MARKET STUDY

PERSONAL MONITORING DEVICES

AND THE

#3500 ORGANIC VAPOR MONITOR

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AND THE

MARKET POSITION AND OPPORTUNITIES FOR THE #3500 OVM

Background

The air breathed by today's worker is subject to contamination by the products, byproducts, and raw materials which the worker is using and producing. These contaminates may be only a nuisance to the worker, but are increasingly being found to be hazardous to the worker's health. Historically, the danger of the contaminate was first monitored directly by the nuisance level . . . and then, later, by the acute effect upon the worker (eye, skin, mucus membrane irritations). Then, various instruments were developed to detect the level of contamination and alert workers when a hazardous level was reached. (Perhaps the first "instrument" was the live canary taken into mines . . . the "alarm" was the canary's death!)

In the modern industrial age, acute effects were first recognized, and area monitoring systems were developed to sample, analyze, and report (alarm) the level of the hazardous substance in the ambient workplace atmosphere. Within the past two or three decades, very low concentrations (down to even a few parts per billion) of some materials have been found to cause health or reproductive problems 20, 30, 40 years later. Area monitoring was found to be insufficient to measure the exposure of an individual worker to these low levels, and methods of sampling the air breathed by the individual worker were developed. The system of personal monitoring gaining widest acceptance was the personal air pump and, for many -- but not all -- contaminants, activated charcoal to trap the contaminant for later analysis. The majority of the known or suspected hazardous materials are organics with sufficient vapor pressure to yield levels of concern in the air; and for most of these organics, activated carbon is a suitable "trap". But for other organics, silica gel or other absorbants are required. For particulate contaminates, some means of filtration or impingement is used to trap the particles for analysis. And for various other contaminants, specific physical and/or chemical "traps" were developed.

These various personal sampling pump systems have served well, but have required much personal attention of specifically trained personnel to maintain and use, and have been cumbersome to the individual worker wearing them.

3M's OH&SP Division entered the personal monitor market with a passive dosimeter for mercury. Unlike the positive, active pump which transferred and measured the amount of air being sampled, the passive dosimeter is based on the transfer of the contaminant . . . in this case, mercury vapor . . . across a diffusion membrane from the ambient atmosphere bearing some discrete level of contaminant into a chamber of "zero" concentration wherein the contaminant was immediately "trapped" by, in this case, a gold film and held for future analysis.

Having successfully gained acceptance and use of the mercury monitor, the OH&SP Division introduced a similar passive dosimeter -- the #3500 OVM -- for organic vapors absorbable by activated charcoal. The principal target market was substitution of the #3500 OVM for the sampling pump and charcoal absorption tubes used in monitoring most of the hazardous organic vapors found in the industrial workplace.

The new business volume for the #3500 OVM has fallen short of the projected market growth curve. The present study was contracted as part of a broader OH&SP Division examination of the reasons for the slower-than-expected growth, and re-assessment of the market potential.

Objective

The overall objective of this study was to profile the personal monitor market -- both pump and passive -- to detail an understanding of the marketplace perception of 3M's #3500 OVM, and to project the market potential for the #3500 OVM.

Specifically, this study provides answers to the following questions:

1. What is the marketplace awareness of 3M in the occupational health and safety field . . . and what is the extent of familiarity with the #3500 OVM?
2. What percent of industry firms are doing personal monitoring?
3. What are the organic vapors being monitored? And, at what concentrations?
4. How much money is being spent for monitoring activities? How are financial resources distributed between monitoring and prevention?
5. Who are the "purchase influencers"? Are these the same people that influence the purchase of safety equipment such as protective masks, etc.?
6. What monitoring equipment is currently being used?
7. What are the perceived advantages/disadvantages of the pump-tube methods . . . and of the passive dosimeter?

8. What are the preferences for/against, and perceptions of, a central analytical service for personal monitoring . . . such as that offered by 3M?
9. Do end-users prefer to purchase direct from manufacturers or through distributors?
10. What trends are anticipated in the "mix" of personal versus area sampling?
11. What factors are most important to end-users in their selection of the specific passive dosimeter to be purchased . . . and how do they rate 3M on these factors?
12. What is the time-frame within which company decisions to use a particular passive dosimeter are made?
13. How do 3M's distributors see the #3500 OVM market? . . . see 3M's development of the market? . . . and perceive the users' selection factors?
14. What are the regulatory factors affecting the #3500 market? . . . and what trends or changes are expected?
15. What is the present and potential competitive activity?
16. What is the potential market for passive dosimeters and, specifically, for the #3500 OVM.

Procedure

This study was based on primary source interviews with known and potential #3500 OVM user-companies, with 3M distributors, competitors, and with others as will be described more fully at the end of this section. Secondary sources such as governmental documents and industry publications were consulted as the market potential was developed.

A training meeting for the Marketing Service Associates, Inc. project team was conducted in Pittsburgh by Terry McClusky and Mimi Merino of 3M to familiarize the MSA project team with the product, its competition, the market, and the requirements of the study. Subsequent to the training meeting, an interview guide was prepared by MSA and sent to 3M for suggested clarifications and changes.

The overall guide was then partitioned into two guides: one for use in interviewing known and potential passive dosimeter users, and the other for use in interviewing distributors. These guides were "tested" in some preliminary interviews to assure that the questions and terminology would be understandable to the interviewees.

