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Seismic Reflection Survey: Health and Safety Plan

Kansas Geological Survey
Exploration Services Section

U.S. Bureau of Reclamation
East Canyon Dam, Utah
August 2004

Open-file Report #2004-40

**KANSAS GEOLOGICAL SURVEY EXPLORATION SERVICES
ACCIDENT PREVENTION PLAN**

I. PROJECT DESCRIPTION

Project Name: Seismic Study at East Canyon Dam, Utah

Location: Near Porterville, Utah

Site Safety Officer: Richard D. Miller

Plan Prepared by: Richard D. Miller

Estimated Duration of Field Work: 7 days

II. STATEMENT OF WORK

A reliable measure of seismic properties as a function of depth is important to the Bureau of Reclamation's comprehensive and accurate appraisal of site response and vibration modes in the thin concrete arch East Canyon Dam in Morgan County, Utah. Material response to shaking within and in proximity to the dam must be reasonably well known for accurate evaluation of failure potential and associated risk considering any significant ground motion at this dam site will likely be controlled or at least influenced by a fault less than 300 ft from the dam structure. Models used to predict dam performance during earthquakes and floods are only as realistic as the material attributes (especially rigidity) incorporated into those simulations. Proven correlation between seismic properties and stiffness/rigidity is the basis for highly detailed measurements of the seismic wavefield at a dam site such as this. Realizations for areas with liquefaction or rock failure potential are enhanced when the velocity field used to calculate Poisson's ratio is based on continuous, detailed, coincident measurements of compressional and shear-wave velocities at each significant geologic contact and within each major geologic unit.

East Canyon Dam

East Canyon Dam is located in north central Utah 11 miles southeast of the town of Morgan, Utah (Figure 1). With a drainage area of around 145 sq miles this 260 ft high dam is the thinnest of the

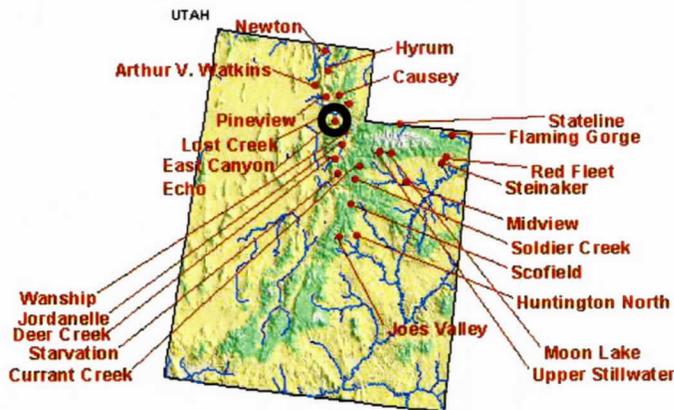


Figure 1. Utah Bureau of Reclamation dams.

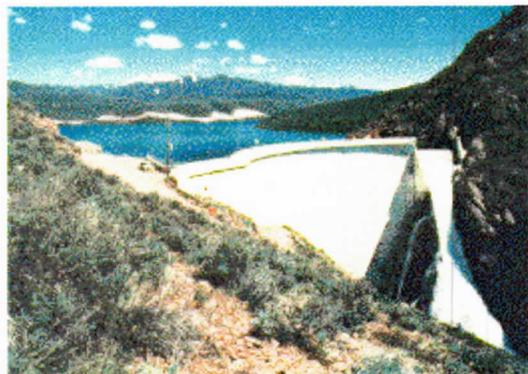


Figure 2. East Canyon Dam

concrete thin arch dams operated by the Bureau of Reclamation (a thin arch dam is defined as having a structural height ratio of 0.2 or less) (Figure 2). With a 7 ft wide crest and base width of only 20 ft, the strength of this 436 ft long (crest) dam comes from its curved geometry (Figure 3). Completed in 1966, it is located in a narrow-walled canyon where the East Canyon Creek has cut through very hard, massive, well-cemented beds of late upper Cretaceous conglomerate (Figure 4). This massive conglomerate is part of a sequence of layers possessing a dominant upstream dip. With the Wasatch Fault located about 12 miles west of the dam and an unnamed fault (previous suggested to be inactive) about 300 feet upstream from the dam, interest in the seismic and structural characteristics of the dam and the upper 300 to 400 ft of sediments supporting the dam is justified.

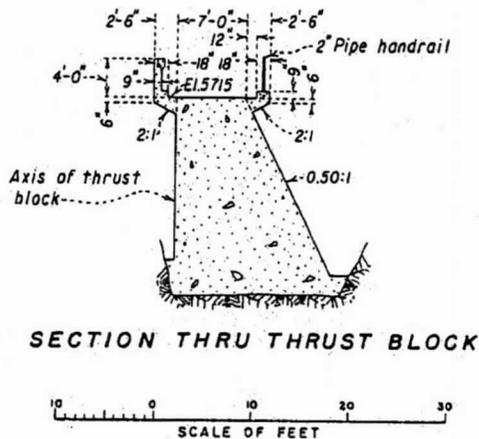


Figure 3. Cross-section of dam structure.



Figure 4. View of conglomerate rock, which is the foundation for the dam.

Program Objectives

Geophysics used during site characterization routinely involves relatively noisy measurements of earth properties, qualitatively incorporated into working subsurface models with ground truth provided by observational data sets (e.g., drilling, outcrop studies, etc.). Near-surface seismic data is no exception to this generality. The primary objective or product of most surveys of this type is the qualitative assessment of subsurface layer topography (Clement et al., 1997; Pullan and Hunter, 1990; Lankston, 1990). Travel time structure maps or two or three layer velocity maps are typical interpretation products of seismic surveys. These seismic interpretation maps are routinely merged into borehole-derived geologic and hydrologic models based for the most part on highly subjective and very sparse data sets. These simplistic models are then used for groundwater monitoring and remediation, geologic hazard detection, or engineering design purposes in an intuitive, experience-based manner (Steeple and Miller, 1990; Miller and Xia, 1999).

Considering the wealth of information contained in the seismic wave field, seismic measurement or imaging data are routinely underutilized for site characterization (Steeple et al., 1995). Surface seismic techniques are generally limited to routine mapping and delineation of subsurface structures, layer topography, anomalies, and stratigraphic changes (Jongierius and Helbig, 1988; Miller et al., 1989; Goforth and Hayward, 1992; Miller et al., 1995; Shtivelman et al., 1998; Guo and Liu, 1999; Stokoe et al., 1994; Michaels, 1999). In many instances, several earth properties (V_p , V_s , Q_p , Q_s , layer orientation, and thickness) can be estimated from the seismic wave field, for each subsurface cell. Velocity is probably the parameter most consistently measured or estimated by all the seismic methods.

This applied research project will measure in-situ compressional and shear velocities using VSP methods, attempt to map reflectors within the upper 350 ft using high-resolution seismic reflection techniques (Steeple and Miller, 1990), and appraise the near-surface shear-wave velocity structures using

MASW data acquired along the dam crest and abutment (Park et al., 1999). Measurements of velocity and maps of bed geometry will support the more general sitewide characterization underway by the Bureau of Reclamation. Velocity measurements in two boreholes—one on the dam crest and one downstream—will be used as control points for site response models. Velocity measurements within the dam itself and at and in close proximity to the contact between the dam and native materials will be used to constrain modal studies at this thin arch dam. Seismic reflection profiles will provide information concerning the consistency and geometry of layering between boreholes and identify anomalies (within the upper 350 ft and 1000 ft upstream and downstream) that might influence realizations. The primary goal of this study is to determine the P- and S-wave velocity distribution in the concrete, at the concrete/rock interface, and within the right abutment rock.

VSP data will be acquired and processed in such a way as to provide compressional and shear velocities throughout the drilled intervals, allowing optimal interfacing to engineering studies of the dam. Both longitudinal and transverse oriented shear velocity measurements will be acquired (assuming the Geological Survey of Canada's three-pod hole-lock geophone is made available to the Bureau of Reclamation) so that shear-wave anisotropy within the boreholes can be identified and trends mapped. Each of the three proposed boreholes will have different targets and specific objectives. Shallow (~100 ft) borings upstream (along the right abutment) and downstream (presumably near the toe and river elevation) of the dam will target near-surface sediments and help establish trends/consistency in material properties away from the structure. A deeper boring will be placed on the dam crest and will sample about 70 ft of the dam's thrust block and another 300 ft or so of the natural foundation material. The upper portion of this native material will be the conglomerate observed in outcrop.

High-resolution seismic reflection surveys will include both compressional and shear-wave modes. Seismic reflection will only provide useful data if the shallow earth possesses physical characteristics conducive to the reflection technique. For example, if the conglomerate is massive with no layering (changes in reflectivity across an interface) there will be nothing for downgoing seismic energy to reflect from. Also, if the conglomerate is very attenuative and absorbs large amounts of energy within the source generated seismic energy frequency band, signal levels of reflections returning from the deeper portion of the target depth range maybe below the noise threshold of the recorded data. An approximately 2000 ft long transect centered on the dam structure and extending upstream along the right side access road is proposed that will attempt to image any seismic impedance contrasts in the upper 300 ft to 500 ft. With the polarized nature of shear-wave energy, optimum recorded shear signal will be from the transverse (SH) component that is recorded when receivers are oriented to be sensitive to motion perpendicular to the survey line. The primary goal of the shear and compressional surveys will be to provide information about layer and V_p/V_s variability between borings.

Surface wave analysis will be undertaken on data acquired on the crest and right abutment. Each profile will use the same spread geometry (30 stations with both compressional and shear receivers located every 4 ft) and permit correlation between the various processed data sets for each line and between the five different lines. With the unique requirements of surface wave measurements it maybe necessary to use an accelerated weight drop source, low frequency receivers, and only selected portions of the fixed spread for each recorded shot. Shear wave velocity maps generated along each profile line will be optimized for resolution, using several unique approaches whose purpose is to minimize smearing resulting from variable wavelength averaging.

Program Components

Downhole/VSP

Surface-to-borehole data will be acquired to determine the 3-C velocity field as a function of depth. Acquisition, processing, and interpretation of vertical seismic profiles (VSP) will follow well-established guidelines (Hardage, 1983). As with most seismic methods, adapting methodologies developed in the oil industry to shallow targets requires deviating from accepted "rules of thumb." Walkaway VSPs will be acquired with the source moving away from the boreholes along the proposed reflection lines for the two shallow boreholes and along the dam crest for the deeper borehole. Near-vertical offset

VSP (ZVSP) will provide the best measure of velocity as a function of depth. Offset VSP (OVSP) profiles will assist with lithologic and structural interpretation of reflection profiles as well as provide valuable, yet somehow limited velocity information a relatively short distance from the borehole. VSP sections will be processed and interpreted so that any reflectors intersecting the borehole could be mapped away from the borehole to a maximum offset of about one-quarter the borehole depth (i.e., 70 ft to 80 ft).

Reflection

A properly designed and executed high resolution P-wave or S-wave seismic reflection survey should be capable of mapping all reflectors with reflectivity of at least 0.5 (e.g. clay/gravel) and separated by 20 ft or more within the interval of interest at the East Canyon Dam site. To maximize our potential for success, efforts will concentrate on: 1) generating and recording high frequency (>120 Hz P-wave and >60 Hz S-wave) signals; 2) optimizing spread deployment and acquisition for 2-D imaging of dipping beds and low reflectivity contacts; 3) establishing the best configurations and parameters to maximize signal-to-noise and resolution potential at this site; 4) correlating P-wave reflections with S-wave reflections as well as with VSP and drill data; 5) insuring offset distributions appropriate for measuring the velocity from NMO curves that can be correlated to average velocity curves from VSPs; 6) integrating well-established shallow high-resolution methodologies and conventional approaches; 7) tailoring processing flows to optimize the accuracy and spatial distribution of velocity analysis for most accurate Vp/Vs; and 8) correlating polarized shear-wave velocities from CMP with oriented and polarized Vs measured in the boreholes. Proven high-resolution techniques will be used to design the data acquisition parameters and determine optimum equipment and methodologies (Steeple and Miller, 1990).

Maximizing the resolution potential, interpretability, and signal-to-noise ratio will be emphasized in the reflection surveys. Continuous CMP profile lines (Mayne, 1962) will be acquired using a 240-channel fixed spread, rolled if necessary to maintain the optimum recording window for each recorded shot (Hunter et al., 1984). The seismic source, geophone type, spread geometry, shots/point, and acquisition philosophy used to acquire the CMP profile lines will be based on the results of walk-away noise tests and VSP data analyses. Data will be initially acquired and processed to delineate local stratigraphic, structural, and topographic features within the upper 1000 ft using state-of-the-art high-resolution methodologies and equipment. Once all interpretable reflections are fully processed, different methods will be evaluated for their effectiveness in extracting detailed velocity information as a function of depth and location relative to the dam structure.

