LA-UR-88-321
TWS-HSE-5/01-88-004

MOL.20051025.0091

QA, NA

ARMM
9-6-05

RPR
45271

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36

TITLE: NNWSI PROJECT ELEMENT WBS-1.2.6.9.4.6.1.B
INTERIM REPORT ON DUST CONTROL PROPOSALS

AUTHOR(S): D. Jeff Burton. HSE-5

SUBMITTED TO: To be published as an LA-UR Report

This document was prepared for the U.S. Department of Energy (DOE) and the DOE has determined that it is an appropriate reference for specific technical information. However, the document was not prepared with the intent of publication or wide distribution, and it may not have undergone a public release review by DOE. The expressed views and opinions of the author(s) may not reflect current DOE policy or conclusions if information contained in the document has been superseded or updated.

By acceptance of this article, the publisher recognizes that the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes.

The Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy

Los Alamos Los Alamos National Laboratory
Los Alamos, New Mexico 87545

NNWSI Project

Element WBS-1.2.6.9.4.6.1.B

Interim Report on Dust Control Proposals

Executive Summary

This report presents interim findings of studies conducted to evaluate dust control equipment during prototype drilling.

Based on available data on silica content, type, particle size, and on proposed dry drilling operations, it is estimated that allowable exposures to free silica will range from 0.07 to 1.5 mg/cu meter. We have concluded that airborne concentrations of dust may approach or exceed these values during normal operations, based on studies conducted as part of this task.

Project management should prepare for over-exposure conditions (e.g., emission controls should be provided where feasible, employees should be fitted for appropriate respirators, and training should be provided to minimize emissions and personal exposures).

Studies will be conducted during prototype drilling to identify emission sources, characterize emissions, quantify employee exposure levels, and determine appropriate and effective control measures. (See Detailed Test Plan, Description of Work, Item No. 2.1(4).)

1.0 Background Information

The Nevada Nuclear Waste Storage Investigations (NNWSI) Project was established to evaluate the potential for storing radioactive wastes in geologic formations on or adjacent to the Nevada Test Site (NTS). Yucca Mountain has been chosen as one of the potential sites, and site characterizations are underway. Prior to in-situ tests in the Exploratory Shaft Facility (ESF) at Yucca Mountain, field-scale tests are to be conducted at G-Tunnel, which is located some 40 km from Yucca Mountain on the NTS. Welded tuffs with properties and in-situ stress states, similar to Yucca Mountain tuffs, are located in the G-Tunnel Underground Facility (GTUF).

U.S. Geological Survey (USGS) hydrologists have recommended that drilling or coring in support of tests be done dry (that is, with air as the circulating fluid) if any possibility exists that liquid drilling fluids could perturb the hydrology. The Prototype Air-Coring Test will address the technical feasibility of air-coring short, horizontal holes in fractured welded tuff, will identify related problem areas, and will provide holes for subsequent prototype tests.

Dry-drilling presents an additional concern because water used as a circulating fluid also reduces the air contaminant generated by the drilling equipment. The proposed test will provide data on the airborne concentrations of dusts and fibers associated with this type of dry-drilling and coring at G-Tunnel.

1.1 Potential Health Hazards

Work to-date at Yucca Mountain has included extensive core drilling and characterization of site mineralogy. These data indicate two areas of concern for potential health hazards to persons exposed to dust and fibers generated from rock at the site. First, the rock generally has high percentages of crystalline silica (including cristobalite, quartz, and tridymite), ranging from 20% to more than 70%. The health hazards associated with inhalation of crystalline silica have been recognized for more than 50 years. Achieving the current occupational exposure levels during dry-drilling of rock

containing high levels of cristobalite, quartz, and tridymite will require excellent dust control procedures. Clinical symptoms due to crystalline silica exposure are not evident until many years later; therefore, the adequacy of controls must be addressed before drilling operations start.