Interviewing was done entirely by Marketing Service Associates, Inc. personnel . . . no work was sublet to others. Those of us involved in this study were:

Richard C. Andres: A.B. Economics -- Allegheny College; MBA -- Indiana University; 6 years -- General Motors in sales and marketing; 6 years -- Koppers Company in marketing research; 1 year as Manager of Marketing Research -- Rockwell Standard Corp. Formed Marketing Service Associates in 1961.

James E. Thompson: B.S. Chemical Engineering -- Texas Tech University; 4 years -- New Product Development and Test Market Management -- Procter and Gamble; 7 years -- Environmental Research Management, Procter & Gamble.

R. Dale Colby: A.B. Economics -- Allegheny College; 12 years in marketing research with Blue Cross of Pennsylvania; former President and current board member, Pittsburgh Chapter of American Marketing Association.

William A. Pardee: B.S. Chemistry -- Emory University; PhD Chemical Engineering -- Yale University; former R&D Gulf Oil Corp.

M. Whitney Greene: A.B. Economics -- Cornell University; MBA -- Harvard University. Retired as Manager of Economics Research and Chief Economist for Koppers Company.

Interviews were all voice-to-voice with the person(s) in each company most responsible for atmospheric monitoring in the workplace. These persons were generally in the Industrial Hygiene or Safety Departments. Reception to our calls was excellent. In only six instances were interviews refused, and in most of these, the prospective respondent stated that they would answer a printed questionnaire should we send one (we didn't since sufficient other contacts were available).

The excellent reception was a result of two factors: First, interest in personal monitoring . . . and particularly new

technology to simplify the process . . . is quite high, and the respondents were generally eager to talk. Secondly, 3M was identified as the project sponsor at the beginning of interviews with distributors, with insurance companies, and with known and potential users (not with governmental agencies, consultants, nor competitors). This "open identification" cleared the air of any suspicion that the caller was from one of the respondent company's competition or from a regulatory agency. A positive future fall-out from "open identification" can be expected as a result of the respondent knowing the identified sponsor is actively concerned with the marketplace's needs and evaluation of the sponsor's products and services.

A table of completed interviews is on the next page. The sample of end users was selected from a list of current accounts supplied by 3M (25% of the end user interviews) and from manufacturing SIC lists (75%). While all manufacturing segments were sampled, 80% of the calls were concentrated in SIC's 28, 29 and 30 wherein the concern for organic vapors is concentrated. The distributor sample was drawn from a supplied list of 3M distributors carrying the #3500 OVM.

Convergence of the results from the various responding cells was good. With consideration given to the number of completions in each cell, the market picture derived from one cell did not differ significantly from that derived from another cell. Of

particular note is the fact that no significant differences were found between the two subsets of the end user cell. Interviews of the known purchasers of #3500 OVM led to conclusions consistent with those reached from interviews of potential end users selected randomly from SIC lists.

COMPLETED INTERVIEWS

RESPONDING CELLS	NUMBER OF COMPLETIONS
END USERS	162(1)
DISTRIBUTORS	37
COMPETITORS	8
INSURANCE COMPANIES	4
REGULATORY	27
CONSULTANTS	4
SECONDARY	16
	258

(1) SAMPLED FROM 20 TWO-DIGIT MANUFACTURING SIC'S; CONCENTRATED IN THOSE THAT SHOWED HIGHEST CURRENT AND EXPECTED FUTURE USAGE:

SIC 28 -- CHEMICALS & ALLIED PRODUCTS
SIC 29 -- PETROLEUM & COAL PRODUCTS
SIC 30 -- RUBBER & PLASTICS PRODUCTS

RESULTS OF

USER INTERVIEWS

Marketplace Awareness of 3M and the #3500 OVM

Almost all of the user company respondents -- 97% -- stated that they were aware of 3M as being a company offering products in the industrial employee safety/health area. Only in five companies did we find no recognition of 3M being in this business.

When asked concerning their awareness of the #3500 OVM, 78% gave a positive response. Not all, but most are aware of the product by "3500" . . . some required prompting by the interviewer's description of the purpose of the product. But those requiring prompting did then have a prior awareness of the 3M product as differentiated from competitive or just a generic awareness.

Extent of Involvement in Personal Monitoring

Of all the user firms contacted, 78% were found to be actively involved in personal monitoring for organic vapors. These companies had purchased some equipment and had at least a minimal monitoring effort.

It is coincidental that this number -- 78% -- is the same as the percent given in the preceding section as the percent of companies aware of the #3500 OVM. While the agreement of positive responses was very large, some companies were involved in personal monitoring and not aware of the #3500, and others aware of the #3500 did not have any monitoring program in effect.

Organic Vapors Being Monitored

Each user interviewee was asked to identify those organic vapors for which his company was concerned in its personal monitoring program. Response in some cases was rather guarded, but we were able to get at least a generic identification of the organics being monitored.

Specific organics were identified in the majority of interviews. Those frequently mentioned are tabulated below, and, on the next page, have been added to the generic mentions from the interviews for an overall ranking of those generic groups most frequently encountered.