Surface Wave Inversion

Surface waves traditionally have been viewed as noise in multi-channel seismic data collected to image targets for shallow engineering, environmental, and groundwater purposes (Steeple and Miller, 1990). Recent advances in the use of surface waves for near-surface imaging have combined spectral analysis techniques (SASW), developed for civil engineering applications (Nazarian et al., 1983), with multi-trace reflection technologies developed for near-surface (Schepers, 1975) and petroleum applications (Glover, 1959). The combination of these two uniquely different approaches to seismic imaging of the shallow subsurface permits non-invasive estimation of shear wave velocities (within 10% of measured in many cases) (Xia et al., 2002) and delineation of horizontal and vertical variations in near-surface material properties based on changes in these velocities (MASW) (Park et al., 1996; Xia et al., 1999; Park et al., 1999).

Extending this imaging technology to include lateral variations in lithology as well as tunnel and fracture detection, bedrock mapping, and subsidence/karst delineation has required a unique approach that incorporates SASW, MASW, and CDP methods. By integrating these techniques, 2-D continuous shear-wave velocity profiles of the subsurface can be generated. Estimating the dispersion curve from up to 60 closely spaced receiving channels calculated every 3 ft to 6 ft along the ground surface enhances the signal and results in a unique, relatively continuous view of shallow subsurface shear wave velocities properties. This highly redundant surface wave method improves the accuracy of calculated shear wave velocities and minimizes the likelihood that irregularities resulting from erratic dispersion curves will corrupt the analysis.

Outline of Proposed Program

Phase I

- 1) Compressional and shear-wave VSPs are planned for two boreholes yet to be drilled at the site. The deepest and probably most important is the hole (~350 ft) planned for the crest at a location directly above the right abutment. This boring will sample the entire drilled interval but will focus on the very important zone directly above, at, and just below the concrete/rock contact. By design this borehole should be approximately 6" in diameter throughout the cement portion of the dam (upper ~70 ft) reducing down to 4" in the native rock interval. A second, shallower (~100 ft) boring is planned for the downstream toe with native materials expected throughout. Near-surface conglomerate (which will compose most of the borehole walls from the base of the dam [70 ft] to near the bottom of the holes [350 ft]) must be sufficiently competent to withstand the repeated clamping pressure exerted by the three single band borehole locking geophone pods. Gravel and cobbles caving from borehole walls could impair movement and risk safe retrieval of the three-pod downhole geophone. The three-pod, three-component alignable hole lock geophones will be provided by the BoR (via the Geological Survey of Canada). Borehole spatial sampling will be determined after preliminary in-field tests, but will likely be between 5 ft and 10 ft. Source locations will be determined after on-site testing but will likely include stations 10 ft offset from borehole (vertical incident VSP) and at least two more, one 50 ft offset from the borehole and another approximately equal to maximum sampling depth (100 ft in shallow holes and 350 ft in deep holes [offset VSP]). The density of source locations will depend on the data quality and number and location of reflecting events that intersect the borehole. Source locations will depend to some degree on access, especially when operating along the crest of the dam (Figures 5 and 6). Each source location and borehole station will be occupied twice, once with the source in compressional-wave mode and once with the source in shear configuration. An IVI minivib1 will be the source for both P- and S-wave datasets (Figure 7). Based on past experience, several 10-second linear up-sweeps (20 to 200 Hz for P-wave and 10 to 120 Hz for S-wave) individually recorded at each shot station should produce the optimum shot gather for the objective and geology. To maximize interpretability of the S-wave data the source will be oriented to produce SH waves. Attempts will be made to develop new source drive software allowing a 180-degree phase reversal of the source's first motion. This polarity reversal will enhance confidence separating first arriving shear from any compressional-wave noise contamination. Approximately 75 records are expected from each source location on the deeper hole (25 compressional and 50 shear with 25 for each polarity) and around 20 from the hole at the downstream toe (6 compressional and 12 shear—6 for each polarity) assuming appropriate phase reversal software can be developed.



Figure 5.



Figure 6.

- 2) Preliminary in-field processing will focus on data quality and optimization of equipment and parameters. On-site processing of VSP data will include formatting, correlation, shot gathers, and filtering. Rough estimates of shear and compressional-wave velocities will be made for both holes. Any reflection arrivals will be interpreted with estimates of two-way travel time made for comparison to surface reflection profiles. Generalized geologic cross sections from drill data will be used to ground truth VSP results. No attempt will be made in-field to process or interpret characteristics of reflection events. In-field processing will be ongoing coincident with the data acquisition and will not impact the proposed full-day field schedules. The majority of the processing will be coincident with the interpretation and will be conducted in the month or two following acquisition.



Figure 7. IVI Minivib1.

Phase II

- 3) Prior to acquisition of the proposed compressional and shear reflection surveys an initial walkaway noise tests will be conducted and used as the basis for establishing optimum configuration and overall effectiveness of each seismic method planned for the site. Walkaway noise testing will be dynamic and exhaustive, modified as dictated by the recorded data. It may be necessary to deploy the entire 240-channel spread for both compressional and shear recording. Source and receiver types and settings will be selected as appropriate for the wave type being evaluated and near-surface conditions. If possible, BoR staff will test high explosives in conjunction with the KGS minivib1 into the 240-channel fixed spread. At least two different source-to-nearest receiver offsets and ground conditions will be investigated. Based on the maximum depth of interest, receiver spacing will likely be around 8 ft for both modes. Around 2000 ft will be necessary for the receiver spread and 2900 ft will be required to evaluate the full suite of potential source offsets. The configuration will provide maximum offsets in excess of 2400 ft with the critical first 500 ft evaluated from at least three different source locations along the proposed profile. All walkaway data will be preliminary processed to establish the ideal configuration for each mode. Processing will include conversions and comparisons to borehole-derived ground truth. A key aspect of this part of phase II is the comparison between high explosive and surface swept seismic methods. Energy cost and environmental impact play a significant role in the application of high-resolution seismic reflection at many sites. If using low energy surface seismic sources does not overly compromise the high quality data generally produced when using high explosives in shallow shot holes, many places currently inaccessible or non-economic might be potential targets for seismic reflection imaging. A preferred source, receiver, offset, spacing, and recording parameters for each mode will be established.

Phase III

- 4) Compressional and shear-wave profiles approximately 2000 ft in length, centered on and perpendicular to the crest of East Canyon Dam will be acquired along the right access road using a 240-channel rolling fixed-spread geometry. For compressional-wave data the IVI minivib and 40 Hz geophones should provide the best possible data quality considering the geology and objectives (Figure 8). Depending on the outcome of walkaway data analysis, the vibrator will most likely be programmed to generate 10-second, 20 to 200 Hz linear up-sweeps during acquisition of compressional-wave data. It is anticipated based on experience, source energy levels, and statistical considerations of potential improvement to signal-to-noise ratio through vertical stacking that three sweeps individually recorded at each station in an uncorrelated format will suffice. Under this acquisition

plan around 180 shot stations, each separated by 16 ft, will be necessary to produce the desired 2000 ft long profile. The resulting nominal 60-fold CMP stacked section will possess 4 ft trace spacing and include the appropriate range of offsets for this target depth range.

- 5) For shear-wave data, horizontal receivers with a 14 Hz natural frequency (Figure 9) will be deployed along the same survey line as the compressional-wave receivers as indicated in item 4. To optimize the polarity-sensitive nature of shear waves, receivers and source will be oriented to generate and record SH mode. Advantages of SH to SV predicate this orientation. Each polarized sweep will be reversed (assuming appropriate software can be written) to enhance attempts during processing to cancel as much compressional-wave noise as possible by subtracting reversed shot gathers and during interpretation to identify arrivals exactly 180 degrees out of phase. Correlation of S- to P-wave reflections will require detailed velocity and time analysis incorporated with borehole first-arrival-derived velocities. The 240-channel shear-wave data will be acquired along the same survey line, occupying the same receiver and source locations as the compressional-wave data. Assuming a velocity ratio (P to S) of around 2.5 to 3 (for the conglomerate), dominant shear-wave reflection frequencies in the range of 60 to 90 Hz will be necessary to minimize resolution-related reflector mismatch between the two datasets.
- 6) Each shot and receiver station will be occupied twice—once with the compressional-wave equipment (as defined in item 4) and once with shear-wave equipment (as defined in item 5). Receiver spacing will likely be 8 ft with 16 ft source spacing if double source spacing is appropriate based on data quality. Benefit from this kind of reduced fold shooting comes in lower costs per mile, with the understanding that data quality is at best unaffected. With the primary objective being reflectors within the upper 300 ft and with the known 40-degree dip of surface layers, this asymmetric split-spread approach will provide maximum accuracy in velocity and good dip control at the same time.

Phase IV

- 7) In conjunction with the VSP (phase 1), an MASW survey will be conducted along the crest of the dam and right abutment. The MASW-generated shear wave velocity field will be incorporated into the shear wave VSP model. Redundancy and azimuthal diversity provided by acquiring shear wave velocities in a borehole and from on top the dam should improve the resolution of intra-dam and abutment anomalous zones, providing some measure of compatibility and confidence in the effectiveness of these techniques. MASW will be acquired to focus on the 5 ft to 150 ft BGS depth ranged. It is anticipated that the MASW shear wave profile will overlap some of the subsurface area sampled by reflection data.
- 8) Preliminary infield processing will focus on data quality and optimization of equipment and parameters. Processing infield for the MASW technique will include calculation of dispersion curves and inversion to shear wave velocities. These shear wave velocity profiles will be compared with any

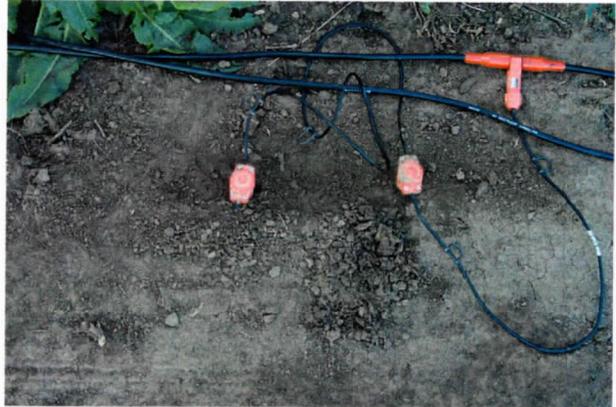


Figure 8. Two 40-Hz high-output geophones.



Figure 9. Minivib in shear-wave orientation.

ground truth (borehole data) available and then contoured to produce a crude first estimate of the shear wave velocity field while on-site. Infield processing will be ongoing coincident with the data acquisition and will not impact the full day field schedules proposed. The majority of the processing will be coincident with the interpretation and will be conducted in the month or two following acquisition.

Phase V

- 9) High-resolution seismic reflection data, by its very nature, lends itself to over-processing, inappropriate processing, and minimal involvement processing. Interpretation 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 (Table 1). 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 correlated shot gathers 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 complete several months after leaving the field. In-field processing will be coincident with data acquisition and will not impact the full-day field schedules.

**Table 1
Basic Processing Flow**

Primary Processing

format
correlation/deconvolution for vibroseis data
preliminary editing
trace balancing
digital filtering
spectral balance
first arrival muting (remove direct wave and refraction)
surgical muting (removal of ground roll based on trace-by-trace arrival)
assign geometries (input source and receiver locations)
elevation correction to multiple, floating datums
sort into CDPs (re-order traces in common midpoints)
velocity analysis (whole dataset analysis on 100 ft/sec increments)
spectral analysis (frequency vs amplitude plots)
NMO correction
surface consistent correlation statics
secondary editing
residual correlation statics
CDP stack
amplitude normalization
correct to flat datum
display

Secondary Processing

f-k filtering
f-k migration
deconvolution (spiking and second zero crossing)
f-x deconvolution

Phase VI

- 10) Interpretation of data and reporting of significant findings will focus on establishing a meaningful V_p/V_s for the drilled interval using both borehole and surface seismic data. First arrivals from near-offset VSP data will be the dominant dataset in establishing the vertical velocity function. Moving away from the boreholes, offset VSPs will be used to both confirm the vertical velocity function and map reflections that intersect the boreholes. To a limited degree, offset VSPs will provide near-borehole dip information about reflectors intersecting the borehole. Surface reflection data will be used to establish the level of consistency in V_p/V_s laterally along the 2000 ft survey line and provide a map of reflector geometry.
- 11) Attempts to establishing a defensible V_p/V_s ratio from near-surface seismic reflection surveys have always suffered from a lack of high-quality ground truth confirmation and confident correlation between P- and S-wave reflection CMP sections. Critical to this correlation are borehole seismic measurements that clearly span the gap between borehole geology (from logs, cuttings, and/or cores) and two-way reflection sections. It is the intent of this applied research project to produce a well-defined seismic velocity cross-section derived from coincident interpretation and integration of borehole and surface datasets that honors the resolution of both datasets without losing the resolution potential of either.

