ISEA Industrial Safety Equipment Association

July 21, 1994

NIOSH Docket Office
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Cincinnati, OH 45226

NIOSH Notice of Proposed Rulemaking on Respiratory Protective Devices, 42 CFR Part 84 (59 FR 26850)

The Industrial Safety Equipment Association (ISEA) is pleased to submit the enclosed comments on behalf of its Respiratory Protection Group. The members of this group are as follows:

The Bilsom Group/Glendale Protective Technologies Inc.
Biosystems Inc.
E.D. Bullard Co.
Cabot Safety Corp.
Louis M. Gerson Co., Inc.
Hornell Speedglas, Inc.
International Safety Instruments, Inc.
3M Company
Mine Safety Appliances Co.
Moldex-Metric, Inc.
Pro-Tech Respirators, Inc.
Racal Health and Safety Inc.
Scott Aviation
Siebe North Inc./North Safety Equipment
Survivair, Inc.
U.S. Safety
Uvex Safety, LLC
WGM Safety Corp./Willson Safety Products

If you have any questions on these comments, please contact William J. Erny, ISEA Manager of Product Groups.

Yours sincerely,

Daniel K. Shipp
President

Enclosure

JUL 22 1994

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Comments of the
ISEA Respiratory Protection Group
to the National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

Respiratory Protective Devices, 42 CFR Part 84

July 22, 1994

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Executive Summary

The Industrial Safety Equipment Association (ISEA) supports the effort by the National Institute of Occupational Safety and Health (NIOSH) to upgrade the existing certification requirements for respiratory protective devices as proposed in 42 CFR 84. ISEA also supports the modular approach that NIOSH is taking to more quickly promulgate this rule.

The association has recommended certain specific alterations to the proposed rule that will make the standard more effective and make its requirements more realistic and reproducible in the laboratory and the workplace. Specifically, ISEA makes the following recommendations:

A. Grandfathering Provisions

1) ISEA recommends that NIOSH accept applications to 42 CFR 84 immediately upon its publication as final and continue to accept new applications to 30 CFR 11 for six months after the publication of 42 CFR 84 as final.

2) ISEA recommends that manufacturers be permitted to sell and ship products certified to the 30 CFR 11 criteria as NIOSH-certified respirators for four years after the date of publication of the final rule.

3) ISEA recommends that NIOSH limit the application of the grandfathering period to respirators under the manufacturers control.

4) ISEA recommends that where changes to filter media or filter specifications would affect filter performance, submittals for extensions of existing product approvals be accepted for two years after the rule becomes final.

5) ISEA recommends that where a manufacturer makes non-substantial changes to respirators that do not affect filter performance, extensions be granted for existing product approvals for four years after the rule becomes final.

6) ISEA recommends that NIOSH confirm that products approved under 30 CFR 11 criteria do not lose their certified status after the sales deadline passes.

B. Testing Parameters

1) ISEA recommends that §84.184 be renamed "Particulate filter penetration characteristics test"

2) ISEA recommends that prior to the publication of a final rule, NIOSH work with the respirator community to identify an appropriate method of aerosol generation.

3) ISEA recommends that prior to the publication of a final rule, NIOSH work with the respirator community to develop test parameters that produce consistent, reproducible results.

4) ISEA recommends that the rule specify the following preconditioning requirements:

- a method of uniform conditioning;
- the gas tight container be no more than three times the volume of the products stored;
- products be placed within the container immediately after conditioning; and
- products remain within the container for no more than 24 hours before testing.

5) ISEA recommends that NIOSH include an allowable airflow tolerance of +/- 2% for resistance testing.

6) ISEA recommends that NIOSH change the resistance requirements to 35 mm H_2O inhalation resistance and 25 mm H_2O exhalation resistance.

7) ISEA recommends that NIOSH work with the respirator community to reevaluate the filter loading limits and develop a scientifically based aerosol loading level.

8) ISEA recommends that a scanning mobility particle sizer (SMPS) or equivalent be used to determine particle size distribution.

C. Filter Efficiency and Classification

1) ISEA supports the filter penetration efficiency of 99.97% designated for Type A filters, and recommends that the designated filter penetration efficiencies for Type B and Type C filters be changed to 96% and 90%, respectively.

2) ISEA recommends that proposed Types A, B and C be reclassified as Class 3, 2 and 1, respectively.[1]

D. Powered Air-Purifying Respirators

1) ISEA recommends that NIOSH does not include any new tests for PAPRs within the first module of the proposed new rule and transfer the existing 30 CFR 11 PAPR requirements to 42 CFR 84

2) ISEA recommends that NIOSH add a new separate module for powered air-purifying respirators (PAPRs) that will focus speciically on these devices

3) ISEA that the new PAPR module be given high priority and inserted into the NIOSH plan at an early stage.

E. Test Statistics

1) ISEA recommends that, if a statistical method is used, the proposed rule allow acceptance of filters tested by NIOSH where the penetration values of the filters are no greater than 0.0003 (Type A); 0.04 (Type B); 0.10 (Type C), as an alternative to the statistical method proposed.

2) ISEA recommends that the K factor be changed to 1.778.

F. Fit Testing

1) ISEA recommends that fit testing not be conducted as part of the certification program.

2) ISEA recommends that, in the alternative, NIOSH adopt either the Bitrex qualitative fit test aerosol using the protocol for saccharin in the OSHA lead standard or use a large particle quantitative fit test.

G. Assigned Protection Factors

1) ISEA recommends that NIOSH call a technical meeting to discuss the issue of appropriate uses for respirators under the new classification scheme of the proposed rule and to allow the public an opportunity to comment.

ISEA looks forward to working with NIOSH to complete this rulemaking and offers its technical resources and expertise to help advance this and subsequent modules.

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[1] Discussed in full in "VI. International Harmonization Should be a NIOSH Goal."

I. Introduction

The members of the Industrial Safety Equipment Association (ISEA) support the efforts of the National Institute of Occupational Safety and Health (NIOSH) to publish a standard for respirator certification that will provide manufacturers and end users alike with clear, succinct and workable criteria for evaluating the effectiveness of filters for particulate respirators.

ISEA is the leading national association for manufacturers of personal protective equipment and clothing. Since its founding in 1933, ISEA has been dedicated to protecting the health and safety of workers at factories, construction sites, farms and health care facilities. Among ISEA's 68 member companies are 18 manufacturers of respiratory protection products, including all of the product categories that would be affected by 42 CFR 84.

The association, whose members produce 95 percent of the NIOSH certified respirators manufactured in the United States, has been an ongoing participant in NIOSH's attempts to revise its existing respirator certification criteria, beginning with the proposed standard released by the agency in 1987 and up through the proposed first module covering filter penetration criteria that was published in the May 24 *Federal Register.*

This rulemaking is vitally important to manufacturers and end users as it will update the criteria currently codified at 30 CFR 11 to mandate that respirators meet stringent technical requirements and provide maximum protection to workers exposed to harmful airborne contaminants. The ability of manufacturers to retool their operations to produce new, higher efficiency respirators will be determined in large part by the NIOSH requirements as they appear in the agency's final rule. ISEA supports the agency's efforts to update and strengthen its certification criteria, and urges NIOSH to do so in such a way as to allow the manufacturing industry adequate time to develop products that meet the new standards.

II. ISEA Supports Improvements in Proposed Filter Performance Requirements

In 1987, NIOSH published a proposed revision to its current respirator certification standard that proposed criteria beyond mere filter performance levels. This proposal was viewed widely as an inaccurate reflection of the state of modern science and technology and an unworkable and overly burdensome standard for manufacturers that would not provide measurable benefits to the end user. Several unwieldy proposals were prepared subsequently by NIOSH, and ISEA objected to each of them.

Although ISEA has not always agreed with positions taken by NIOSH, we have tried to work closely with the agency in order to reach a consensus on the certification requirements that ultimately would appear in the proposed rule. For example, on March 21, 1991 ISEA provided NIOSH with an extensive compilation of workplace protection factor studies measuring the effectiveness of particulate respirators at various levels of airborne contaminants. These studies provide valuable information to assist NIOSH in its development of the present rulemaking as well as for other modules.

The proposed filter performance criteria are, in part, a reflection of this continuing dialogue that ISEA has attempted to maintain with NIOSH. The agency has modified several elements of the proposed criteria that ISEA objected to in the 1987 version, including:

- in earlier proposals, a manufacturer was required to obtain certification for protection against both liquid and solid particulates, whereas NIOSH's current proposal allows for separate certification for either solid—or liquid and solid—particulates; and

- the statistical handling of test data in earlier proposals used a sample size ISEA considered too small, whereas NIOSH's current proposal would require 30 samples rather than three or six.

ISEA recognizes and appreciates NIOSH's willingness to understand the suggestions and concerns of manufacturers; likewise, ISEA appreciates the challenges that NIOSH has posed to manufacturers in their attempt to provide worker protection in the context of a feasible certification standard.

III. Respirators Are a Critical Asset in Protecting Workers

Respiratory protective devices are an invaluable component of any workplace health and safety program. ISEA recognizes the established hierarchy of controls where an employer looks first to engineering controls to eliminate or mitigate occupational hazards. In certain situations, however, workplace conditions dictate that engineering controls are not feasible and an alternative means of providing protection must be utilized. This is especially true at many construction, agriculture, mining and maritime workplaces.

Where engineering controls would fail to provide adequate protection or are not otherwise feasible, respirators and other personal protective equipment are recognized as an effective means of protecting employees against the dangers of the workplace. In other instances, equipment failure or routine maintenance operations may necessitate the use of respirators. The effectiveness of respirators was demonstrated by the workplace studies that ISEA provided to

NIOSH in 1991. As an added benefit, respirators present a less costly alternative to capital-intensive engineering controls.

The degree of protection that a particular respirator provides is dependent upon a number of factors, one of which is filter performance. Because we recognize the value of well-engineered performance in respirators, ISEA considers this rulemaking to be of critical importance to the industry and to the end user. The member companies of ISEA share NIOSH's goal of protecting workers from respirable hazards in the workplace and see this module on filter performance as the first step towards bringing the agency's certification criteria up to date with modern science and technology.

IV. The Modular Approach is an Effective Tool to Advance the Respirator Certification Rulemaking

ISEA supports NIOSH's decision to use an innovative and results-oriented modular approach in this rulemaking. The lack of success that NIOSH had with earlier attempts to update the existing requirements in 30 CFR 11 demonstrates that an incremental approach to the rulemaking might be a more feasible alternative. The agency chose to accomplish this by releasing its proposed respiratory certification criteria in a series of steps or "modules," rather than as one overwhelming new regulation. Not only should this approach make for a more workable rulemaking process, it also would allow manufacturers time to develop the improved technology necessary to meet the requirements of the proposed standard.

The modular approach also should benefit interested parties by creating a more efficient rulemaking process that results in measurable progress. This has the potential to increase internal agency motivation that flows from NIOSH accomplishments. Positive and progressive results also are likely to enhance external relationships with the regulated community.

While in the past the agency attempted to release overly burdensome new regulatory schemes as entire packages that turned out to be confusing and excessive, this new format should permit NIOSH to release focused and concise portions of the rule that ultimately will be incorporated into an overall respirator certification scheme. Each module would be more easily understood and addressed by the regulated public, and the entire rulemaking process should speed up as a result. Ultimately, NIOSH has come up with a workable and cooperative new means of ensuring workplace safety that should help avoid the litigation and delay that traditionally have been an intimate part of the regulatory process.

Two key elements to a successful modular development program are the sequence and timing of module release. Air-purifying respirators are the most widely used class of respirator. Updating the filter performance requirements within the first module will have the largest potential health contribution and ISEA agrees it should receive priority. ISEA agrees with the overall sequence proposed for issuance of the 42 CFR 84 modules. However, ISEA encourages the addition of separate modules for powered air-purifying respirators (PAPRs) and airline/combination respirators. Because of the interrelation of assigned protection factors (APFs), PAPR testing and the need for well defined PAPR system test requirements, and combination gas/vapor/particulate cartridges, the PAPR module and the gas vapor module should be scheduled for release after that on APFs.

The timing for release of the remaining modules should be maintained as proposed to ensure that revision of the entire rule is complete. The role of NIOSH should be that of project manager to coordinate and maintain program completion. ISEA suggests that a five-year overall schedule be added as a requirement for completion of all of the proposed modules.

In addition to sequence and timing, ISEA is concerned about certain ambiguities inherent in 42 CFR 84 as proposed. These areas of concern include the extent to which the different modules interrelate, any overlap among the different modules and their requirements, and the increased costs of research and development. These costs may include research and development to meet the certification criteria of the first module as well as retooling and recertification to comply with the requirements of future modules. The implications of various grandfathering provisions for each module figure into these concerns, as do the potential costs of retooling existing manufacturing processes.

ISEA would like to maintain open communication with NIOSH in the development of future modules. Research and development requirements and laboratory time are significant and costly. A close functional working relationship between manufacturers and regulators will help reduce costs to the market that often result from unrealistic performance requirements and help expedite the placement of advanced products on the market through focused research and development.

V. Interagency Coordination Needs Priority Attention

As the proposed respiratory certification criteria contained in 42 CFR 84 move toward promulgation as a final rule, it is crucial that NIOSH reassert its interagency leadership role. Both the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA)

have delayed publication of their respective standards on respiratory protection until after release of the NIOSH certification rule.

Now that the first of the proposed NIOSH modules is publicly available, however, OSHA and MSHA have indicated that they soon will advance their respective respiratory protection rules. Respirator certification by NIOSH ties directly to the respiratory protection requirements of OSHA and MSHA—as well as those of certain other agencies such as the Environmental Protection Agency and the Nuclear Regulatory Commission—and to industry respiratory protection programs.

It is especially important for NIOSH to link the new performance standards to faceseal leakage requirements and APFs. Assigned protection factors traditionally have been the responsibility of OSHA; under the revised standard, however, NIOSH will take the lead in setting APFs. NIOSH is the appropriate agency to evaluate overall respirator performance under workplace conditions, and therefore to determine APFs for the different respirator classes with input from respirator users and manufacturers.

Although the schedule included in the preamble to the proposed rule indicates that APFs are to be included in a future module, the agency needs to provide some indication of what uses or applications are appropriate for the various new classes of respirators. The practical applicability of respirators produced under the new standard must be understandable to end users and manufacturers for product mix and planning purposes.

The essential elements for establishing assigned protection factors, moreover, are present in the proposed rule. Namely, the first module proposes specific filter and face piece performance characteristics, from which APFs are derived. Here again, the workplace protection factor studies submitted by ISEA in 1991 are particularly relevant. The ISEA submission recommended that NIOSH adopt the assigned protection factors found in the current version of American National Standard Institute (ANSI) Standard Z88.2 (1992). These APFs were supported by the more than two dozen workplace or simulated workplace studies reviewed.

NIOSH has indicated in the preamble to 42 CFR 84 that it will be issuing a Respirator User's Notice simultaneous with publication of the final rule. This notice must provide users with enough information for them to determine which respirators are appropriate for particular hazardous exposures. It will be used to cross-reference the new classes of respirators under 42 CFR 84 with particular workplace hazards against which the respirators are intended to protect workers (e.g. nuisance dusts, paints, pesticides, and substance-specific standards). This document would provide guidance to both manufacturers and end users until the module on APFs is released.

ISEA strongly supports creation of this document, and recommends that NIOSH develop the Respirator User's Notice in conjunction with OSHA, MSHA, EPA, end users and manufacturers. Interagency coordination, led by NIOSH, is essential to creating a cross-reference tool that will provide guidance to manufacturers to help direct their research and development efforts and will be readable and understandable to the end user.

Regarding the subject of the continued use of respirators already in the workplace, ISEA recommends that NIOSH develops a memorandum of understanding with other Regulatory Agencies whereby respirators approved under 30 CFR 11 may be used indefinitetly, provided they are suitable and maintained in good condition.

VI. International Harmonization Should be a NIOSH Goal

Another goal of NIOSH during the process of promulgating the various modules of 42 CFR 84 should be the creation of a standard that is, wherever possible, compatible with existing international standards. Such compatibility would result in lower non-tariff barriers to trade and would simultaneously increase U.S. manufacturers' ability to export U.S. products.

As the United States continues to increase its involvement in foreign markets, it is in the best interests of manufacturers and users to move towards common ground when establishing certification and use standards. This is as applicable in the case of respirator certification and respiratory protection as anywhere. A great deal of international harmonization is ongoing under the guidance of the Geneva-based International Organization for Standardization (ISO). The ISO 9000 standards are global standards for quality systems, for instance, and NIOSH may want to coordinate the development of the 42 CFR 84 module on quality assurance with ISO 9000.

Such harmonization will increase understanding of other countries' systems, the processes available to harmonize U.S. standards with those other systems, and how to initiate the harmonization process. Standards have been harmonized among European countries for some time.

ISEA recommends that the nomenclature of the proposed NIOSH respirator class designations be changed to more closely correspond with those used internationally. Specifically, ISEA recommends that the proposed Types A, B and C respirators be redesignated to Classes 3, 2 and 1, respectively.

VII. Empowering of Industry Will Expand Resources Available to NIOSH

The current NIOSH respirator certification program is composed of five primary elements: (1) certifying respirators; (2) assuring quality in the manufacturing process; (3) investigating field complaints; (4) providing technical assistance to the respirator community; and (5) developing respirator standards. In combination, these elements are extremely resource-intensive, affecting directly the overall respirator certification process. Delays in processing certifications, outdated regulations and limited product auditing are common results of the increasing demands placed on the certification program.

In the face of increasing demands on internal resources and shrinking federal budgets, NIOSH must find more efficient ways to conduct its certification program. ISEA understands that a vision has been developed for the agency that would broaden the influence of the certification program without requiring significant additional resources. ISEA supports NIOSH's vision, which is based on integrating four philosophies: continuous improvement, industry empowerment, matrix management, and goal champions.

In particular, ISEA strongly supports the concept of industry empowerment, which could greatly expand the resources and expertise within NIOSH by creating partnerships with the private sector. Empowering industry would broaden significantly the base of resources available to NIOSH and simultaneously free federal funds to be applied directly to other projects designed to improve workplace health and safety.

ISEA encourages NIOSH to establish processes that will permit the creation of cooperative partnerships between the government and the private sector, taking advantage of the abundant private sector knowledge and resources available to help protect the health and safety of the American worker. Areas that could be explored include: use of consensus standards as encouraged by OMB Circular A-119 ("Federal Participation in the Development and Use of Voluntary Standards"); use of scientific studies conducted outside the agency by the establishment of a standard peer review process; use of qualified laboratories to perform standardized performance tests; and use of certified ISO 9000 quality auditors to conduct manufacturing audits.

VIII. Economic Impact

ISEA is concerned that the economic impact has been underestimated due to the limited information previously available. An internal ISEA member survey resulted in an estimated annual cost increase to the user in excess of $100 million. This is based upon current information and estimates relative to

additional research and development, plant retooling and material costs affected by the performance requirement modifications.

ISEA recommends a closer working relationship with NIOSH in module development to better focus resources and develop a more cost-effective rulemaking process. ISEA also recommends opening the efficiency ratings for respirator classes to meet a larger range of user requirements and reduce the cost impact.

IX. Specific Issues Regarding 42 CFR 84 as Proposed

A. Grandfathering Provisions

ISSUE:

All applications submitted to NIOSH after 42 CFR 84 becomes effective will be required to meet the filter penetration criteria of the new rule. The rule will take effect 30 days after publication as final in the *Federal Register*. During this 30-day period, NIOSH will continue to accept submittals that purport to meet the requirements of 30 CFR 11.

RECOMMENDATION:

ISEA recommends that NIOSH accept applications to 42 CFR 84 immediately upon its publication as final and continue to accept new applications to 30 CFR 11 for six months after the publication of 42 CFR 84 as final.

RATIONALE:

During the NIOSH public hearings, ISEA stated its support for NIOSH's proposal to accept new submittals in accordance with the criteria of 30 CFR 11 for 30 days after publication of 42 CFR 84 as a final rule. During the hearings it became apparent to ISEA that many of the parameters required for the development of respirators meeting the requirements of proposed 42 CFR 84 are not known and manufacturers are reluctant to throw all their resources into the development of 42 CFR 84 respirators. Consequently, respirator development to the 30 CFR 11 criteria continues. Therefore, ISEA recommends that 30 CFR 11 applications be accepted for six months from the date of publication of 42 CFR 84 as final so that valuable research and development efforts and dollars that are currently being invested in improved 30 CFR 11 designs are not wasted.

ISSUE:

Two years after publication of the final rule, manufacturers may no longer sell or distribute respirators certified to the 30 CFR 11 criteria as NIOSH-certified respirators.

RECOMMENDATION:

ISEA proposes that manufacturers be permitted to sell and ship products that are approved under 30 CFR 11 as NIOSH-certified respirators for four years after the date of publication of the final rule.

RATIONALE:

This four-year period was chosen for several reasons. First, the experience of manufacturers in Europe indicates that three-plus years are required to develop respirators that meet the updated criteria. Second, NIOSH proposed a five year transition period in the 1987 version of 42 CFR 84 and has given no reason for the change. Third, NIOSH has limited resources with which to approve respirators within the time frame it has proposed. Fourth, the experience of the Bureau of Mines as it transferred certification authority to NIOSH and MSHA demonstrated the need for a sufficient time in which to make such a transition. Fifth, the lack of available filter media in all filter categories will slow manufacturers' efforts to develop respirators meeting the new 42 CFR 84 criteria.

ISSUE:

Two years after publication of the final rule, manufacturers may no longer sell or distribute respirators certified to the 30 CFR 11 criteria as NIOSH-certified respirators.

RECOMMENDATION:

ISEA recommends that NIOSH limit application of the grandfathering period to respirators that remain under the manufacturer's control.

RATIONALE:

Manufacturers have limited control over respirators once they have entered the distribution channels.

ISSUE:

NIOSH will continue to process previously-submitted applications for approval under 30 CFR 11 criteria for six months after publication of the final rule. The proposed rule does not address extensions of existing product approvals involving changes in filter media or filter specifications affecting filter performance.