MOST FREQUENTLY MENTIONED SPECIFIC ORGANIC COMPOUNDS

Benzene	24% of User Cos. Monitor
Toluene	24%
Methyl Ethyl Ketone	11%
Acetone	11%
Vinyl Chloride	9%
Styrene	9%
Formaldehyde	8%
Acrylonitrile	8%
1,1,1-Trichloroethane	7%
Trichloroethylene	7%
Ethyl Alcohol	7%

MOST FREQUENTLY MONITORED ORGANICS

BY GENERIC GROUP

Benzene and Derivatives	87% of User Cos.
Chlorinated Hydrocarbons	57%
Ketones	36%
Hydrocarbons	28%
Solvents	27%
Alcohols	25%
Acid and Low MW Organic Gases	23%
Nitrogenous Hydrocarbons	20%
Ethers	5%
Aldehydes	4%

Organic Concentrations Being Monitored

Respondents, for the most part, did not feel free to mention or discuss the specific concentrations of organics being found in their personal monitoring programs. Most would say only that their levels were "at, or below, the allowable levels" established by OSHA.

Of particular interest would be benzene levels . . . both because benzene and its derivatives were found to be the most frequently monitored, and because of the soon to be handed-down decision of the U.S. Supreme Court (this case will be discussed in a later section). It was found that benzene levels are generally below the 10 ppm level (8-hour Time Weighted Average) adopted in 1970, but in many cases exceed the 1 ppm 8-hour TWA promulgated in the 1976 OSHA regulation that was set aside by a lower court and on which the Supreme Court is soon to rule.

Should the decision be in favor of OSHA, therefore re-establishing the 1 ppm benzene level, the monitoring activity for benzene will increase . . . at least for several months . . . by several fold as companies that currently are doing very little monitoring pending the court's decision scramble to position themselves relative to the re-established regulation.

Monitoring Expenditures

Each user respondent was asked to estimate the total expenditures for monitoring workplace atmospheres within his plant. From the responses received, it was obvious that expenditures for this activity are very infrequently identified and segregated within the overall industrial hygiene or safety departmental budgets. This lack of fiscal segregation suggests that costs are not a primary control of monitoring activities.

Never-the-less, we pushed for the respondent's best estimate and did get a figure from almost all respondents. User expenditures, per plant location, run . . .

Low	$ 200 per year
High	1,200,000 per year
Median	20,000 per year.

Based upon the discussion that normally accompanied these estimates, we have distributed the median expenditure as follows:

Sampling pumps and other equipment	$5,000 per year
Non-analytical personnel costs allocated to monitoring	8,000
Tubes and other supplies	2,000
Analytical	8,000
TOTAL	$20,000

Respondents were asked how they saw the expenditure for monitoring moving within the next few years . . .

Will be "up" . . . . . 83% of respondents

Will be "down" . . . . . 7% of respondents

Will be "about the same" . . . . 10% of respondents.

The reasons most frequently given for an upward trend were:

1. Expectation that governmental regulations will cover additional organic compounds (particularly chlorinated hydrocarbons and ketones).
2. Increasing internal corporate "concern" for worker safety and/or for long-term corporate liability for occupational disease.
3. Expectation that the U.S. Supreme Court will rule in OSHA's favor on the benzene case.

Those 17% of respondents that projected a downward trend or no change in expenditures had, in most cases, recently made significant expenditures for sampling pumps or other monitoring equipment and did not anticipate having to make that expenditure again during the next several years.

Distribution of Resources Between "Prevention" and "Monitoring"

Respondents were asked to describe how the available funds were allocated between the functions or activities of: 1) preventing organic vapors from entering the workplace atmosphere; and 2) monitoring the concentration of organics that were in the atmosphere.

We found that this was seen as an "apples and oranges" type of comparison. At the present stage of evolving control of worker exposure to atmospheric organics, there is not a practical trade-off between the two areas. The desired end result is that workers not be exposed to more than the known "safe" or "regulated" levels. Money must be spent to determine, by initial monitoring, the exposure level under current engineering and housekeeping practices. If this level is higher than the "safe" or "regulated" levels, then funds must be allocated for engineering and housekeeping changes to reduce the levels. And, then monitoring is necessary to evaluate the effect of the changes and to demonstrate that the new, reduced levels are satisfactory.

While the respondents tell us that there is not a practical trade-off, as outlined in the paragraph above, there is a theoretical trade-off that in some situations might be operative and would thus influence the expenditure of funds for personal monitors. The theoretical situation can occur when organic levels are found to be between the regulated permissible level and one-half that

level. OSHA regulations generally state that if the level (determined through monitoring) falls between the permissible level and one-half that level, then monitoring must be continued. If, however, the actual level is less than one-half the permissible level, monitoring may be discontinued until such time that there is reason to suspect that the atmospheric levels would have increased.

Thus, should a company find in a given situation that the monitored levels were within this range of 50 to 100% of the permitted level, consideration should be given to the costs of further engineering or other "prevention" changes in comparison to the costs of continued monitoring.

We believe that this "theoretical" situation trade-off will have an insignificant effect upon the personal monitor market. In the first place, the concentration range over which this situation occurs is a small portion of the practical range, over which actual concentrations may be found. Secondly, "reasons" to suspect that the atmospheric levels may have increased occur frequently. And thirdly, if a company finds that its organic concentrations are even close to the 50% of permissible level, good management practice would direct it to continue monitoring to develop the historical data needed to defend itself against potential regulatory agency or employee charges.