Equipment: Configuration and Evaluation

- 1) Seismic system – 240-channel R60 Strata View w/StrataVisor controller from Geometrics
- 2) Source and Receivers
 - single 14 Hz GS-11D Geospace horizontal geophones
 - double 40 Hz L-28E Mark Products geophones
 - single 3 component hole lock Geostuff geophone
 - single P-44 Mark Products hydrophone
 - variety of combinations –hammer (20 lb, 16 lb, 8 lb, 2 lb) and
–plate (1 sq ft x 1", 0.25 sq ft x 1", 2" shaft, 1" shaft, punch)
 - mini-block shear wave hammer source
 - 13,000 lb IVI Buggy mount high frequency vibrator (15 to 500 Hz, 6500 lb peak force)
- 3) Testing will include:
 - establishing source characteristics
 - geophone response and sensitivity (surface and downhole)
 - orientation accuracy borehole 3-C (empirical)
 - several different types of linear sweeps within the 20-400 Hz range (P and S)
 - number of sweeps to obtain optimum vertical stacking
 - optimum receiver station spacing (vertical and horizontal)
 - source power and offset (optimum window for surface and OVSP for downhole)
 - determination of sampling interval (spatial and time) based on appropriate sampling
 - surface 480-trace, pseudo-continuous walkaway
 - spectral analysis

Likely Survey Parameters

Likely optimal design for surface seismic surveys:

- 1) **Reflection—P-wave:** Vibrator (3 sweeps/station), 10-second upsweep from 20 to 200 Hz, 240 recording channels, 40 Hz geophones, 8 ft receiver spacing, 16 ft source spacing, and rolling fixed spread. Approximately 3000 ft (1 day) profile centered on the dam crest.

- 2) **Reflection—S-wave:** Vibrator (4 sweeps/station), 10-second upsweep from 15 to 120 Hz, 240 recording channels, 14 Hz geophones, 8 ft receiver spacing, 16 ft source spacing, and rolling fixed spread. Approximately 3000 ft (1 day) profile with source and receivers occupying the same stations as P-wave stations.
- 3) **3-C, VSP—S-wave:** Vibrator (2 sweeps/station), 5-second upsweep from 15 to 300 Hz, 9 recording channels, 3 pod-3 component borehole shuttle, 5 ft receiver spacing, and 10 ft 50 ft 100 ft source offsets. Source offsets aligned along center of the dam crest road for deep hole and as near coincident with CMP profile as possible for downstream toe profile.
- 4) **3-C, VSP—P-wave:** Vibrator (2 sweeps/station), 5-second upsweeps from 20 to 400 Hz, 9 recording channels, 3 pod-3 component borehole shuttle, 5 ft receiver spacing, and 10 ft 50 ft 100 ft source offsets. Source offsets aligned along the center of the dam crest for deep hole and as near coincident with CMP profile as possible for downstream toe profile.
- 5) **MASW:** Accelerated weight drop (3 impacts), thirty 4.5 Hz geophones in landstreamer profile along portion of crest and segment of right abutment. Source offset around 8 ft with source interval of 8 ft.

Approximate Timeline of Proposed Program

- 1) Planned Research Schedule:

	<u>Approx. Duration</u>
Mobilization/Demobilization	2 weeks
Travel	3 days
Phase 1—VSP	1½ days
Phase 2—Walkaway surface reflection	½ day
Phase 3—Collect P and S surface reflection	2½ days
Phase 4—Collect MASW data	1 day
Phase 5—Processing all data	3 months
Phase 6—Interpretation and reporting	3 months

- 2) Deliverables Schedule:

Phases 1, 2, 3, and 4—Preliminary report 2 months after completion of fieldwork.
 Phase 5—Preliminary report 3 to 4 months after completion of fieldwork.
 Phase 6—Preliminary report 6 to 8 months after completion of fieldwork
Final Report after review and comment by Bureau of Reclamation

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- Hunter, J.A., S.E. Pullan, R.A. Burns, R.M. Gagne, and R.L. Good, 1984, Shallow seismic reflection mapping of the overburden-bedrock interface with the engineering seismograph—Some simple techniques: *Geophysics*, v. 49, p. 1381-1385.
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III. RESPONSIBILITIES

The responsibility for providing each employee a safe working environment 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 BoR 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 and/or by lightning detector).
2. If conditions become excessive (i.e., temperature $> 100^{\circ} < 30^{\circ}$ F), continuous day operations may be modified to minimize chances for heat- or cold-related medical problems. Breaks of up to one hour after every hour of work might be necessary in extreme situations (i.e., temperature $> 110^{\circ} < 0^{\circ}$ F). 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 open-air vehicles or sources. Safety glasses are recommended when planting geophones.
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 foodstuff 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 BoR 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.
11. Work along roads will comply with regulations as established by KDOT (in Kansas) or local department of transportation (for out-of-state).

IV. SAFETY PERSONNEL

Safety Personnel and Emergency Contacts

1. Rick Miller (KGS)—Site Safety Officer
2. Chad Gratton (KGS)—Operations
3. Rich Markiewicz (BoR)—Technical Representative
4. Dave Copeland (BoR)—Site Representative

V. **EMERGENCY INFORMATION**

Utah State Patrol
461 Stewart, Box A-1, Ogden, UT (801) 393-1136 _____

Morgan County Sheriff (801) 829-3745 non-emergency _____

Emergency/Police/Ambulance: 911 _____

Lodging—
BW Dunmar, Evanston, WY (307) 789-3770 / fax (307) 789-3758 _____
(Exit #3 off I-80)
1601 Harrison, Evanston, WY 82930

BW Landmark Inn, Park City, UT (435) 649-7300 / fax (435) 649-1760 _____
(Exit #145 south off I-80, turn rt on Landmark Drive)
6560 N Landmark Drive, Park City, UT 84098

BoR Emergency Contacts

Rich Markiewicz, cell 303-941-9413
Dave Copeland, cell 720-320-6194

KGS Emergency Contacts

Safety Coordinator and Project Manager
Rick Miller, Kansas Geological Survey, 785-864-2091
Cellular (in the field): 785-766-8638

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

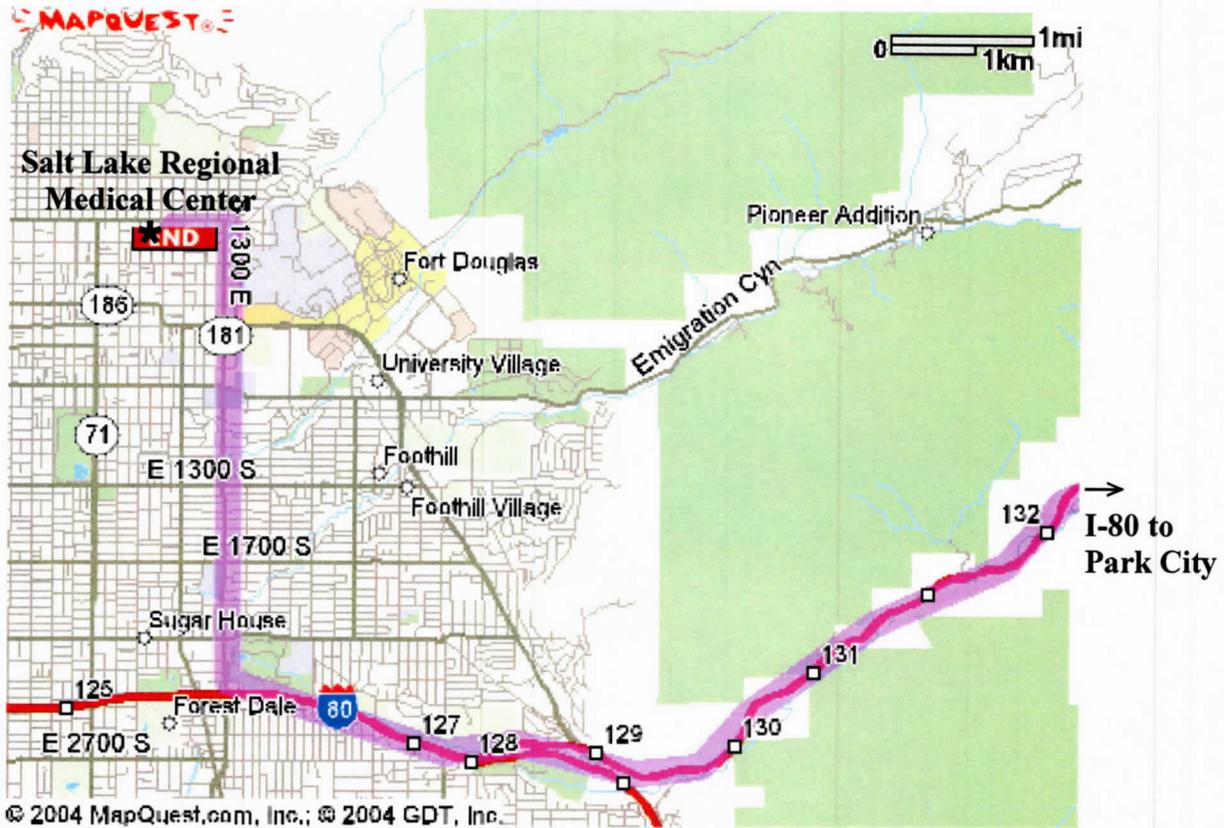
General Map



BW Landmark Inn,
Park City, UT

Emergency Route

From I-80 to Salt Lake Regional Medical Center
1050 E South Temple, Salt Lake City, UT 84102

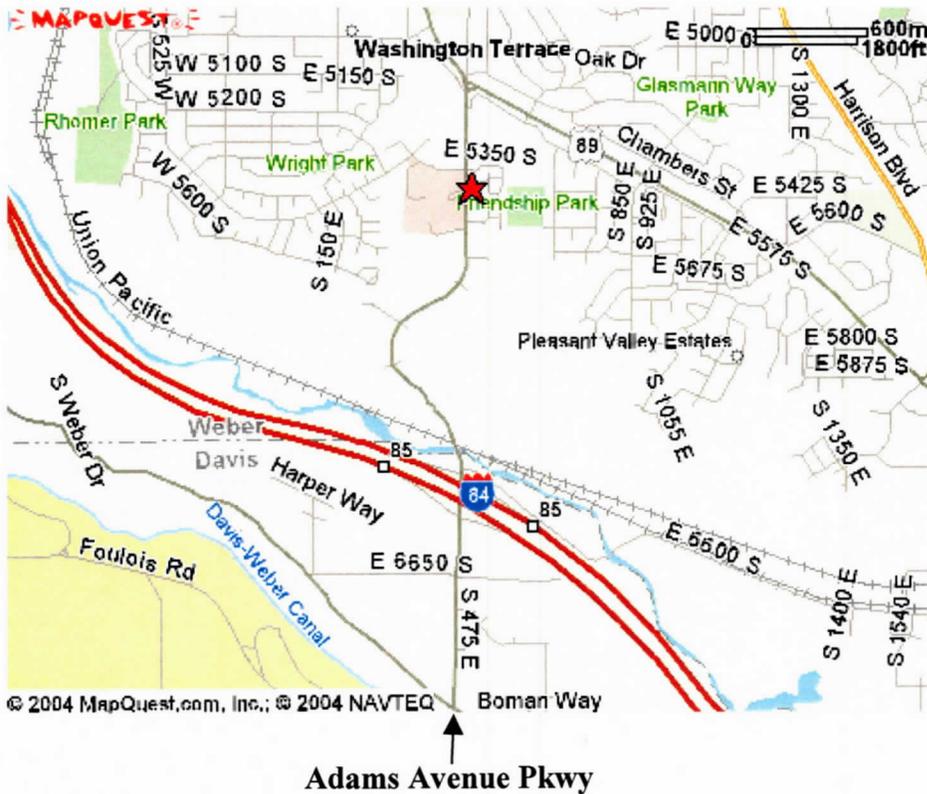


- 1: Start out going southeast on LANDMARK DR toward UT-224.
- 2: Turn LEFT onto UT-224. 0.2 miles
- 3: Turn LEFT onto ramp. 0.3 miles
- 4: Merge onto I-80 W. 18.5 miles
- 5: Take the UT-181/13TH EAST exit-
exit number 126- toward SUGAR HOUSE. 0.2 miles
- 6: Turn RIGHT onto S 1300 E/UT-181.
Continue to follow S 1300 E. 3.3 miles
- 7: Turn LEFT onto E SOUTH TEMPLE. 0.3 miles
- 8: End at 1050 E SOUTH TEMPLE SALT LAKE CITY UT

Emergency Route

From I-84 to Ogden Regional Medical Center ph 801-829-6866
5475 South 500 East, Ogden, UT 84405
[Alt. phone (from web) 801-479-2111 or 2376]

See general map to get from East Canyon Dam to I-84.