Second, natural zeolites (predominately clinoptilolite, mordenite, and heulandite) are also abundant, with some zones ranging as high as 90%. Very little is known about the hazards associated with dusts containing zeolites. Some zeolites are fibrous, leading to concerns that inhalation of zeolite dusts may result in asbestos-like lung diseases. Erionite has been identified as a fracture-lining mineral in a sample from only one borehole. Animal toxicology studies performed with erionite indicate that it may have a far greater potential for causing lung tumors than asbestos (causing almost 100% tumor incidence in the animals, compared to about 20% for asbestos). Epidemiologic studies of a village in Turkey where airborne erionite is present also indicate high incidence of lung disease, including mesothelioma, which is usually associated only with asbestos exposure. Because this disease will not manifest itself for many years after exposure, adequate exposure controls must be identified before routine drilling begins.

2.0 Overview of Health Hazard Evaluation Project

The evaluation of exposure to airborne dusts and fibers is part of WBS 6.1.A entitled, "The Prototype Air Coring of Short Horizontal Holes in Fractured Welded Tuff."

The evaluation is divided into four tasks:

- (1) Analysis of bulk samples of core material from G-Tunnel and Yucca Mountain to assess the potential for producing airborne fibers from the various zeolites. This analysis will result in a preliminary evaluation of the potential exposure associated with such airborne materials.
- (2) Evaluation of the dust control equipment by a review of the manufacturer's technical literature, user experience, and regulatory agency experience to define the probable level of efficiency expected with such air-cleaning systems. (This item is the subject of this report: See Paragraph 3.0 below for details.)
- (3) Performance of a field study during the prototype air-coring project at G-Tunnel to determine the effectiveness of the dry-drilling dust-control equipment in operation, as well as to evaluate the potential for exposure to airborne zeolite fibers and crystalline silica.

- (4) Recommendations of operating procedures and health/safety requirements during ESF studies at Yucca Mountain.

3.0 Methods

Dust control for the prototype drilling operations at G-Tunnel will include the use of commercial air cleaners in conjunction with the drilling system. The proposed equipment is a two-stage air cleaner; the first stage is a cyclone/inertial collector, and the second stage a fabric filter.

A review of available manufacturer's technical literature, user experience, and regulatory agency experience has been made to estimate the level of control expected under actual work conditions. No experimental field or test activities has been performed. The review has involved consideration of the factors noted below, with the constraint that data and/or information has not been available for many of these factors.

- (a) Measured and published efficiency of the bag filter media for respirable size dusts;
- (b) Measured or calculated 1st stage efficiency for dust size and concentrations expected to be produced and of health significance;

- (c) Air-flow/pressure drop characteristics of the system blower, which together with the information obtained in (a-b) will indicate the operational requirements for filter cake removal;
- (d) Expected effectiveness of cake removal procedures, based on published technical literature (by the manufacturer and others), which will indicate operational requirements and potential problems;
- (e) Air/cloth ratio (ratio of the volume of gas to the filter area), and how this relates to probable filter performance;
- (f) Design capture velocity and collection efficiency;
- (g) Seal design characteristics; and
- (h) Filtrate removal procedures and potential for secondary sources of particle release.

Potential sources of information have included:

- (1) manufacturer of the equipment proposed for use,
- (2) users of the systems to be used at G-Tunnel and the ESF,

- (3) the project drilling consultant,
- (4) U. S. Bureau of Mines and Mine Safety Health Administration,
- (5) available literature, and
- (6) unpublished researcher reports.

As part of this effort, we have attempted to identify potential emission sources (Para. 4.0), quantify (where possible) emission rates and exposure levels to drilling and test personnel (Para. 5.0), suggest potential emission/exposure controls (Para. 6.0), and evaluate proposed dust control equipment (Para. 7.0).

The final deliverable for this task will be a report evaluating the probable level of control expected with the actual air-cleaning system. This report presents our interim findings.

4.0 Identifying Emission Sources

Prototype drilling will be performed dry. Water will not be allowed in the drilling area. As such, there is a high potential for creating very dusty conditions.

There are many potential emission sources, including:

- o fugitive emissions from dust collection equipment (hoses, boots, fittings, and so forth),
- o fugitive emissions from the dust collector itself,
- o process emissions from vibrating equipment, moving equipment, and drilling operations,
- o fugitive emissions from dust reentrainment (air movement, moving equipment, people moving about),
- o background sources of airborne dust from other tunnel operations, and
- o direct emissions from contaminated clothing and equipment.