Purchase Influencers

From both pre-interview screening, to arrive at the best person to interview in each user company, and from direct questioning during the interview, the department having the greatest influence on the type and source of personal monitoring equipment was determined:

Department	% of Plants
Industrial Hygiene	50%
Safety	30%
Environmental Health	15%
Medical	5%

Frequently these departments are combined or closely linked. Just how closely is important to 3M's marketing strategy in light of the sales contacts and distributors used for protective devices (masks, etc.). Respondents were asked if the department responsible for personal monitoring was also responsible for worker protective devices:

	% Plants
Yes, Same Department	35%
No, Different Departments	65%

In those plants wherein the responsibility is not in the same department, the "Safety Department" has the responsibility for protective devices, and the Industrial Hygiene or other departments have responsibility for monitoring. In the few "small" companies

interviewed, monitoring responsibility may reside with the plant manager even though other "safety" items are delegated.

These data on purchase influencers suggest caution in relying, for #3500 OVM marketing strategy, upon distribution patterns that have been developed by 3M for the marketing of personal protective equipment.

This potential problem has obviously not been overlooked by 3M, as evidenced by the 78% #3500 OVM "awareness" reported earlier in this report.

Personal Monitoring Equipment Encountered

Each interviewee was asked to identify the type and the manufacturer of personal monitoring equipment in use in their plant. Of those plants doing personal monitoring (78% of the total contacted), 62% reported some brand of personal monitoring pump and no passive dosimeters in use. Thirty-eight percent reported using both pumps and passive dosimeters, but no company was found to be using only the passive dosimeter for monitoring.

It was found that all the companies "using" passive dosimeters were doing so in only a test mode. In other words, passive dosimeters are in various stages of evaluation, but nowhere did we find them currently accepted for routine use. In most companies "using" dosimeters, the testing is still at the very earliest stage of evaluation . . . but in a few companies, evaluation has progressed to "acceptance" but the usage is in parallel monitoring with the pump and carbon tube methods.

In some cases, initial company evaluation has yielded a preliminary "OK", but any use is pending OSHA acceptance (to be discussed later).

The manufacturers identified for both pumps and the passive dosimeters are listed on the next page, with the percent of plants using that brand based on the total number of plants having a monitoring program. The manufacturer categories are not mutually

exclusive since most plants had purchased products made by two or more manufacturers.

The high ratio of "3M" to "DuPont" should be viewed as transitory since DuPont's entry into this market is fairly recent; this ratio will probably decrease with time. The "3M" to "Abcor" ratio will probably increase as Abcor is generally seen as a subsiding brand.

MANUFACTURERS ENCOUNTERED

	Used by This Percent of Those Plants Monitoring
PUMPS:	
MSA	58%
DUPONT	55%
BENDIX	37%
SIPIN	35%
SKC	27%
DRAEGER	12%
MDA	9%
PASSIVE DOSIMETERS:	
3M	38%
ABCOR	12%
DUPONT	4%

54

Perceived Advantages/Disadvantages:
Pump Versus Dosimeter

ADVANTAGES OF PUMP:

1. Users perceive the personal sampling pump and carbon or other "traps" as NIOSH/OSHA approved. As OSHA is the primary regulatory agency whose standards the user company must meet, use of an "approved" methodology and equipment is seen as very important. While neither OSHA nor NIOSH actually have approved any such sampling equipment (as is the case of NIOSH certification of respirators), the NIOSH "Manual of Sampling Data Sheets" does specify personal air sampling pumps as the means of collecting workplace atmosphere samples for monitoring of organics. (Only in the method for mercury utilizing 3M's mercury monitor does NIOSH depart from the pump sampling specification.)
2. OSHA uses the pump in its field investigations. This actual use of the pump by OSHA is probably of greater importance to many companies than is their belief that the pump is NIOSH/OSHA approved. Several respondents stated that as soon as the OSHA inspector began to use a passive dosimeter, their company would quickly follow.
3. The historical records of organic vapor levels is based upon the pump/tube method. There is some fear that if the passive dosimeter should give higher results, the record would then indicate an overall increase in the hazard to which the company allowed workers to be exposed.

4. There is greater confidence in the pump actually sampling a stated volume of air because of its positive flow rather than the passive "flow" of the dosimeter. This feeling exists more among the less sophisticated personnel rather than the technically trained industrial hygienist.
5. The pump and tube method is seen as a proven method.

DISADVANTAGES OF PUMP:

1. The pump/tube is seen as costly in two areas: initial cost of the pumps and analysis costs. One respondent stated that in his laboratory, analytical effort was only half as much for the analysis of the passive dosimeter carbon disc as for the carbon tubes used with the pump. (The perceived initial cost of the pumps also works as an advantage of continued use of the pump method once the initial capital purchase has been made . . . "get our money's worth out of the pumps before switching to the passive dosimeters".)
2. As expected, users find the pump cumbersome for workers to wear. This is reflected in both worker resistance to wear the pump and in the pump's interfering with the worker's movement . . . which in itself could be an unsafe practice.
3. The pumps are difficult and time-consuming to keep in calibration.
4. In addition to calibration problems, overall maintenance is seen as a problem. One respondent said that only one-half of his pumps were operable at any one time.