1. Merge onto I-84 W toward OGDEN.
2. Take the exit- exit number 85- toward UINTAH/SO. WEBER.
3. Turn RIGHT onto ADAMS AVENUE PKWY (Portions toll).
4. End at 5475 S 500 E Ogden UT

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. This certification was received through participation in the “First Aid Basics” and “Adult CPR” 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~~ Chad Gratton

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 BoR 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 BoR, with copies available on-site for inspection by local authorities.

VI. 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 barbitol. 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.

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.

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.

Weight Drop

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

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.

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.

VIII. ACTIVITY HAZARD ANALYSIS

A. 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. Flagmen will be used along roadways with limited sight areas or speed limits exceeding 45 mph. For sites with traffic speeds above 45 mph and work requiring shoulder access, lane closure must be considered.

B. 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.

C. **Work Item: Accelerated Weight Drop**



The accelerated weight drop (AWD) generates acoustic energy by accelerating a 50 to 100 lb weight through a 2 ft stroke impacting an 18 in diameter steel plate held to the ground surface by the weight of a skid-steer style loader. The weight is accelerated within an enclosed steel guide. The drive mechanism consists of a hydraulic motor turning a set of sprockets that deliver power to a cycling lift arm that pulls the weight against the resisting force of an industrial rubber band. Simply

envisioned, this device is analogous to a sling-shot. All moving parts are shielded, with the contact area between the weight and plate sufficiently enclosed to avoid and possibility of debris becoming airborne and representing a risk to the operator or bystanders.

Control Measures

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

D. **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.

Control Measures

- 1) Every ATV operator shall possess a valid Kansas driver's license and shall have completed an ATV training course prior to operation of the vehicle.
- 2) The manufacturer's recommended payload shall not be exceeded at any time.
- 3) Gloves and an approved motorcycle helmet with full face shield or goggles shall be worn at all times while operating an ATV at speeds in excess of 15 mph.
- 4) ATVs are to be used to haul equipment and supplies only.
- 5) Only ATVs with four or more wheels are permitted to be used.
- 6) All ATVs shall be equipped with a warning signal device (horn).

E. Work Item: *Slide Hammer and Sledgehammers*

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

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



F. Work Item: *Geophones and Land Streamer*

Geophones are electromechanical devices that respond to earth movement, producing an electric pulse representative of the ground motion. They are coupled to the ground with 3-5 inch spikes. The land streamer is a collective group of geophones connected by a single belt and dragged along the ground surface, maintaining pressure contact with the ground.



Specific Hazards

- 1) Geophone spikes can puncture the skin and string or groups of geophones can be excessively heavy and represent a lifting hazard.
- 2) The land streamer is large, heavy, and awkward to handle. Muscle strains and pulls are possible.



Control Measures—

- 1) Keep geophone strings away from legs while walking and carrying.
- 2) Never carry more than one hasp of geophones per arm.
- 3) Always bend knees and use proper lifting techniques when loading or unloading land streamer.
- 4) Wear gloves and safety shoes to protect extremities from smash or crush hazards.

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)

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

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 repellent. These protective chemicals will be available for use on-site.

XI. SAFETY ANALYSIS

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

A. Mobilization – Loading & Unloading

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Sprained back	Use proper lifting technique, get help
Backing vehicle into equipment or personnel	Use spotter, back-up alarms on vehicles. Driver to insure that rear-view mirrors are adjusted properly.

B. Mobilization – Travel To / From Site

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Traffic accidents	Use proper defensive driving technique.
Livestock or other animals on road	Watch sides of the road, especially at dawn & dusk; try to avoid larger animals.
Equipment falling off of trucks	Check load before leaving shop or overnight lodging, after first 25 miles, then after every 150 miles.
Losing control or falling asleep at the wheel.	Watch driving speed versus road condition and posted legal limits. Get good rest, use buddy system on long drives, pull over if necessary.

C. Vibroseis Operations – See also IAGC Manual

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Vibrating over buried natural gas, electric, or telephone lines.	Use utility location if needed before commencing work. Look for posted notices of buried utilities.
Lightning in area.	If thunder is within 5 seconds of lightning, shut down operations, get into truck cab.
Slips, trips, falls.	Clear work area of obstacles, be sure of your footing.

D. Working Along Highways – This section highlights some of the more common issues. It is not meant to be a guide to traffic control, which should be conducted only by qualified personnel. Traffic signs, cones, and flaggers should be used as appropriate when working on road shoulders. Signs, cones, and flaggers must be used when working in a closed traffic lane.

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Pedestrian / Automobile accident	Wear high-visibility vests. Watch traffic. Don't assume traffic control will keep cars & trucks out of area. Work <u>facing</u> traffic, <u>not</u> back to traffic. If traffic drifts into the lane you are working in, <i>drop what you are doing and get away to safety.</i>
Slips, trips, falls.	Clear work area of obstacles, be sure of your footing.

E. Laying Out and Picking Up Seismic Cables and Geophones

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Slips, trips, falls.	Clear work area of obstacles, be sure of your footing.
Back or neck injury	Get assistance with heavy cables, use proper lifting technique.
Tangled cables.	Use proper winding / unwinding technique, get help with untangling heavy cable or untangling cable where footing is slippery or steep.
Lightning in area.	If thunder is within 5 seconds of lightning, get away from cables, shut down operations, disconnect cables from any recording equipment mounted in truck, get into truck cab. Keep an eye on the weather if thunder storms are forecast.

F. Environmental Concerns

<i>Potential Hazards</i>	<i>Recommended Safe Procedures</i>
Fuel & hydraulic fluid leaks.	Check equipment for leaks and repair as needed. Use absorbent materials, clean up any spills.

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.

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

<u>Potential Hazard</u>	<u>Consequences</u>	<u>Mitigation/Prevention Mechanism</u>
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.

<u>Potential Hazard</u>	<u>Consequences</u>	<u>Mitigation/Prevention Mechanism</u>
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):

Site Safety Officer

**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):

Site Safety Officer

**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):

Site Safety Officer

American
Red Cross



Together, we can save a life

This recognizes that
RICK MILLER
has completed the requirements for
First Aid Basics

conducted by
Douglas County Chapter

Date completed **03/02/04**

The American Red Cross recognizes this certificate
as valid for **3** year(s) from completion date.

American
Red Cross



Together, we can save a life

This recognizes that
RICK MILLER
has completed the requirements for
Adult CPR

conducted by
Douglas County Chapter

Date completed **03/02/04**

The American Red Cross recognizes this certificate
as valid for **one** year(s) from completion date.

MEDICAL EVALUATION FORM

Employee Name: RICHARD D. MILLER
Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047

Date of Exam: 3-20-97

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:

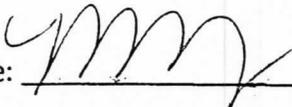
 X has no medical contraindications to full participation in hazardous waste site work, when conducted under the conditions of adequate training and a health and safety plan.

 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.)

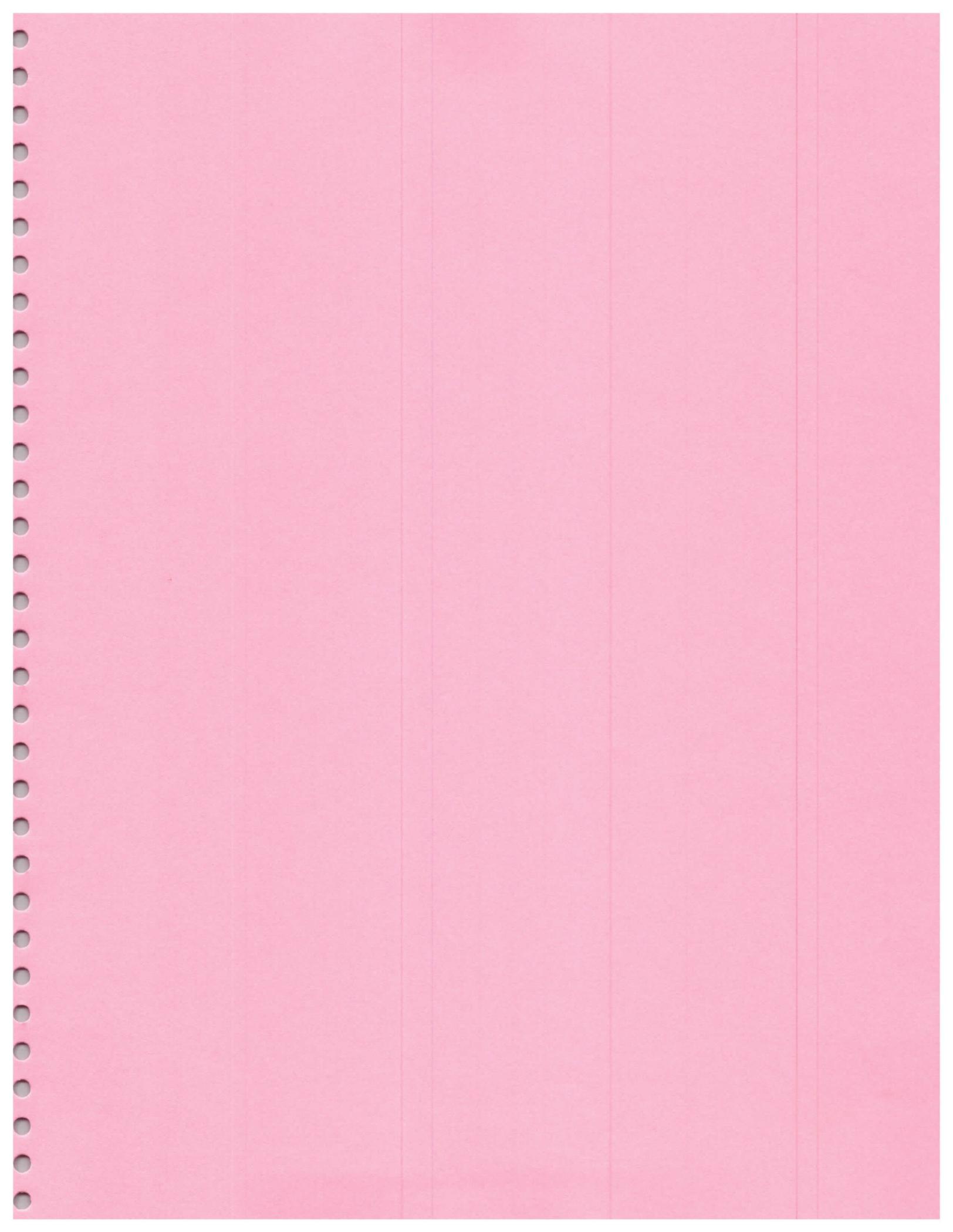
Comments: _____

Name of Physician: Mary Vernon
Please Print

Signature: 

Address: 500 Rockledge Rd
Lawrence, KS 66049

Date: 3-20-97



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

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

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

1. In field:

Always point down or away from populated areas

Always avoid lodging foreign material in barrel

Never strain to carry, get a second person

Never assume anything

2. To and from site and storage:

Must be storage in a metal locked container

Must be stored with bolt and gun in separate locations

Must be completely broke down and cleaned prior to storage

Access to guns and ammo must be limited to trained personnel only

Live rounds cannot be stored closer than 5 ft from guns

B. *Cleaning*

1. Daily:

Must be inspected for unusual wear, signs of metal fatigue, or structural weakness at the beginning and end of each days service

Bolt and breech must be oiled and check for mechanical operation

At the end of each 1/2 day service the barrel will be carefully inspected and checked for signs of fatigue.

The bolts that secure the gun to the protective steel plate are checked at least 3 times a day.

2. Seasonal:

R/R springs in extraction system and those associated with the firing rod

R/R bolts and nuts that attach to protective steel plate.

R/R mounting bracket as necessary

C. *Firing*

1. Assumptions

NONE

2. Never Do's

Move from downhole placement with shell in chamber

Gun loaded with no one standing on plate

With one person on plate

With knees locked

Extract a shell in less than 2 minutes that does not detonate

Without both operators aware of detonation

Drop a loaded round

Return a mis-fire to live round canisters

March 24, 1987

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

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

Operational Safety Rules

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

Downhole Mode

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

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

Surface Mode

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

5/10/92

OPERATION/SAFETY RULES AND REGULATIONS
FOR THE

AUGER GUN

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

Operation and Safety Regulations

- 1) Each day the Site Safety Officer (SSO) must brief all members of the seismic crew on the proper operation and maintenance of the auger gun.
- 2) Prior to set-up on any location the site must be cleared of all potential underground hazards and utilities. The 'tip-over' potential of a site (directly related to topography) must also be considered prior to access with the loader.
- 3) The firing rod is never transported or stored loaded or in firing mode (locked into the auger) prior to downhole placement of the auger.
- 4) The firing rod is stored unloaded (no sleeve snapped onto the bottom) in the left side storage holster during downhole placement and in-field movement.

