APPENDIX B

HAZARD ANALYSIS FOR AMMONIA

QUEST
CONSULTANTS INC.®

June 14, 2005

Ms. Debra Bright
Environmental Audit, Inc.
1000-A Ortega Way
Placentia, California 92670-7125

Dear Ms. Bright:

Quest Consultants Inc. has performed a series of release and dispersion calculations in an effort to quantify the dispersion of ammonia gas accidentally released from pressurized cylinders. The releases were designed to simulate what would happen if the line (tubing) leaving the ammonia cylinder were ruptured. An additional case was evaluated assuming that two lines on two separate ammonia cylinders were ruptured simultaneously.

Several of the parameters defined in the analysis are:

Ammonia cylinder (DOT 3A480) contains 150 lbs ammonia

Temperature of ammonia in cylinder	= 80°F
Pressure of ammonia in cylinder	= 152 psia
Pipe (tubing) diameter	= 1/4-inch
Release elevation	= 4 ft above grade
Release direction	= horizontal (with the wind)

Atmospheric Conditions

Wind speed = 2 m/s and 5 m/s
Relative humidity = 70%
Air temperature = 80 F
Atmospheric stability = Pasquill-Gifford F (extremely stable) and Pasquill-Gifford D (neutral) [Atmospheric stability is classified by the letters A through F. In general, the most unstable atmosphere is characterized by stability class A. Stability A would correspond to an atmospheric condition where there is strong solar radiation and moderate winds. This combination of radiation and winds allows for rapid fluctuations in the air and thus greater mixing of the released gas with time. Stability D is characterized by fully overcast or partial cloud cover during both daytime and nighttime. The atmospheric turbulence is not as great during D conditions as during A conditions; thus, the gas will not mix as quickly with the surrounding atmosphere. Stability F corresponds to the most "stable" atmospheric conditions. Stability F generally occurs during the early morning hours before sunrise (thus, no solar radiation) and

MAILING: P.O. BOX 721387 NORMAN, OK 73070-8069
SHIPPING: 908 26TH AVENUE NW, SUITE 103 NORMAN, OK 73069
TELEPHONE: (405) 329-7475 FAX: (405) 329-7734
E-mail: info@questconsult.com

Ms. Debra Bright
June 14, 2005
Page 2

under low winds. The combination of low winds and lack of solar heating allows for an atmosphere which appears calm or still and thus restricts the ability to actively mix with the released gas.]

Release/dispersion calculations were made in order to examine the effect of atmospheric conditions on the downwind travel of ammonia. The dispersion calculations were performed until specific ammonia concentrations were reached in the downwind direction. Three ammonia gas concentrations were chosen for evaluation. The definitions of the three levels evaluated are:

ERPG-1 for Ammonia = 25 ppm

Emergency Response Planning Guideline (ERPG) Level 1. The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

ERPG-2 for Ammonia = 200 ppm

Emergency Response Planning Guideline (ERPG) Level 2. The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action.

ERPG-3 for Ammonia = 1,000 ppm

Emergency Response Planning Guideline (ERPG) Level 2. The maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to one hour without experiencing or developing life threatening health effects.

The hazard zones resulting from the selected releases were evaluated to determine the extent and location of an ammonia/air gas cloud. When performing site-specific consequence analysis studies, the ability to accurately model the release, dilution, and dispersion of gases and aerosols is important if an accurate assessment of potential exposure is to be attained. For this reason, Quest uses a modeling package, CANARY by Quest®, that contains a set of complex models that calculate release conditions, initial dilution of the vapor (dependent upon the release characteristics), and the subsequent dispersion of the vapor introduced into the atmosphere. The models contain algorithms that account for thermodynamics, mixture behavior, transient release rates, gas cloud density relative to air, initial velocity of the released gas, and heat transfer effects from the surrounding atmosphere and the substrate. The release and dispersion models contained in the QuestFOCUS package (the predecessor to CANARY by Quest) were reviewed in a United States Environmental Protection Agency (EPA) sponsored study[1] and an American Petroleum Institute (API) study[2]. In both studies, the QuestFOCUS software was evaluated on technical merit (appropriateness of models for specific applications) and on model predictions for specific releases. A study prepared for the Minerals

[1] *Evaluation of Dense Gas Dispersion Models*. Prepared for the U.S. Environmental Protection Agency by TRC Environmental Consultants Inc., East Hartford, Connecticut, 06108, EPA Contract No. 68-02-4399, May, 1991.

[2] *Hazard Response Modeling Uncertainty (A Quantitative Method)*; Volume II, Evaluation of Commonly-Used Hazardous Gas Dispersion Models, S. R. Hanna, D. G. Strimaitis, and J. C. Chang, Study cosponsored by the Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, and the American Petroleum Institute, and performed by Sigma Research Corporation, Westford, Massachusetts, September 1991.

Ms. Debra Bright
June 14, 2005
Page 3

Management Service [Gulf of Mexico OCS Region][3] reviewed models for use in modeling routine and accidental releases of flammable and toxic gases. CANARY by Quest received the highest possible ranking in the Science and Credibility areas. In addition, the report recommends CANARY by Quest for use when evaluating toxic and flammable gas releases. The specific models contained in the CANARY by Quest software package have also been extensively reviewed.

The results of the dispersion analysis are presented in Table 1. For each of the release scenarios, the plumes would not change size as long as the release rate was maintained. In essence, the plumes reach steady state within seconds of a release, and will maintain their shape until the cylinder is empty (a couple of minutes) or the release is terminated.

In all cases, the ammonia concentrations are quickly diluted below the ERPG-1 level (25 ppm). This is due to the rapid mixing of the released material with the surrounding air. The rapid mixing is due to the high velocity of the released material.

I believe this is the information you were asking for. Should you have any questions or require any other information, please give me a call.

Sincerely,

John B. Cornwell.
Principal Engineer

nsm

[3] *A Critical Review of Four Types of Air Quality Models Pertinent to MMS Regulatory and Environmental Assessment Missions*, Joseph C. Chang, Mark E. Fernau, Joseph S. Scire, and David G. Strimaitis. Mineral Management Service, Gulf of Mexico OCS Region, U.S. Department of the Interior, New Orleans, November, 1998.

Ms. Debra Bright
June 14, 2005
Page 4

Table 1
Dispersion Results

Release Scenario	Atmospheric Conditions		Downwind Distance (ft) to Ammonia Endpoint					
	Wind Speed (m/s)	Atmospheric Stability	ERPG-1 25 ppm	Time (sec) to reach 25 ppm	ERPG-2 200 ppm	Time (sec) to reach 200 ppm	ERPG-3 1000 ppm	Time (sec) to reach 1000 ppm
Horizontal release from a single cylinder	2.0	F	130	31	60	12	30	3
	5.0	D	40	5	20	2	12	1
Simultaneous release (horizontal) from two cylinders	2.0	F	160	38	80	14	45	5
	5.0	D	55	8	21	2	12	1

QUEST