5.0 Quantifying Potential Emission Sources and Exposures

Unfortunately, there is little information with which to quantify the emission sources identified above, except for fugitive emissions from the dust collector.

Appendix A presents copies of handwritten calculations used to estimate the quantity of airborne dust likely to be emitted during drilling operations from the dust collector itself. Terms used in calculations are defined below:

- C - concentration of dust in air, mg/cu meter
- K - mixing factor, unitless

Wt - weight of rock drilled out of hole (does not include rock core), mg/min
 Ws - weight of rock material collected in pre-separators, mg/min
 Wc - weight of dust collected in air cleaner, mg/min
 N - efficiency of air cleaner, unitless
 D2 - outside diameter of drilled material, inches
 D1 - outside diameter of core, inches
 L - length of drilled core, inches
 t - time of drilling, minutes
 SG - specific gravity of rock, re: water
 Qs - air supplied to the drill area, actual cubic feet per minute
 Qr - air returned (or exhausted) from the drill area, acfm
 Vol - volume of air in tunnel between drill face and some distance f back from the face, cubic feet
 h - height of tunnel, ft
 f - length of tunnel, ft
 T - temperature of tunnel air, degrees F
 d - density correction for air at temperature and pressure, unitless

Equations 1-10 in Appendix A were used to estimate C, the expected airborne concentration of dust in air. Estimated values of the input terms were obtained from manufacturer's data and from drill operations descriptions, and are summarized below:

77360180

K - 0.80
L/t - 0.60 inches/minute
D1 - 2.5 inches
D2 - 3.79 inches
T - 65 degrees F
d - 0.80
SG - 3, unitless
Ws - 0.9Wt mg/min
Qs - Qr - 3500 acfm
h - 20 feet
f - 30 feet
N - 99.5%

All other terms were calculated using equations 1-10,
Appendix A.

Based on these assumptions and estimates, employee exposures due to fugitive emissions from the dust collector itself may exceed 1.2 mg/cu meter. This concentration represents total dust in air and does not take into consideration the percentage of silica or zeolite, nor does it take into consideration additional controls that could be applied to the dust collector exhaust.

As mentioned above, there may be many other significant sources of emission, so this concentration is the minimum to be expected before emission controls are implemented.

- 77460183
- o The exhaust air from the dust collector should be ducted to the main exhaust system; or a secondary filter might be fitted to the outlet of the primary filter if sufficient static pressure is available.
 - o Dust suppression materials could be used on the tunnel floor (e.g., wet sawdust, sand, or other suitable material).
 - o Housekeeping should be provided to remove settled dust from drilling and attendant equipment.
 - o Employees should use emission-reducing work practices (e.g., appropriate drill speeds, attention to placement of control equipment, minimizing vibrations, keeping the area clean, avoidance of drilling during collection equipment malfunction, and so forth).
 - o Dilution ventilation should be provided to control fugitive emissions and to maintain airborne concentrations of dust at acceptable levels.
 - o Respirators should be provided and maintained.
 - o Rigorous maintenance of dust control equipment should be the rule.
 - o People and machinery traffic should be limited in the area.

Because it is difficult to accurately characterize emission sources, it is also difficult to suggest which controls will be most effective. Therefore, prototype drilling operations can be used to identify those controls which are most cost effective and technically feasible for future drilling activities.

7.0 Evaluation of Proposed Dust Drill Collection Equipment

It has been proposed by James M. Ray (see letter of July 13, 1987; WBS 1.2.6.9.4.6.1.A "Prototype Air Coring") that the purchase or rent of an Atlas Copco DCT 90, DCT-95-4, DCT 100-F, or a similar dust collector. Appendix B presents manufacturer's literature describing the proposed equipment.

All of the above mentioned equipment are equipped with two-stage air cleaners. The first stage is a baffled-inertial or cyclone-based separator capable of removing most of the large dust particles. The second stage is a bag or envelope-type fabric filter. These units are capable of being cleaned, either by bag shaking or reverse air flow through the filter.