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

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

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

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

RESULTS

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

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

ground roll are still present on filtered files. The general characteristics of the 80 ms reflection seem to be consistent for both sources.

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

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

CONCLUSION

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

ACKNOWLEDGMENTS

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

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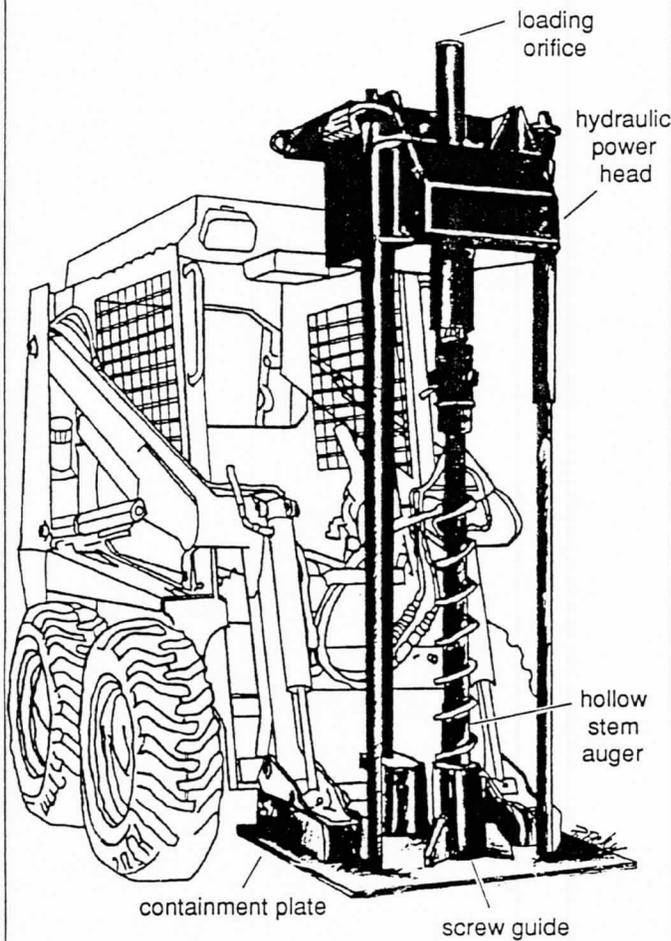


Fig. 1 Diagram represents the auger gun in above-ground position. Modified buffalo-gun portion of the auger gun is not shown, but is conceptually the same as previously documented (Pullan and MacAulay, 1987).

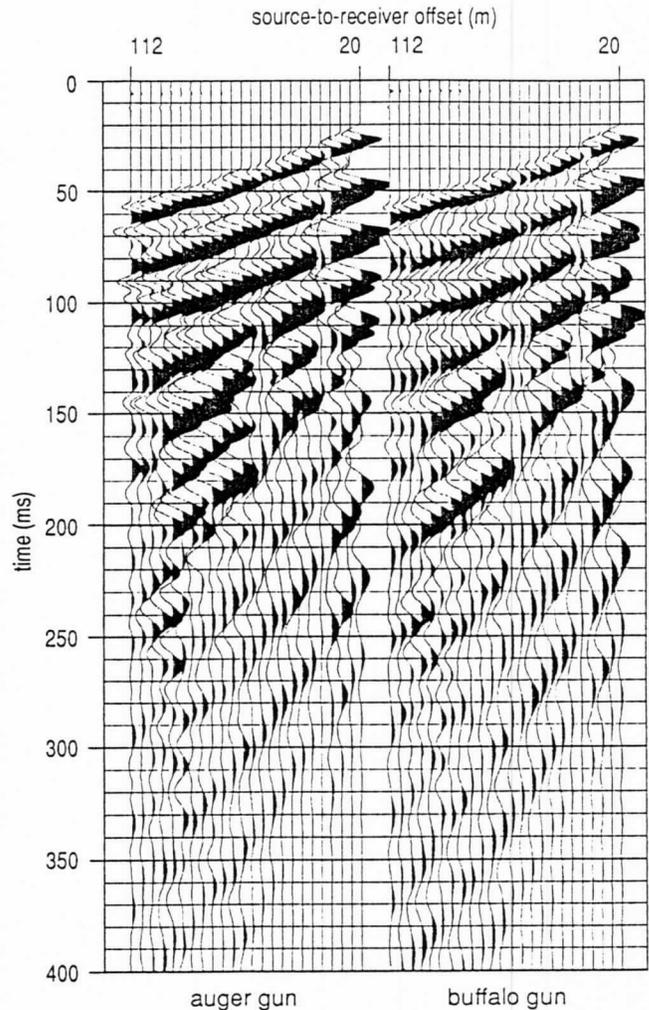


Fig. 2 Auger gun field file (left) compared to the buffalo gun (right).

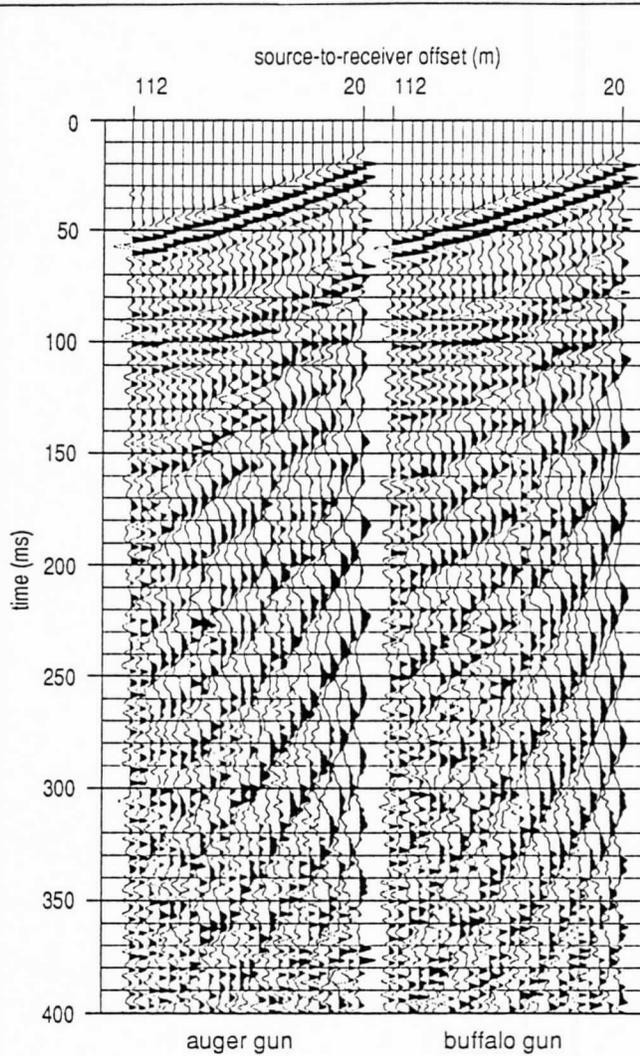


Fig. 3 A 150 Hz digital low-cut filter enhanced the 80 ms reflection event on both the auger (left) and buffalo (right) guns.

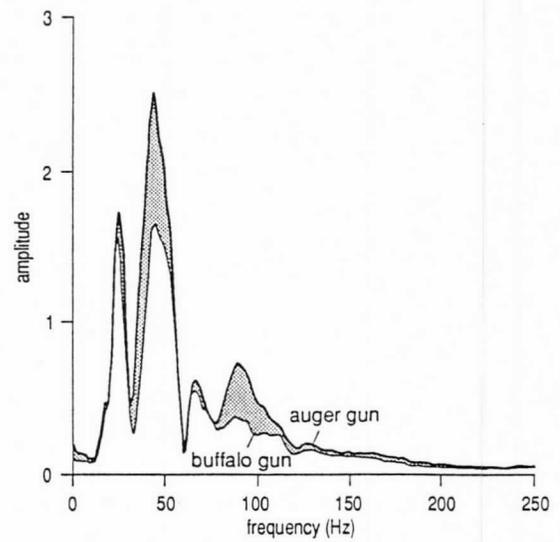


Fig. 4 The darkened area represents the difference between the lower curve (buffalo gun) and the upper curve (auger gun).

Downhole .50-caliber Rifle—An Advance In
High-resolution Seismic Sources

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

SUMMARY

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

INTRODUCTION

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

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

DESIGN AND TECHNIQUE

The general design centers around optimizing the conversion of energy produced by a .50-caliber rifle bullet into seismic (acoustic) waves. The

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

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

FREQUENCY AND AMPLITUDE

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

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

SAFETY

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

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

CASE STUDY

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

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

Downhole .50-caliber Field Files and Spectrum

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

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

ACKNOWLEDGMENTS

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- Steeple, 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.

Downhole 50-caliber Rifle
Field File

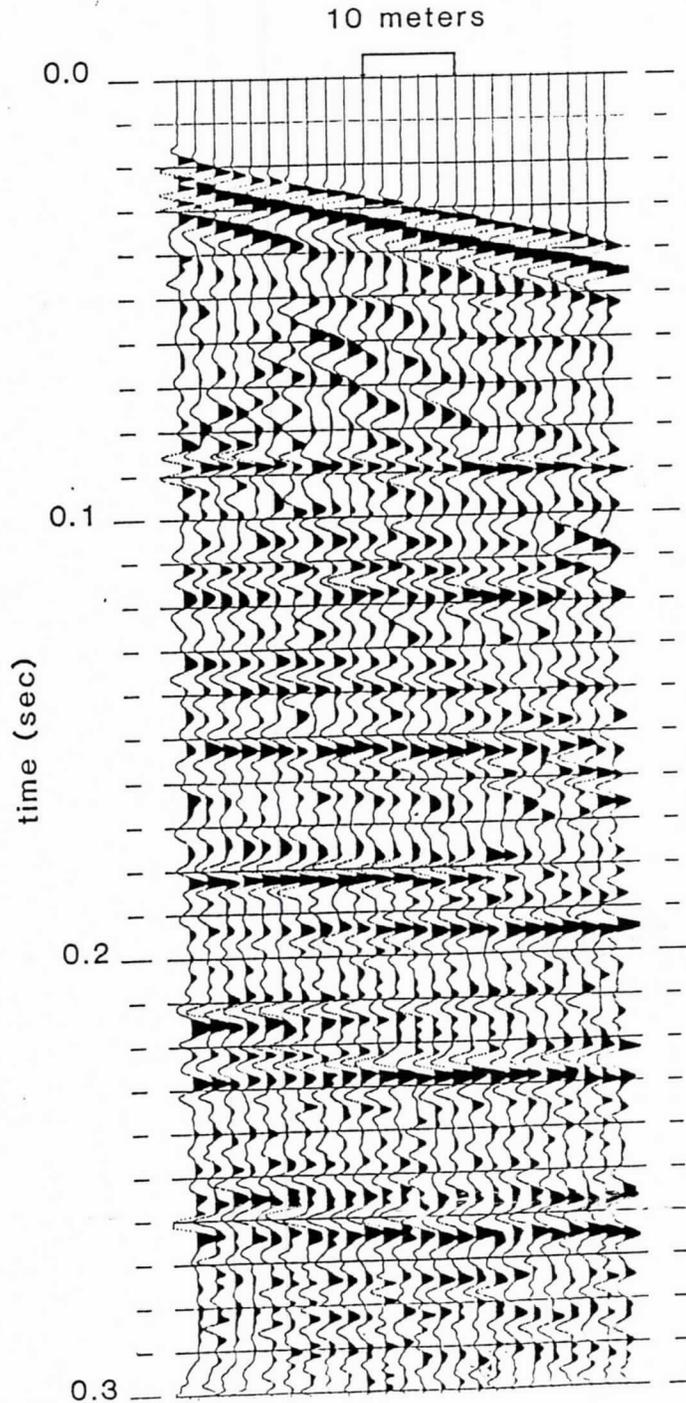


FIG. 2. -This single-shot field file with an AGC applied illustrates the high frequencies and therefore the resolution easily obtainable with a downhole .50-cal.