RECOMMENDATION:

ISEA recommends that in situations where a manufacturer wants to make changes in filter media or filter specifications affecting filter performance, ISEA recommends that submittals for extensions of existing product approvals be accepted for two years after publication of the final rule.

RATIONALE:

The proposed rule needs to account for changes made to respirators previously certified under 30 CFR 11 that require the manufacturer to obtain an extension of approval. Some of these changes affect filter performance and others will not. A manufacturer that changes the vendor or supplier of its filter media, for instance, would need to obtain an extension of approval under the existing system of 30 CFR 11. It is essential that the proposed rule account for changes affecting filter performance that would not normally need to proceed through the entire certification process. A two year period would provide an adequate amount of time for manufacturers to make these types of changes before shifting over to the new criteria of 42 CFR 84.

ISSUE:

NIOSH will process previously-submitted applications for approval under 30 CFR 11 criteria for six months after publication of the final rule. The proposed rule does not address extensions of existing product approvals involving non-substantial changes to respirators that do not affect filter performance.

RECOMMENDATION:

ISEA recommends that in situations where a manufacturer wants to make non-substantial changes to respirators that do not affect filter performance, extensions to existing product approvals be accepted for four years after publication of the final rule.

RATIONALE:

As stated previously, the proposed rule needs to account for changes made to respirators previously certified under 30 CFR 11 that require the manufacturer to obtain an extension of approval. Some of these changes affect filter performance and others will not. Some examples of non-substantial changes that would not affect the filter's performance and that would need an extension of approval under the existing system of 30 CFR 11 include: changing the face mask color; changing the exhalation valve material; changing the headband supplier; or adding a qualification for formaldehyde to an acid gas/mist/dust cartridge.

It is essential that the proposed rule account for non-substantial changes that do not affect filter performance that would not normally need to proceed through the entire certification process. A four year period would provide an adequate amount of time for manufacturers to make these types of changes before shifting over to the new criteria of 42 CFR 84.

ISSUE:

The proposed rule does not address clearly whether distributors or users who receive respirators certified under 30 CFR 11 prior to the sales deadline will be able to continue to sell or use these products as NIOSH-certified after the deadline passes.

RECOMMENDATION:

ISEA recommends that NIOSH confirm that products approved under 30 CFR 11 criteria do not lose their certified status after the sales deadline for manufacturers passes.

RATIONALE:

ISEA members are concerned that, once the deadline passes, distributors and users, operating under the assumption that these products are no longer NIOSH-certified, will start returning previously-approved respirators to the manufacturer. Not only would this needlessly confuse the end users who the proposed rule is intended to protect, but it also would create a costly logistical nightmare for manufacturers and distributors.

Distributors and users should be allowed to continue selling and using 30 CFR 11 NIOSH-certified respirators after the deadline passes. Products that have been certified by NIOSH should retain their certified status.

B. Testing Parameters

ISSUE:

Section 84.184 currently is titled *"Particulate instantaneous penetration filter test."*

RECOMMENDATION:

ISEA recommends that §84.184 be renamed *"Particulate filter penetration characteristics test."*

RATIONALE:

The test as specified in the proposed rule would measure filter penetration in discrete increments over a period of time and would not provide a continuous measurement as implied by the existing title. Therefore, it is not accurately termed a measure of "instantaneous" penetration. This is a function of the sensitivity of the measuring instrumentation and the frequency with which it can take measurements of filter penetration. Additionally, the recommended title more accurately represents the objective of the test.

ISSUE:

While dioctyl phthalate (DOP) is specified as the appropriate challenge aerosol for "liquid and solid" certifications, the proper method of aerosol generation is not identified. There is simply too much that is not known about this test protocol and those factors that influence test outcomes such as preconditioning and challenge aerosol concentration to promulgate this into a final rule, as written.

RECOMMENDATION:

ISEA recommends that prior to the publication of a final rule, NIOSH work with the respirator community to conduct further research and better develop and define this filter penetration test.

ISEA member companies welcome the opportunity to work with NIOSH scientists in further developing a filter penetration test that both improves the proposed regulation and satisfies NIOSH's stated intent to significantly improve the protection provided to wearers of respirators and enable the classification

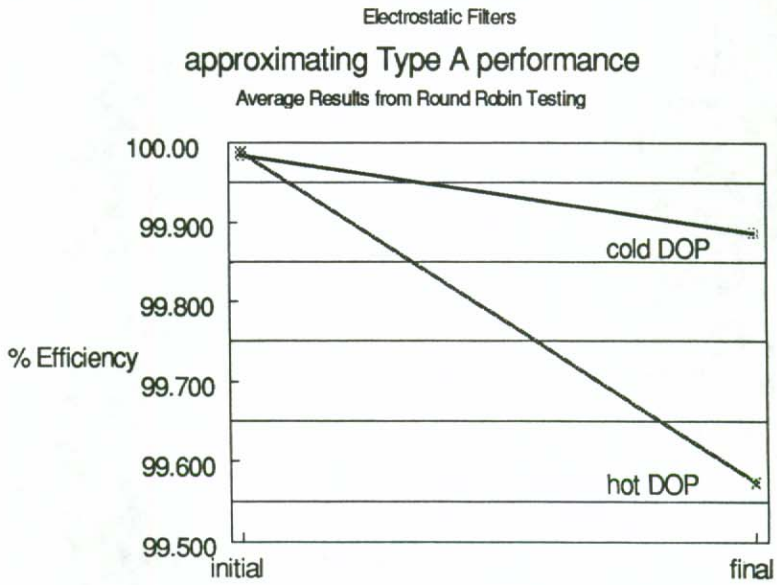
of filters based on their ability to inhibit the penetration of particulates of the most penetrating size.

RATIONALE:

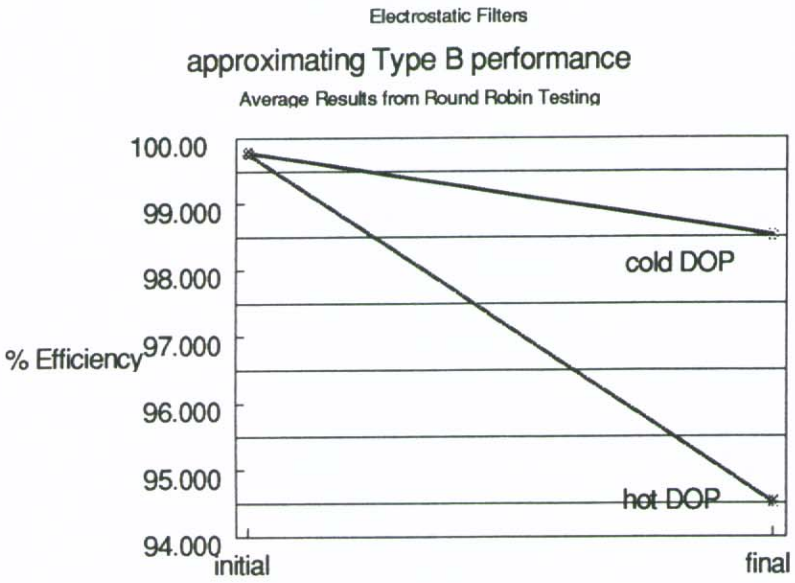
NIOSH has previously stated that their testing has shown no difference in test results (and subsequent filter efficiency ratings) if filters are tested against today's benchmark, thermally generated DOP, or the intended tester, a cold nebulized DOP generator. For mechanical filter media, this is accurate and has been confirmed by industry testing. However, for electrostatic filter media, limited testing has shown considerable disparity in test results and the resulting filter efficiency classifications for particulate filter elements. This disparity appears to be dependent upon the method of aerosol generation, i.e. "hot" or "cold".

ISEA recently conducted a round robin testing program in which five ISEA respirator manufacturers tested approximately 30 controlled samples of filter media from the same production lot against both a cold nebulized and thermally generated DOP challenge aerosol. This was done for both electrostatic filter media and mechanical filter media. The test results for mechanical filter media confirmed that both test methods give similar results (see Table 1). The tests for electrostatic filter media, however, did not produce consistent results (see Table 2). Comparing the "average % max. penetration" for electrostatic filter media from all five test sites showed variations between thermally generated and cold nebulized DOP aerosols. NIOSH testing indicates that DOP decomposes when exposed to heat. ISEA believes that the continuous generation of decomposed material within thermally generated DOP may contribute to the difference or variability between the hot and cold generated test agents.

For the electrostatic filter media approximating the "Type A" efficiency level, the recorded "initial" average percent penetration was nearly identical between the two methods. However, the "final" (i.e., after the 42 CFR 84 proposed DOP load had contacted the filter) average percent penetration was dramatically different depending on the test method used. Final efficiency ratings (for the same media) were

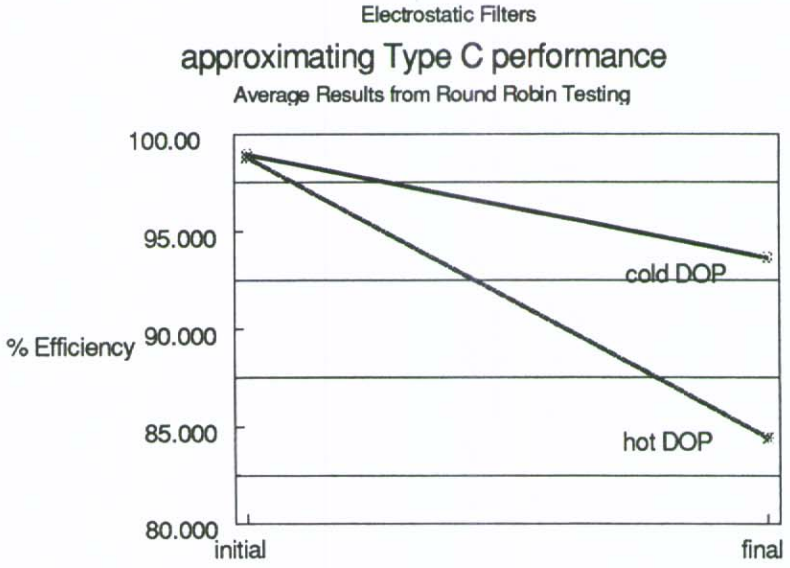


99.89% when tested against cold nebulized DOP and 99.57% when tested against thermally generated DOP.



For the electrostatic filter media approximating the "Type B" efficiency level, the recorded "initial" average percent penetration was also nearly identical. However, the "final" average percent penetration was dramatically different depending on the test method used. Final efficiency ratings (for the same media) were 98.51% when tested against cold nebulized DOP and 94.52% when tested against thermally generated DOP.

For the electrostatic filter media approximating the "Type C" efficiency level, the results were characteristically similar to those of Type A and B. The recorded "initial" average percent penetrations were nearly identical. However, the "final" average percent penetrations were significantly different depending on the test method used. Final efficiency ratings (for the same media) were 93.69% when tested against cold nebulized DOP and 84.43% when tested against thermally generated DOP.



Based on the limited comparative testing which NIOSH has conducted (mechanical filters only), the disparity in test results seen in the ISEA round robin industry test program and the importance of successfully launching this first module, the ISEA strongly urges NIOSH to reevaluate the proposed test

protocol and test equipment, and to take a leadership role in developing a filter penetration test that is consistent, repeatable and ultimately improves worker safety for the next generation of NIOSH-certified respirators.

ISSUE:

The proposed rule requires filter penetration testing to be conducted using a new type of test equipment. Limited testing has shown that consistent and repeatable test results have not been demonstrated with the proposed test equipment.

RECOMMENDATION:

ISEA recommends that prior to publication of a final rule, NIOSH work with the respirator community to conduct further research and develop test parameters that produce consistent and reliable results. There is simply too much that is not known about this test protocol and those factors that influence test outcomes to promulgate this into a final rule, as written.

In conducting further research, NIOSH will reduce the potential for disputes between NIOSH and the many respirator manufacturers, users and researchers within the industrial hygiene community.

RATIONALE:

In limited testing conducted by ISEA members, the following ranges were seen in filter penetration test results using the same filter media at five different test sites, on five different TSI AFT machines.

Approximate Filter Classification	**% Efficiency Range**	
	max	**min**
Type A	99.94	99.78
Type B	99.06	97.94
Type C	95.31	91.50

ISSUE:

The humidity preconditioning requirements of §84.184(c) state that "filters shall be sealed in a gas tight container." However, §84.184(c) does not provide: (1) detail regarding uniform preconditioning, (2) the size of the container; (3) the "allowable time after conditioning" at which filter media must be placed

within the container; or (4) the allowable time for the filter to remain within the container until tested.

RECOMMENDATION:

1) NIOSH should specify a circulation air chamber and a means of filter separation of filtering elements to provide uniform conditioning.

2) The rule should specify a maximum size for the gas-tight container. ISEA recommends that the volume of the container be no more than three times the volume of the products stored.

3) The rule should specify the allowable time after conditioning within which the filter media must be placed in the container. ISEA recommends that the rule require that filters be sealed in the gas-tight container immediately after pre-conditioning.

4) The rule should specify an allowable time for the filter to remain within the container until tested. ISEA recommends that testing be conducted within 24 hours after the filters are sealed in the container.

RATIONALE:

These recommended test parameters would help ensure uniformity in testing among different laboratories and other test facilities. This, in turn, will help NIOSH reduce disparities in test results between the agency and others within the respiratory protection community that conduct these tests. By not specifying these parameters, disputes in penetration test results could occur depending on their interpretation. For example, if conditioned filters were placed in a very large gas tight container (perhaps a freezer sized bin) drying could occur which might influence the penetration test results.

ISSUE:

The proposed rule requires an airflow of 85 lpm for resistance testing as specified in section 84.183 (a) but does not include an allowable airflow tolerance.

RECOMMENDATION:

ISEA recommends that NIOSH include in section 84.183 (a) an allowable airflow tolerance of ±2% for resistance testing.

RATIONALE:

Specifying an allowable airflow tolerance of ±2% would help ensure uniformity in testing among different laboratories and other test facilities. This, in turn, will help NIOSH reduce disparities in test results between the agency and others within the industrial hygiene community that conduct these tests.

ISSUE:

Section 84.183 states that the resistance of a complete respirator mounted on a fixture must be tested at a continuous airflow rate of 85 liters per minute. The initial inhalation resistance of the respirator must not exceed 30 mm H_2O and its initial exhalation resistance must not exceed 20 mm H_2O.

RECOMMENDATION:

Although proposed resistance requirements in 42 CFR 84 are the same as those in 30 CFR 11, the filter efficiency requirements are much more stringent. It is generally accepted that all filter media (particularly mechanical filters) have two competing characteristics: resistance and efficiency. Given the restrictions on filter size and surface area inherent in current facepiece designs, ISEA recommends that NIOSH change the resistance requirements in the proposed rule to 35 mm inhalation resistance and 25 mm exhalation resistance.

RATIONALE:

When filter efficiency goes up, the resistance of the filter will rise as well. The limits for certain chemical cartridge combinations under 30 CFR 11 already allow substantially higher inhalation resistance levels. The suggested changes will grant manufacturers more latitude in respirator design. Higher resistance requirements also make it more feasible for manufacturers to develop respiratory protection equipment without exhalation valves for the medical markets.

Leaving the resistance requirements as proposed might require manufacturers to pleat particulate filters—even Type B and Type C filters—to increase the surface area enough that it lowers a filter's resistance to a level below the requirement. It is unknown whether this is technologically feasible for certain media, but it will increase substantially the raw material and manufacturing costs of respirator production.

ISSUE:

The proposed rule requires that the filter penetration test be stopped when 200 mg of challenge aerosol contacts the filter unit (or 100 mg if testing a single filter of a pair configuration).

RECOMMENDATION:

ISEA recommends that prior to publication of a final rule, NIOSH work with the respirator community to conduct further research and develop a scientifically based aerosol loading level.

ISEA strongly recommends that the filter loading limit(s) be reevaluated as part of the proposed plan to redesign the filter penetration test -- a redesigned test that is consistent, repeatable and ultimately improves worker safety for the next generation of NIOSH-certified respirators.

RATIONALE:

NIOSH has indicated that the 200 mg load limit was based on their experience in testing and that the test could not continue "forever." ISEA presumes that the "experience" NIOSH is referring to is testing conducted on mechanical-type filtering elements where loading does not appreciably change filter penetration performance. However, recent industry testing indicates that filter penetration performance for electrostatic filters can vary greatly depending on factors such as challenge aerosol generation method. Arbitrarily setting the conclusion of the test at 200 mg may be too severe, or not severe enough, depending on NIOSH's intent.

ISSUE:

Section 84.184(h) specifies that a differential mobility particle sizer (DMPS) be used to determine particle size distribution.

RECOMMENDATION:

ISEA recommends that a scanning mobility particle sizer (SMPS) or equivalent be specified.

RATIONALE:

The DMPS is obsolete and no longer available, and has been effectively replaced by the SMPS.

C. Filter Efficiency and Classification

ISSUE:

ISEA agrees that testing filters with the most penetrating aerosol size is the best method of quantifying performance and ISEA supports the penetration efficiency of 99.97% that NIOSH has proposed for Type A filters. However, ISEA questions the penetration efficiencies of 99% and 95% that NIOSH has proposed for Type B and Type C filters.

RECOMMENDATION:

ISEA recommends that the efficiencies of Type B and Type C particulate respirators should be set at 96% and 90%, respectively.

RATIONALE:

NIOSH appears to base its choice of efficiencies for particulate respirators on the perception that current filters fail to meet the needs of health care community. The Type B and C filter penetration limits proposed by ISEA would provide the market with the best range and differentiation of respiratory protection for hazardous atmospheres, including tuberculosis exposures and medium and low toxicity particulate atmospheres.

The 90% penetration, Type C respirator will prevent a void in respiratory protection that would exist if Type C efficiencies were set at an unnecessarily high level. This void would be filled by lower cost, unapproved respirators.

The market needs an inexpensive NIOSH certified respirator for workers exposed to low toxicity particulates such as cement dust, gypsum and cellulose. This respirator should have an assigned protection factor of 10 and a minimum penetration efficiency of 90%. While APFs are based on total inward leakage, a respirator's maximum use concentration is based on a time-weighted average. The proposed NIOSH test method looks for the maximum instantaneous penetration over time and not the average efficiency and uses a narrowly dispersed test aerosol of worst case particle size which does not exist in actual use. As a result, a respirator having a maximum instantaneous filter penetration of 10% will most likely have an APF greater than 10.

Type B penetration was chosen at 96% for two reasons. First, the difference in penetration between Types A and B as proposed is less than 1%, giving virtually no differentiation. Second, a 96% penetration would allow a respirator to have an APF of 25 by the same rationale as given above.

ISSUE:

The proposed rule requires that particulate respirators will be classified as either "solid" (S) or "liquid and solid" (L&S).

RECOMMENDATION:

ISEA recommends that NIOSH redesignate the particulate classifications from "solid (S)" to "solid and water based aerosols" and from "liquid and solid (L&S)" to "solid and liquid aerosols".

RATIONALE:

Solid and water based aerosols perform differently than other liquid aerosols. This classification would be in harmony with the European classifications (EN 143) and are born out in the Danish Study (see attached). This would permit lower cost and lower breathing resistance respirators to be used in protection against 75.6% of the hazards.

D. Powered Air-Purifying Respirators (PAPRs)

ISSUE:

The proposed rule for PAPRs contain inconsistencies in the filter penetration tests and inappropriately includes systems tests in the first module, sections 84.184 and 84.185.

RECOMMENDATION:

ISEA recommends that NIOSH does not include any new tests for PAPRs within the first module of the proposed new rule. ISEA recommends that the tests currently specified under 30 CFR 11 for PAPRs be bought through into 42 CFR 84 to allow for PAPR certification under the new rule during the interim period, pending the introduction of better specified tests.

ISEA recommends that NIOSH add a separate module for PAPRs that will focus specifically on these devices and contain requirements and tests that will adequately assess their performance.

ISEA recommends that the PAPR module be given a high priority and inserted in the NIOSH plan at an early stage to minimize the interim period.

RATIONALE:

Simply applying filter penetration tests for PAPRs within the first module neglects the unique aspects of PAPRs. This is evidenced by the fact that NIOSH is proposing systems tests different than that already in 30 CFR 11. Until all performance requirements of PAPRs are adequately addressed, the existing tests should remain in effect.

The development of innovative PAPRs by manufacturers and their certification by NIOSH have been held back by the nature of 30 CFR 11. This is mainly due to the fact that the current certification requirements force the classification and certification of PAPRs into categories that do not relate to modern powered air technology and design configurations. Both the current PAPR requirements in 30 CFR 11 and the proposed requirements in 42 CFR 84 stifle product innovation and prevent the development of creative PAPR system designs such as lighter weight and variable duration units. The health care community for instance, could greatly benefit from the availability of a 15 or 30 minute duration unit that would require smaller batteries resulting in lighter, more comfortable and less expensive products that could provide a higher level of protection compared to conventional products currently used in the health care setting.

For most types of PAPRs, the airflow, filter efficiency, and respirator inlet covering or facepiece "fit" all interact strongly, and it is not possible to specify or determine any one of these parameters without some knowledge of the other two. The combination of these factors leads to the overall assigned protection factor, the key parameter for the wearer. ISEA recognizes that the discussion of APFs will be covered in the second module of 42 CFR 84. For PAPRs, however, it is not possible to address fully the filter efficiency questions in the first module without also specifying airflow and duration tests, for example. NIOSH has recognized this principle by including new tests in sections 84.184 and 84.145, and by adding PAPR-related amendments to several of the test criteria. Unfortunately, the tests proposed in 42 CFR 84 are not consistent with themselves or with modern powered air designs.

ISEA recognizes that the re-introduction of the 30 CFR 11 tests implies the continuation of the dust/mist/fume type respirator for PAPRs, whereas it is NIOSH's intention to eliminate these types through the introduction of 42 CFR 84. Because of the close correspondence of the proposed new Type A filter and the existing HEPA type filter, and recognizing that the majoity of PAPRs currently in the market are mechanical HEPA type filters, ISEA believes that manufacturers would consider with-holding applications for non-HEPA based PAPR systems until the PAPR module is released.