We have made extensive inquiries trying to establish the collection efficiency of the proposed equipment. The manufacturer's literature claims filter efficiencies of "nearly 100%" for particles smaller than 5 μ m in diameter. However, no quantitative data are available to establish the actual level of collection efficiency. As of this date no one, including the

manufacturer, has tested this collector to determine collection efficiency. We have asked Atlas Copco to conduct such tests. This information may be available sometime during prototype drilling, but will represent efficiencies at laboratory conditions, not those of an ongoing production activity.

Calculations presented in Appendix A have assumed a high level of efficiency, +99.5%. This efficiency is consistent with the collection equipment to be used. (See efficiency data published by Vandergrift, Stairmand, and AAF in Appendix B. These data suggest that inertial collectors in series with fabric filters provide collection efficiencies of 95.0-99.9%.)

Based on the available information, and on our studies to-date, we can make the following assumptions about the collection system:

- (1) We do not know the exact collection efficiency of the air cleaner, but it will likely be 99+% during favorable operating conditions. (Re: data in Appendix B, drilling contractor's experience.)
- (2) The first stage filter is capable of removing a large percentage of the dust reaching the collector (i.e., 60-80%). (Re: data in Appendix B.)

- 7746 0191
- (3) The filter device may quickly load up, requiring cleaning and maintenance on a regular basis, e.g., every 4 hours during routine operations. (Re: drilling contractor's experience.)
 - (4) All of the suggested air cleaners should be capable of providing the flow rates and static pressures required to operate the local exhaust system, i.e., DCT-90 exhausts up to 620 acfm against 6 inches water gauge pressure. (Re: analysis in Appendix A.)
 - (5) Actual testing of equipment under drilling conditions will be required to evaluate the suitability of the collection equipment for routine and ongoing drilling operations. (Re: analysis in Appendix A.)
 - (6) Cleaning and disposal of the collection equipment will be labor intensive and will require careful handling to avoid contamination. (Re: drilling contractor's experience.)
 - (7) The close capture design of the local exhaust hood (boot) should provide a high degree of dust control at the drill shaft. However, the boot will require maintenance and careful attention to positioning. (Re: analysis in Appendix A, drilling contractor's experience.)

Appendix A

Calculations

77 6 019

3-26-87

THIS BOOK IS FOR USE BY O. JEFF BURTON
TO RECORD ACTIVITIES ASSOCIATED WITH
WORK PROGRAM ~~5324~~ AND ~~N311~~ DJS B329, B308,
WBS ELEMENT 1.2.6.9.4.6.1.8, "EVALUATION
OF POTENTIAL DUST RELATED HEALTH HAZARDS
ASSOCIATED WITH DRILLING," NANSI PROJECT.

DURING THE PAST THREE DAYS I REVIEWED
THE PROJECT WORK PLANS (A & B), AND
OTHER MEMO'S, TECHNICAL LITERATURE, AND
MANUFACTURER'S SALES LITERATURE.

4
3-14-87 CALCULATIONS RELATED
TO AIR CLEANING (AND FOR MEETING
ON WEDNESDAY WITH JON NEWSON AND
MIKE RAY.)

$$C = \frac{\text{WEIGHT OF MATERIAL GENERATED/HRS}}{\text{VOLUME OF AIR PROVIDED}} \times \frac{1}{K} \quad (1)$$

Where K = MIXING FACTOR

C = CONC IN AIR

L WEIGHT OF MATERIAL GENERATED

$$W_c = W_f - W_s \quad (2)$$

And $\dot{W}_f = \frac{\cancel{W_f} - \cancel{W_s}}{(\dot{W}_f - \dot{W}_s)(1-H)} \quad (3)$

WE NEED $\dot{W}_f$, $\dot{W}_s$ AND H

$\dot{W}_f$ DEVELOPMENT

$\dot{W}_f = \frac{\pi}{4} (D_2^2 - D_1^2) \left(\frac{L}{T} \right) (S.G.) \left(0.03611 \frac{US}{IN^3} \right) \times \left(454 \frac{gm}{LB} \right) \left(1000 \frac{mg}{gm} \right)$

$$\dot{W}_f = 0.0129 (D_2^2 - D_1^2) \left(\frac{L}{T} \right) (S.G.) \times 10^6 \quad (4)$$