Surface 50-caliber Rifle -vs- Downhole 50-caliber Rifle

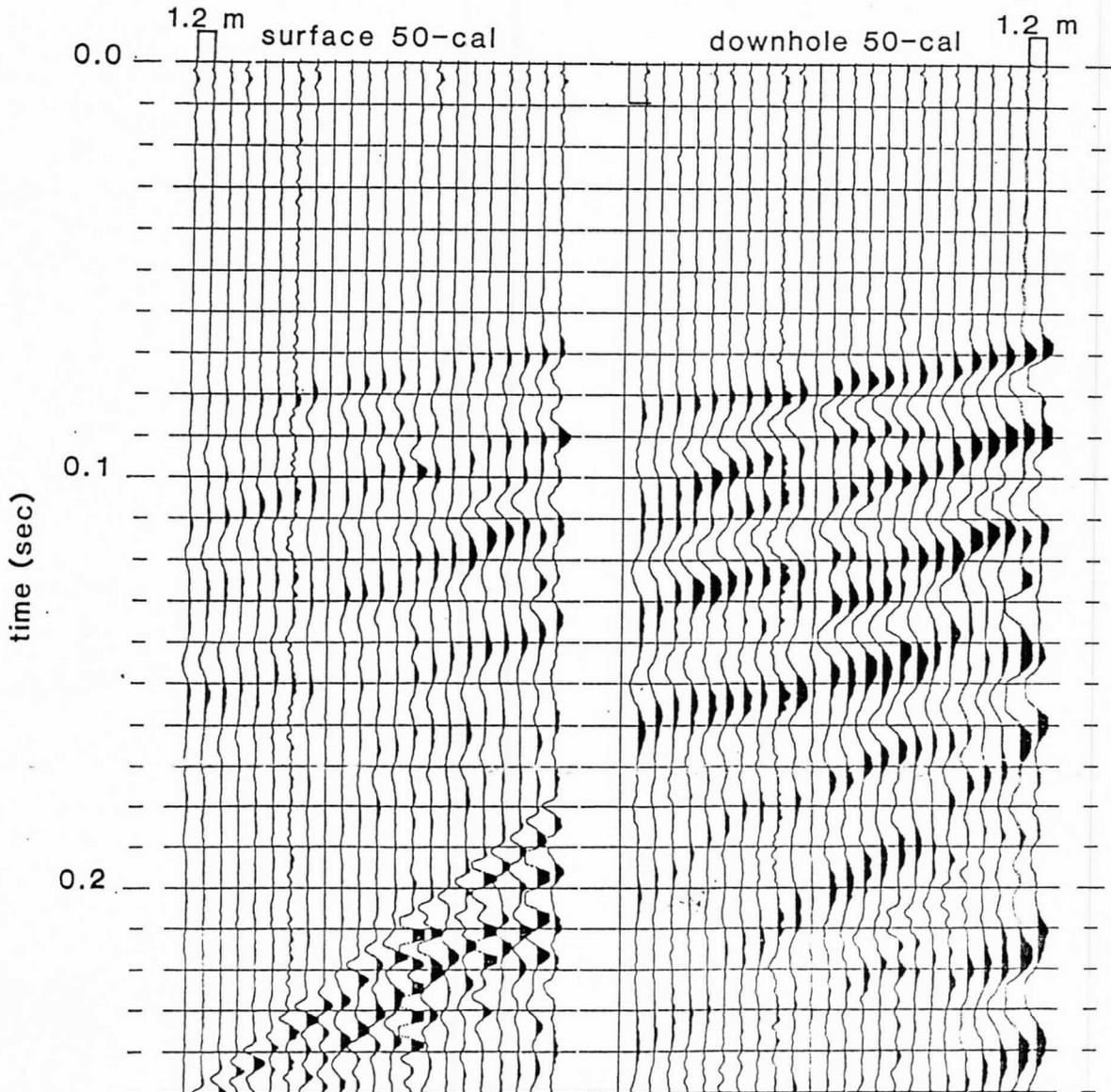
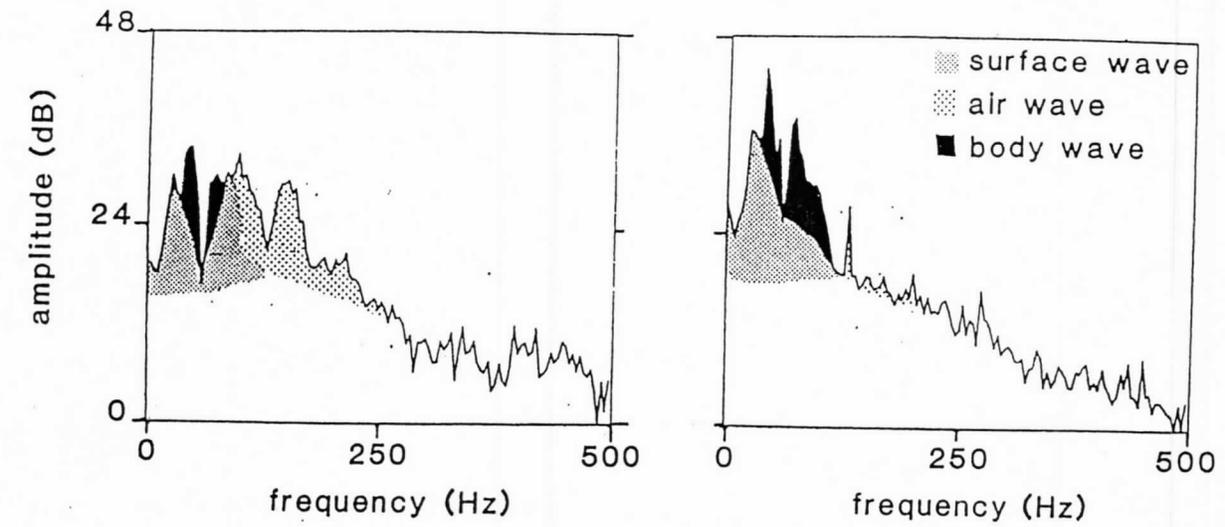


Figure captions.

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

85 msec Reflector Wavelet
Amplitude Spectrum

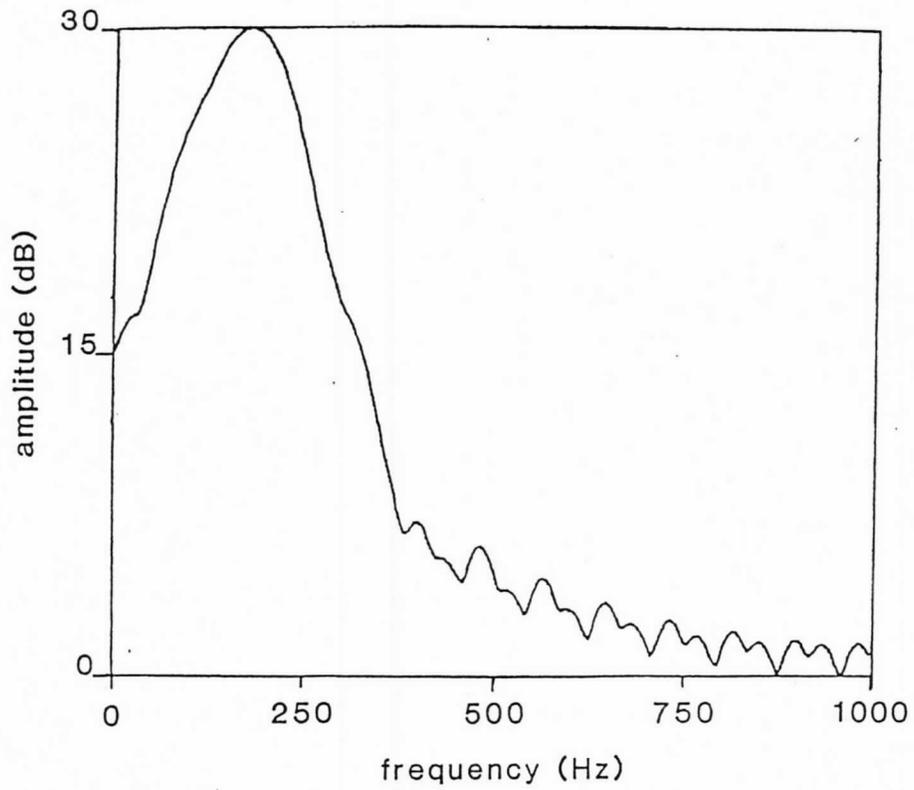


FIG. 3. -The amplitude spectrum of the reflection pulse at 85 msec is almost 3 octaves

Eight Shot Vertical Stack
Downhole 50-caliber Rifle

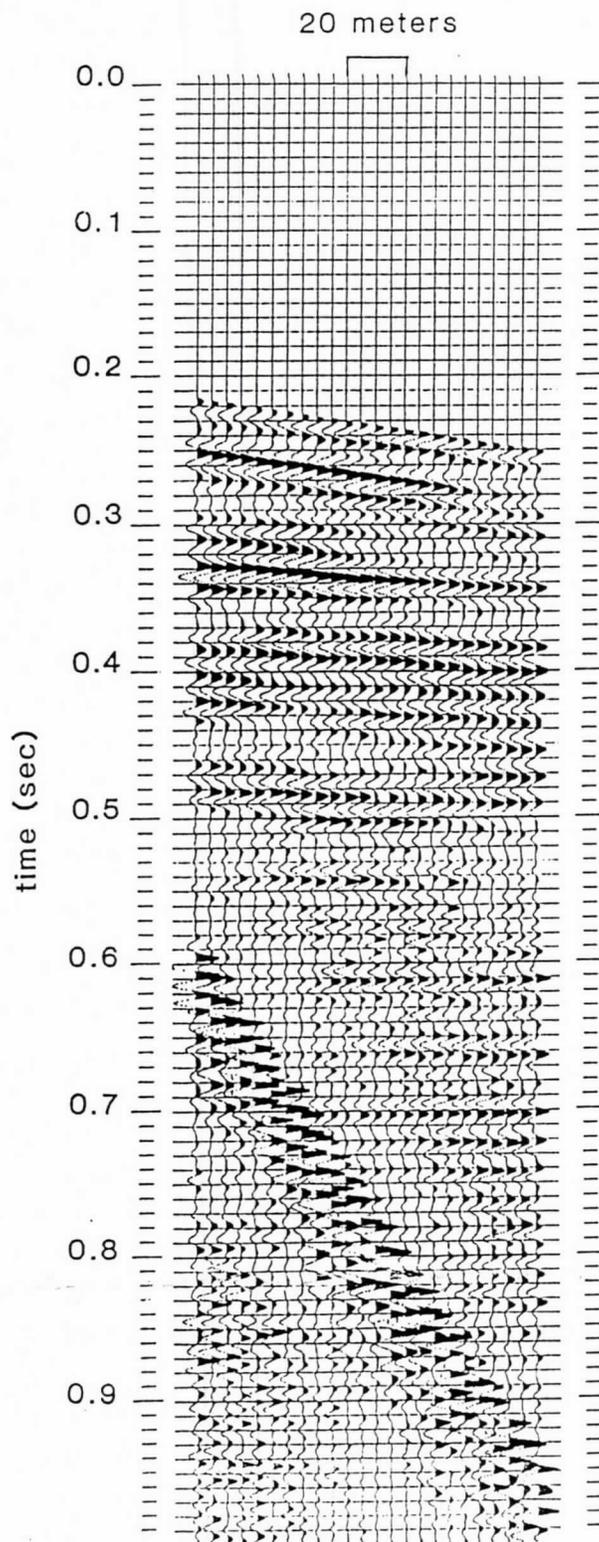
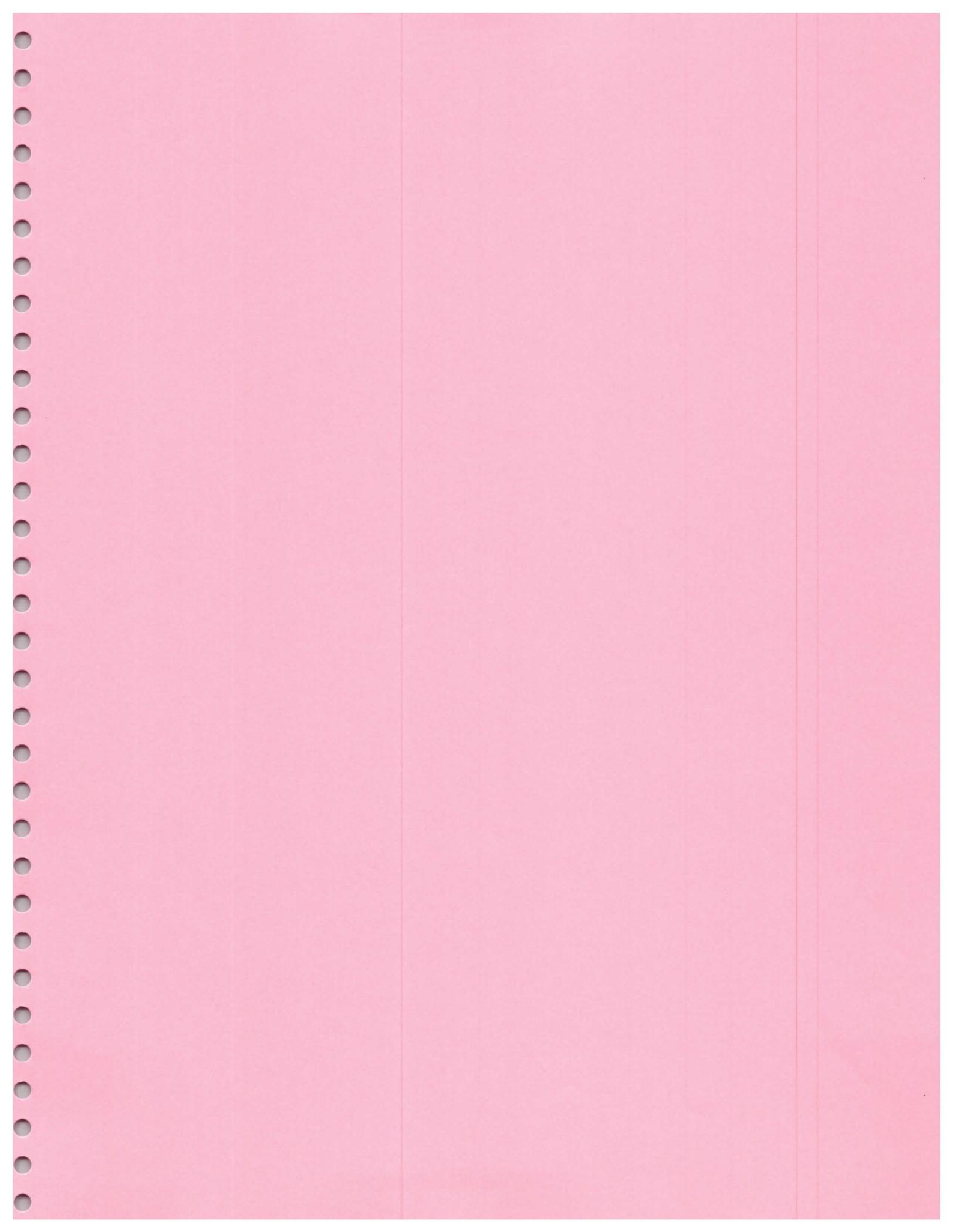