E. Test Statistics

ISSUE:

Section 84.184 (j) requires maximum filter penetration to be determined and recorded for each of 30 filters. The test statistic U is then calculated to determine whether these filters meet the performance criteria established in the rule. Test statistic U is derived by assuming that the tested samples meet a normal distribution. However, there are many situations in which the sample submitted to NIOSH would not meet this criteria. The result of assuming a normal distribution might disallow filters that meet the intended criteria.

RECOMMENDATION:

ISEA recommends that the proposed rule allow acceptance of filters tested by NIOSH where the penetration values of the filters are no greater than 0.0003 (Type A); 0.04 (Type B); 0.10 (Type C), as an alternative to the statistical method proposed. Manufacturers who request use of an alternate method, such as sorting filters to assure that they meet specific acceptance values, must demonstrate to NIOSH that all filters with penetration levels greater than the acceptable limit will be removed from the production line and will not be shipped. The testing protocol that ensures that filters meet the penetration requirements would have to be submitted and approved by NIOSH as part of the alternate acceptance value program.

RATIONALE:

Many manufacturers sort 100% of filters for penetration testing. Each filter is penetration tested, and those filters that fail the test are discarded. Samples chosen from this truncated distribution would then be subjected to the statistical test of §84.184. This is not a valid way to determine whether the total population of filters tested meets the required performance levels.

Consider the following example. A manufacturer of HEPA filters tests six samples and demonstrates that these mechanical HEPA filters show no rise in penetration with loading. Thus, the manufacturer can test and easily discard filters on its production line, and can demonstrate that all product to be shipped will have a penetration of less than 0.0003. If NIOSH samples the truncated filters, however, the test data NIOSH generates may show an average penetration of less than 0.0002, but have a calculated standard deviation of 0.0001. Using the NIOSH test equation to determine test statistic U (which is less than or equal to the mean penetration plus 2.22 multiplied by the

standard deviation), the value calculated by NIOSH is greater than 0.0003. The result of this artificial calculation—based on the assumption of a normal distribution—disallows filters that in fact meet the intended criteria.

ISSUE:

NIOSH has proposed a K factor of 2.22, which represents a 95% confidence level that 95% of the filters produced will meet or exceed specifications. This K factor is too high.

RECOMMENDATION:

ISEA recommends that, if a statistical method is used, NIOSH use a K factor of 1.778. This K factor is equivalent to what would have been used for 30 samples in the 1987 proposal and represents a 95% confidence level that 90% of filters meet or exceed the requirements.

RATIONALE:

ISEA has determined that the proposed K factor of 2.22 was derived from one-sided tolerance limits for normal distributions. With a sample size of 30 filters, this represents a 95% confidence level that 95% of filters produced meet or exceed specifications. In the 1987 proposal, NIOSH proposed a K factor of 6.158 with a sample size of three filters. This represents a 95% confidence level that 90% of filters would meet or exceed specifications. The equivalent K factor extrapolated to maintain the confidence levels proposed in 1987 and made applicable to a sample size of 30 filters, would be 1.778. ISEA believes that increasing the confidence level to 95/95 is overly burdensome and will significantly increase the costs of particulate filters while the relative protection provided by respirators will not. This unnecessary extra cost burden will fall on the user without a clear benefit.

F. Fit Testing

ISSUE:

In sections 84.181 and 84.182 of the proposed rule, NIOSH requires that all particulate respirators be fit tested.

RECOMMENDATION:

ISEA recommends that fit testing not be conducted as a part of the certification program.

RATIONALE:

ISEA strongly believes that fit testing during the certification process will create a false sense of confidence in the wearer and will discourage fit testing in the field. No certification fit test can ever take the place of performing a fit test on each individual for every respirator they actually wear. This is already an OSHA requirement and should be left in the hands of the user. The market will ensure that users obtain the respirators that fit best because only those respirators will pass the fit test on the greatest percentage of users.

In lieu of fit testing, NIOSH could require the manufacturer to provide conventional fit testing data as a part of the submittal application. The general duty clause, 84.63, would permit NIOSH to assess the efficacy of the fit test data. In addition, NIOSH could require stronger approval label language concerning the fit testing requirements of end users.

ISSUE:

The proposed rule requires that particulate respirators be fit tested with isoamyl acetate, an organic vapor. The proposed rule requires a two-minute isoamyl acetate test for respirators without replaceable filters and a five-minute isoamyl acetate test for respirators with replaceable filters. To perform these tests, a manufacturer would need to replace the particulate filtering element with an activated carbon element to filter the test agent properly.

RECOMMENDATION:

ISEA recommends that fit testing not be conducted as a part of the certification program.

However, if fit testing is included as a part of the certification process, ISEA recommends that NIOSH either adopt the Bitrex qualitative fit test aerosol using the protocol as described in the OSHA lead standard for Saccharin or use a large particle (greater than two microns) quantitative fit test. (see the attached Bitrex test protocol).

In addition, ISEA believes there should be no distinction between disposable and non-disposable respirators since their end use is the same. If NIOSH wishes to make a distinction in the application of the two-minute test versus the five-minute test, then the distinction should be made on the basis of respirator classification. ISEA believes it would be appropriate to require the two-minute test for Type C respirators and the five-minute test for Type A and

Type B respirators. This distinction can be justified by the anticipated use of the Type A and Type B filters.

RATIONALE:

ISEA does not believe it appropriate to require the testing of a particulate respirator with an organic vapor. In many cases, changing the particulate filter to a filter that removes organic vapor would result in the creation of a surrogate respirator with fit characteristics much different from the actual respirators in use. This is particularly true for certain disposable respirators.

G. Assigned Protection Factors

ISSUE:

NIOSH has indicated that prior to release of the scheduled APF module it plans to recommend new assigned protection factors that account for the new nomenclature and new test criteria proposed in 42 CFR 84. These new APFs will be published in a Respirator User's Notice that is to accompany publication of the final rule. This method, however, does not allow for public comment or participation in the development of the new APFs.

RECOMMENDATION:

ISEA recommends that NIOSH call a special Technical Meeting on this issue to allow a discussion of the issues and solicit public input prior to publishing 42 CFR 84 as final. This meeting also should involve officials from both OSHA and MSHA, as their interests are affected by any change in certification standards. ISEA would support and participate in such a meeting and would encourage the participation of organized labor and any other parties with a direct interest in APFs.

ISEA reiterates its position that APFs should only be assigned to classes of respirators (class specific APFs) and not to an individual manufacturers respirator (model specific APFs) and recommends that NIOSH adopt the APF values in the *American National Standard for Respiratory Protection, ANSI Z88.2 - 1992.*

RATIONALE:

APFs play an extremely important role in the development of new technology by manufacturers and in determining the practical applicability of particular respirators at the worksite. Because of this, public comment and participation by both industry and labor is critical. To maximize the acceptance and

workability of these modifications, the proposed "interim" APFs that will appear in the Respirator User's Notice should follow *ANSI Z88.2 - 1992* until a future APF module is developed.

X. Conclusion

ISEA supports NIOSH's proposal to upgrade its certification requirements for particulate filter respirators. ISEA also supports the modular approach that NIOSH is taking with this rulemaking as a novel and effective method of modernizing a complex and important worker safety standard.

ISEA urges NIOSH to work with OSHA, MSHA, EPA, other agencies, end users and manufacturers to develop a document that will explain to users the proper applications for the various new respirator categories. This will make for a smooth transition to the new 42 CFR 84 requirements and will avoid some of the confusion inherent in the process of creating a new standard. Efforts at international harmonization will make acceptance and understanding of the agency's new rule easier in the global safety product market.

ISEA has suggested some specific areas that association members believe could be improved, including: external cooperation, grandfathering provisions, testing parameters, filter efficiency, test statistics, fit testing and assigned protection factors. ISEA also recommends that a separate module be scheduled for powered air-purifying respirators and all PAPR requirements be deleted from the proposed rule.

Overall, ISEA members encourage the agency to make the recommended modifications, publish this rule as final and begin to develop the remaining modules of this important NIOSH standard.

TABLE 1.

MECHANICAL FILTER TESTING

Test Summary

Type A Filter Media

ID	Test Site	AFT	Q-127
A1	1	0.012	0.009
A1	2	0.009	0.013
A1	3	0.018	0.016
A1	4	0.014	0.016
A1	5	0.013	0.008
A2	1	0.010	0.007
A2	2	0.010	0.016
A2	3	0.017	0.013
A2	4	0.014	0.017
A2	5	0.013	0.003
A3	1	0.012	0.006
A3	2	0.012	0.013
A3	3	0.018	0.017
A3	4	0.014	0.013
A3	5	0.014	0.007
A4	1	0.012	0.005
A4	2	0.010	0.017
A4	3	0.017	0.015
A4	4	0.012	0.015
A4	5	0.013	0.004
A5	1	0.011	0.007
A5	2	0.010	0.016
A5	3	0.016	0.016
A5	4	0.013	0.010
A5	5	0.013	0.004
	average	0.013	0.011

Type B Filter Media

ID	Test Site	AFT	Q-127
B1	1	0.386	0.280
B1	2	0.353	0.382
B1	3	0.524	0.480
B1	4	0.486	0.480
B1	5	0.431	0.350
B2	1	0.405	0.290
B2	2	0.380	0.410
B2	3	0.539	0.550
B2	4	0.448	0.530
B2	5	0.408	0.320
B3	1	0.389	0.280
B3	2	0.441	0.411
B3	3	0.521	0.550
B3	4	0.454	0.530
B3	5	0.426	0.410
B4	1	0.370	0.280
B4	2	0.402	0.447
B4	3	0.520	0.530
B4	4	0.469	0.390
B4	5	0.427	0.310
B5	1	0.367	0.320
B5	2	0.381	0.422
B5	3	0.516	0.510
B5	4	0.470	0.350
B5	5	0.414	0.290
	average	0.437	0.404

Type C Filter Media

ID	Test Site	AFT	Q-127
C1	1	2.270	2.300
C1	2	2.430	2.550
C1	3	2.870	3.200
C1	4	2.700	3.000
C1	5	2.500	2.000
C2	1	2.300	2.200
C2	2	2.450	2.430
C2	3	2.840	2.900
C2	4	2.590	2.700
C2	5	2.570	2.400
C3	1	2.350	2.100
C3	2	2.410	2.400
C3	3	2.850	3.000
C3	4	2.480	2.200
C3	5	2.330	2.200
C4	1	2.340	2.050
C4	2	2.340	2.430
C4	3	2.900	2.800
C4	4	2.580	2.500
C4	5	2.440	2.700
C5	1	2.340	1.950
C5	2	2.410	2.510
C5	3	2.890	2.800
C5	4	2.530	2.400
C5	5	2.460	2.100
	average	2.527	2.473

TABLE 2.
ISEA ROUND ROBIN TESTING RESULTS

Type A Filter Media

TSI (AFT)	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 ** (Survivair)					% pen. avg.
	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	
initial pen.	0.015	0.016	0.014	0.011	0.013	0.015	0.012	0.013	0.009	0.012	0.026	0.027	0.019	0.036	0.037	0.009	0.012	0.008	0.008	0.010	*0.587*	*0.424*	*0.454*	*0.362*	*0.254*	0.016 initial pen.
max penetr.	0.099	0.122	0.103	0.084	0.096	0.108	0.118	0.106	0.061	0.088	0.161	0.143	0.112	0.220	0.213	0.072	0.111	0.075	0.074	0.095	*1.270*	*1.000*	*1.050*	*0.904*	*0.714*	0.113 max penetr.

Q-127	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 (Survivair)					
	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	
initial pen.	0.002	0.003	0.001	0.002	0.001	0.024	0.023	0.017	0.017	0.021			0.016	0.017	0.020	0.027	0.025	0.019	0.008	0.021	0.001	0.001	0.001	0.001	0.002	0.012 initial pen.
max penetr.	0.105	0.098	0.038	0.033	0.035	0.983	0.795	0.695	0.786	0.911			0.490	0.480	0.400	0.720	0.750	0.570	0.330	0.740	0.260	0.150	0.170	0.094	0.160	0.426 max penetr.

Type B Filter Media

TSI (AFT)	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 ** (Survivair)					avg.
	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	
initial pen.	0.194	0.129	0.148	0.214	0.195	0.301	0.223	0.144	0.165	0.169	0.242	0.320	0.348	0.514	0.345	0.207	0.169	0.138	0.154	0.150	*1.460*	*1.330*	*1.350*	*1.550*	*2.000*	0.223 initial pen.
max penetr.	1.270	0.966	1.170	1.670	1.810	2.060	1.820	0.943	1.070	1.270	1.380	1.680	1.780	1.840	1.830	1.920	1.290	1.080	1.320	1.670	*4.080*	*3.910*	*4.180*	*4.600*	*5.630*	1.492 max penetr.

Q-127	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 (Survivair)					
	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	B1	B2	B3	B4	B5	
initial pen.	0.052	0.091	0.066	0.064	0.044	0.215	0.299	0.249	0.329	0.263	0.380	0.460	0.430	0.450	0.370	0.290	0.380	0.510	0.200	0.330	0.120	0.080	0.110	0.100	0.170	0.242 initial pen.
max penetr.	1.950	2.950	2.350	2.300	1.500	6.310	7.260	7.730	9.340	8.080	5.900	6.900	7.300	6.600	6.800	6.100	7.900	7.900	4.900	6.400	3.600	3.200	4.700	3.800	5.300	5.483 max penetr.

Type C Filter Media

TSI (AFT)	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 ** (Survivair)					avg.
	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	
initial pen.	0.78	0.99	0.85	0.95	1.00	0.82	0.98	0.70	1.00	0.97	1.41	1.63	1.71	1.17	1.10	0.95	1.26	0.80	1.05	0.90	*4.97*	*4.55*	*4.93*	*5.68*	*6.34*	1.051 initial pen.
max penetr.	4.69	5.78	5.57	6.53	6.43	5.18	6.30	5.48	6.47	5.35	6.39	7.26	7.57	5.77	5.83	7.98	8.50	5.80	6.30	6.99	*14.30*	*12.50*	*13.10*	*13.80*	*15.70*	6.309 max penetr.

Q-127	Test Site 1 (Moldex)					Test Site 2 (3M)					Test Site 3 (North)					Test Site 4 (MSA)					Test Site 5 (Survivair)					
	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	C1	C2	C3	C4	C5	
initial pen.	0.53	0.65	0.45	0.53	0.48	1.37	1.48	1.42	1.45		2.40	2.20	1.60	1.40	1.90	1.50	1.50	0.80	1.10		0.83	0.80	0.74	1.10	1.10	1.19 initial pen.
max penetr.	10.20	13.00	8.40	9.90	9.80	22.50	21.90	21.20	23.10		19.00	18.50	16.00	16.00	17.50	14.00	19.00	11.00	16.00		12.00	14.00	12.00	15.00	18.00	15.57 max penetr.

** Test Site 5 reported that filter preconditioning was at relative humidities much higher than that called for in 42CFR84. It is believed that this increase caused dramatically higher initial penetrations and final penetrations. Therefore, those values in italics were not used in the "average % penetration" calculation.

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AEROSOL EXPOSURE IN THE WORKING ENVIRONMENT

Erik Balieu
and
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December 30, 1986

P R E F A C E

The present project entitled "Aerosol Exposure in the Working Environment" was conducted at the Danish Toxicology Centre during the months of July through December, 1986.

The results obtained, as presented here, are based on published literature (periodicals, monographs and other reports), Danish data bank information and interviews with the Danish Health Service Centres. We found it necessary to use all three types of sources of information in order to obtain a sufficiently broad but also detailed picture of which aerosols workers are exposed to in their working environments.

In order to make an attemt of quantification of the exposure to aerosols, the above-mentioned information was combined with statistical information on the employment in the different branches in the Danish manufacturing industry.

The amount of information generated in the project is overwhelming, and from the basic facts presented numerous new results can be calculated. It should i.a. be possible to combine the lists presented on the occurence of the different aerosols in the different branches with statistical information on the employment in the same branches in other industrialized countries.

However, we are of the opinion that the relative importance of the solid aerosols as compared to the liquid aerosols will be approximately the same in all modern industrialized countries of the western world.

The present report should initially be read in its entirety so that the reader can be familiarized with the stepwise methods (and procedures) we have developed in order to get to the final picture and assessment of the aerosol hazards in the working environment. Thereafter, the report can be used as a manual or as a basis for further assessments.

The authors want to express their gratitude to Mrs. Birthe Arp Hansen, the National Labour Inspection, for fruitful discussions at the early stages of the investigation, and Mr. Ole Bruun, also from the National Labour Inspection, for many good advices and fruitful discussions at all stages of the investigation.

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CHAPTER 1

INTRODUCTION

1.1 General Remarks and Scope of the Investigation

Numerous materials of different origin and with different properties are being processed or otherwise used in our modern industrialized society, and it is a well established fact that some of these materials are more or less dangerous to health. As human exposure to many of the substances is an unavoidable complication, strong efforts shall be made to minimize such an exposure. Preventive measures are being taken of either administrative and legislative nature or technical solutions are introduced. The more efficient way to deal with the problems is generally to use a combination of these principles.

However, one essential prerequisite of successful implementation of countermeasures is that the range and magnitude of exposure to the dangerous substances is known. Other prerequisites are an indepth knowledge of the properties of the substances with regard to e.g. chemistry and toxicology and knowledge of the possible technical solutions, including their advantages and limitations.

The scope of the present investigation is to make an assessment of the nature of aerosol exposure (air pollutants in a particulate state) in the working environment i.e. to try answering the following important questions:

1) Which aerosols, liquid and solid, are found in the different branches of trade and industry, and in related activities?

2) Which work processes give rise to the formation of solid and/or liquid aerosols?

3) How many people are exposed to solid aerosols, and how many to pure liquid aerosols or liquid aerosols in combination with gases and vapours?

The results of the present investigation are based on statistical information on the number of employees in the different branches of trade and industry and related areas combined with information on the more important working processes and operations used in the brances and the types of air pollutants found, as described in literature and in other sources.

1.2 Classification of Air Pollutants

Depending on their physico-chemical properties, air pollutants exist in the solid, liquid or gaseous state. Solid and liquid substances can be dispersed in air as particles forming grit, dust, smoke, fume, mist or fog, all of which are heterogeneous systems which can be classified in common as aerosols. Gaseous substances, instead of being dispersed, are dissolved in the air, thus forming solutions of the gases or vapours in the atmosphere.

Table 1

Classification of air pollutants.

State of pollutants	Examples	Classification
Gaseous	Gases, vapours from liquids and solids	Gases
Liquid	Smoke, mist, fog	Aerosols
Solid	Grit, dust, fume, smoke	

1.3 Definition of "Aerosols"

In the present context the term "aerosol" is used to describe any particle, solid or liquid, which is suspended in air. The sizes of the particles as described by their diameter may be in the range from 1000 µ - 0.001 µ depending on which materials they consist of as well as the type of process by which they were formed.

Solid particles may either be pure chemical substances or mixtures of them. Liquid particles can be pure liquid chemical substances, solutions or suspensions.

The particles in aerosols interact with each other as well as with their surroundings. These interactions greatly influence the stability of aerosol systems and give rise to phenomena as coagulation, sedimentation and vapourization. The major forces playing a role in these processes are inertia, gravity, electrostatic attraction and repulsion, and Brownian diffusion, their relative importance being dependent on the size and mass of the particles, electrostatic charges, velocity of the particles, temperature and pressure.

1.4 Basic Mechanisms for the Formation of Air Pollutants in the Working Environment

Air pollutants are formed in the working environment as by-products when materials are subjected to e.g. mechanical forces or heat. Some materials are easily broken down or evaporated, while others need a substantial raise in temperature in order to be evaporated, or strong mechanical impacts to be disintegrated and dispersed. The initial formation of air pollutants during e.g. various processes at elevated temperatures can be referred to as primary processes. Once liberated to the surrounding atmosphere by a primary process the air pollutants in some cases can undergo secondary processes, and they are said to be more or less unstable.

As an example of the formation of an aerosol by a primary process, the spray painting aerosol can be mentioned. By this process small droplets are formed initially by the spray nozzle, but then in a successive step evaporation of solvent from the droplets takes place as a secondary process.

In some extreme cases the secondary processes are very closely linked to the primary formation process (ultra short time). This is the case e.g. when metal vapours are formed at the very high temperatures used during welding. The vapours formed initially condense immediately in a secondary process forming particles of the metals or oxidation products thereof. In such cases it is common practice to consider the formation as only one primary process giving rise to a solid aerosol (welding smoke), and the gases generally referred to in connection with the welding processes are of other origin e.g. nitrogen oxides formed from the atmospheric oxygen and nitrogen or carbonmonoxide formed from the use of carbon dioxide as a shielding gas.

Basically aerosols can be generated either by evaporation of materials and subsequent condensation or by dispersion of materials. These basic principles are used in the laboratory in the different aerosol generators when aerosols are to be studied. It is exactly the same mechanisms which in the industrial environment gives rise to the formation of aerosols as dust, smoke, fume, etc.

Formation of aerosols by evaporation and subsequent condensation can be expected in work processes involving elevated temperatures, if the materials can be evaporated.

Formation of aerosols by disintegration and dispersion can be expected in those work processes where mechanical forces are used e.g. cutting, grinding, turning, spraying, etc.

The formation of air pollutants in the working environment, specially aerosols, is in some cases the result of rather simple processes and in other cases of complex processes. Furthermore, in some cases rather stable aerosols are formed e.g. grinding dust, whereas in other cases more or less unstable aerosols are formed which can undergo further transformations. As an example the spray painting aerosol has already been mentioned. Further examples are given in Figure 1.