5. While the pumps method was generally seen as a "proven method", performance failures are apparently frequent. There just isn't any assurance that the pump does in fact keep pumping during the time that the worker is wearing it. Some companies have the industrial hygienist or an IH technician stay with the worker wearing the pump to see that the pump does continue to work.

ADVANTAGES OF THE PASSIVE DOSIMETER:

1. It is lightweight, and thus comfortable to wear. No worker resistance is encountered . . . as is sometimes the case with the pump.
2. The use of the passive dosimeter is seen as less expensive overall than the pump/tube method. No initial pump cost, no maintenance costs, frequently less analytical costs, and significantly lower personnel costs in conducting a monitoring program.
3. No continuing calibration is required. This advantage is perceived as outweighing the costs of the initial "calibration" required to qualify the passive dosimeter for a particular application.
4. Less skilled technician effort is required. The passive dosimeter is seen as a device that can even be mailed to a workplace location to be monitored . . . with very simple, easy-to-follow instructions yielding acceptable and dependable monitoring results. This is in contrast to the need for an experienced

technician to maintain, set-up, calibrate, put on and take off the pump for each use.

DISADVANTAGES OF THE PASSIVE DOSIMETER:

1. The passive dosimeter is yet quite controversial among the professional people. Moreover, there is yet sufficient assurance that it will come to be accepted by OSHA.
2. Many people just do not understand diffusion as a means of collecting a sample . . . "Where is the flow of air?"
3. There is a lack of published laboratory and field test data. Each potential user wants to be able to refer any challenger of his data to published reports by third parties demonstrating acceptable results.

Analytical Service

Various practices and attitudes of the respondents were obtained concerning the analytical aspects of monitoring organics that are "trapable" by activated charcoal.

First . . . current practice (almost entirely related to analysis of charcoal tubes from the pump and tube method):

Analysis is done by . . .	% of Plants
In-Plant Laboratory Only	48%
Outside Laboratory, including Company Headquarters Laboratory	32%
Both In-Plant and Outside	20%

Turn-around time for analyses . . .	
Median (all plants)	11 Days
Range (all plants)	2-35 Days

Is your present turn-around time adequate?	
Yes, it is generally "OK"	87%
No, generally need sooner	13%

What turn-around time would you like to have?	
Median (all plants)	7 Days

Turn-around time was defined as the time lapsed from sample submission to receipt of result . . . either via written report or by telephone if quicker response was needed.

The respondents' attitudes toward using the services of a nationwide, independent laboratory . . . such as 3M's . . . were obtained. Care was taken to frame this question so as to focus on samples from the passive dosimeter as well as from the pump and tube method.

The result was almost a toss-up . . . 44% of the persons interviewed had a positive attitude toward sending samples to a central, independent laboratory, and 56% were not inclined to use any outside analytical service.

Reasons given for the positive attitudes were:

1. No internal G.C. capability;
2. Internal G.C. capacity filled;
3. Independent, "unbiased" result desired;
4. Parallel analysis to check internal results;
5. Less expensive than internal analysis;
6. Less turn-around time required;
7. Better technical capabilities.

Reasons given for the negative attitudes were:

1. Samples could be lost in mail;
2. Samples could be confused with others;
3. Uncertainty of outside lab capabilities;
4. More expensive than internal analyses;
5. Loss of confidentiality (competition and regulatory).

User Preference for Distribution Route

User respondents were polled for their preference for buying personal monitoring equipment and supplies direct from manufacturers versus buying from their local distributor. The following data show that the great majority prefer dealing with distributors or have no preference:

Prefer Direct from Producer	14%
Prefer Through Distributor	40%
Have No Preference	46%

The persons interviewed reported that DuPont and MSA sell only direct and that Bendix, Sipin, SKC, and Abcor sell through distributors.

A distributive consideration arises when one considers the data previously reported on purchase influencers. With 65% of the companies reporting that responsibility for personal monitoring rests with a department other than that department responsible for personal protective devices, it may be that distribution of the #3500 OVM should not be restricted to the traditional "safety equipment" distributors. Other types of distributors . . . such as laboratory supply houses . . . might be added to the distributor system to reach a broader range of those professionals involved in personal monitoring.

Personal Monitoring Versus Area Monitoring

Workplace atmospheres may be sampled either from a fixed position or from a mobile position . . . usually as close as possible to the face of a worker. The former is generally referred to as "area sampling" and the latter "personal sampling". (The "sampling" plus analysis plus record-keeping is the "monitoring" program.)

Area sampling is a necessary approach in situations where immediate analysis is needed to alert workers to the presence of hazardous concentrations of materials that pose an immediate, acute health or safety hazard. Area sampling is necessary because the required analytical equipment is not usually attachable to a worker. Most hazardous organics are not ones that present an immediate, acute hazard, and thus area sampling is not a required approach in monitoring programs for these substances.

Area sampling might be used for convenience or cost or other reasons in organic vapor monitoring programs even though this approach to sampling might not be "required". One consultant we talked with reported that at least one company is exploring the possibility of combining area sampling (and subsequent analysis) with computer assisted descriptions of worker movements within the workspace to yield Time Weighted Averages of worker exposure. The uncertainty that this approach would give sufficient correlation with the actual exposure of a given worker, and the high cost of

developing the system, would both suggest that this approach will find little if any acceptance among user companies . . . much less by regulatory agencies.