FIG. 4. This stacked field file has 100 Hz reflection energy as deep as 1100 meters.





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

MATERIAL SAFETY DATA

SECTION I - IDENTIFICATION

CHEMICAL NAME & SYNONYMS Industrial Ammunition 8 Gauge (Small Arms Ammunition)		
CHEMICAL FAMILY Not applicable	FORMULA Mixture	TRADE NAME Not applicable
DESCRIPTION Container with powders and projectile		CAS NO. 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 Gloves None necessary Other Hearing protection recommended during discharge	Local mechanical exhaust ventilation recommended during confined space 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 Not Applicable	OSHA CLASSIFICATION Explosive	FLAMMABLE EXPLOSIVE LIMITS -	LOWER -	UPPER -
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
ACUTE DERMAL LD 50	> 2 g/kg	MUTAGENICITY	May be mutagenic
ACUTE INHALATION LC 50	Not known	EYE IRRITATION	May be an irritant
		PRIMARY SKIN IRRITATION	Not an irritant
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
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SECTION IX - REACTIVITY DATA

STABLE <input checked="" type="checkbox"/> UNSTABLE <input type="checkbox"/>	AT _____ °C _____ °F	HAZARDOUS POLYMERIZATION	MAY OCCUR
CONDITIONS TO AVOID		WILL NOT OCCUR <input checked="" type="checkbox"/>	
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 ₂ O = 1)	N/A	pH	N/A	VAPOR DENSITY (Air = 1)	N/A

INFORMATION FURNISHED BY: C. C. Noonan
(203) 789-5436

DATE November 16, 1985

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

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)
 All Shotshell Ammunition

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.

Section I "Small Arms Ammunition"

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

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			
Nitroglycerin (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 (H₂O = 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) Not applicable	Flammable Limits Not applicable	LEL NA	UEL NA
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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 temperatures (130°C)
	Stable	X	

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 - Particles^{location?}

Health Hazards (Acute and Chronic) Anemia, fatigue, nocturia, 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/Hygenic Practices Wash hands after skin contact with cartridges.

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

DEFINITIONS OF ACRONYMS

- OSHA PEL:** Occupational Safety and Health Administration's Permissible Exposure Limit.
- ACGIH TLV:** American Conference of Governmental Industrial Hygienists' Threshold Limit Values.
- TWA:** Time Weighted Average.
- STEL:** Short Term Exposure Limit, the 15 minute exposure which should not be exceeded at any time during a workday.
- CEILING:** The concentration which is not to be exceeded at any time during a workday.
- CAS:** Chemical Abstracts Service number.

SECTION #3 - PHYSICAL DATA

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

SECTION #4 - FIRE FIGHTING & EXPLOSION DATA:

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

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

SECTION #5A - EXPOSURE & EFFECTS -- INHALATION

ROUTE OF EXPOSURE & EFFECTS - INHALATION

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

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

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

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

SECTION #5B - EXPOSURE & EFFECTS -- SKIN

ROUTES OF EXPOSURE & EFFECTS - SKIN

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

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

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

SECTION #5C - EXPOSURE & EFFECTS -- EYES

ROUTES OF EXPOSURE & EFFECTS - EYES

- Acute: Contact with large volumes of smoke may cause minor eye irritation.
- Chronic: None reported
- First Aid: Remove person to fresh air. If foreign body is suspected, wash eyes in fresh water for 15 minutes, contact physician.

SECTION #5D - EXPOSURE & EFFECTS -- INGESTION

ROUTE OF EXPOSURE & EFFECTS -- INGESTION

- Acute: Acute ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under acute inhalation in addition to gastrointestinal irritation.
- Chronic: Chronic ingestion of lead may occur from poor personal hygiene associated with the handling of lead bearing materials. The effects of lead ingestion would be similar to those listed under chronic inhalation.
- Note: Wash hands thoroughly with soap and water before eating or smoking.
- First Aid: Ingestion is not a likely route of exposure. In case of ingestion, contact physician.

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

- N.T.P. No
- I.A.R.C.: Group 2B, possibly carcinogenic in humans.
- OSHA: No

SECTION #5F - EXPOSURE & EFFECTS -- COMMENTS

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

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

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

AGGRAVATION TO PRE-EXISTING HEALTH CONDITIONS

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

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

SECTION #6 - REACTIVITY & POLYMERIZATION

Stability: Stable under normal use conditions

Conditions to Avoid: Individual cartridges may ignite if the primer is struck or if the cartridge is exposed to excess heat

Incompatible Materials: Oils, acids, Alkalies, Ammonia, and other corrosive materials

Hazardous Decomposition Materials: Oxides of Barium, Lead, Antimony, Aluminum, Magnesium, Nitrogen, Carbon, and Sulfur. Lead and Antimony fume may also be produced.

Polymerization: Will not occur

SECTION #7 - SPILLS, LEAKS & DISPOSAL PROCEDURES

STEPS TO BE TAKEN - SPILLS:

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

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

SECTION #8 - SPECIAL PROTECTIVE EQUIPMENT

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

Protective Equipment:

Eyes: Recommend protective eyewear conforming to ANSI Z-87

Gloves: Not generally required

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

Hearing Protection: Hearing protection recommended while discharging cartridges

SECTION #9 - SPECIAL PRECAUTIONS -- STORAGE & HANDLING

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

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

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

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Although reasonable care has been taken in the preparation of this document, Federal Cartridge Company extends no warranties and makes no representation as to the accuracy or completeness of the information contained herein and assumes no responsibility regarding the suitability of this information for the user's intended purpose or the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose.

Remington Arms

Material Safety Data Sheet

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	HMIS Rating
Molecular Weight:	N/A	Health: 2
Grade:	N/A	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 |

*Remington Arms**Material Safety Data Sheet***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.

Remington Arms**Material Safety Data Sheet****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.

Remington Arms**Material Safety Data Sheet****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 <i>HMIS Rating</i>)
Pressure Hazard:	Sudden release of pressure.
Reactivity Hazard:	1 (per <i>HMIS Rating</i>)

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.

*Remington Arms**Material Safety Data Sheet***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

The information contained in this *Material Safety Data Sheet* is provided to all individuals who are or will be exposed to this product through use, handling, storage or transport. Remington believes, yet makes no warranty, that all information contained in this document is current as of the date of publication.

GENERAL MOTORS CORPORATION MATERIAL SAFETY DATA SHEET

SECTION I

PRODUCT NAME OR NUMBER (as it appears on label) ALL MODELS OF DELCO BATTERIES		GM COMMON CODE
MANUFACTURER'S NAME Delco Remy Division, GMC		EMERGENCY TELEPHONE NO. (317) 646-3080
ADDRESS (Number, Street, City, State and Zip Code) 2401 Columbus Avenue, Anderson, IN 46018		MANUFACTURER'S D-U-N-S NO.
HAZARDOUS MATERIAL DESCRIPTION, PROPER SHIPPING NAME, HAZARD CLASS, HAZARD ID NO. (49 CFR 172.101) Battery, Wet, Filled with Acid, (Corrosive Material) Class 8 - UN2794		
ADDITIONAL HAZARD CLASSES (as applicable)		
CHEMICAL FAMILY Liquid Content - Sulfuric Acid	FORMULA Liquid Content - H2SO4	

SECTION II — INGREDIENTS (list all ingredients)

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

SECTION III — PHYSICAL DATA

BOILING POINT 233 °F °C	SPECIFIC GRAVITY (H ₂ O = 1) Varies with battery size	Average 1.280 ± .01
VAPOR PRESSURE (at 77 °F 25 °C) <input checked="" type="checkbox"/> mm Hg <input type="checkbox"/> psi	PERCENT VOLATILE BY VOLUME (%)	PERCENT SOLID BY WEIGHT (%)
VAPOR DENSITY (AIR = 1)	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	UEL
EXTINGUISHING MEDIA			NA	NA
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 <input checked="" type="checkbox"/> TLV=1 mg/m ³ PERMISSIBLE EXPOSURE LIMIT <input type="checkbox"/> Sulfuric Acid OTHER LIMIT <input type="checkbox"/>
PRIMARY ROUTES OF ENTRY Inhalation <input checked="" type="checkbox"/> Skin Contact <input type="checkbox"/> Other (specify) Ingestion	
EMERGENCY AND FIRST AID PROCEDURES Do not exceed 1 mg/m ³ 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 white 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.	
RCRA (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	
<input checked="" type="checkbox"/> Theoretical 4 lb/gal	<input type="checkbox"/> Analytical NA lb/gal

SECTION VIII-SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type) Use NIOSH approved respiratory protection if 1 mg/m ³ 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 <i>Robert A. Chisman</i> Title Senior Industrial Hygienist Date May 8, 1991
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ANSULANSUL 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 Aluminium Silicate (Attapulgate 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 ₂ O = 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
Special Fire Fighting Procedures:	NONE — THIS IS AN EXTINGUISHING AGENT				
Unusual Fire and Explosion Hazards:	None				

SECTION 4 — PHYSICAL HAZARDS

Stability:	Unstable <input type="checkbox"/> Stable <input checked="" type="checkbox"/>	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 <input type="checkbox"/> Will Not Occur <input checked="" type="checkbox"/>	Conditions to Avoid:	N/A

SECTION 5 — HEALTH HAZARDS

FORAY (Continued)

Threshold Limit Value:	OSHA nuisance dust limit of 15 mg/M ³ or ACGIH nuisance dust value of 10 mg/M ³ 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 <input type="checkbox"/> No <input checked="" type="checkbox"/>	I.A.R.C. Monographs: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	OSHA: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

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	<u>1</u> HEALTH
3 Serious Hazard	<u>0</u> FLAMMABILITY
2 Moderate Hazard	<u>0</u> REACTIVITY
1 Slight Hazard	
0 Minimal Hazard	

N/A = Not Applicable NDA = No Data Available

ANSUL and FORAY are registered trademarks.



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** -----

<u>INGREDIENT</u>	<u>PERCENT</u>	<u>TLV/PEL</u>	<u>V.P.</u>	<u>CAS.#</u>
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. SP. GRAVITY (WATER=1): 0.89
 % VOLATILE VOLUME: N.A. EVAPORATION RATE: N.A.
 VAPOR DENSITY: N.A. SOLUBILITY IN WATER: Insoluble
 APPEARANCE/ODOR: dark amber/slight odor 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

The information contained herein is believed to be accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Furthermore, vendee assumes the risk in use of the material.



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 Rating¹: 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

¹Hazard 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.