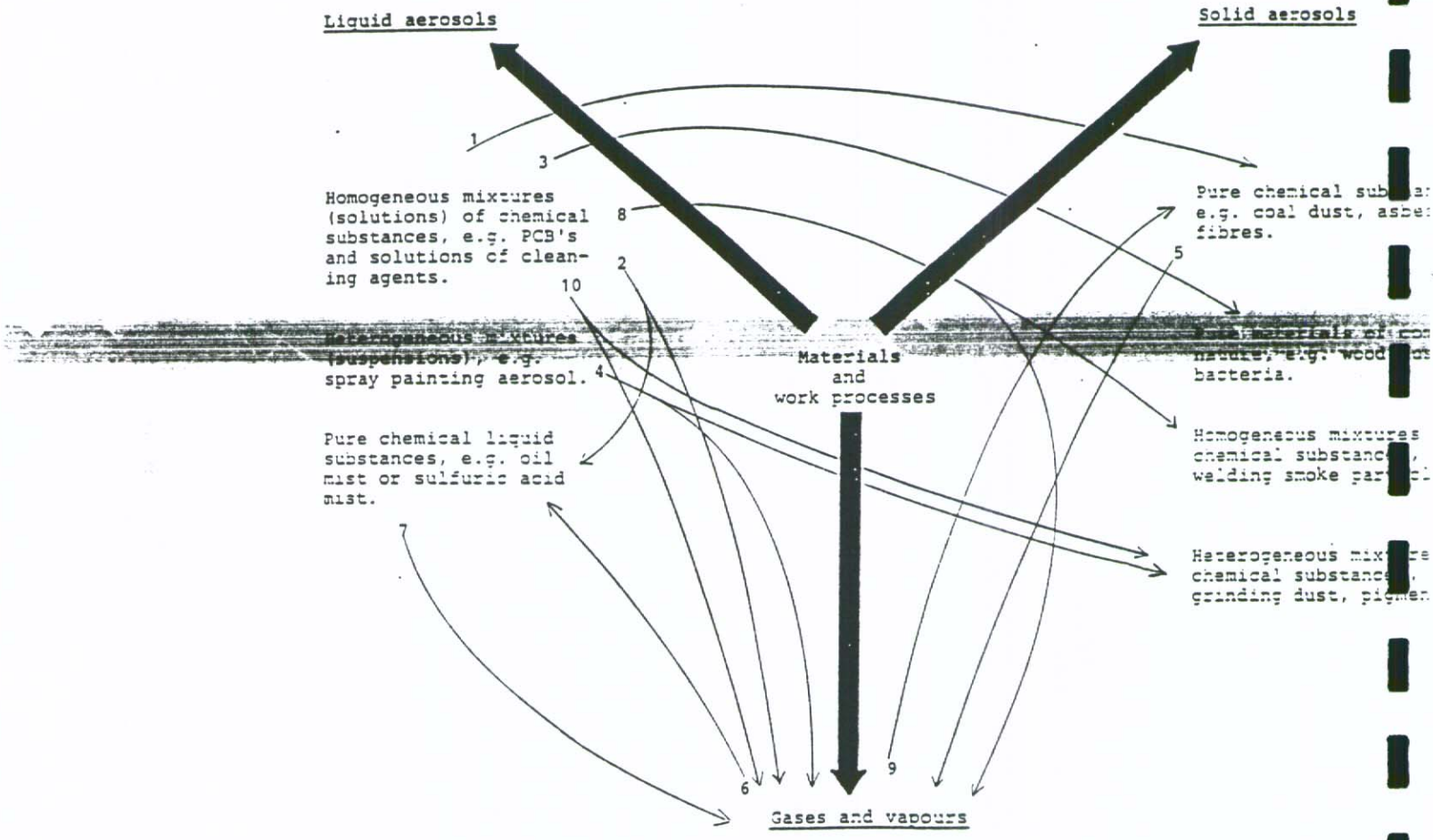

Figure 1. Examples on formation and conversion of aerosols.

1) Aqueous solution of cleaning agent e.g. phosphoric acid or oxalic acid. 2) Aqueous solution of cleaning agent e.g. triethanolamine. Furniture polish spray. 3) Bacteria suspended in water droplets. 4) Spray painting aerosol based on either water or organic solvents containing insoluble pigments. 5) Hydroquinone. Chloroacetophenone tear gas. 6) Polyaromatic hydrocarbons and oil vapours. 7) Ethylene glycol aerosol. 8) Polychlorinated biphenyls in solution. 9) Arsenic oxides. 10) Aqueous solution of sodium hydroxide partially converted to hydrogen carbonate.

1.5 Use of Respirators for Protection against Aerosols

When all other technical measures fail, respirators must be used in the working environment to protect people against inhalation hazards.

The air pollutants in the working environment exist either as gases or as particulates (aerosols). In a limited number of cases the same substances exist both as vapours and as particles.

In some cases only aerosols exist consisting of either solid or liquid particles, whereas in other cases only gases or vapours exist. In a number of cases aerosols of one chemical exist together with vapours of other chemicals, thus forming a complex mixture. Whatever situation is found in practice, it is essential for the selection of proper respiratory protective devices of the filtering type to establish whether the air pollutants are present as particles or as gases (vapours).

Where aerosols alone are present in the working environment suitable particle filters can be chosen, but when aerosols exist in combination with gases or vapours, socalled combined filters must be chosen. The particles of some aerosols are solid (e.g. dust) whereas other aerosols consist of liquid particles (e.g. mist) depending on the physical and chemical properties of the materials forming the particles.

Particle filters behave in different ways when filtering solid particles and when filtering liquid particles. For glass fibre filters e.g. the general tendency is that the filtration efficiency for solid particles increases with loading, whereas for liquid particles the filtration efficiency decreases with loading.

Consequently, it is essential for the selection of filters to have rather detailed information on the nature and properties of the air pollutants, incl. information on whether particles are solid or liquid, and whether gases and vapours are present too.

Generally, filters of high efficiency against liquid particles are more expensive than filters with a correspondingly high efficiency against solid particles. Consequently, it seems reasonable to have two separate classes of filters, one intended for use against solid aerosols only, and one for use against solid and liquid aerosols.

Another important difference between the filter types is that filters having a high filtration efficiency against solid and liquid aerosols generally have higher air flow resistance than filters having high efficiencies only against solid aerosols. This is of importance from a user's point of view. A respirator with a small breathing resistance is more comfortable to wear than one with a higher resistance.

This fact also supports the idea of having two classes of aerosol filters, one for protection against only solid aerosols, and one for protection against both solid and liquid aerosols.

Furthermore, such a classification seems justified not least if the majority of aerosols found in the working environment are solid aerosols. In the many cases where liquid aerosols are present (e.g. spray painting work) vapours are present additionally, and combined filters or even air supplied equipment will be needed to obtain proper respiratory protection.

1.6 How to quantify Exposure in the Working Environment

The very simple question: "How many people are exposed to aerosols in the working environment?" cannot be answered in a simple way. In order to make an assessment of the magnitude and importance of exposure in the working environment to specific substances one should consider what exposure is. In inhalation toxicology studies it is common practice to quantify exposure as the product of the concentration (c) of a certain substance and the time (t) during which the substance is inhaled. Following this concept in an assessment of aerosol exposure in the working environment one should consider the number and duration of situations in which one specific person is exposed to a specific aerosol in a certain period of time e.g. each day, each week or perhaps each year. In some work situations, e.g. the spraying of crops in agriculture, a realistic time span to consider would be a year (seasonal work).

This type of detailed analysis is almost impossible to perform for the entire industry, because it will require an indepth knowledge of the work routines etc. in each individual factory and workshop, and the work routines may differ substantially from factory to factory. However, it can be made in a limited number of cases, where individual factories or workshops are thoroughly analyzed.

Another problem which is difficult to overcome, except in analysis of individual workplaces in individual factories, is the assessment of exposure to more than one substance. In the majority of factories and workshops it is not unusual that several different substances will be present as air pollutants, and they will be present more or less simultanously.

This rises the question whether all people employed in the factory will be exposed to all the different substances or only to some of them. One can imagine a situation where one group of employees is exposed to one specific aerosol while another group of employees is exposed to another aerosol. Alternatively, both groups may be exposed to both aerosols. The situation is extremely complex in case more than two substances are present, and only in an indeed very limited number of investigations published in literature a more detailed picture of the actual exposure has been given.

In an extensive investigation like the present one, it therefore is impossible to quantify exposure following the above-mentioned principles, and the reason for this is that the information available in literature, data banks, etc. is not sufficiently detailed. Consequently, we decided to try to give an estimate of the exposure to solid and liquid aerosols following another principle as described in the following.

1.7 Exposure Indices

The method implies the use of socalled "exposure indices" for the individual branches and the individual aerosols. The exposure index of a certain aerosol X in a certain branch Y is the number of workers employed in branch Y where aerosol X has been found to be present. The exposure index of the aerosol X in all branches (1---Y) is the total number of workers in all branches where aerosol X is present. By classifying the aerosols in solid aerosols and liquid aerosols, and classifying e.g. water based aerosols separately, the exposure indices for the individual branches has been summed up to give an estimate of the number of workers exposed to the classes of aerosols chosen.

The following examples can be given:

Example 1

Tobacco dust is a solid aerosol. It has been reported present in the working environment during tobacco manufacturing. According to statistical information the number of people employed in the Danish tobacco industry in 1984 were 2146. Among these, 1638 were wage earners (workers). The exposure index of tobacco dust in the branch of tobacco manufacturing consequently is 1638.

As tobacco dust has not been reported present in other branches, the exposure index of tobacco dust in all branches is also 1638 (the exposure indices for all other branches are zero).

Example 2

Epoxy dust is another solid aerosol which has been reported present in the furniture industry, in certain branches of the fabricated metal industry and in other manufacturing industry.

If the number of workers employed in each of these branches are as follows:

Furniture industry	11361
Metal furniture industry	2876
Metal furniture industry other	642
Industrial paintshops	1262
Manufacture of agricultural machinery	4513
Other manufacturing industry	1273

Total No. of people (total exposure index)	21928

The exposure index for epoxy dust in each of the above-mentioned branches is the number of people employed in the particular branches, and the total exposure index for epoxy dust in all the branches is the total number of people employed in all the branches.

By performing this type of analysis for all the different types of aerosols in all branches and grouping the aerosols in solid and liquid aerosols, incl. water based aerosols, it is possible to calculate a total exposure index for solid aerosols and a total exposure index for liquid and water based aerosols.

The exposure indices as calculated according to the above principles will not give the true number of exposure situations or exposed people, because it does not take into account whether one group of people is exposed to one aerosol and another group of people is exposed to another aerosol or both groups are exposed to both aerosols in the branch. The use of exposure indices as outlined in the above examples implies that all people in each of the branches are potentially exposed to all types of aerosols found to be present in the branch where they are employed. The exposure index therefore is related to the probability of exposure to certain aerosols in certain branches. However, the exposure indices will give a picture of the relative importance of the hazards created by certain aerosols or classes of aerosols in the branches of trade and industry and at related activities.

Taking the above-mentioned examples, the exposure indices for tobacco dust and epoxy dust can be compared by dividing them, and the resulting figure indicates that for each individual potentially exposed to tobacco dust there will be thirteen other individuals who are potentially exposed to epoxy dust.

C H A P T E R 2

STATISTICAL INFORMATION ON TRADE AND INDUSTRY AND RELATED ACTIVITIES

2.1 The International Classification System

In statistical work it is common practice to classify industrial and economic activities in certain groups, and the more commonly used system is the socalled ISIC-system (International Standard for Industrial Classification) as published by the United Nations (reference 1, this Chapter). The ISIC-system divides the different industrial and economic activities in Major Divisions, Divisions, Major Groups and Groups or Categories, and each of these are assigned one-, two-, three-, or four digit numbers for identification purposes. One major division is e.g. mining and quarrying which is made up of the four divisions: Coal mining, Crude petroleum and Natural gas production, Metal ore mining and Other mining. Among these Metal ore mining is further divided into the groups Iron ore mining and Non-ferrous metal ore mining.

A total of ten major divisions is described in the ISIC-system, and they are further subdivided in order to facilitate processing of statistical information e.g. on the number of people employed in different industries.

The entire classification according to ISIC is given together with further explanations in reference 1. The major divisions are shown in Table 2.1. The more detailed classification is given in Annex 1.

The use of the ISIC-system enables one to compare statistical information on an international level i.e. between countries in those industrialized parts of the world where the system has been adopted.

Table 2.1. Major Divisions of Industrial and Economic Activities

Major Division	
1	Agriculture, hunting, forestry and fishing
2	Mining and quarrying
3	Manufacturing
4	Electricity, gas and water
5	Construction
6	Wholesale and retail trade and restaurants and hotels
7	Transport, storage and communication
8	Financing, insurance, real estate and business services
9	Community, social and personal services
0	Activities not adequately defined

In the present project the ISIC-system has been used for linking together working processes and established or presumed exposure to aerosols with the different groups or categories of trade and industry in order to get information on the magnitude of aerosol exposure in industry and related areas with special emphasis to potential exposure to solid aerosols vs. liquid aerosols.

In the present report the term branch will be used at random referring to the terms major division, division, major group or group. As can be seen from the classifications listed in Annex 1, some of the major divisions are extensively divided in subsections (specially Major division 3, Manufacturing) whereas other major divisions are more broadly defined, e.g. Major division 5, Construction, which is not at all subdivided.

2.2 The Danish Classification System

The Danish statistical classification system is based on the international ISIC-system. It is however more detailed, as further subdivisions have been added to the groups. These subdivisions are characterized by a fifth digit added to the international 4-digit code of ISIC. The Danish classification system is described in reference 2.

2.3 Statistical Information on the Manufacturing Employment in Denmark

Extensive information on the employment in Denmark in the major divisions 2 and 3 (mining and quarrying, and manufacturing) has been published (reference 3).

According to the Danish statistical information the number of workers (wage earners) constitute from 56 to 80 per cent of the total staff employed depending on branch. The lower figure refers to the chemical industry and the higher figure refers to e.g. the wood industry and the textile industry. These different figures presumably reflect the different technological levels acquired by the branches respectively. However, as a mean value 70 per cent of the total staff employed in the Danish manufacturing industry (ISIC-codes 31-39) plus mining and quarrying (ISIC-code 29) are workers, and it seems reasonable to anticipate that this figure will be valid for the major industrialized countries of Europe.

A survey is given in Table 2.2. A more detailed survey is given in Danish in Annex 2 (reference 3).

Table 2.2. Danish Employment in Mining and Quarrying and Manufacturing, 1984

ISIC-code	Branch	Total employment	No. of wage earners	Wage earners per cent of
29	Mining & quarrying	1127	821	72.8
30	Manufacturing industry	379477	267065	70.3
31	Food, beverage and tobacco	75331	58498	77.6
32	Textile, wearing apparel and leather	29512	23321	79.0
33	Manufacture of wood and wood products, incl. furniture	23989	19161	79.9
34	Manufacture of paper and paper products. Printing and publishing	33507	20760	61.9
35	Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products	37247	20841	56.0
36	Manufacture of non-metallic mineral products, except products of petroleum and coal	17678	12907	73.0
37	Basic metal industries	6053	4659	77.0
38	Manufacture of fabricated metal products, machinery and equipment	150524	103079	68.5
39	Other manufacturing industries	5636	3839	68.1

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CHAPTER 3

SOURCES OF INFORMATION IN THE PRESENT INVESTIGATION

3.1 Major Types of Sources of Information

The essential information in the present investigation is information on the different types of aerosols found to be present in the branches or which are presumed to be present in the branches and information on the employment in the different branches of trade and industry and at related activities.

The information available on employment in the different branches has been discussed more detailed in Chapter 2 together with the classification of the branches in Denmark and at international level, and will not be further discussed here.

Information on the occurrence of aerosols in the different branches stems from the following three major types of sources:

1. Literature
2. Data bank information
3. Questionnaires

The information was collected during July-November, 1986. The final choice of sources was made after a preliminary screening was carried out in June, 1986.

3.2 Literature Sources. Periodicals

The results of analysis of the working environment are published in a variety of scientific papers in periodicals, monographs, books, research reports, etc. which are related to disciplines such as chemistry, medicine, biology, aerosol physics, etc.

Table 3.1. Periodicals included in the Investigation

Title of periodical	Origin	Language
American Industrial Hygiene Association Journal x)	US	English
American Journal of Industrial Medicine	US	English
Annals of Occupational Hygiene x)	UK	English
Archives des Maladies Professionelles de Médicine du Travail et de Sécurité Sociale	F	French
British Journal of Industrial Medicine	UK	English
Pas På (now Arbejdsmiljø)	DK	Danish
Prévention et Sécurité du Travail	F	French
Scandinavian Journal of Work, Environment and Health	DK, SF, N, S	English
Staub Reinhalt. Luft	D	German
Travail et Sécurité	F	French

x) Screened back to 1975.

Ten periodicals were chosen after the preliminary screening process. The ten periodicals are shown in Table 3.1. They were generally screened for information published during 1981-1985. The three more important ones were screened for information back to 1975. The periodicals represent to the best of our knowledge the most important sources for information on topics as industrial hygiene, industrial medicine, occupational health, accident prevention, etc. in the modern industrialized countries.

3.3 Literature Sources. Monographs and Reports

In Denmark the Working environment Fund has been established under the Working Environment Act of 1977. This fund is sponsoring research and investigation within the field of the working environment in Denmark. Most of the results are published in monographs and reports in Danish, giving results of investigations carried out in specific branches of trade and industry and related areas or on specific harmful substances found in the working environment, e.g. cobalt. Some of the reports give detailed information on exposure, chemical composition and particle size of aerosols found as air pollutants in the working environment. Other reports are based on the author's interpretation of different aspects of environmental health in certain industries combined with interviews with the workers.

3.4 Data Bank Information

The Danish Labour Inspection (The Danish Health and Safety Executive) has filed workplace measurements in its own data bank "ATABAS" since January 1, 1983. ATABAS is situated at the National Institute of Occupational Health. The information stored is the result of workplace measurements carried out in Denmark in all branches of trade and industry and related areas. The measurements were taken either because it was recognized that specific problems existed in the working environment (exposures exceeding current TLVS) or as a control of

preventive measures which had been introduced earlier because problems had existed. Table 3.2 gives the number of investigations carried out and analytical results stored in ATABAS. The data bank lists all the chemical substances identified in the workplace measurements and relates them to industrial branches, work processes and products. The entry codes are ISIC-number (see Chapter 2), work processes (special code) and CAS-numbers. The CAS-numbers are international code numbers used for identification of chemical substances. An example on the outprints from ATABAS is shown in Annex 2.

At an early stage of the present investigation other data bases were considered, primarily at DIMDI in Germany and CIS (ILO, Switzerland). However, trial runs on these either gave very little information of importance for the present study or only information which was already obtained from literature.

3.5 Questionnaires

The Health Service in Denmark is a nationwide network of health centres (BST-centres in Danish) which deals with all aspects of health and safety in the working environment. They promote health and safety e.g. by assisting undertakings all over the country in measuring physical and chemical hazards, and they give recommendations regarding technical installations and other matters of importance. At present they do not cover all branches.

A detailed survey of the branches covered by the Health Service is given in Annex 3.

The staff of the Health Service includes chemical engineers, physicians, technicians, nurses, physiotherapists, etc. They are all in very close contact with the undertakings in their local communities.

Table 3.2.

Number of Investigations and Analytical Results registered in ATABAS

	1983	1984	1985
Investigations	1892	1833	1659
Analytical results	13284	13078	11955

Of prime importance is that the centres have a thorough knowledge on the working environment at local level. The centres were asked to fill in questionnaires (example in Annex 4). More specific, they were asked to give information on the occurrence of aerosols in the working environment according to measurements carried out by the centres or according to their general experience obtained during their visits to the undertakings. More detailed, they were asked where aerosols occur, which substances they consist of and from which work processes they originate. A further important question was whether gases or vapours are present additionally. They were also asked to classify the aerosols in either of the three groups: Solid aerosols, liquid aerosols and water based aerosols.

For further details regarding the questionnaires Annex 4 should be consulted.

In order to ensure that the questions were correctly understood the questionnaires were sent to 4 selected Health Service Centres with a request for comments, and minor changes based on these comments were introduced before the final distribution of the questionnaires.

3.6 Practical Difficulties in the Interpretation of Information from the Different Sources

In the present investigation the major question to be answered is whether a substance is present in the working environment as an aerosol or as a gas (vapour). In many papers published, e.g. epidemiological studies, the authors have been more concerned with giving descriptions of the harmful effects of the substances to the major target organs, e.g. the liver of the exposed people. The physical state and the chemical composition of the air pollutants found in a certain industrial environment is not in all cases unambiguously described, and in such cases it is difficult to make a clear judgement as to whether the substances exist as aerosols or gases (or even in both states).

If the working process is more or less described, this will give a valuable indication of the nature of the air pollutants formed. Also indirect conclusions can be drawn if the chemical substance is identified and is generally known to be of low volatility. Another method is to look at the sampling methods used, if they are described, or the use of specific instrument types in the analysis. It is logical to assume that when filters are used during sampling, the substances identified have been present at least partly as particles, whereas when e.g. charcoal tubes have been used for sampling, the substances identified have been present as gases or vapours.

In a number of workplace investigations no direct sampling methods (e.g. filters or cascade impactors) have been used. Instead biological monitoring were used. This method implies that samples of blood or urine are taken from the people exposed. In such cases it may be difficult to decide whether the harmful substances were present as aerosols or gases and vapours.

The difficulties in interpretation of the published information are also met in evaluation of some of the data from ATABAS. The substances listed in ATABAS are listed by name and CAS-number, and it is obvious that e.g. cadmium and its inorganic compounds will be present as dust, as any chemist would know. Less straight forward is the answer in the case of α-pinen which is an organic solvent of relatively low volatility, and a molecular weight of 136 ($C_{10}H_{16}$). In this and similar cases it has been necessary to check with the National Institute of Occupational Health which sampling method they actually used when taking their measurements. In the case of α-pinen a filter method was used, and consequently it could be established to be present as an aerosol.