IN mg/min

Where

- D_2 = OUTSIDE DIAMETER OF DRILLED MATERIAL, IN
- D_1 = " " OF CORE, INCHES
- $D_2 - D_1$ = DRILLED MATERIAL
- L = LENGTH OF DRILLED CORE, INCHES
- T = TIME OF DRILLING, MINUTES
- $S.G.$ = SPECIFIC GRAVITY OF ROCK, RE H_2O

W_s DEVELOPMENT

ESTIMATED BY DRIVERS —
EMPIRICAL

η DEVELOPMENT

USE MANUFACTURER'S DATA.
OR EMPIRICAL

$$\dot{W}_f = \left[0.0129 (O_2^2 - O_1^2) \left(\frac{L}{T} \right) (S.G.)_{\text{air}} - W_s \right] [1 - \eta] \quad (5)$$

2. VOLUME OF AIR PROVIDED

$$Q_s = Q_R \quad (7)$$

$$VOL \equiv \left(\frac{\pi h^2}{4} \right) (l) \quad \text{FT}^3 \quad (8)$$

where h = HEIGHT OF TUNNEL, FT
 l = LENGTH OF TUNNEL, FT

(ROUND TUNNEL)

From (1) :

$$C = \frac{\dot{W}_f}{Q_s} \times \frac{1}{K} \quad (9)$$

$\dot{W}_f$ - Room Formula 5, mg/min

Q_s - Room flows, ft³/min

K - ESTIMATED EFFECTIVENESS OF DILUTION, UNITLESS
PROBABLY ~~0.5 TO 0.80~~
 $K = 0.5$ TO 0.80

$$C = \frac{\text{mg/min}}{\text{ft}^3/\text{min} \times \frac{1 \text{ m}^3}{35.3 \text{ ft}^3}} \times \frac{1}{K} \quad (10)$$

$$C = \frac{35.3 \dot{W}_f}{Q_s} \times \frac{1}{K} \quad (10)$$

THE ABOVE CONCENTRATION REPRESENTS
THAT ASSOCIATED ONLY WITH THE COLLECTOR.
OTHER SOURCES ARE VIBRATION, MOVEMENT,
WIND, ETC OF EXTERNAL SOURCES.

3. AIR FLOW IN AIR COLLECTOR

NEXT PAGE

AT STP: (AIR ONLY)

$$\dot{Q}_{IN} = \dot{Q}_{OUT} + \text{DUST LOSS} \quad (11)$$

$$\dot{Q}_{EXH} = \dot{Q}_{OUT} + \dot{Q}_{ROOM} \quad (12)$$

BY WEIGHT OF AIR: ($\dot{W} = \text{LB/MIN}$)

$$\dot{W}_{OUT} = \dot{W}_{IN} + \text{DUST LOSS}, \dot{W}_T \quad (13)$$

$$\dot{W}_{EXH} = \dot{W}_{OUT} + \dot{W}_{ROOM} + \dot{W}_f \quad (14)$$

DJB: 4-14-87

4-17-87

ON 4-15-87 BARBARA SKAGGS AND I MET WITH MIKE AM AND JON NEWSON TO DISCUSS EMISSIONS AND EXPOSURE CONTROLS DURING DRILLING OF FIRST TWO TEST DRILL OPERATIONS.

Information obtained during the meeting is summarized below:

- Jon expects to use the Atlas Copco air collector, probably the OC7 80 or 180.
- Filter efficiency is "99.5%" although Jon has no further information.
- The first test hole will be

$$\begin{aligned}OD &= 3.780" \\ID &= 2.50"\end{aligned}$$

- Drill rate ≈ 3 ft/hr (L/T)
- The dust generated during drilling will be "very fine" due to the type of drill bit used.
- S.G. of rock = 2.5-3.0
- Silica content = unknown (But check with Barbara.)
- Jon thinks about 90% of generated rock dust will go out prior to filter bags / 10% will go to bags.
- pressure (air) at the drill site will be about 80 psi
- The tunnel is about 20' wide with a flat bottom

- Jon suggests a wall 30 feet back from the face.