NA-Not Applicable

ND-No Data

NE-Not Established

CITGO No. 2 Fuel Oils, All Grades (AG2FO, September 26, 1997, CIN: 5388)

Page 1 of 7

2.0 PHYSICAL DATA (continued)

Boiling Point, 760 mm Hg, °C (°F):	160 - 360 (320 - 680)
Specific Gravity (0 °F) (H ₂ O = 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: <u>0</u> Flammability: <u>2</u> Reactivity: <u>0</u>
Flammable Limits (% by volume in air):	Lower: <u>0.6</u> Upper: <u>7.0</u>
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.)

²Hazard Rating: least-0; slight-1; moderate-2; high-3; extreme-4.

CITGO assigned these values based on an evaluation conducted pursuant to NFPA guidelines.

NA-Not Applicable

ND-No Data

NE-Not Established

CITGO No. 2 Fuel Oils, All Grades (AG2FO, September 26, 1997, CIN: 5388)

Page 2 of 7

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.

NA-Not Applicable

ND-No Data

NE-Not Established

CITGO No. 2 Fuel Oils, All Grades (AG2FO, September 26, 1997, CIN: 5388)

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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 lipid 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:	<u>Yes</u>	Sudden Release of Pressure Hazard:	<u>No</u>
Delayed (Chronic) Health Hazard:	<u>Yes</u>	Reactive Hazard:	<u>No</u>
Fire Hazard:	<u>Yes</u>		

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):

<u>Component:</u>	<u>Effect:</u>
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

<p><u>DANGER:</u></p> <p>HARMFUL IF SWALLOWED - CAN ENTER LUNGS AND CAUSE DAMAGE</p> <p>CONTAINS PETROLEUM DISTILLATES</p> <p>COMBUSTIBLE LIQUID</p> <p>CAUSES SKIN IRRITATION</p> <p>MAY CAUSE CANCER BASED ON ANIMAL DATA</p> <p>TARGET ORGAN(S): Skin</p> <p><u>HANDLING:</u></p> <p>Keep away from heat, sparks and flames. Keep container closed.</p> <p>Avoid breathing vapor or mists.</p> <p>Avoid direct dermal contact.</p> <p><u>FIRST AID:</u></p> <p>If swallowed, do not induce vomiting.</p> <p>Call a physician immediately.</p> <p>In case of contact, remove contaminated clothing immediately and wash thoroughly with soap and water.</p>
--

ALL STATEMENTS, INFORMATION, AND DATA PROVIDED IN THIS MATERIAL SAFETY DATA SHEET ARE BELIEVED TO BE ACCURATE AND RELIABLE, BUT ARE PRESENTED WITHOUT GUARANTEE, REPRESENTATION, WARRANTY, OR RESPONSIBILITY OF ANY KIND, EXPRESSED OR IMPLIED. ANY AND ALL REPRESENTATIONS AND/OR WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY DISCLAIMED. USERS SHOULD MAKE THEIR OWN INVESTIGATIONS TO DETERMINE THE SUITABILITY OF THE INFORMATION OR PRODUCTS FOR THEIR PARTICULAR PURPOSE. NOTHING CONTAINED HERE IN IS INTENDED AS PERMISSION, INDUCEMENT OR RECOMMENDATION TO VIOLATE ANY LAWS OR TO PRACTICE ANY INVENTION COVERED BY EXISTING PATENTS, COPYRIGHTS OR INVENTIONS.

NA-Not Applicable
 CITGO No. 2 Fuel Oils, All Grades (AG2FO, September 26, 1997, CIN: 5388)

ND-No Data

NE-Not Established
 Page 7 of 7

MATERIAL SAFETY DATA SHEET

PRODUCT SA 825 0012
ELL-BEE LITHIUM M-P GREASE

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

SECTION I

WITCO MANUFACTURING DIVISION OR SUBSIDIARY		EMERGENCY TELEPHONE	
ADDRESS (NUMBER, STREET, CITY, STATE, ZIP CODE)		MANUFACTURER 782-5800	
CHEMICAL NAME OR FAMILY		CHEM TREC 1-(800) 424-9300	
3 Petroleum Hydrocarbon	FORMULA	NA	

SECTION II - CHEMICAL AND PHYSICAL PROPERTIES

<p>HAZARDOUS DECOMPOSITION PRODUCTS</p> <p>6 Carbon monoxide, carbon dioxide</p> <p>INCOMPATIBILITY (KEEP AWAY FROM)</p> <p>6 Strong oxidizing agents such as: hydrogen peroxide, chromic acid, bromine</p> <p>LIST ALL TOXIC AND HAZARDOUS INGREDIENTS</p> <p>7 None</p>	<p>FORM</p> <p>8 Semi-solid</p> <p>ODOR</p> <p>9 Mineral Oil</p> <p>APPEARANCE</p> <p>10 Grease</p> <p>COLOR</p> <p>11 Amber</p> <p>SPECIFIC GRAVITY</p> <p>12 (WATER = 1) RT 0.924</p> <p>BOILING PT.</p> <p>13 NDA °C</p> <p>MELTING PT.</p> <p>14 NA °C</p> <p>SOLUBILITY IN WATER</p> <p>15 AT 25 °C Negligible</p> <p>% VOLATILE (BY WT %)</p> <p>16 NA</p> <p>EVAP. RATE</p> <p>17 NA</p> <p>VAPOR PRESSURE (mm Hg at 20 °C)</p> <p>18 NA</p> <p>VAPOR DENSITY (AIR = 1)</p> <p>19 NA</p> <p>pH AS IS</p> <p>20 NA</p>
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SECTION III - FIRE AND EXPLOSION DATA

<p>SPECIAL FIRE FIGHTING PROCEDURES</p> <p>24 Fire fighters should wear an approved self contained breathing apparatus.</p> <p>UNUSUAL FIRE AND EXPLOSION HAZARDS</p> <p>25 Dense smoke</p>	<p>FLASH POINT (METHOD USED)</p> <p>Above C.O.C.</p> <p>26 190 °C 374 °F</p> <p>FLAMMABLE LIMITS %</p> <p>27 LOWER NDA UPPER</p> <p>EXTINGUISHING AGENTS</p> <p>28 <input checked="" type="checkbox"/> DRYCHEMICAL <input checked="" type="checkbox"/> CO₂ <input type="checkbox"/> WATERSPRAY <input checked="" type="checkbox"/> FOAM <input checked="" type="checkbox"/> WATERFOG <input checked="" type="checkbox"/> SAND/EARTH <input type="checkbox"/> OTHER</p>
---	---

SECTION IV - HEALTH HAZARD DATA

<p>PERMISSIBLE CONCENTRATIONS (AIR)</p> <p>29 NDA</p> <p>EFFECTS OF OVEREXPOSURE</p> <p>30 May cause skin & eye irritation with prolonged contact.</p> <p>TOXICOLOGICAL PROPERTIES</p> <p>31 NDA</p> <p>EMERGENCY FIRST AID PROCEDURES</p> <p>32 EYES Flush with large amounts of water for at least 15 min. Call a physician immediately.</p> <p>33 SKIN CONTACT Wash thoroughly with soap and water.</p> <p>34 INHALATION NDA</p> <p>35 IF SWALLOWED Call a physician immediately.</p>	<p>STRONG ACID _____</p> <p>STRONG BASE _____</p> <p>STABLE _____</p> <p>UNSTABLE _____</p> <p>21</p> <p>VISCOSITY SUS AT 100 °F</p> <p>22 < 100 100 OR > XX</p> <p>23 NA</p>
--	--

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

SECTION VI - HANDLING OF SPILLS OR LEAKS

PROCEDURES FOR CLEAN-UP

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.

41

WASTE DISPOSAL

By methods consistent with local, state and federal regulations.

42

SECTION VII - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Keep containers closed.

43

SECTION VIII - TRANSPORTATION DATA

UNREGULATED BY D.O.T. <input checked="" type="checkbox"/>	U.S. D.O.T. PROPER SHIPPING NAME	
44	47	
REGULATED BY D.O.T. <input type="checkbox"/>	U.S. D.O.T. HAZARD CLASS	I.D. NUMBER
45	48	49
TRANSPORTATION EMERGENCY INFORMATION CHEM TREC 1-(800) 424-9300	RQ	LABEL(S) REQUIRED
	50	51
	FREIGHT CLASSIFICATION Petroleum Lubricating Grease	
	SPECIAL TRANSPORTATION NOTES	
46	52	53

SECTION IX - COMMENTS

KEEP OUT OF REACH OF CHILDREN!!

54

SIGNATURE <u>Ray G. Leonard</u>	TITLE <u>Manager Technical Compliance</u>
REVISION DATE _____	SENT TO ATTN. _____
SUPERSEDES _____	DATE <u>3/05/84</u>

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

Page 1

 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/m ³	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

Page 2
Print Date : 04/02/90

----- 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.



Tox no. : 042840

Page 3
Print Date : 04/02/90

----- PROTECTIVE MEASURES AND TREATMENTS -----

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

----- NOTES TO PHYSICIANS -----

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

----- SPILLS, LEAKS AND DISPOSAL -----

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

----- SPECIAL REMARKS -----

This is an acidic material.

----- U. S. DEPARTMENT OF TRANSPORTATION INFORMATION -----

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

The chemical name(s) appearing below under "NAME" must appear as part of shipping name IF the amount being shipped in each container exceeds the quantity shown under "RQ" below. The letters "RQ" must also appear as part of the shipping name, in the form:

shipping name, chemical name, RQ.

For U.S. shipments from Ford Facilities, consult the "Ford Hazardous Material Transportation Control Program" Manual, otherwise consult 49CFR172.

-----CAS-- RQ(lbs) -NAME-----

7664-93-9 2777 SULFURIC ACID

M S D S
(CONTINUED)

Tox no. : 042840

Print Date : 04/02/90 Page 4

----- 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.

PAGE 02 OF 05

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

This material safety data sheet and the information it contains is offered to you in good faith as accurate. We have reviewed any information contained in this data sheet which we received from sources outside our company. We believe that information to be correct but cannot guarantee its accuracy or completeness. Health and safety precautions in this data sheet may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. No statement made in this data sheet shall be construed as a permission or recommendation for the use of any product in a manner that might infringe existing patents. No warranty is made, either express or implied.

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 (H ₂ O=1)	.951
VAPOR PRESSURE (mm Hg)	N/A	PERCENT VOLATILE BY VOLUME (%)	N/A
VAPOR DENSITY (AIR=1)	N/A	EVAPORATION RATE (H ₂ O=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	Let	Uel
EXTINGUISHING MEDIA	Dry chemical, CO₂ 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.			

SECTION V HEALTH HAZARD DATA	
THRESHOLD LIMIT VALUE Methyl Alcohol- 200ppm, 8 hour time-weighted average	
EFFECTS OF OVEREXPOSURE Ingestion- Poisonous, causes blindness, perhaps death. Inhalation- Narcosis, headache, nausea, loss of consciousness. Skin- Drying, irritation. Eye- Burning.	
EMERGENCY AND FIRST AID PROCEDURES Ingestion- Induce vomiting of conscious person, call M.D. Inhalation- Remove person to fresh air. Skin- Remove contaminated clothing and wash with water. Eyes- Flush eyes with water for at least 15 min. Contact a physician immediately.	

SECTION VI REACTIVITY DATA			
STABILITY	UNSTABLE		CONDITIONS TO AVOID Sparks, heat and flames.
	STABLE	X	
INCOMPATIBILITY (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 MELT/SPD OIL 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	SPECIAL	
	When appropriate to control employee exposure.		OTHER
MECHANICAL (General)			
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 convenient one-pound, one-half, one-third, and one-quarter pound cartridges and formulated to provide a seismic pulse equal to dynamite for clear, sharp seismic records.

Although classified as high explosive, seisPRIME/E emulsions are non-headache and have excellent resistance to accidental detonation by friction or impact.

Spiral-wound 1/4 to 1/2-pound paper cartridges are easily capped and 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 and "mini-hole" applications. seisPRIME/E in the one-pound size is packaged in thin-walled, easy coupling cartridges for vertical stacking or larger downhole shots.

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

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

STATICMASTER[®] Electric Detonators for Seismic Exploration



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

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

WATER AND WEATHER-PROOF - Legwire insulation is designed to withstand extremes of heat and cold and the severe conditions encountered in deep-hole logging. All detonators contain a double-crimped rubber plug to provide a water-tight seal. 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 EXTRANEIOUS 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	Ref: Registry of Toxic Effects of Chemical Substances (RTECS) N = No Criteria Match Y = Positive Criteria Match per RTECS nd = No Data
Corrosive	N	N	
Highly Toxic	N	N	
Irritant	N	N	
Sensitizer	N	N	
Toxic	N	N	
Target Organ Effects	N	N	

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.