As referred to previously, it has also been important in the present investigation to obtain information on whether gases or vapours are present in addition to the aerosols, either because the aerosols themselves are sufficiently volatile or because other substances of high volatility are being used in the same work process or at another work process in the neighbourhood. This type of information is frequently given in the papers published in the periodicals, in monographs and reports and in the questionnaires from the Health Service Centres. However, it is not given in the outprints from ATABAS and can only be obtained by going back in the files and going through the original reports which form the basis for the ATABAS registration. At present, at least 6000 original reports are filed.

It is obvious that this will be extremely time consuming and therefore has not been possible within the frames of this investigation.

CHAPTER 4

AEROSOLS REPORTED PRESENT IN THE WORKING ENVIRONMENT

4.1 General Survey

The result of the systematic screening of the sources referred to in Chapter 3 is given in Tables 4.1 - 4.6. Results from the literature are given in Table 4.1 (solid aerosols) and Table 4.2 (liquid aerosols, incl. water based aerosols). Tables 4.3 and 4.4 give results obtained from the data bank, and Tables 4.5 and 4.6 give results from the questionnaires also grouped as solid and liquid aerosols.

In each of the tables the aerosols have been listed alphabetically, and to each aerosol, branch codes on two-digit level, have been added. The branch codes can be used for identifying those branches in which the aerosols have been reported to be present or are assumed to be present. For translation of the code numbers, the reader is referred to the survey given in Annex 1.

In those Tables where liquid aerosols are listed, information is also given on whether the aerosol is water based, in which case a "W" is added, or whether on some occasions it is water based which is indicated by "(W)". Furthermore, the additional presence of vapours has been referred to as far as information has been given or in case the presence of vapours can be predicted.

4.2 Number of different Aerosols reported present in the Working Environment from the different Sources of Information.

The number of different aerosols reported from the different sources of information is given in Table 4.7. It shall be stressed that on many occasions the different sources of information refer to the same aerosol, e.g. aluminium or mineral oil.

Table 4.1

Solid aerosols referred to in literature and correlated to ISIC-divisions.

Actinomycin spores 11
Aflatoxins 11, 71
Aluminium 37
Aluminium fluoride 37
Aluminium oxide 37
Antigens 11
Arsenic dust 32, 37, 38
Asbestos 29, 32, 34, 36, 37, 38, 41, 50, 71, 95

Bacteria and fungi 11, 32, 92
Beryllium 37, 38, 41
Benzidine dust (benzidine sulfate) 35
Bitumen fumes 32, 35, 50

Cadmium 37, 38
Cadmium selenosulphide 35
Cadmium sulphide 35, 37
Calcium (salts) 35
Carbon black 35
Chlorophenols and wood dust 12, 35
Chromium 32, 35, 41
Coal dust 21, 41
Coal tar fumes 41
Cobalt 37
Copper 37
Cotton dust 31, 32
Cured rubber dust 35

"Dust" 11, 22,31, 32, 34, 35, 36, 37, 38, 71, 92

EDTA 31
Endotoxins 11, 32
Enzymes (trypsin-like) 31

Fibres 35
Flax 32
Flour 11, 31
Fluorides 37
Fluorochemicals (ammoniumperfluorooctanoic acid) 35
Fungi 11, 34

Granite dust 29
Grain dust 71

Table 4.2

Liquid and/or water based aerosols referred to in literature and correlated to divisions. Additional information on the presence of vapours and gases.

Borine compounds W, 38

Cleaning agents W, 31, 38, 92
Cooking fumes 31
Cutting oils (W), 38

Epoxy and polyurethane aerosols (car painting) 95, (org. solvents)

Ink aerosol (from ink-jet recorders in hospitals) 93,(org.solvents)
Ink mist (newspaper printing) 34, (org. solvents)
Isocyanates 95, (vapours)

Lubricants (W), 38

NTA (nitrilotriacetic acid) W, 38

Oil mist 37, 38, (in some cases vapours)
Oxalic acid W, 71 (vapours may be present)

PCB's 41, (vapours may be present)
Phthalate esters 35

Silicon oil mist 37
Soot 35
Spray painting (W), 95, (in many cases vapours of organic solvents)
Sulphuric acid mist W, 38 (in some cases sulfur oxides)

Triethanolamin W, 38

Totally 18, incl. 9 water based

W = water based
(W) = water based in some cases

Table 4.3

Table of solid aerosols identified from ATABAS and correlated to ISIC-divisions.

Aluminium and aluminium oxide 37, 38, 39
Antimony 36, 38, 95
Arsenic compounds 33, 36, 38, 50, 91
Asbestos 38, 41, 50, 91, 93, 95
Asphalt 50

Beryllium 37, 38

Cadmium and its inorg. compounds 37, 38, 39, 93, 95
Calcium hydroxide 37
Christobalit (resp.) 37
Chromium and chromates 33,34,35,37,38,39,50,71,91,92,93,95,36,41
Cobalt and its inorg. compounds 33, 38
Copper dust, copper smoke 95,33,35,36,37,38,39,41,50,61,71,91,92, 94,34,93
Cotton dust 32

Epoxy dust 33, 38, 39

Fibres, non MMMF, respirable and non-respirable 34, 36, 91, 93
Fluorides 38, 92, 93

Iron oxide 33,35,36,37,38,39,41,50,61,71,91,92,93,95

Lead 11,33,34,35,36,37,38,39,41,590,61,71,91,92,93,94,95

Magnesium 37
Manganese and its compounds 36, 37, 38, 39, 50, 61, 93
Mineral dust 11,31,32,33,34,35,36,37,38,39,41,50,61,71,91,92,93,94,95
MMMF, non-respirable, respirable and total 23,29,33,35,36,37,38,39,41 50,61,71,91,92,93,95

Nickel (metal and its compounds) 36, 37, 38, 39, 93

Organic dust 11,31,32,33,34,35,36,37,38,39,41,50,61,71,91,93,95

PAH 31, 94
Phosphoric acid 38
Phthalic acid enhydride 35

Quartz 23,29,31,36,37,38,41,50,71,83,92,35,93,95

Table 4.4

Liquid and/or water based aerosols identified from ATABAS and correlated to ISIC-divisions. Additional information on the presence of vapours and gases.

1.6-Hexyldiisocyanate 38, 50, 91, 95, (vapours)

MDI 32, 33, 35, 36, 37, 38, 39, 41, 50, 91, 93, (vapours)
Mineral oil 32, 33, 34, 38, 50, 93, 94, 95, (in some cases vapours)

-Pinen 32, (vapours may be present)

Sulfuric acid (W) 34, 38, 93, (in some cases sulfur oxides)

TDI 32, 34, 35, 36, 38, 91, 93, (vapours)

Totally 6, incl. 1 water based

W = water based
(W) = water based in some cases

Table 4.5

Solid aerosols identified from BST-questionnaires and correlated to ISIC-divisions

Acrylates 32
Aluminium 38
Aluminium oxide (carbon monoxide may be present) 38
Ammonium chloride 38
Asbestos 38, 50

Bacteria (viruses) 92

Calcium 35
Cement dust (oil and other hydrocarbon vapours may be present) 36,50
Chromium and chromates 33
Cleaning agents 31
Concrete dust 36
Copper (carbon monoxide may be present) 33, 35, 38

Dust (phosphine and formaldehyde) 31,
(in some cases also oil vapours and other organic vapours) 36,38
(in some cases nitrogen oxides, carbonmonoxide & dioxide) 92,95

Drugs (isopropanol may be present) 35

Enzymes (organic solvents may additionally be present) 31
Epoxy dust 38

Fluorides 35
Fly ash 36
Fumes (formaldehyde and phenol) 33

Gold (sulfur dioxide) 37

Iron (carbonmonoxide) 35, 38
Iron oxide 36, 38

Lead (carbonmonoxide) 35, 38
Lead oxide (carbonmonoxide may be present) 38

Melamine dust (formaldehyde) 35
Metals 36
Metal oxides (sulfur dioxide) 37, 38
MMMF 36, 50

Table 4.6

Liquid and/or water based aerosols identified from BST-questionnaires and correlated to divisions. Additional information on the presence of vapours and gases.

Arsenicals W, 33

Bacteria (viruses) W, 92
Bitumen 95

Ceramic materials W, 36
Chlorothene 95, (also vapours)
Chromates W, 33
Cleaning agents W, 31, 38, 71 (in some cases also vapours)
Cobalt aluminate W, 36
Concrete dust W, 36
Copper W, 33

Dust 38, 95 (in some cases oil and white spirit vapours)
(also in some cases CO)

Fatty acids W, 35

Hydrochloric acid W, 35, 38 (hydrogen chloride)

Mineral oil (W) 31, 36, 38, 50, 95
(in some cases NO_X and CO, CO_2)

Organic solvents 71, 95 (vapours)
Oxalic acid W, 71 (vapours may also be present)

Pesticides 35
Polyurethanes 50 (isocyanates, amines, org. solvents)

Silicone oils 36
Sodium hydrogen sulfite W, 31 (sulfur dioxide)
Spray painting (W) (solvent vapours) 33, 35, 38, 50, 71, 95
Sulfuric acid W (sulfur dioxide) 35, 38

Waxes (org. solvents may also be present) 95

Totally 23 incl. 15 water based

W = water based
(W) = water based in some cases

Table 4.7

Number of Aerosols reported from the different Sources of Information.

Source of information	No. of solid aerosols reported	No. of liquid aerosols reported, incl. water based
Literature	82	19 (9 water based)
ATABAS	39	6 (1 water based)
Questionnaires	41	23 (15 water based)

4.3 Alphabetical Listing of Solid and Liquid Aerosols and Main Entry to Branches

The combined results of our investigation have been listed in Tables 4.8 and 4.9 for solid aerosols and liquid aerosols, respectively. In the tables information is given for each aerosol on the branch or branches where the aerosol has been reported present. The branch codes are given on two-digit level.

The tables should be consulted when the reader wants to know whether a specific type of aerosol has been reported to be present in the working environment. Furthermore, the tables can be used as a main entry to the branch or branches in which it has been reported to be present.

Eventually, information is given, as far as possible, on whether gases or vapours are additionally present. For the liquid aerosols (Table 4.9) information is given whether the aerosol is water based, W, or water based in some cases, (W).

Table 4.8. Solid Aerosols in the Working Environment

Actinomycin spores 11
Acrylates 32
Aflatoxins 11, 71
Aluminium 37, 38, 39
Aluminium fluoride 37
Aluminium oxide 37,38,39 (Carbon monoxide may be present)
Ammonium chloride 38
Antigens 11
Antimony 36, 38, 95
Arsenic compounds 32, 33, 36, 37, 38, 50, 91
Asbestos 29, 32, 34, 36, 37, 38, 41, 50, 71, 91, 93, 95
Asphalt 50

Bacteria and fungi (incl. viruses) 11, 32, 92
Benzidine dust 35
Beryllium 37, 38, 41
Bitumen fumes 32, 35, 50

Cadmium and inorg. compounds 37, 38, 39, 93, 95
Cadmium selenosulphide 35
Cadmium sulphide 35, 37
Calcium (incl. salts) 35, 37
Carbon black 35
Chlorophenols (and wood dust) 12, 35
Christobalit 37
Chromium and chromates 32,33,34,35,36,37,38,39,41,50,71,91, 92,93,94 (Carbon monoxide may be present)
Cleaning agents 31
Coal dust 21, 41
Coal tar fumes 41
Cobalt and its inorg. compounds 33, 37, 38
Concrete dust 36
Copper dust, smoke 33,34,35,36,37,38,39,41,50,61,71,91,92, 93,94 (Carbon monoxide may be present)
Cotton dust 31, 32

Drugs 35 (Isopropanol may be present)
Dust 11,22,31,32,34,35,36,37,38,71,92

EDTA 31
Endotoxins 11, 32
Enzymes (trypsin-like) 31
Epoxy dust 33, 38, 39

Fibres 34, 35, 36, 91, 93
Flax 32
Fluorides 35, 37, 38, 92, 93
Flour 11, 31
Fluorochemicals (ammoniumperfluoro octanoic acid) 35
Fly ash 35, 36
Fumes (formaldehyde and phenol vapours) 33
Fungi 11, 34

Table 4.9. Liquid Aerosols in the Working Environment

Arsenicals 33, W

Bacteria 92, W
Bitumen 95
Borine compounds 38, W

Ceramic materials 36, W
Chlorothene 95 (also vapours)
Chromates 33, W
Cleaning agents 31,38,71,92, W (in some cases also vapours)
Cobalt aluminate 36, W
Concrete dust 36, W
Cooking fumes 31
Copper 33, W
Cutting oils 38, (W)

Dust 38, 95 (in some cases also vapours of oil and white spirit, CO in some cases)

Epoxy and polyurethane aerosols 95 (solvent vapours)

Fatty acids 35, W

1.6-Hexyldiisocyanate 38, 50, 91, 95 (vapours)
Hydrochloric acid 35, 38, W (hydrogen chloride)

Ink aerosol 93 (org. solvents)
Ink mist 34 (org. solvents)
Isocyanates 95 (vapours)

Lubricants 38, (W)

MDI 32,33,35,36,37,38,39,41,50,91,93 (vapours)
Mineral oil 31,32,33,34,36,38,50,93,94,95, (W)
(in some cases vapours)

NTA (nitrilotriacetic acid) 38, W

Oil mist 37, 38 (in some cases vapours)
Organic solvents 71, 95 (vapours)
Oxalic acid 71, W (in some cases vapours)

PCBs 41 (in some cases also vapours)
Pesticides 35
Phthalate esters 35
α-Pinen 32 (vapours may be present)
Polyurethanes 50 (vapours)

Silicone oil 36, 37
Sodium hydrogen sulfite 31, W (sulfur dioxide)
Soot 35
Spray painting aerosol 33,35,38,50,71,95, (W)
(in some cases vapours)
Sulfuric acid 34,35,38,93,(W) (sulfur oxides)

TDI 32, 34, 35, 36, 38, 91, 93 (vapours)
Triethanolamine 38, W

Waxes 95 (solvent vapours may be present)

Totally 147 different aerosols have been identified in our investigation. The number of solid aerosols is 105, and there are 41 liquid aerosols. Among the liquid aerosols, 15 have been identified as water based, and furthermore 4 have been identified as being water based under some circumstances. The results are summarized in Table 4.10.

Table 4.10

Number and physical State of identified Aerosols

Total number of aerosols	Liquid aerosols	Water based aerosols
146	41	15 (19)

CHAPTER 5

WHICH AEROSOLS ARE FOUND IN THE DIFFERENT BRANCHES?

5.1 Distribution of Aerosols in the Divisions

In order to give a survey of the occurrence of aerosols in the divisions, the Tables 5.1 (solid aerosols) and 5.2 (liquid aerosols) are presented.

The aerosols are listed alphabetically in each of the divisions. The tables give an impression of the number and types of aerosols occurring in each division. In these tables reference is not given to any additional presence of gases or vapours. For this information the reader is referred to the tables in the previous Chapter 4.

5.2 Number of Solid and Liquid Aerosols, incl. Water based Aerosols, in the branches

Table 5.3 gives the number of solid and liquid aerosols, including water based aerosols, in the divisions. Not surprisingly, it can be seen that the greatest number of aerosols are found in the divisions 31-39 which covers the manufacturing industry (Major division 3), and within these divisions the highest score is found in division 38 which is manufacturing of fabricated metal products, machinery and equipment. In this division, totally 58 aerosols have been found. Among these, 43 are solid aerosols and 15 are liquid aerosols. Of the 15 liquid aerosols, 5 are water based and 10 are other liquid aerosols.

A substantial number of solid as well as liquid aerosols is also reported in division 95. The total number of aerosols in this division is 23, and the major contribution seems to stem from the automobile repairing workshops.

From the columns of the table several conclusions can be drawn with regard to the relative importance of solid, liquid and water based aerosols. It can e.g. be seen that in some divisions, e.g. 11 and 12, no liquid aerosols have been reported. Of particular interest is the information on the number of liquid aerosols, including water based aerosols, in per cent of the total number of aerosols.

The Tables 5.1 and 5.2 should be consulted when the reader wants information on which aerosols have been reported present in a certain branch (division). Table 5.3, together with Fig. 2, is intended to give a comprehensive view of the occurrence of liquid aerosols as compared to solid aerosols.

Of special importance for the choice of respirators for protection against aerosols in the working environment is the number of solid and water based aerosols and their percentage of the total number of aerosols in the working environment. In the present drafts for the forthcoming European standards on respirator filters it has been suggested that in some of the filter classes, filters shall be classified according to their ability to protect against:

1) Solid aerosols, including water based aerosols and
2) Solid and liquid aerosols.

This classification seems reasonable in the light of the results given in the last column of Table 5.3.

Table 5.1

Occurrence of solid aerosols in the different branches, based on data from ATABAS, BST- questionnaires and literature.

Major division 1. Agriculture, hunting, forestry and fishing

11. Agriculture and hunting

Actinomycin spores
Aflatoxins
Antigens
Bacteria
Dust
Endotoxins
Flour
Fungi
Insecticides (pesticides)
Lead
Lipopolysaccharides
Mica
Mineral dust
Organic dust

12. Forestry and logging

Chlorophenols
Organic dust
Wood dust

Major division 2. Mining and quarrying

21. Coal mining

Coal dust

22. Crude petroleum and natural gas production

Dust
Metals
PAH

23. Metal ore mining

MMMF
Quartz
Radioactive aerosol

29. Other mining

Asbestos
Granite dust
Mica
MMMF
Potash dust
Quartz
Talc

Major division 3. Manufacturing

31. Manufacture of food, beverages and tobacco

Cleaning agents
Cotton dust
Dust
EDTA
Enzymes
Flour
Mineral dust
Organic dust
PAH
Phosphoric acid
Quartz
Respirable dust
Sodium hydroxide and sodium compounds
Tea dust
Tobacco dust

32. Textile, weaving apparel and leather industries

Acrylates
Arsenic dust
Asbestos
Bacteria
Bitumen fumes
Chromium
Cotton dust
Dust
Endotoxins
Flax
Fungi
Hemp
Leather dust
Mineral dust
Organic dust
Vegetable dust

33. Manufacture of wood and wood products, including furniture

Arsenic compounds
Chromium and chromates
Cobalt and inorg. compounds
Copper
Epoxy dust
Fumes
Iron oxide
Lead
Mineral dust
MMMF
Organic dust
Tin, inorg.
Wood dust
Zinc oxide

34. Manufacture of paper and paper products; printing and publishing

Asbestos
Chromium and chromates
Copper
Dust
Fibres, non MMMF
Fungi
Lead
Mineral dust
Organic dust
Tin, inorg.
TNF
Zinc oxide

35. Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products

Benzidine dust
Bitumen fumes
Calcium
Chromium and chromates
Copper
Dust
Drugs
Fibres
Fluorides
Fluorochemicals
Hydroquinones and other benzenediols
Iron oxide
Ispagula powder
Lead

Magnesium and salts
Melamine dust
Mercury and comp.
Mineral dust
MMMF
Organic dust
PAH
Pesticides
Phthalic acid anhydride
Pigments
Polypropylene dust
PVC-dust
Quartz
Rubber dust
Sodium hydroxide and compounds
Soot
Talc
Titanium dioxide
TNT-dust
Welding smoke
Zinc oxide

36. Manufacture of non-metallic mineral products, except products of petroleum and coal

Antimony
Arsenic compounds
Asbestos
Cement dust
Chromium and chromates
Concrete dust
Copper
Dust
Fibres, non MMMF
Fly ash
Iron oxide
Lead
Manganese
MMMF
Metals
Mineral dust
Nickel
Organic dust
Quartz
Resp. dust
Welding smoke
Wood dust
Zinc oxide

37. Basic metal industries

Aluminium
Aluminium fluoride
Aluminium oxide
Arsenic dust
Asbestos
Beryllium
Cadmium and inorg. comp.
Calcium hydroxide
Christobalite
Chromium and chromates
Cobalt
Copper
Dust
Fluorides
Fluorochemicals
Gold
Iron
Iron oxide
Lead
Magnesium
Manganese
Metals
Metal oxides
Mineral dust
MMMF
Molybdenum
Nickel
Nickel oxide
Organic dust
PAH
Quartz
Resp. dust
Silver
Tin, inorg.
Tin, org.
Vanadium pentoxide
Wolfram
Zinc
Zinc oxide

38. Manufacture of fabricated metal products, machinery and equipment

Aluminium
Aluminium oxide
Ammonium chloride
Antimony
Arsenic compounds
Asbestos
Beryllium

Cadmium and inorg. comp.
Chromium and chromates
Cobalt and inorg. comp.
Copper
Dust
Epoxy dust
Fluorides
Iron
Iron oxide
Lead
Lead oxide
Manganese
Manganese dioxides
Metal
Metal oxides
Mica
Mineral dust
MMMF
Nickel
Organic dust
Phosphoric acid
Pottery dust
Quartz
Respirable dust
Silanes
Silver and solub. compounds
Sodium hydroxide and solub. comp.
Soldering smoke
Soot
Tin, inorg.
Tin, org.
Welding smoke
Wolfram
Wood dust
Zinc
Zinc oxide

39. Other manufacturing industries

Aluminium
Aluminium oxide
Cadmium and inorg. comp.
Chromium and chromates
Copper
Epoxy dust
Iron oxide
Lead
Manganese
Mineral dust
MMMF
Nickel
Organic dust
Tin, inorg.
Tin, org.
Total dust
Welding smoke
Zinc oxide

Major division 4. Electricity, gas and water

41. Electricity, gas and steam

Asbestos
Beryllium
Chromium and chromates
Coal dust
Coal tar fumes
Copper
Fly ash (pulverized fuel ash)
Iron oxide
Lead
Mineral dust
MMMF
Nickel
Organic dust
PAH
PCB
Quartz
Respirable dust
Welding smoke
Zinc oxide

Major division 5. Construction

50. Construction

Arsenic compounds
Asbestos
Asphalt
Bitumen fumes
Cement dust
Chromium and chromates
Copper
Iron oxide
Lead
Manganese
Mica
Mineral dust
MMMF
Organic dust
Quartz
Wood dust