- Dust in the tunnel is high / background?

$$T = 68^{\circ}F \quad R_{14} \sim 70\%$$

- Jon doesn't know the Q_s but Barbara will call Reed to check on it.

- The OCT-50 is capable of 640 cfm.

$$Q_{exh} = 300 \frac{LIT}{SEC} \times \frac{1 FT^3}{21.3 LIT} \times \frac{60 SEC}{MIN} = 640 cfm$$

- Some air will be lost in fractures.

$$so \quad Q_{ovr} = Q_{in} - Q_{lost} \quad (15)$$

lost in fractures.

- Elevation of tunnel at Jaser Shaft = 6210 ft

$$V_A = 4000 - 7000 \text{ fpm}$$

- Jon thinks velocity in annulus will not get much above 4500 fpm.
- Data given by Jon:

Core Bore

HOLE	3.780"
Core	2.50"
ANNULUS	0.187"
OUTER TUBE O.D.	3.625"
INNER TUBE I.D.	2.625"

- Temp of exhaust air - $\sim 20^\circ \text{F}$
- ANNULUS VOLUME = 217 LIT

$$= \frac{217 \text{ LIT}}{30 \text{ meters}} \times \frac{1 \text{ ft}}{28.3 \text{ LIT}} \times \frac{1 \text{ meter}}{3.3 \text{ ft}} = 0.0775 \frac{\text{ft}^3}{\text{ft}} \text{ (LINEAR)}$$
- OCT 90 COST $\sim \$7,000$
- VOLUME OF CUTTING = 1.277 $\text{ft}^3 / 10 \text{ ft CUT}$
- Supply dust = 18" ($Q_S = 3500 \text{ actm ?}$)

- 1. Stressed multiple emission sources and need to identify and characterize each:

For example:

- 1- fugitives from around boat and hoses.
 - 2- " " air cleaner
 3. Vibration of equipment
 4. wind blown dust from air movement
 5. Walking and working in dust
- 1. felt excess flow would be necessary.
i.e., 2X output Q from drill hole.
This will keep fugitive emissions from boat to a minimum and will reduce need for tight fit of boat to wall.
 - 2. reds figure 9 on page 9:

and

$$Q_{OUT} = Q_{IN} - Q_{LOSS}$$

(15)

$$Q_{EXHAUSTION} = Q_{OUT} + Q_{EXCESS}$$

(12)

- I think it a good idea to take real-time particle analyzer to site (Sibata P-5 or GCA-mini ram) to help characterize the emission sources and major contributors to employee BE.
- 2 people will work in drill operations.
- Jon thinks the air supplied to the drill hole will be about 250-300 cfm ~~(500)~~ at conditions 6200 ft/20°F.
- Jon gave me two more documents:
 - "Dust collection with DCT"
 - "Bit generated Rock Textures and their effect on Evaluation of Lithology, Porosity, and Shores in Drill-cutting Samples"
- Barbara gave me a document, "NNWSI Exploring Shaft Facility - ESF Dust Abatement Shop REPORT (70-11)"

Based on this information I have estimated the resultant dust concentration in the air as follows:

ASSUME:

$$K = \text{~~1.0~~} 0.80$$

$$L/T = 3 \text{ FT/HR} = 0.05 \text{ FT/MIN} = 0.60 \text{ IN/MIN}$$

$$D_2 = 3.770 \text{ ~~IN~~ INCHES}$$

$$D_1 = 2.50''$$

$$S.G. = 3.0$$

$$W_s = 90\% W_t$$

$$\eta = 99.5\% \quad (\text{ideal?})$$

$$Q_s = 3500 \text{ cfm}$$

$$h = 20' \text{ Round}$$

$$L = 30'$$

$$(4) \quad W_T = 0.0129 (D_2^2 - D_1^2) \left(\frac{L}{T}\right) (5.6) \times 10^6 \text{ in } \frac{\text{mg}}{\text{min}}$$

$$= 0.0129 (3790^2 - 2.5^2) (.6) (3.0) (10^6)$$

$$= 0.1884 \times 10^6 \text{ mg/min}$$

$$(5) \quad \cancel{W_f = W_T - W_s = W_T (.1) = 0.1884 \times 10^6 \frac{\text{mg}}{\text{min}}}$$