Another factor that affects the choice between area and personal sampling is the position taken by regulatory agencies, most notably OSHA. All promulgated regulations to date that actually prescribe a sampling procedure require personal monitoring . . . not area monitoring.

While we did not attempt to get a direct measure of the usage of area monitoring, we can conclude from our interviews in general that the great proponderance of sampling for organic vapors is by personal sampling.

We did ask directly concerning the respondents' expectation of any changes in the "mix" of personal versus area sampling. The results give no reason to expect that personal monitoring will decrease in favor of area monitoring:

"See no change from current mix"	22%
"Trend is definitely toward personal" . .	71%
"Trend is toward area"	7%

Personal Monitor Selection Factors

What factors are most important to the key purchase influencers in making decisions as to which passive dosimeter to purchase and use? To answer this most important question, we evaluate the unaided comments made by the respondent and directly query the respondent concerning a number of generally found selection factors. We use a 1-10 numerical rating scale that is rooted to some generally accepted evaluatory terms. A similar scale is then used to obtain the respondents evaluation of the performance of the manufacturer on the same factors.

RATING SCALE

Scale	Importance	Performance
0.0 - 1.9	"Not at all important"	"Lousy"
2.0 - 3.9	"Not too important"	"Poor"
4.0 - 5.9	"Somewhat important"	"Fair"
6.0 - 7.9	"Important"	"Good"
8.0 - 10.0	"Very Important"	"Super"

On the following page are the factors and importance ratings for passive organic vapor monitors, and the ratings for 3M's #3500 OVM.

The most important three factors will be discussed individually in sections that follow. On the other six factors, 3M rates quite favorably compared to the importance that the respondents place on the various factors. The one "yellow light" is in the area of "Knowledgeable Sales Reps" which should be interpreted as being both

3M's representatives that are in contact with potential users and 3M's distributors. Somewhat more technical and application knowledge is desired from these people.

PERSONAL MONITOR SELECTION FACTORS

RANK	FACTOR	IMPORTANCE RATING 1-10 SCALE	3M PERFORMANCE RATING	DIFF.
VERY IMPORTANT				
1	PRODUCT QUALITY	9.6	8.2	-1.4
2	NIOSH APPROVAL	8.1	--(1)	--
3	TECHNICAL LITERATURE	8.0	6.8	-1.2
IMPORTANT				
4	SIMPLICITY OF USE	7.9	9.3	+1.4
5	KNOWLEDGEABLE SALES REPS	7.7	7.2	-0.5
6	COMPANY REPUTATION	7.3	9.1	+1.8
7	WORKER ACCEPTANCE	7.2	9.5	+2.3
8	DELIVERY TIME	7.0	9.0	+2.0
9	PRICE	6.5	7.8	+1.3
10	ANALYSIS TIME	6.2	8.3	+2.1

(1) A numerical rating here would be meaningless since most respondents either said that "approval" was being awaited, or didn't know if the #3500 was "approved" or not. Many asked if it was approved.

Factors of Product Quality (DOES IT WORK?)

The selection factor given the highest rating by users was "product quality". This is a very broad term, but it can be boiled down to the basic question: "Will the passive dosimeter do the job it is intended to do?" And more specifically, the concern of each individual is will it work on the organics that are potentially present in his plant. In the earliest stages of consideration, the user looks to see if the manufacturer claims that his product will work on the specific organics of concern. In other words, the first test of product quality are the manufacturer's claims in the promotional literature. The importance of literature will be discussed more fully in a later section of this report.

Because of the incumbant position held by the pump and carbon tube method, the user wants to see that the passive dosimeter gives results that agree with those that his company, or regulatory agencies, have obtained previously using the pump and tube method. This is important both from the standpoint of not disrupting the historical data line, and of being able to use the two methods interchangeably.

If no pump-and-tube data are available for comparison, the user is concerned with "accuracy" . . . generally determined by sampling a known concentration of the organic vapor in a vapor chamber. Closely related to "accuracy", which is a measure of the

correctness of the result, is "precision" . . . a measure of the sensitivity of the method. In other words, will the passive dosimeter distinguish between important differences in vapor levels.

Other related analytical concerns relate to the consistency of the results. Are they reproducible? Badge to badge . . . day to day . . . analysis to analysis.

All of these analysis related factors must be lumped together to determine if the passive dosimeter gives results that will meet the "accuracy" section of those OSHA regulations that specifically require personal monitoring.

Another concern related to product quality is for the effect of other organic vapors upon the dosimeter's ability to measure the organic of specific concern. Will the dosimeter accurately measure one organic in the presence of other, often less critical and higher concentrations, organics.

Other product quality questions relate to the susceptibility to high temperature, high humidity, and low ambient air speeds.

And finally, is the capacity of the passive dosimeter exceeded in the user's specific application? How do you know if overloading has occurred? These questions arise primarily from the practice of using and analyzing a "back-up" section of activated carbon in the pump and tube method.

As may be seen in the Selection Factor table, 3M's #3500 OVM performance falls short in its "Product Quality" rating when

compared to the importance that potential users attach to product quality. While we found very few opportunities to evaluate users' perceptions of the #3500 in comparison to competition, those few situations strongly suggest that 3M is perceived as being better than any competition in "product quality" . . . particularly in the analytical areas of accuracy, precision, and reproducibility.