Major division 6. Wholesale and retail trade and restaurants and hotels

61. Wholesale trade

Copper
Iron oxide
Lead
Manganese
Mineral dust
MMMF
Organic dust
Respirable dust
Selenium
Zinc oxide

63. Hotels, rooming houses, etc.

PAH

Major division 7. Transport, storage and communication

71. Transport and storage

Aflatoxins
Asbestos
Chromium and chromates
Copper
Dust
Grain dust
Iron oxide
Lead
Mineral dust
MMMF
Organic dust
PAH
Quartz
Zinc oxide

Major division 8. Financing, insurance, real estate and business services

83. Real estates and business services

Organic dust
Quartz

Major division 9. Community, social and personal services

91. Public administration and defence

Arsenic compounds
Asbestos
Chromium and chromates
Copper
Fibres, non MMMF
Iron oxide
Lead
Mineral dust
MMMF
Organic dust
Selenium
Tin, inorg.
Total dust
Wood dust
Zinc oxide

92. Sanitary and similar services

Bacteria (viruses)
Chromium and chromates
Copper
Dust
Fluorides
Iron oxide
Lead
Mineral dust
MMMF
Organic dust
Quartz
Respirable dust
Zinc oxide

93. Social and related community services

Asbestos
Cadmium and inorg. comp.
Chromium and chromates
Copper
Fibres, non MMMF
Fluorides
Insecticides and pesticides
Iron oxide
Lead
Manganese
Mineral dust
MMMF
Nickel
Organic dust
Quartz
Respirable dust

Tin, inorg.
Total dust
Welding smoke
Wood dust
Zinc oxide

94. Recreational and cultural services

Copper
Lead
Mineral dust
Organic dust
PAH
Total dust
Zinc oxide

95. Personal and household services

Antimony
Asbestos
Cadmium and inorg. comp.
Chromium and chromates
Copper
Iron oxide
Lead
Mineral dust
MMMF
Organic dust
Quartz
Tin, org.
Zinc oxide

Table 5.2

Occurrence of liquid aerosols in the different branches, based on data from ATABAS, EST- questionnaires and literature

---

Major division 1. Agriculture, hunting, forestry and fishing

None

Major division 2. Mining and quarrying

None

Major division 3. Manufacturing

31. Manufacture of food, beverages and tobacco

Cleaning agents W
Cooking fumes (W)

~~Mineral oil (W)~~
~~Sodium hydrogen sulfite W~~

32. Textile, weaving apparel

MDI
Mineral oil
α-Pinen
TDI

33. Manufacture of wood and wood products, including furniture

---

Arsenicals W
Chromates W

MDI
Mineral oil

Spray painting (W)

34. Manufacture of paper and paper products; printing and publishing

Ink mist

Mineral oil

Sulfuric acid (W)
TDI

35. Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products

Fatty acids W
Hydrochloric acid W
MDI
Pesticides
Phthalate esters
Soot
Spray painting (W)
Sulfuric acid (W)
TDI

36. Manufacture of non-metallic mineral products, except products of petroleum and coal

Ceramic materials W
Cobalt aluminate W
Concrete dust W
Copper W
MDI
Mineral oil (W)

Silicone oils
TDI

37. Basic metal industries

MDI

Oil mist

Silicone oil mist

38. Manufacture of fabricated metal products, machinery and equipment

Borine compounds W
Cleaning agents W
Cutting oils (W)
Dust
1.6-hexyldiisocyanate
Hydrochloric acid W
Lubricants (W)
MDI

Mineral oil
NTA (nitrilotriacetic acid) W
Oil mist
Spray painting (W)
Sulfuric acid (W)
TDI
Triethanolamine W

39. Other manufacturing industries

MDI

Major division 4. Electricity, gas and steam

41. Electricity, gas and steam

MDI

PCB's

Major division 5. Construction

50. Construction

1.6-hexyldiisocyanate

MDI

Mineral oil
Polyurethanes
Spray painting (W)

Major division 6. Wholesale and retail trade and restaurants and hotels

None

Major division 7. Transport, storage and communication

71. Transport and storage

Cleaning agents W

Organic solvents
Oxalic acid W

Spray painting (W)

Major division 8. Financing, insurance, real estate and business services

None

Major division 9. Community, social and personal services

91. Public administration and defence

1.6-hexyldiisocyanate

MDI

TDI

92. Sanitary and similar services

Bacteria (viruses) W

Cleaning agents W

93. Social and related community services

Ink aerosol
MDI
Mineral oil
Sulfuric acid (W)
TDI

94. Recreational and cultural services

Mineral oil

95. Personal and household services

Bitumen
Chlorothene
Dust
Epoxy and polyurethane aerosols
1.6-hexyldiisocyanate
Isocyanates
Mineral oil
Organic solvents
Spray painting (W)
Waxes

Table 5.3 Distribution of solid and liquid aerosols, including water based, in the divisions of all economic activities. Data from all sources of information.

ISIC code	Branch	Number of solid aerosols	Number of liquid aerosols	Total number of aerosols	Number of water based aerosols	Number of other liquid aerosols	Number of liquid aerosols in percent of total	Number of solid and water based aerosols	Number solid a water b aerosol percent total
11	Agriculture & hunting	14	0	14	0	0	0	14	100
10	Forestry & logging	3	0	3	0	0	0	3	100
21	Coal mining	1	0	1	0	0	0	1	100
22	Crude petro- & natural gas production	3	0	3	0	0	0	3	100
23	Metal ore mining	3	0	3	0	0	0	3	100
29	Other mining	7	0	7	0	0	0	7	100
31	Manufacture of food, beverages & tobacco	15	4	19	2 (4)	2	21	17 (19)	89
32	Textile industry	16	4	20	0	4	20	16	80
33	Wood and wood products	14	5	19	2 (3)	3	26.3	16 (17)	84
34	Paper and printing	12	4	16	(1)	4	25	12 (13)	75
35	Chemicals	35	9	44	2 (4)	7	20.5	37 (39)	84
36	Non-metallic mineral products	23	8	31	4 (5)	4	25.8	27 (28)	87
37	Basic metal industry	39	3	42	0	[illegible]	[illegible]	[illegible]	93
38	Fabricated metal products	43	15	58	5 (9)	10	25.9	48 (52)	83
39	Other manufacturing industry	18	1	19	0	1	5.2	18	95
41	Electricity, gas & water	19	2	21	0	2	9.5	19	90
50	Construction	16	5	21	(1)	5	23.8	16 (17)	76
61	Wholesale trade	10	0	10	0	0	0	10	100
63	Hotels	1	0	1	0	0	0	1	100
71	Transport & storage	14	4	18	2 (3)	2	22.2	16 (17)	89
83	Real estate & business service	2	0	2	0	0	0	2	100
91	Public administration & defence	15	3	18	0	3	16.7	15	83
92	Sanitary & similar services	13	2	15	2	0	13.3	15	100
93	Social & related community services	21	5	26	(1)	5	19.2	21 (22)	81
94	Recreational & cultural services	7	1	8	0	1	12.5	7	88
95	Personal & household services	13	10	23	(1)	10	43.5	13 (14)	57

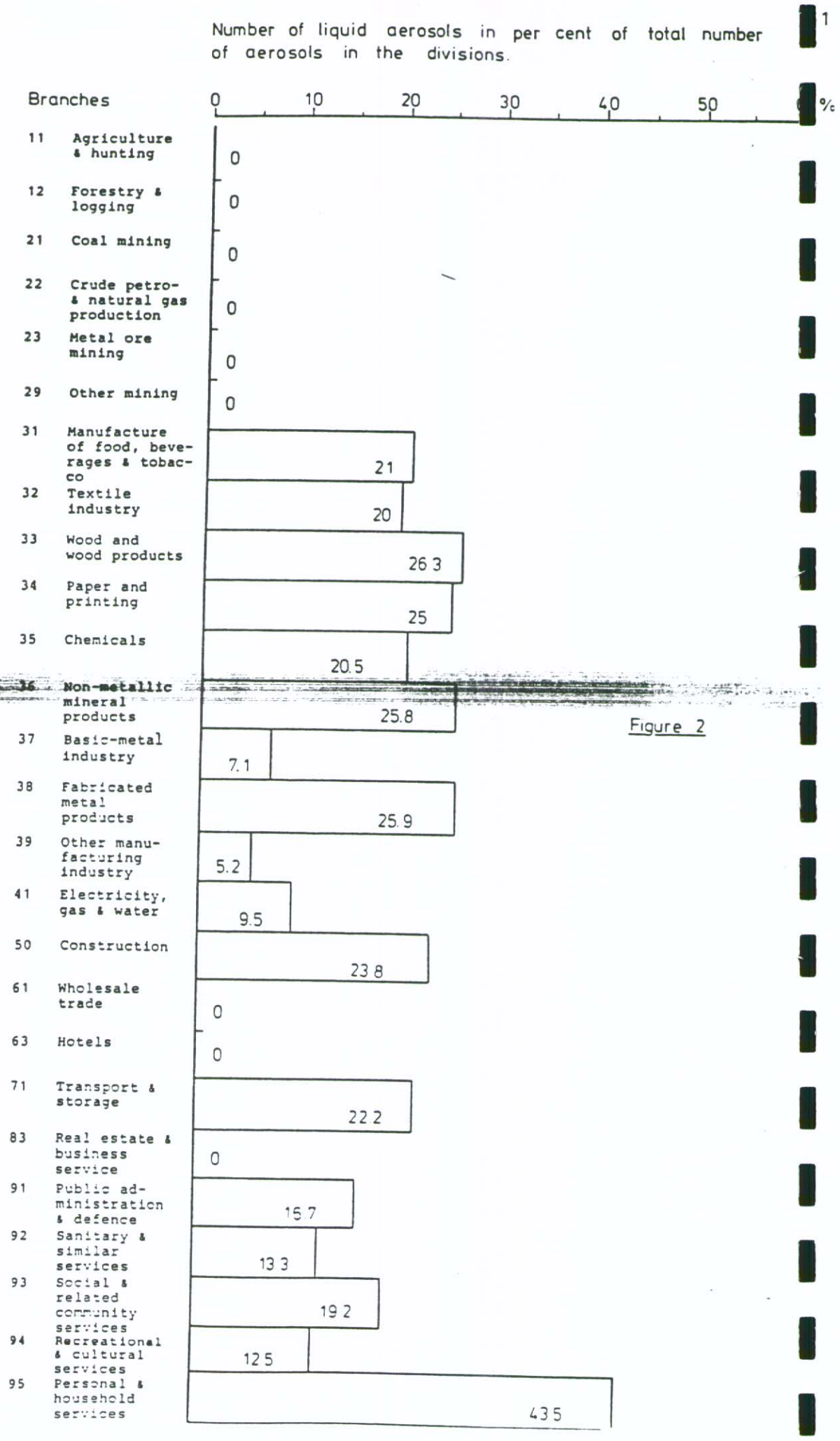
Number of liquid aerosols in per cent of total number of aerosols in the divisions.
Branches
0
10
20
30
40
50
%
11 Agriculture & hunting
12 Forestry & logging
21 Coal mining
22 Crude petro- & natural gas production
23 Metal ore mining
29 Other mining
31 Manufacture of food, beverages & tobacco
32 Textile industry
33 Wood and wood products
34 Paper and printing
35 Chemicals
36 Non-metallic mineral products
37 Basic-metal industry
38 Fabricated metal products
39 Other manufacturing industry
41 Electricity, gas & water
50 Construction
61 Wholesale trade
63 Hotels
71 Transport & storage
83 Real estate & business service
91 Public administration & defence
92 Sanitary & similar services
93 Social & related community services
94 Recreational & cultural services
95 Personal & household services
0
0
0
0
0
0
21
20
26 3
25
20.5
25.8
7.1
25.9
5.2
9.5
23 8
0
0
22 2
0
15.7
13 3
19 2
12 5
43 5

Figure 2

CHAPTER 6

EXPOSURE INDECES

6.1 Exposure Indeces for the Manufacturing Industry in Denmark

The concept of exposure indeces was introduced and explained in Chapter 1, section 1.7, where two examples were given. These examples were presented at an early stage of the investigation and were based on a limited amount of information. In the present context they only serve the purpose of illustrating principles for calculation of exposure indeces.

Exposure indeces can, according to the definition laid down, be used in different ways and at different levels to describe the probability of exposure to certain substances in the working environment. The exposure index of a certain aerosol in a particular branch or group of branches can be calculated or the total exposure index of certain types of substances in all branches can be calculated. As the amount of information is overwhelming in the present investigation, numerous different results can be calculated.

We have chosen to present the exposure indeces for the different solid and liquid aerosols in the manufacturing industry, incl. mining, in Denmark. This corresponds to the major divisions 2 and 3 of the ISIC-code. The indeces for the solid aerosols are given in Table 6.1, and for the liquid aerosols in Table 6.2.

The exposure indeces for each of the solid aerosols have been added up to give a total exposure index for solid aerosols, and the total exposure index for the liquid aerosols have been calculated in the same way. Finally,

Table 6.1

Exposure Indeces for Solid Aerosols in the Manufacturing Industry

Acrylates	23321	
Aluminium	111577	
Aluminium fluoride	4659	
Aluminium oxide	111577	
Ammonium chloride	103079	
Antimony	115986	
Arsenic compounds	163127	
Asbestos	165547	
Bacteria and fungi (incl. viruses)	23321	
Benzidine dust	20841	
Beryllium	107738	
Bitumen fumes	44162	
Cadmium and inorg. compounds	111577	
Cadmium selenosulphide	20841	
Cadmium sulphide	20841	
Calcium (incl. salts)	25500	
Carbon black	20841	
Chlorophenols (and wood dust)	20841	
Christobalit	4659	
Chromium and chromates	208567	
Cleaning agents	58498	
Cobalt and its inorg. compounds	126899	
Concrete dust	12907	
Copper dust, smoke	185246	
Cotton dust	81819	
	20841	
Drugs	244065	
Dust		
EDTA	58498	
Endotoxins	23321	
Enzymes (trypsin-like)	58498	
Epoxy dust	126079	
Fibres	54508	
Flax	23321	
Fluorides	128579	
Flour	58498	
Fluorochemicals (ammoniumperfluoro octanoic acid)		20841
Fly ash	33748	
Fumes (formaldehyde and phenol vapours)		19161
Fungi	20760	

Gold	4659
Granite dust	821
Hemp	23321
Hydroquinones and other benzenediols	20841
Iron	128579
Iron oxide	124484
Ispagula powder	20841
Lead	185246
Lead oxide	120645
Leather dust	23321
Magnesium	4659
Magnesium salts	20841
Manganese and its compounds	124484
Melamine dust	20841
Metals	120645
Metal oxides	107738
Mica	103900
Mineral dust	267065
MMMF	165307
Molybdenum	4659
Nickel	107738
Nickel oxide	4659
Nickel and its compounds	124484
Organic dust	267065
PAHs	83998
Pesticides	20841
Phosphoric acid	161577
Phthalic acid anhydride	20841
Pigments	20841
Polypropylene	20841
Potash dust	821
Pottery dust	103079
PVC-dust	20841
Quartz (silica)	200805

Silanes	103079
Silver and its soluble compounds	107738
Sodium hydroxide and other sodium containing compounds	182418
Soldering smoke	103079
Soot	123920
Talc	21662
Tea dust	58498
Tin, organic	111577
Tin, inorganic	151498
Titanium dioxide	20841
TNF-dust	20760
TNT-dust	20841
Tobacco dust	58498
Vanadium pentoxide	4659
Vegetable dust (fibres)	23321
Welding smoke	140666
Wolfram	107738
Wood dust	135147
Zinc	107738
Zinc oxide	185246

Table 6.2

Exposure Indeces for Liquid Aerosols in the Manufacturing Industry

Arsenicals	19161
Borine compounds	103079
Ceramic materials	12907
Chromates	19161
Cleaning agents	161577
Cobalt aluminate	12907
Concrete dust	12907
Cooking fumes	58498
Copper	19161
Cutting oils	103079
Dust	103079
Fatty acids	20841
1.6-Hexyldiisocyanate	103079
Hydrochloric acid	123920
Ink mist	20760
Lubricants	103077
MDI	187807
Mineral oil	237726
NTA (nitrilotriacetic acid)	103079
Oil mist	107738
Pesticides	20841
Phthalate esters	20841
α-Pinen	23321
Silicone oil	17566
Sodium hydrogen sulfite	58498
Soot	20841
Spray painting aerosol	143081
Sulfuric acid	144680
TDI	180608
Triethanolamine	103079

a total exposure index for aerosols (liquid and solid) in the manufacturing industry has been calculated. The results have been summarized in Table 6.3.

Table 6.3

Exposure Indeces for Solid Aerosols, Liquid Aerosols and all Aerosols in the Manufacturing Industry, incl. Mining in Denmark

Type of aerosol	Exposure index
Solid	7 324 940
Liquid	2 366 901
All (liquid and solid)	9 691 841

These figures give an impression of the relative importance of solid and liquid aerosols. From the above figures the exposure index for solid aerosols in per cent of the total exposure index for aerosols has been calculated together with the corresponding figure for liquid aerosols. These figures are:

Solid aerosol exposure index in % = 75.6 %

Liquid aerosol exposure index in % = 24.4 %

6.2 Exposure Indeces for the more important Solid and Liquid Aerosols

As it can be seen from the Tables 6.1 and 6.2 some aerosols have high exposure indeces while others have low ones. The exposure index is high if the aerosol has been found to be present in many branches and if many people are employed in these branches. If an aerosol has been reported to be present in only one or few branches,

the exposure index generally will be small. The highest exposure indices for the solid aerosols have been found to be approx. 267000, and the lower ones to be approx. 800. A total of 92 solid aerosols and 30 liquid aerosols were found in the major divisions 2 and 3.

In order to give an impression of the more important aerosols as judged from the magnitude of their exposure indeces, those with values exceeding a 100000 have been listed in the Tables 6.4 and 6.5.

6.3 Exposure Indeces for Aerosols in other Industrialized Countries than Denmark

The exposure indeces as calculated in the preceeding sections have been based on statistical information on the workers' employment in the branches in Denmark as given in Table 2.2 which is an extract of Annex 2.

The employment in the different branches will differ from country to country in absolute numbers. The distribution of the different aerosols in the branches, however, we think will be approximately the same in the major industrialized countries. It therefore should be possible by means of the distributions of aerosols given in the present report to calculate exposure indeces in other countries than Denmark, if the employment in the different branches is known - which generally is the case.

Table 6.4

Exposure Indeces for the more important Solid Aerosols

Aerosol	Exposure index
Mineral dust	267065
Organic dust	267065
Dust	244065
Chromium and chromates	208567
Quartz	200805
Copper	185246
Lead	185246
Zinc oxide	185246
Asbestos	165547
MMMF	165307
Arsenic compounds	163127
Phosphoric acid	161577
Tin, inorg. comp.	151498
Welding smoke	140665
Fluorides	128579
Iron	128579
Cobalt	126829
Epoxy dust	126079
Manganese	124484
Nickel and its compounds	124484
Iron oxide	124484
Soot	123920
Lead oxide	120645
Metal	120645
Aluminium	111577
Aluminium oxide	111577
Cadmium and its inorg. compounds	111577
Tin, org. compounds	111577
Beryllium	107738
Metal oxides	107738
Nickel	107738
Wolfram	107738
Zinc	107738
Silver	107738
Mica	103900
Soldering smoke	103079
Silanes	103079
Pottery dust	103079

Table 6.5

Exposure Indeces for the more important Liquid Aerosols

Aerosol	Exposure Index
Mineral oil	237726
MDI	187807
TDI	180608
Cleaning agents	161577
Sulfuric acid	144680
Spray painting aerosol	143081
Hydrochloric acid	123920
Oil mist	107738
Borine compounds	103079
Cutting oils	103079
Dust	103079
1,6-Hexyldiisocyanat	103079
Lubricants	103079
NTA (nitrilotriacelic acid)	103079
Triethanolamine	103079

CHAPTER 7

IMPORTANT WORKING PROCESSES AND OPERATIONS IN THE DIFFERENT BRANCHES OF TRADE AND INDUSTRY AND RELATED ACTIVITIES

7.1 Working Processes and Products

Working processes and operations can be defined as activities where raw materials or more complex materials are stored, transported or processed in some way. By the processing materials can be changed in e.g. size and shape, and/or materials can be joined together to form a product with certain desired properties. In the present context working processes and operations also include work necessary for running and maintaining the production facilities.

The manufacture of any product implies the use of a number of working processes and operations. Some products are relatively simple and need only few working processes and operations to be finished, e.g. nails, whereas other products are the result of numerous working processes and operations, e.g. an automobile.

Many different types of working processes and operations are used in the different branches (divisions, major groups and groups) of trade and industry, but not all of them are used in all branches. However, the majority of them are being used in more than one branch.

A comprehensive survey of the important working processes has been given in Patty's Industrial Hygiene (Reference 1). The survey discusses typical working processes in typical industries, and refers to the air pollutants of major importance associated with the processes.

Generally, it can be stated that in branches where many different working processes and materials are used, also the biggest number of different air pollutants will be found. This is typically the case in division 38, manufacturing of fabricated metal products, machinery and equipment.

7.2 Information on Working Processes and Products from the Data Bank ATABAS

The data bank ATABAS gives exhaustive information also on the types of working processes and the production in connection with the reported air pollutants. A total of 275 working processes and 281 types of production have been referred to. Unfortunately, the information is available in Danish only. However, it will be possible to extract the necessary information for substances and branches of particular interest, but it will be time consuming and could not be made within the given frames for the present investigation. However, the original outprints in Danish from ATABAS will be available at request for those readers who are particularly interested.

7.3 Information on Working Processes and Branches from the other Sources of Information

Information on working processes, branches and aerosols reported present in the branches is given in Annex 5, in special schemes. In these schemes, branch codes have been given on 4-digit level. This ensures a most detailed picture of the specific branches, working processes and types of aerosols formed in connection with each branch and process.

A list of important working processes has been given in Table 7.1. The processes have been grouped in five categories and listed alphabetically within each category.