$$W_f = (W_T) (0.1) (1 - .995)$$

$$= (0.1884 \times 10^6) (.1) (.005)$$

$$W_f = 94.2 \frac{\text{mg}}{\text{min}}$$

$$(10) \quad C = \frac{\text{mg/min} (35.3)}{Q_s} \times \frac{1}{K} =$$

$$= \frac{(94.2) (35.3)}{3500} \times \frac{1}{.8} \cong 1.2 \text{ mg/m}^3$$

$$C = 1.2 \text{ mg/m}^3$$

The above calculation assumes good collection by air cleaner - 99.5% at filter. We need to check in silica content and

Appendix B

Atlas Copco Literature
Collector efficiency literature

Dust, dust suppression methods, choice of dust collector

Reg. code
AHB DCT 00-17
1979-02

Contents

	Page		Page		Page
Dust	2	DCT dust collectors	5	DCT 180 series	17
Generation and risks	2	Survey	5	DCT 260 series	18
Regulations for dust suppression	2	Function of the dust collectors	6	Optional equipment	18
Dust suppression methods	3	Technical description	8	Choice of DCT equipment	19
Water flushing	3	Filter unit	8	DCT for Atlas Copco standard	
Dust-binding with water mist or		Drive ejector	10	equipment	19
additives	3	Fan	10	Investigate whether DCT can be	
Dust collection according to the		Assembly set	10	used	19
DCT method	3	Suction hose	10	Choose a suitable filter unit	19
Advantages with DCT dust collection	3	Collector device	11	Choose a suitable collector device	20
Areas of application for DCT	4	DCT programme	13	Data	21
Bench drilling from the surface	4	DCT 31 series	13		
Underground drilling	4	DCT 35 series	14		
Dimension stone industry	4	DCT 50 series	14		
Other work which requires movable		DCT 90 series	15		
dust suppression equipment	4	DCT 100 series	16

Fig. 1. Rock drilling without
dust collector

1. Filter unit 2. Collector device
Fig. 2. Rock drilling with dust collector
(DCT 97)

DCT dust collectors

Survey

DCT dust collectors are manufactured in seven sizes for Atlas Copco rock drilling equipment (Fig. 5)

DCT 31 series

intended for hand-held rock drills and for drilling with benchers

DCT 35 series

intended for rock drills of type BBC 24 mounted on wagon drills or on crawler drills

DCT 50 series

intended for rock drills of type BBC 100F and COP 115EB, mounted on wagon drills and crawler drills

DCT 90 series

intended for wagon drills and crawler drills equipped with rock drills in size range BBC 100F – COP 150EB, with a flushing air pressure of 6–7 bar

DCT 100 series

intended for drilling with COP 4 at a working pressure of 10.5 bar, and for COP 150EB and COP 1038HB with a flushing air pressure of 8 bar

DCT 180 series

intended for drilling with COP 4 and COP 6 at a working pressure of 18 bar

DCT 260 series

intended for rotary drill rigs of the Rotamex type and similar.

DCT dust collectors can in addition easily be adapted for mounting on drill rigs of other makes.

Note. 1 bar = 100 kPa = 14.5 psi

DCT 31 series

DCT 35 series

DCT 50 series

DCT 90 series

DCT 100 series

DCT 180/260 series

Fig. 5. Survey of DCT dust collectors

The DCT 31, DCT 35 and DCT 90 series differ considerably from the DCT 50, DCT 100, DCT 180 and DCT 260 series, but the principle of a partial vacuum is common to all types. The partial vacuum is created either by an ejector (4a) or by a fan (4b). The drill cuttings which spurt out of the drill hole are gathered in a collector device (2) and are prevented either by a brake ejector (5, DCT 90 series) or by a sleeve from leaking out around the drill steel or drill pipe.

and filter unit (1). The suction capacity is modified by the length and diameter of the suction hose. 90% of the coarse cuttings are separated in the coarse separator and the remainder in the filters where particles smaller than 0.005 mm are separated to a degree of nearly 100%.

Filter cleaning is very important since the filters are capable of holding only a certain amount of dust. When the filters are filled with dust, the suction ability drops appreciably and finally almost ceases.