The product quality shortfall comes primarily as a result of lack of information. Where data is available, it should be effectively communicated to potential users. And where the data is lacking, laboratory and field testing that will address these product quality concerns should be conducted and reported. Test data should be developed by third parties . . . not by 3M. Preferably the third party should be under NIOSH, or the testing done under NIOSH or OSHA auspices.

Users' Attitudes Regarding NIOSH/OSHA Approval

The significance of the second-ranked selection factor -- NIOSH Approval -- is much greater than its importance rating indicates. While the first-ranked "Product Quality" is in many ways a vague term, and satisfaction in 3M's performance on this factor can be achieved by effective communication of present or future data, meeting potential users expressed needs for "NIOSH Approval" will be much more difficult.

We find that the expression "NIOSH Approved" covers a range of official endorsements: 1) Many respondents are familiar with the NIOSH certification program for respirators, and a similar certification for the Bendix-type, colormetric gas analysis tubes. They would like the same assurance of acceptability with the passive dosimeters. 2) The NIOSH Manual of Sampling Data Sheets details the type of sample collection with each method. For mercury, there is a method detailing 3M's Mercury Monitor passive dosimeter. Users want to see NIOSH published methods that detail the dosimeter as the means of sample collection. 3) OSHA at least implicitly "approves" the pump and tube methodologies, even though the promulgated regulations state that any method is acceptable if it meets the prescribed "accuracy" requirements. 4) And perhaps most importantly, OSHA inspectors sample workplace atmospheres . . . and whatever method used by the inspector is assumed to be the most acceptable method

for the company to use in meeting OSHA requirements.

Gaining any one of the above four "endorsements" would satisfy users' demands for "NIOSH Approval".

The individual importance ratings given to the selection factor "NIOSH Approval" were not spread over the 1-10 scale continuum. Rather, they fell into one of four distinct classes:

11% of Users -- Little, if any, regard for "NIOSH Approval", NIOSH approval not needed before they would use passive dosimeters routinely.

20% of Users -- Approval desired, but they would use passive dosimeters if their evaluation showed that the dosimeter was satisfactory in their application. Sufficient data would be generated to meet the OSHA regulation requirements for accuracy, and to otherwise demonstrate to regulatory people the acceptability of the dosimeter.

25% of Users -- Approval is very important, but they might use for some internal control monitoring even if approval was not expected. "Official" monitoring would continue to be with the pump and tube method.

44% of Users -- Approval is absolutely necessary, will not use passive dosimeter unless "NIOSH Approved".

Technical Literature Considerations

The potential user is looking for extensive literature coverage on the attributes and applications of the passive dosimeter. This attitude is directed toward both sales and promotional literature, as well as technical reports of laboratory and field testing.

To most potential users, the passive dosimeter is still a new concept. He needs to be sold on the diffusion sampling approach. The potential user looks for answers to all the questions raised in the previous section on "Product Quality"; and when he doesn't find the answer, a negative is assumed. He looks particularly for "NIOSH APPROVED" or "MEETS ALL OSHA REQUIREMENTS" or some similar statement. And he expects to see his particular application mentioned among the applications discussed in the promotional literature.

If the potential user does not find his organic listed as a "Recommended Compound" in the 3M Compound Guide he assumes that the #3500 OVM is not applicable to his situation.

He would like to have reprints of articles in technical journals presenting data from laboratory and field tests involving the specific organic compound and possible interferences that he would encounter in his potential application.

In short, the potential user is looking for literature that will allay his every concern about the acceptability of using the #3500 in his plant.

Time Frame for Decisions to Use a Passive Monitor

ORDER FOR INITIAL EVALUATION . . . . . ½ - 1½ Months

The advantages of the passive dosimeter over the pump and tube method are sufficient to elicit a sample order from most people engaged in personal monitoring. But "I'd like to try a few" quantities do very little to increase sales once the distributor pipeline is filled.

ORDER FOR ROUTINE USE, ASSUMING "NIOSH APPROVAL"*. . 2 - 24 Months

Average Time . . . 13½ Months

Respondents were asked "If NIOSH approved, how long would it take for your company to evaluate and make a decision to use a passive dosimeter?" Some said they would begin using quickly . . . if NIOSH approved, then they would assume satisfaction in their application. Others said that they would still have to do extensive evaluatory testing before any decision for routine use and/or replacement of the pump and tube method was made.

ORDER FOR ROUTINE USE, ASSUMING "NIOSH APPROVAL" WAS NOT FORTHCOMING . . . . . 44% of companies would not consider for use

the other . . . . . 56%: 2 - 36 Months

Average Time: . . . . . 18 Months

Those companies that would use in the absence of "NIOSH Approval" would require additional time for more complete testing and consideration than if approval were forthcoming.

*"NIOSH APPROVAL" is used here to mean any of the four "official endorsements" discussed earlier.

RESULTS OF
DISTRIBUTOR INTERVIEWS

Results of the distributor interviews are presented in a question and response format followed by ratings of business selection factors as ranked by the distributor respondents.

1. To what industries do you sell personal organic monitoring devices (passive or pump)?

	% of Distributors*
Chemical	40%
Metals Finishing	20%
Petroleum	15%
Petrochemical	10%
Glass, Paper, Textiles, Electronics, Gas	5% each

The high ranking of the metals finishing industry was unexpected, but explainable in hindsight: Solvents -- most of them considered by NIOSH/OSHA as hazardous -- are used extensively as cleaning agents. Also, safety equipment distributors have an "in" with this industry through supplying protective clothing and eyewear.