At all these processes, aerosols can be formed to a greater or smaller extent, and the particles of the aerosols can consist of the materials which are being processed, or of auxiliary substances used in the process e.g. cutting oils and lubricants. In some of the processes, gases or vapours from the materials and substances will be formed as well, e.g. due to high temperatures. A number of examples have been given in Fig. 1 (page 5) which illustrate the complexity of the formation of air pollutants in the working environment. In order to give an impression of those processes, which we consider being of a more hazardous nature, these have been marked with an "x" in Table 7.1. We consider them specially hazardous, because some of them give rise to large amounts of aerosols of harmful substances whose spreading is difficult to control. In some cases, gases and vapours will be released as well, in large quantities, and in some cases, the pollutants formed are of a highly toxic nature.

Table 7.1

Classification of important working processes.
Processes of particular danger are marked with an "x".

Category	Examples
I Manufacturing processes	
Bending	Iron- and steel plates
Casting x)	Cast iron articles
Crushing	Stones
Cutting x)	Metal & plast materials
Drilling	Metal & plast materials
Folding	Metal plates
Grinding	Chemicals
Melting x)	Lead, copper and brass articles
Milling	Flour
Moulding x)	Metal, rubber and plast materials
Rolling	Metal sheets
Sawing	Wood materials
II Joining processes	
Gluing	Plast objects. Chipboard production
Laminating	Plywood production
Sewing	Wearing appareil
Soldering x)	Electronic equipment
Welding x)	Fabricated metal articles maintenance and repair work

III Surface treatment

a) Cleaning processes	Examples
Cleaning	Maintenance work
Degreasing x)	Metal articles
Desinfection	Food industry
High pressure cleaning x)	Food industry
Polishing	Metal articles
Sand blasting x)	Metal articles
Shot blasting x)	Metal articles

b) Coating processes	
Coating	Dip baths
Electolysis x)	Galvanized articles
Lubrication	Machinery
Printing	Newspapers, books
Spray painting x)	Ships, automobiles

IV Transportation and handling

Bottling operations	Drugs, beverages
Conveyoring	Grains
Filling operations	Chemicals
Handling	Tea, tobacco
Loading and unloading	Coal
Mixing	Fertilizers
Packing	Chemicals
Tanning and similar processes	Leather articles

V Other processes

Chemical processes and production	Chemicals
Construction and building	Concrete buildings
Demolishion work	Buildings
Drying	Pottery work
Fermentation	Medicinal industry
Filtration	Pigments
Freeze drying	Food industry
Grannulation	Chemicals
Insulation work	Polyurethane foam
Mining and drilling	Coal
Spraying x)	Pesticides

References:

1) Patty's Industrial Hygiene and Toxicology.
Volume 1. Third Revised Edition.
John Wiley & Sons.
New York. 1978, p. 1149-1220

CHAPTER 8

REFERENCES

8.1 Tables giving References to the Sources of Information

In order to enable the reader to seek further detailed information on certain aerosols, their reported presence and their properties the Tables 8.1 (solid aerosols) and 8.2 (liquid aerosols) have been prepared. In each of the tables the divisions have been listed, and for each division the aerosols have been listed alphabetically. For each aerosol one or more references are given. An "A" refers to ATABAS (the data bank) and a "Q" refers to the questionnaires from the Health Service Centres. All figures given in the tables refer to the list given in section 8.2. A total of 227 references have been given covering different periodicals, monographs and research reports. In a number of cases reference has been given to papers of more general interest which could be of importance for further studies.

Table 8.1

References, Solid Aerosols

Major division 1. Agriculture, hunting, forestry and fishing

11. Agriculture and hunting

Actinomycin spores 1, 2
Aflatoxins 3, 14
Antigens 4
Bacteria 5, 11
Dust 6, 7, 8, 9, 10
Endotoxins 5
Flour 210
Fungi 5
Insecticides (pesticides) 12, 13
Lead A
Lipopolysaccharides 50
Mica 15
Mineral dust A
Organic dust 6, 7, 8, 9, 10, 16

12. Forestry and logging

Chlorophenols 17
Organic dust 16
Wood dust 18

Major division 2. Mining and quarrying

21. Coal mining

Coal dust 20, 21, 22, 23

22. Crude petroleum and natural gas production

Dust 24, 25
Metals 24
PAH 24

23. Metal ore mining

MMMF A
Quartz A
Radioactive aerosol 26

29. Other mining

Major division 3. Manufacturing

31. Manufacture of food, beverages and tobacco

32. Textile, weaving apparel and leather industries

33. Manufacture of wood and wood products, including furniture

Arsenic compounds A
Chromium and chromates Q, A
Cobalt and inorg. compounds A
Copper A, Q
Epoxy dust A
Fumes Q
Iron oxide A
Lead A
Mineral dust A
MMMF A
Organic dust A
Tin, inorg. A
Wood dust A, Q, 56, 57, 58, 59, 60, 19
Zinc oxide A

34. Manufacture of paper and paper products; printing and publishing

Asbestos 61
Chromium and chromates A
Copper A
Dust 62
Fibres, non MMMF A
Fungi 62
Lead A, 63
Mineral dust A
Organic dust A
Tin, inorg. A
TNF 64
Zinc oxide A

35. Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products

Benzidine dust 65
Bitumen fumes 46
Calcium Q
Chromium and chromates A, 66
Copper A, Q
Dust Q, 67, 68, 69, 70, 71, 72, 214
Drugs Q
Fibres 73, 74
Fluorides Q
Fluorochemicals 75
Hydroguinones and other benzenediols 76
Iron oxide A
Ispagula powder 77
Lead A, Q, 63

Magnesium and salts A
Melamine dust Q
Mineral dust A
MMMF A, 79
Organic dust A, Q, 16
PAH 80, 203
Pesticides Q
Phthalic acid anhydride A
Pigments 72, 81, 82
Polypropylene dust Q
PVC-dust Q
Quartz A
Rubber dust 71
Sodium hydroxide and compounds A, 83
Soot 71
Talc 71
Titanium dioxide 81
TNT-dust 84, Q
Welding smoke Q
Zinc oxide A

36. Manufacture of non-metallic mineral products, except products of petroleum and coal

Antimony A
Arsenic compounds A
Asbestos 85, 86, 43
Cement dust Q
Chromium and chromates A
Concrete dust Q
Copper A
Dust Q, 88, 215, 216
Fibres, non MMMF A, 89
Fly ash Q
Iron oxide A, Q
Lead A, 90, 63
Manganese A
MMMF A, Q, 91, 74
Metals Q
Mineral dust A, 88
Nickel A
Organic dust A
Quartz A, Q, 33, 216
Resp. dust A
Welding smoke Q
Wood dust Q
Zinc oxide A

37. Basic metal industries

Aluminium A, 92
Aluminium fluoride 92, 93, 94
Aluminium oxide A
Arsenic dust 95, 96, 97
Asbestos 98, 43
Beryllium A, 103
Cadmium and inorg. comp. A, 100, 101
Calcium hydroxide A
Christobalite A, 103
Chromium and chromates A
Cobalt 102
Copper A, 95
Dust 95, 104
Fluorides 92, 93, 94
Fluorochemicals 75
Gold Q
Iron 104
Iron oxide A
Lead A, 105, 106, 107, 108, 109, 110, 63, 95
Magnesium A
Manganese A
Metals 112, 157
Metal oxides Q
Mineral dust A
MMMF A
Molybdenum 155
Nickel A, 113, 114
Nickel oxide 113
Organic dust A
PAH 115, 116, 117, 118, 119, 201, 203, 204
Quartz A, 104, 120, 121, 122, 123, 103, 34, 33
Resp. dust Q
Silver Q
Tin, inorg. A
Tin, org. A
Vanadium pentoxide 124, 125, 126
Wolfram 102
Zinc 101
Zinc oxide A

38. Manufacture of fabricated metal products, machinery and equipment

Aluminium A, Q
Aluminium oxide A, Q
Ammonium chloride Q
Antimony A
Arsenic compounds A, 127, 128, 129
Asbestos A, Q, 130, 131, 43
Beryllium A, 132

Cadmium and inorg. comp. A, 133
Chromium and chromates A, 135, 136, 137
Cobalt and inorg. comp. A
Copper A, Q, 137
Dust Q, 139, 217
Epoxy dust A, Q
Fluorides A
Iron Q, 135
Iron oxide A, Q
Lead A, Q, 130, 141, 142,, 143, 144, 145, 146, 63
Lead oxide Q
Manganese A
Manganese dioxides A, 147
Metal 148
Metal oxides Q
Mica 15
Mineral dust A
MMMF A
Nickel 136, 137, 135, 158
Organic dust A
Phosphoric acid A, 149
Pottery dust 150
Quartz A, Q, 151
Respirable dust A
Silanes 152
Silver and solub. compounds A
Sodium hydroxide and solub. comp. A
Soldering smoke 217, 218
Soot Q, 153
Tin, inorg. A
Tin, org. A
Welding smoke A, Q, 135, 136, 137, 138, 154, 155, 156, 218
Wolfram 102
Wood dust A, 130
Zinc A
Zinc oxide A

39. Other manufacturing industries

Aluminium A
Aluminium oxide A
Cadmium and inorg. comp. A
Chromium and chromates A
Copper A
Epoxy dust A
Iron oxide A
Lead A
Manganese A
Mineral dust A
MMMF A
Nickel A
Organic dust A
Tin, inorg. A
Tin, org. A
Total dust A
Welding smoke A
Zinc oxide A

Major division 4. Electricity, gas and water

41. Electricity, gas and steam

Asbestos A, 159
Beryllium 159
Chromium and chromates 159
Coal dust 160, 219
Coal tar fumes 161
Copper A
Fly ash (pulverized fuel ash) Q, 162, 163, 164
Iron oxide A
Lead A, 164
Mineral dust A
MMMF A
Nickel 164, 159
Organic dust
PAH 159, 165
PCB 159
Quartz A
Respirable dust A
Welding smoke 219
Zinc oxide A

Major division 5. Construction

50. Construction

Arsenic compounds A
Asbestos A, Q, 167, 168, 169, 170
Asphalt A
Bitumen fumes 46, 172
Cement dust Q, 220, 221
Chromium and chromates A
Copper A
Iron oxide A
Lead A
Manganese A
Mica 15
Mineral dust A
MMMF A, Q, 173, 220
Organic dust A
Quartz A, 33
Wood dust A, Q

Major division 6. Wholesale and retail trade and restaurants and hotels

61. Wholesale trade

Copper A
Iron oxide A
Lead A
Manganese A
Mineral dust A
MMMF A
Organic dust A
Respirable dust A
Selenium A
Zinc oxide A

63. Hotels, rooming houses, etc.

PAH 203

Major division 7. Transport, storage and communication

71. Transport and storage

Aflatoxins 14, 3
Asbestos 131, 174
Chromium and chromates A
Copper A
Dust 175, 176, 202, 222, 223
Grain dust 177
Iron oxide A
Lead A, 176
Mineral dust A
MMMF A
Organic dust A
PAH 176
Quartz A
Zinc oxide A

Major division 8. Financing, insurance, real estate and business services

83. Real estates and business services

Organic dust 16, 224
Quartz A

Major division 9. Community, social and personal services

91. Public administration and defence

Arsenic compounds A
Asbestos A
Chromium and chromates A
Copper A
Fibres, non MMMF A
Iron oxide A
Lead A
Mineral dust A
MMMF A
Organic dust A
Selenium A
Tin, inorg. A
Total dust A
Wood dust A
Zinc oxide A

92. Sanitary and similar services

Bacteria (viruses) Q, 179, 180
Chromium and chromates A
Copper A
Dust Q, 225
Fluorides A
Iron oxide A
Lead A
Mineral dust A
MMMF A
Organic dust 16
Quartz A
Respirable dust A
Zinc oxide A

93. Social and related community services

Asbestos A
Cadmium and inorg. comp. A
Chromium and chromates A
Copper A
Fibres, non MMMF A
Fluorides A
Insecticides and pesticides 181
Iron oxide A
Lead A
Manganese A
Mineral dust A
MMMF A
Nickel A
Organic dust A
Quartz A
Respirable dust A

Tin, inorg. A
Total dust A
Welding smoke A
Wood dust A
Zinc oxide A

94. Recreational and cultural services

Copper A
Lead A
Mineral dust A
PAH A
Total dust A
Zinc oxide A

95. Personal and household services

Antimony A
Asbestos A, 182, 183
Cadmium and inorg. comp. A
Chromium and chromates A, 185
Copper A
Iron oxide A
Lead A, 146, 63, 145, 185
~~Mineral dust A~~
~~MMMF A~~
Organic dust A
Quartz A
Tin, org. A
Zinc oxide A

Table 8.2

References, Liquid Aerosols

Major division 1. Agriculture, hunting, forestry and fishing

None

Major division 2. Mining and quarrying

None

Major division 3. Manufacturing

31. Manufacture of food, beverages and tobacco

Cleaning agents Q, 35, 36, 207, 208
Cooking fumes 209

Mineral oil Q
Sodium hydrogen sulfite Q

32. Textile, weaving apparel

MDI A
Mineral oil A
α-Pinen A
TDI A

33. Manufacture of wood and wood products, including furniture

Arsenicals Q
Chromates Q

MDI A
Mineral oil A

Spray painting Q

34. Manufacture of paper and paper products; printing and publishing

Ink mist 186

Mineral oil A

Sulfuric acid A
TDI A

35. Manufacture of chemicals and chemical, petroleum, coal, rubber and plastic products

Fatty acids Q
Hydrochloric acid Q
MDI A
Pesticides Q
Phthalate esters 187, 188
Soot
Spray painting Q
Sulfuric acid Q
TDI A

36. Manufacture of non-metallic mineral products, except products of petroleum and coal

Ceramic materials	Q
Cobalt aluminate	Q, 215
Concrete dust	Q
Copper	Q
MDI	A
Mineral oil	Q
Silicone oils	Q
TDI	A

37. Basic metal industries

MDI A

Oil mist 189

Silicone oil mist Q

38. Manufacture of fabricated metal products, machinery and equipment

Borine compounds	36, 149
Cleaning agents	Q, 36, 149, 218, 227
Cutting oils	190, 191, 92, 193
Dust	Q
1.6-hexyldiisocyanate	A
Hydrochloric acid	Q
Lubricants	190
MDI	A
Mineral oil	A, Q
NTA (nitrilotriacetic acid)	149, 35, 36
Oil mist	189, 191
Spray painting	185, 194
Sulfuric acid	Q, A
TDI	A
Triethanolamine	149

39. Other manufacturing industries

MDI A

Major division 4. Electricity, gas and steam

41. Electricity, gas and steam

MDI A

PCB's 195, 196

Major division 5. Construction

50. Construction

1.6-hexyldiisocyanate A

MDI A

Mineral oil	A, Q
Polyurethanes	Q, 197
Spray painting	Q, 185, 194

Major division 6. Wholesale and retail trade and restaurants and hotels

None

Major division 7. Transport, storage and communication

71. Transport and storage

Cleaning agents Q

Organic solvents Q
Oxalic acid 175

Spray painting Q, 185, 194

Major division 8. Financing, insurance, real estate and business services

None

Major division 9. Community, social and personal services

91. Public administration and defence

1.6-hexyldiisocyanate A, 197

MDI A, 197

TDI A, 197

92. Sanitary and similar services

Bacteria (viruses) Q, 179, 180

Cleaning agents 35, 36, 226

93. Social and related community services

Ink aerosol 198
MDI A
Mineral oil A, Q
Sulfuric acid A
TDI A

94. Recreational and cultural services

Mineral oil A

95. Personal and household services

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CHAPTER 9

DISCUSSION AND CONCLUSIONS

9.1 The Importance of Solid and Liquid Aerosols in the Working Environment

Solid as well as liquid aerosols occur frequently in the working environment.

They can consist of substances of different nature and chemistry having different toxicological effects. Some substances are highly toxic and can give rise to acute intoxications after short-term exposure, while other substances have cronic effects which are induced only after long-term exposure.

The present study, however, has not been concerned with a grading of the toxicological properties of aerosols in the working environment. Its only concern has been to attemt to give a survey of the solid and liquid aerosols one can expect to find in the working environment, whether these occur frequently or less frequently, and whether rather few or many workers are potentially exposed to these aerosols.

The survey given in Chapter 4 gives information on which aerosols one can expect to find in the working environment. A total of 146 solid aerosols and 41 liquid aerosols have been reported present in the working environment. Among the liquid aerosols, 15 were reported as being water based, and 4 additional ones as being water based occasionally.

It is likely that it will be asked why relatively few liquid aerosols have been described in literature and elsewhere as compared to the number of solid aerosols.

There may be several possible reasons for that:

1) The number of liquid aerosols in the working environment is actually much smaller than the number of solid aerosols, and this fact is reflected in the smaller number of liquid aerosols reported.

2) The existence of a number of different liquid aerosols in the working environment has not been reported because:

   a) their existence has not yet been recognized or
   b) their existence has been recognized, but measurements have not been made, because these aerosols in many cases are more difficult to measure than solid aerosols.

We think, based on our findings as presented here, that actually the number of liquid aerosols is much smaller than the number of solid aerosols.

We also think that the existence of some liquid aerosols has not yet been realized, but this will also apply to some degree to the solid aerosols.

From the answers received in the questionnaires, it is also clear that a number of liquid aerosols have been realized as existing, but measurements have not been carried out, because the aerosols are short-lived due to e.g. fast evaporation, and therefore need advanced analytical measuring equipment for their characterization.

We therefore conclude that solid aerosols constitute a greater hazard in the working environment, solely because their number far exceeds the number of liquid aerosols.

The exposure indeces as calculated and presented in Chapter 5 gives an indication of the probability of exposure to each of the aerosols listed, and to solid aerosóls and liquid aerosols taken as separate groups and compared to one another. The total exposure index for solid aerosols calculated in per cent of the total exposure index for all aerosols is 75.6, and the corresponding total exposure index for liquid aerosols is 24.6.

We think that these figures indicate that the number of situations where workers in the manufacturing industry are exposed to solid aerosols in their working environment far exceeds the number of situations where they are exposed to liquid aerosols.

We also think that the magnitude of the exposure indeces indicates that exposure to solid aerosols will occur approx. three times as frequently as exposure to liquid aerosols in the manufacturing industry.

9.2 Selection and Use of Respirators for Protection against Aerosol Hazards

As referred to in Chapter 5, the present draft for a European standard for particle filters (reference 1) allows for a subclassification of filters in two groups, one containing filters for protection against solid aerosols, including water based aerosols, and one containing filters for protection against solid and liquid aerosols in general.

Referring to the discussion in Section 1.5 we think that the results of the present investigation support the idea of having this subclassification for the particle filters.

One argument against this subclassification has been that it may be difficult for the user to make an assessment of the aerosol hazard facing him, and therefore it may be difficult for him to choose the right filter.

This may be true to some degree, but we are of the opinion that, referring to Table 4.9 and Fig. 1, there is a great danger that on many occasions where liquid aerosols are present in the working environment there will be additional risk of inhalation of gases or vapours. In these situations, combined filters should be used instead of only particle filters, and we think that neglect of this fact is a bigger problem than generally anticipated, and it may well be a bigger problem for the user than the problem of estimating whether an aerosol consists of solid particles or liquid particles.