Filter cleaning is normally carried out on the following occasions:

- a) each time a drill steel is changed, i.e. every third drill metre
- b) on the completion of each drill hole (when taking up the drill string)
- c) when the suction ability is too low (e.g. when dust leaks out from under the suction hood)
- d) in conjunction with changing sacks

Filter cleaning should continue for about one minute each time. In the event of longer interruptions in drilling (more than 5 minutes), the filter cleaning should be stopped.

Operation

All DCT units are easy to operate. On many types the ejector starts up automatically when the flushing air control is opened. Filter cleaning then starts automatically when the flushing air control is closed. On fan-powered dust collectors there is a separate control for filter cleaning, which stops automatically after the set cleaning time.

DCT 100/180 series

DCT 260 series

1. Filter unit
2. Collector device
3. Suction hose
- 4a. Ejector
- 4b. Fan
5. Brake ejector

Fig. 6. Functioning of the dust collectors

Fig. 2.2.2 Extrapolated fractional efficiency of control devices. (From Vandergrift.)

fabric). A schematic representation of the arrangement of a typical fabric filter system is shown in Fig. 2.3.1 from a simple industrial ventilation application. Principal components of the system are identified as:

- Hood (enclosing or, adjacent to, or attached to source of contaminant)
- Ductwork (from source to collector)
- Collector
- Fan (exhaust fan, induced draft fan, or blower)
- Ductwork (from fan to outlet stack or vent, breeching)
- Stack (vent)

The presence or absence of the components and their nomenclature varies with each collector system application. For example, the particulate source may be a powdered material receiving silo and the gas may be from a pneumatic conveyor bin vent exhaust, or the source may be a

Fig. 2.1 Total Annual Operating Costs of Gas Cleaning Equipment Treating Fine Industrial Dust (from Stairmand)

1969 British Pence, 8000 hrs.

To convert to 1975 dollars, multiply pence by $.024 \times 187.2/107.7$ equals .042. To convert back to current pence or pounds, one should use the current exchange rate of 2.08 lbs/dollar.

Key:

- 1 Inertial Collector
- 2 Medium Efficiency Cyclone
- 3 Low Resistance Cellular Cyclones
- 4 High Efficiency Cyclone
- 5 Impingement Scrubber (Doyle Type)
- 6 Self Induced Spray Deduster
- 7 Void Spray Tower
- 8 Fluidized Bed Scrubber
- 9 Irrigated Target Scrubber (Peabody Type)
- 10 Electrostatic Precipitator
- 11 Irrigated Electrostatic Precipitator
- 12 Flooded-Disc Scrubber Low-Energy
- 13 Flooded-Disc Scrubber Med.-Energy
- 14 Venturi-Scrubber, Med.-Energy
- 15 High-Efficiency Electrostatic Precipitator
- 16 Venturi Scrubber - High Energy
- 17 Shaker-Type Fabric Filter
- 18 Reverse-Jet Fabric Filter

RANGE OF PARTICLE SIZES, CONCENTRATION, & COLLECTOR PERFORMANCE
 COMPILED BY S. SYLVAN, APRIL, 1952 : COPYRIGHT 1952 AMERICAN AIR FILTER CO. INC.
 ACKNOWLEDGMENTS OF PARTIAL SOURCES OF DATA REPORTED:
 FORD, R.E. - AMERICAN AIR FILTER - SIZE AND CHARACTERISTICS OF AIR BORNE SOLIDS - 1931
 FIRST AND GUNNER - ARCHIVES OF INDUSTRIAL HYGIENE AND OCCUPATIONAL MEDICINE - APRIL, 1952

AMERICAN CONFERENCE OF
 GOVERNMENTAL INDUSTRIAL HYGIENISTS

RANGE OF PARTICLE SIZE

DATE 1-80

Fig. 11-1

QA NA

Los Alamos NNWSI Project Element WBS-1.2.6.9.4.6.1.B Interim
Report On Dust Control Proposals.
Any obliteration or illegibility throughout the pages of this records package does not
impact the technical content or meaning.

A horizontal line is drawn across the page, starting from the end of the signature and extending to the right.