)

Tox no. : 042840

Print Date : 04/02/90

PREPARATION INFORMATION

Health and safety information has been evaluated by:

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

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

This is the last page of this MSDS.

MATERIAL SAFETY
DATA SHEET

AMOCO REGULAR LEAD-FREE GASOLINE

MSDS NO: 02003992

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

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

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

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

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

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

HEALTH HAZARD INFORMATION

EYE

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

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

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

SKIN

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

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

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

INHALATION

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

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

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

HEALTH HAZARD INFORMATION - CONTINUED

INGESTION

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

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

FIRE AND EXPLOSION INFORMATION

FLASHPOINT: -45°F

FLAMMABLE LIMITS: UPPER: 7.6% LOWER: 1.3%

AUTOIGNITION TEMPERATURE: 495°F

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

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

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

REACTIVITY INFORMATION

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

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

STABILITY: Burning can be started easily.

CHEMICAL AND PHYSICAL PROPERTIES

BOILING POINT: 80°F TO 430°F, Range

SOLUBILITY IN WATER: Negligible, below 0.1%.

SPECIFIC GRAVITY (WATER = 1): 0.75

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

VAPOR DENSITY (AIR = 1): 3 TO 4

STORAGE AND ENVIRONMENTAL PROTECTION

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

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

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

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

TOXICOLOGICAL INFORMATION

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

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

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

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

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

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

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

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

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

REGULATORY INFORMATION

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

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

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

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

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

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

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

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

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

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

SUPPLEMENTAL INFORMATION

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

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

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

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

SUPPLEMENTAL INFORMATION - CONTINUED

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

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

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

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

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

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

ISSUE INFORMATION

BY:

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

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

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

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME: Clifton Chemical Co.	EMERGENCY TELEPHONE NO.: (815) 697-2123
ADDRESS (Number, Street, City, State, and ZIP Code): 160 So. Locust St, 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			CONDITIONS TO AVOID
	UNSTABLE		Sparks, heat and flames.
	STABLE	X	

INCOMPATABILITY (Materials to avoid)
None

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

HAZARDOUS POLYMERIZATION			
	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

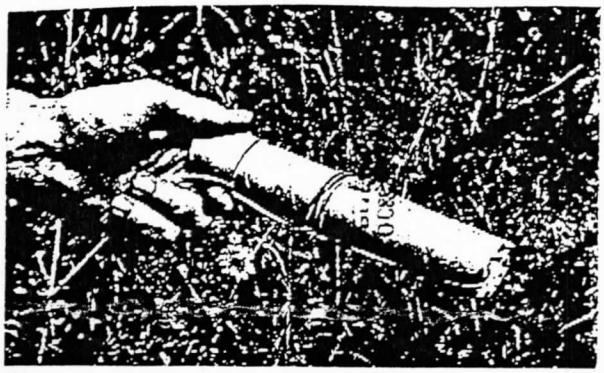
PROTECTIVE GLOVES: Neoprene or rubber gloves
EYE PROTECTION: Chemical safety goggles
OTHER PROTECTIVE EQUIPMENT

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 convenier one-pound, one-half, one-third, and one-quarter pound cartridges an formulated to provide a seismic pulse equal to dynamite for clear, shar seismic records.

Although classified as high explosive, seisPRIME/E emulsions are nor headache and have excellent resistance to accidental detonation by friction c impact.

Spiral-wound 1/4 to 1/2-pound paper cartridges are easily capped an 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

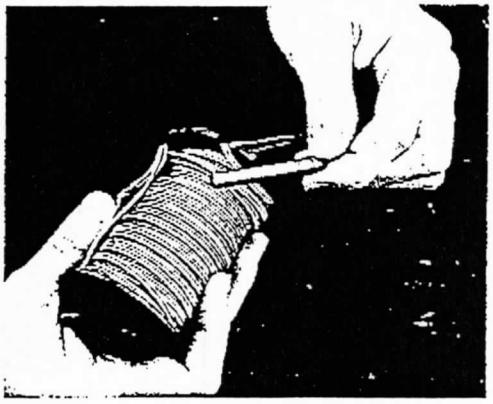
PACKAGING

Available in four sizes to meet vertical stacking an "mini-hole" applications. seisPRIME/E in the one-poun size is packaged in thin-walled, easy couplin cartridges for vertical stacking or larger downhol shots.

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

All sizes have excellent water resistance and can b initiated with a #8 strength STATICMASTER detonator.

STATICMASTER® Electric Detonators for Seismic Exploration



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

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

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

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 electric detonators meet all requirements for series firing.

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

PACKAGING

STATICMASTER electric detonators come with **spooled** duplex copper lead wires (yellow color) in lengths of 40', 60', 80', 100', 120', 150', 160', 200', 250', 300', and 400'; and in shorter legwire lengths (**folded** duplex wires, yellow) measuring 12', 20', 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 Liquid
Mixture	Neg.	nd	nd	125	1.1 to 1.3	NA	None	White Grease

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.