2. With what department do you mostly deal in selling personal monitoring devices?

Safety	75%
Purchasing	45%
Industrial Hygiene	45%

*The responses to most of the questions are not mutually exclusive categories; thus, the percentages do not total 100%.

This mix should be carefully considered in light of the previously discussed mix of "purchase influencers" in which we found that persons other than in the safety department comprise 70% of the influence. Converting the above data to mutually exclusive categories of "Safety" and "Industrial Hygiene", it would appear that only about 40% of the distributor effort is being applied to potential purchasers outside the safety department.

3. Is there a "call for" passive dosimeters or do you have to "sell"?

"Call For"	5%
"Sell"	65%
Both	30%

Obviously, "pull through" marketing on the part of the manufacturer is currently required.

4. What approaches do you find effective in selling?

Personal Sales Calls	100%
Direct Mail	50%
Advertising	50%
Telephone Calls	10%
Trade Show Promotion	5%

Most respondents said that only the personal sales call would actually produce a sale . . . the other approaches were useful only in creating interest.

5. How does 3M help in selling the #3500 OVM?

3M Reps Make Calls with Distributor	65%
Advertising	45%
Provides Literature	25%
Provides Leads	20%
Does Direct Mailings	5%
Runs Field Testing	5%

6. How could 3M improve its sales support?

Nothing More is Needed (Two distributors said that 3M is the best of their OEM's!)	55%
Better 3M Sales Representation	30%
Not Have so Many Competing Distributors	15%
Provide More Leads	5%

7. Are you satisfied with the frequency of 3M representative contact with you? What frequency is desired?

Current Frequency is Satisfactory 80%

Median: 52 times per year

Range: 4-120 times per year

Current Frequency is Not Satisfactory 20%

Current Range: 1-12 times per year

Desired Range: 4-36 times per year

While the responses to this question show a moderate need for increased rep contacts, consideration of the responses to Questions 5 and 6, and other data from this study, point out rather strongly the need for 3M's reps to be better qualified technically and to be able to transmit either verbally or with literature the technical information that is needed by potential users.

8. What other personal monitoring devices do you offer?

None	75%
Bendix	10%
National Draeger	10%
Gas Tech	5%
Abcor	5%
"Color Chromatograph Badge" - Mfg. Not Known	5%

The most important aspect of these data is that three-fourths of the distributors have no experience in selling organic vapor monitoring equipment other than the #3500 OVM (unless they used to carry a "pump and tube" line and have dropped it). They may have very little knowledge of carbon absorption technology, and may not appreciate the advantages that the passive monitor offers compared to the pump and tube.

9. How does your profit margin on 3M's #3500 OVM compare to that on competitive devices?

Same	15%
3M is Better	15%
3M is Poorer	0%

10. What percent of your total sales of industrial safety products is in 3M's 3500 OVM?

Mean response	2.6%
Median	2.0%
Range	Nil to less than 10%

11. What trend do you see in the sales of personal organic vapor monitors?

Increasing	75%
Decreasing	0%
No Change	5%
Don't Know	5%
No Response	15%

Distributor's Comments:

. . . If benzene decision is in favor of OSHA, demand for #3500 will be very large.

. . . #3500 sales will grow faster than the overall personal monitor market.

. . . 3M will be the leader in a "sky rocketing" market.

. . . Abcor will go "down the drain".

. . . #3500 market will "fly" . . . but will take much longer to develop than 3M has projected.

12. Do your #3500 customers have their G.C. analyses done . . .?

In House	35%
Outside, Local	25%
By 3M	50%
Don't Know	10%

DISTRIBUTOR'S SELECTION FACTORS

IMPORTANCE AND 3M PERFORMANCE RATINGS

RANK	FACTOR	IMPORTANCE RATING	3M PERFORMANCE RATING	DIFFERENCE
VERY IMPORTANT				
1	COMPANY REPUTATION	9.3	9.4	+0.1
2	ACCURACY OF RESULTS	9.1	9.1	--
3	EASE OF ANALYSIS	8.9	8.9	--
4-5	ACCESSIBILITY OF LOCAL DISTRIBUTOR	8.8	9.1	+0.2
4-5	KNOWLEDGEABLE MFG. SALES REPS	8.8	8.6	-0.2
6	DELIVERY	8.7	9.0	+0.3
7	NIOSH APPROVAL	8.5	9.1*	+0.6
IMPORTANT				
8	PRICE	7.8	9.1	+1.3
9	LIGHT WEIGHT/EASE OF USE	7.7	9.0	+1.3
10	TECHNICAL LITERATURE	7.6	8.9	+1.2
11-12	ANALYTICAL TIME	7.3	8.8	+1.5
11-12	WORKER'S ACCEPTANCE	7.3	8.9	+1.6
13	ONE-TIME-USE ITEM	6.9	8.9	+2.0
14	QUANTITY DISCOUNTS	6.5	8.6	+2.1

*3M's distributors appear to believe that NIOSH approval, or at least some form of official endorsement, has been received. If this claim is being made to knowledgeable prospects, it presents either or both a lack of knowledge of the field or a "credibility gap".