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ANNEX 1

INDEXES TO THE INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION OF ALL ECONOMIC ACTIVITIES

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
			Major Division 1. Agriculture, Hunting, Forestry and Fishing		
11			Agriculture and Hunting	01, 03	Excluded are cemetery upkeep; veterinary services and animal hospitals and care centres; and leasing and renting out of agricultural machinery and equipment.
	111	1110	Agricultural and livestock production	011	Landscape gardening is included.
	112	1120	Agricultural services	012	Landscape gardening; cemetery upkeep; veterinary services and animal hospitals and care centres; and leasing and renting out of agricultural equipment and machinery without drivers are excluded.
	113	1130	Hunting, trapping and game propagation	030	
12			Forestry and Logging	02	
	121	1210	Forestry	021	
	122	1220	Logging	022	
13	130		Fishing	04	Excluded are factory-type vessels engaged in processing only which can be treated as separate establishments.
		1301	Ocean and coastal fishing	041, 042	Excluded are factory-type vessels engaged in processing only, i.e., not also catching and taking fish, crustacea and other ocean and coastal water products, which can be treated as separate establishments; and the operation of cultivated oyster, pearl and laver beds and farms.
		1302	Fishing not elsewhere classified	043	The operation of cultivated oyster, pearl and laver beds and farms is included.
			Major Division 2. Mining and Quarrying		Excluded in the case of each of the groups of this major division are the activities performed on a fee or contract basis, of developing and preparing mineral properties and sites or prospecting for minerals.
21	210	2100	Coal Mining	110	Included is the agglomeration, at the mining site, of coal or lignite into briquettes and packaged fuels.
22	220	2200	Crude Petroleum and Natural Gas Production	130	
23	230		Metal Ore Mining	12	
		2301	Iron ore mining	121	
		2302	Non-ferrous metal ore mining	122	
29	290		Other Mining	14, 19	
		2901	Stone quarrying, clay and sand pits	140	
		2902	Chemical and fertilizer mineral mining	192	
		2903	Salt mining	191	
		2909	Mining and quarrying not elsewhere classified	199	
			Major Division 3. Manufacturing		
31			Manufacture of Food, Beverages and Tobacco		
	311-312		Food manufacturing	20, 312	
		3111	Slaughtering, preparing and preserving meat	201	The fabrication of meat pies and puddings is included
		3112	Manufacture of dairy products	202	
		3113	Canning and preserving of fruits and vegetables	203	
		3114	Canning, preserving and processing of fish, crustacea and similar foods	204	Included are factory-type vessels engaged in the processing only of fish, crustacea and other ocean and coastal water products which can be treated as separate establishments

Present version of ISIC				Corresponding major group and group(s) of preceding version of the ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
		3115	Manufacture of vegetable and animal oils and fats	312 and part of 209	The part of 209 consists of the manufacture of olive oil, margarine, compound cooking fats and blended table and salad
		3116	Grain mill products	205	
		3117	Manufacture of bakery products	206	The manufacture of macaroni, spaghetti, noodles and similar products is included.
		3118	Sugar factories and refineries	207	
		3119	Manufacture of cocoa, chocolate and sugar confectionery	208	
		3121	Manufacture of food products not elsewhere classified	209	Excluded are the manufacture of meat pies and puddings;olive oil, margarine, compound cooking fats and table and salad oils; and of prepared feeds for animals and fowl.
		3122	Manufacture of prepared animal feeds	Part of 209	
	313		Beverage industries	21	Excluded is ethyl alcohol distilled from sulphite residues of pulp manufacturing; included is the bottling of natural spring and mineral water at the source.
		3131	Distilling, rectifying and blending spirits	211	Excluded is ethyl alcohol distilled from sulphite residues of pulp manufacturing
		3132	Wine industries	212	
		3133	Malt liquors and malt	213	
		3134	Soft drinks and carbonated waters industries	214	The bottling of natural spring and mineral waters at the source i included.
	314	3140	Tobacco manufactures	220	
32			Textile, Wearing Apparel and Leather Industries		
	321		Manufacture of textiles	23, 244	Excluded are the repair services listed below, in respect of each group.
		3211	Spinning, weaving and finishing textiles	231	Excluded is the manufacture of woven carpets and rugs
		3212	Manufacture of made-up textile goods except wea ing apparel	244	Excluded is the repair for the general public of the household made-up textile goods of this group.
		3213	Knitting mills	232	Excluded are establishments primarily engaged in the repair of knit wear for the public.
		3214	Manufacture of carpets and rugs	Part of 231, part of 239	Excluded is the repair of carpets, rugs and mats for the general public
		3215	Cordage, rope and twine industries	233	
		3219	Manufacture of textiles not elsewhere classified	239	Excluded is the manufacture of unwoven carpets and rugs and mats and matting, except of rubber. Included is the manufacture of linoleum and other hard-surfaced floor covering (excluding rubber, plastic or cork) irrespective of type of backing material.
	322	3220	Manufacture of wearing apparel, except footwear	243	The manufacture of umbrellas and canes and the repair of wearing apparel for the general public, are excluded.
	323		Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel	29	Establishments specializing in the repair of luggage, handbags and other leather goods for the public, are excluded.
		3231	Tanneries and leather finishing	291	
		3232	Fur dressing and dyeing industries	292	
		3233	Manufacture of products of leather and leather substitutes, except footwear and wearing apparel		Establishments specializing in the repair of luggage, handbags and other leather goods for the general public, are excluded.
	324	3240	Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear	241	The production of footwear by moulding plastic material and the manufacture of footwear made entirely of wood are excluded.
33			Manufacture of Wood and Wood Products, Including Furniture	25	Includes the manufacture of footwear made entirely of wood
	331		Manufacture of wood and wood and cork products, except furniture		

Present version of ISIC				Corresponding major group and group(s) of preceding version of the ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
		3311	Sawmills, planing and other wood mills	251	
		3312	Manufacture of wooden and cane containers and small cane ware	252	
		3319	Manufacture of wood and cork products not elsewhere classified	259	Includes the manufacture of footwear made entirely of wood
	332	3320	Manufacture of furniture and fixtures, except primarily of metal	260	Excluded are the manufacture of furniture and fixtures primarily of metal and the production of moulded plastic furniture
34			Manufacture of Paper and Paper Products; Printing and Publishing		
	341		Manufacture of paper and paper products	27	
		3411	Manufacture of pulp, paper and paperboard	271	The manufacture of off-machine coated, glazed, gummed and laminated paper is excluded.
		3412	Manufacture of containers and boxes of paper and paperboard	Part of 272	
		3419	Manufacture of pulp, paper and paperboard articles not elsewhere classified	272	Excludes the manufacture of containers, boxes and bags of paper and paperboard.
	342	3420	Printing, publishing and allied industries	280	
35			Manufacture of Chemicals and Chemical, Petroleum, Coal, Rubber and Plastic Products		
	351		Manufacture of industrial chemicals	311, part of 319	The manufacture of white spirit and composite thinners is excluded; the manufacture of ethyl alcohol from sulphite residues of pulp manufacturing is included.
		3511	Manufacture of basic industrial chemicals except fertilizer	Part of 311	The manufacture of white spirits and composite thinners is excluded; the manufacture of ethyl alcohol from sulphite residues of pulp manufacturing is included.
		3512	Manufacture of fertilizers and pesticides	Part of 311, part of 319	
		3513	Manufacture of synthetic resins, plastic materials and man-made fibres except glass	Part of 311	
	352		Manufacture of other chemical products	313, 319	The manufacture of composite thinners is included.
		3521	Manufacture of paints, varnishes and lacquers	313	The manufacture of composite thinners is included.
		3522	Manufacture of drugs and medicines	Part of 319	
		3523	Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations	Part of 319	
		3529	Manufacture of chemical products not elsewhere classified	Part of 319	Included is the manufacture of prepared photo-chemical materials and sensitized film, paper and cloth.
	353	3530	Petroleum refineries	321	The manufacture of white spirits is included.
	354	3540	Manufacture of miscellaneous products of petroleum and coal	329	Excludes the manufacture of coal and lignite briquettes and packaged fuels at mining sites. Includes coke ovens in iron and steel works which it is feasible to treat as separate establishments.
	355		Manufacture of rubber products	30	
		3551	Tyre and tube industries	Part of 300	
		3559	Manufacture of rubber products not elsewhere classified	Part of 300	
	356	3560	Manufacture of plastic products not elsewhere classified	Part of 399 and certain activities from a number of other groups.	
36			Manufacture of Non-Metallic Mineral Products, except Products of Petroleum and Coal		
	361	3610	Manufacture of pottery, china and earthenware	333	

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
	362	3620	Manufacture of glass and glass products	332	
	369		Manufacture of other non-metallic mineral products	331, 334, 339	
		3691	Manufacture of structural clay products	331	
		3692	Manufacture of cement, lime and plaster	334	Included is the manufacture of Keene's and similar cement and of lime and plaster
		3699	Manufacture of non-metallic mineral products not elsewhere classified	339	Excluded is the manufacture of Keene's and similar cement lime and plaster.
37			Basic Metal Industries		
	371	3710	Iron and steel basic industries	341	Excluded are coke ovens in iron and steel works which it is feasible to treat as separate establishments.
	372	3720	Non-ferrous metal basic industries	342	
38			Manufacture of Fabricated Metal Products, Machinery and Equipment		
	381		Manufacture of fabricated metal products, except machinery and equipment	35, part of 26	Excluded are the manufacture of small arms and accessories and specialized repair and servicing of hand tools, locks and other hardware, and cutlery for the general public. Included are the manufacture of small metal ware; and the production of machinists' precision hand tools.
		3811	Manufacture of cutlery, hand tools and general hardware	Part of 350	Excluded are the specialized repair and servicing of hand tools locks and other hardware and cutlery for the general public. Included is the manufacture of machinists' precision hand tools
		3812	Manufacture of furnitures and fixtures primarily of metal	Part of 260	
		3813	Manufacture of structural metal products	Part of 350	
		3819	Manufacture of fabricated metal products except machinery and equipment not elsewhere classified	Part of 350	Excluded is the manufacture of small arms and accessories. Included is the manufacture of small metal ware.
	382		Manufacture of machinery except electrical	36	Included are the fabrication and assembly of digital and analog computers, and accessories; the manufacture of small arms and accessories; and the production of all engines and turbines which are not made in establishments mainly engaged in manufacturing transport equipment or in manufacturing specialized engines and turbines for given types of transport equipment. Excluded are the production of vacuum cleaners, floor polishers and waxers and of certain electrical household cooking and laundry equipment; establishments specializing in the repair, servicing and installation of household refrigerators, household washing machines and laundering equipment, household cooking equipment, etc. and of typewriters for the general public; and the production of machinists' precision hand tools.
		3821	Manufacture of engines and turbines	Part of 360	Included is the production of all engines and turbines which are not made in establishments mainly engaged in manufacturing transport equipment or in manufacturing specialized engines and turbines for given types of transport equipment.
		3822	Manufacture of agricultural machinery and equipment	Part of 360	
		3823	Manufacture of metal and wood working machinery	Part of 360	Excluded is the manufacture of machinists' precision hand tools
		3824	Manufacture of special industrial machinery and equipment except metal and wood working machinery	Part of 360	
		3825	Manufacture of office, computing and accounting machinery	Part of 360	Included is the fabrication and assembly of digital and analog computers and accessories. Excluded is the repair of typewriters for the general public.
		3829	Machinery and equipment except electrical not elsewhere classified	Part of 360	Included is the manufacture of small arms and accessories. Excluded are the production of vacuum cleaners, floor polishers and waxers and certain electrical household cooking equipment; and establishments specializing in the repair, servicing and installation of household refrigerators, household washing machines and laundering equipment, household cooking equipment, etc.
	383		Manufacture of electrical machinery apparatus, appliances and supplies	37	Included are the manufacture of vacuum cleaners, floor polishers and waxers and certain electrical household cooking equipment; and the production of gramophone records and pre-recorded magnetic tapes. Excluded are the fabrication and assembly of

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
					digital and analog electronic computers and accessories and establishments specializing in the repair, servicing and installation of radio and television sets, gramophones, tape recorders and household and personal electrical appliances for the general public.
		3831	Manufacture of electrical industrial machinery and apparatus	Part of 370	
		3832	Manufacture of radio, television and communication equipment and apparatus	Part of 370	Excluded are the fabrication and assembly of digital and analog electronic computers and accessories; and establishments specializing in the repair, servicing and installation of radio and television sets, gramophones and tape recorders for the general public. Included is the production of gramophone records and pre-recorded magnetic tapes.
		3833	Manufacture of electrical appliances and housewares	Part of 370	Included is the manufacture of vacuum cleaners, floor polishers and waxers and certain household cooking equipment. Excluded are establishments specializing in the repair of household and personal electrical appliances for the general public.
		3839	Manufacture of electrical apparatus and supplies not elsewhere classified	Part of 370	
	384		Manufacture of transport equipment	38	Excluded are group 384 (Repair of motor vehicles) and the repair of motorcycles, bicycles and other vehicles for the general public. The manufacturing of engines and turbines for transport equipment is covered in the categories of the major group only if carried on in establishments primarily engaged in fabricating and assembling the specified transport equipment or in producing specialized engines or turbines for the specified transport equipment.
		3841	Shipbuilding and repairing	381	
		3842	Manufacture of railroad equipment	382	
		3843	Manufacture of motor vehicles	383	
		3844	Manufacture of motorcycles and bicycles	385	Excluded are establishments specializing in the repair of motorcycles and bicycles for the general public.
		3845	Manufacture of aircraft	386	
		3849	Manufacture of transport equipment not elsewhere classified	389	Excluded are establishments engaged in the repair of baby carriages, sleighs, etc..
	385		Manufacture of professional and scientific and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods	391, 392, 393	Excluded are the production of photo-chemical materials and sensitized film plates and paper; and establishments specializing in the repair of cameras, binoculars and photographic equipment, and watches and clocks for the general public
		3851	Manufacture of professional and scientific, and measuring and controlling equipment not elsewhere classified	391	
		3852	Manufacture of photographic and optical goods	392	Excluded are the production of photo-chemical materials and sensitized film, plates and paper; and establishments specializing in the repair of cameras, binoculars and photographic equipment for the general public.
		3853	Manufacture of watches and clocks	393	Excluded are establishments specializing in the repair of watches and clocks for the general public
39	390		Other Manufacturing Industries	394, 395, 399	Excluded are the moulding and extruding of plastic goods; the fabrication of small metal ware; the production of gramophone records and pre-recorded magnetic tapes; and establishments primarily engaged in repairing jewellery, musical instruments, athletic goods, toys, fountain pens, etc. for the general public. Included is the production of umbrellas and canes.
		3901	Manufacture of jewellery and related articles	394	Excluded are establishments primarily engaged in the repair of jewellery.
		3902	Manufacture of musical instruments	395	Excluded are the production of gramophone records and pre-recorded magnetic tapes; and establishments primarily engaged in the repair of musical instruments for the general public.
		3903	Manufacture of sporting and athletic goods	Part of 399	Excluded are the production of these goods by moulding or extruding plastic materials; and the repair of sporting and athletic goods for the general public.
		3909	Manufacturing industries not elsewhere classified	Part of 399	Excluded are the production of the goods by moulding or extruding plastic materials; and the repair of the goods for the general public

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
			Major Division 4. Electricity, Gas and Water		
41	410		**Electricity, Gas and Steam**	51	Included are establishments which sell a significant amount of electricity to others, as well as produce electricity for the parent enterprise.
		4101	**Electric light and power**	511	Included are establishments which sell a significant amount of electricity to others, as well as produce electricity for the parent enterprise.
		4102	**Gas manufacture and distribution**	512	
		4103	**Steam and hot water supply**	513	
42	420	4200	**Water Works and Supply**	521	
			Major Division 5. Construction		
50	500	5000	**Construction**	400	Included are the activities of preparing and constructing mining sites and drilling crude oil and natural gas wells on a fee or contract basis; and unit of enterprises which are primarily engaged in construction and which can be separately reported.
			Major Division 6. Wholesale and Retail Trade and Restaurants and Hotels		
61	610	6100	**Wholesale Trade**	611	Excluded is the bottling of spring and mineral water at the source.
62	620	6200	**Retail Trade**	612	Included is the renting of household and personal goods to the general public.
63			**Restaurants and Hotels**		
	631	6310	**Restaurants, cafés and other eating and drinking places**	852	Included are establishments and institutions and catering services operated as independent businesses and eating and drinking facilities in plants and offices which can be separately reported.
	632	6320	**Hotels, rooming houses, camps and other lodging places**	853	
			Major Division 7. Transport, Storage and Communication		
71			**Transport and Storage**		
	711		**Land transport**	711-714, 719	Excluded are dining-car services operated as an independent business and ambulance services. Included is the leasing and rental of railroad cars.
		7111	**Railway transport**	711	Included are suburban railroads. Excluded is dining-car services operated as an independent business.
		7112	**Urban, suburban and inter-urban highway passenger transport**	712	Excluded are suburban railroads.
		7113	**Other passenger land transport**	713	Excluded are the rental of automobiles without drivers; and ambulance services
		7114	**Freight transport by road**	Part of 714	
		7115	**Pipeline transport**	719	
		7116	**Supporting services to land transport**	Part of 714	Included are the rental of automobiles without drivers; and the leasing and rental of railroad cars.
	712		**Water transport**	715, 716	Included is the leasing and rental of ships.
		7121	**Ocean and coastal water transport**	715, part of 716	
		7122	**Inland water transport**	Part of 716	
		7123	**Supporting services to water transport**	Part of 716	Included is the leasing and rental of ships.
	713		**Air transport**	717	Included is the leasing and rental of aircraft
		7131	**Air transport carriers**	Part of 717	
		7132	**Supporting services to air transport**	Part of 717	Included is the leasing and rental of aircraft
	719		**Services allied to transport**	718, 72	Excluded are the leasing and rental of railroad cars, ships and aircraft.
		7191	**Services incidental to transport**	718	Excluded are the leasing and rental of railroad cars, ships and aircraft
		7192	**Storage and warehousing**	720	
72	720	7200	**Communication**		

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
			Major Division 8. Financing, Insurance, Real Estate and Business Services		
81	810		Financial Institutions	62	
		8101	Monetary institutions	Part of 620	
		8102	Other financial institutions	Part of 620	
		8103	Financial services	Part of 620	
82	820	8200	Insurance	630	
83			Real Estate and Business Services		
	831	8310	Real estate	640	
	832		Business services except machinery and equipment rental and leasing	83	Included are establishments primarily engaged in geological surveys and prospecting on a fee or contract basis. Excluded are the leasing and rental of machinery and equipment; and authors, music composers and other artists who work on own account (are self-employed).
		8321	Legal services	831	Included are notaries public.
		8322	Accounting, auditing and bookkeeping services	832	Excluded are establishments primarily engaged in data processing and tabulating services of a general character on a fee or contract basis.
		8323	Data processing and tabulating services	Part of 832	
		8324	Engineering, architectural and technical services	833	Included are establishments primarily engaged in geological surveys and prospecting on a fee or contract basis.
		8325	Advertising services	Part of 839	
		8329	Business services, except machinery and equipment rental and leasing, not elsewhere classified	Part of 839	Excluded are notaries public; and authors, music composers and other artists who work on own account (are self-employed).
	833	8330	Machinery and equipment rental and leasing	Part of 839	Included is the rental and leasing of agricultural machinery and equipment.
			Major Division 9. Community, Social and Personal Services		
91	910	9100	Public Administration and Defence	810	
92	920	9200	Sanitary and Similar Services	522	Included are char, chimney and window cleaning, janitor, exterminating, fumigating and disinfecting, and similar services.
93			Social and Related Community Services		
	931	9310	Education services	821	
	932	9320	Research and scientific institutes	823	
	933		Medical, dental, other health and veterinary services	822, part of 012	Included are ambulance services
		9331	Medical, dental and other health services	822	Included are ambulance services
		9332	Veterinary services	Part of 012	
	934	9340	Welfare institutions	825	
	935	9350	Business, professional and labour associations	826	
	939		Other social and related community services	824, 829	
		9391	Religious organizations	824	
		9399	Social and related community services not elsewhere classified	829	
94			Recreational and Cultural Services		
	941		Motion picture and other entertainment services	841 - 842	Included are authors, music composers and artists who work on own account (are self-employed).
		9411	Motion picture production	Part of 841	
		9412	Motion picture distribution and projection	Part of 841	
		9413	Radio and television broadcasting	Part of 842	Excluded are entertainers and producers of programmes for radio and television who work on own account.

Present version of ISIC				Corresponding major group and group(s) of preceding version of ISIC	Differences in scope of major groups and groups between present and preceding version of ISIC
Division	Major group	Group	Title of category		
		9414	Theatrical producers and entertainment services	Part of 842	Excluded are actors, entertainers and directors of plays who work on own account.
		9415	Authors, music composers, and other independent artists not elsewhere classified	Part of 839, part of 842	
	942	9420	Libraries, museums, botanical and zoological gardens, and other cultural services not elsewhere classified	827	
	949	9490	Amusement and recreational services not elsewhere classified	845	Included is the operation of football, racing and similar pools
95			Personal and Household Services		
	951		Repair services not elsewhere classified	242, 384, parts of certain other groups	
		9511	Repair of footwear and other leather goods	242, part of 293	
		9512	Electrical repair shops	Part of 370 and of 360	
		9513	Repair of motor vehicles and motorcycles	384, part of 385	
		9514	Watch, clock and jewellery repair	Part of 333 and of 394	
		9519	Other repair shops not elsewhere classified	Parts of 350, 392, 395 and 399	
	952	9520	Laundries, laundry services, and cleaning and dyeing plants	854	Included are the parts of 243, 244 and 252 consisting of the specialized repair of wearing apparel and household textiles for the general public.
	953	9530	Domestic services	851, part of 859	
	959		Miscellaneous personal services	855, 856 and part of 859	Excluded are rental of household and personal goods to the gene public; char, chimney and window cleaning, disinfecting and exterminating and janitorial services, operation of football, racing and similar pools; and domestic services furnished by business establishments. Included is the upkeep of cemeteries.
		9591	Barber and beauty shops	855	
		9592	Photographic studios, including commercial photography	856	
		9599	Personal services not elsewhere classified		Excluded are rental of household and personal goods to the gene public; char, chimney and window cleaning, disinfecting and exterminating and janitorial services, operation of football, racing and similar pools; and domestic services furnished by business establishments. Included is the upkeep of cemeteries
96	960	9600	International and Other Extra-Territorial Bodies		
	Major Division 0. Activities not Adequately Defined				
0	000	0000	Activities not adequately defined.		

ANNEX 2

MANUFACTURING EMPLOYMENT IN DENMARK

Tabel 8. Antal virksomheder, antal beskæftigede (årsgennemsnit), antal arbejdstimer og lønudgift i industrien 1984

ISIC 1968	Industrigruppe	Antal virksomheder 1	Antal beskæftigede: I alt (3+4+5) 2	Antal beskæftigede: Indehavere 3
29	**Råstofudvinding[2]**	**82**	**1 127**	**20**
29011, 13	Grusgrave, stenbrud, kalk- og kridtbrud	72	779	17
29030, 90	Saltudvinding og anden ikke- metallisk råstofudvinding	10	348	3
3	**Industri i alt**	**6 735**	**379 477**	**1 444**
31	**Nærings- og nydelsesmiddelindustri**	**841**	**75 331**	**113**
31111	Svineslagterier inkl. tilhørende kødkonservesafd. og pølsemagerier	59	16 849	–
31112	Kødvare- og kødkonservesfabrikker	36	3 964	4
31113, 15	Kreaturslagterier og talgsmelterier	17	844	14
31117	Fjerkræslagterier	20	1 675	4
31121	Mejerier	186	7 176	8
31122	Smelteostfabrikker	16	702	2
31123	Mælkekondenseringsfabrikker	15	1 430	–
31124	Konsumisfabrikker	16	1 138	–
31130	Grønt- og frugtkonservesfabrikker	47	2 756	1
31141	Røgning og saltning af fisk	20	620	4
31142	Fiskehermetik-, fiskefars- og fiskeldetfabrikker (inkl. dybfrysning af fisk)	83	8 015	14
31151, 62	Oliemøller og margarinefabrikker	[illegible]	[illegible]	[illegible]
31153	Fiskemelsfabrikker	[illegible]	[illegible]	[illegible]
31154	Destruktionsanstalter og kødmoderfabrikker	[illegible]	[illegible]	[illegible]
31160	Møller	15	1 214	–
31171	Brødfabrikker	41	1 749	14
31172–73, 79	Kiks-, vaffel- og kagefabrikker samt anden fremstilling af bagervarer	29	2 356	13
31180	Sukkerfabrikker og -raffinaderier	7	2 351	–
31190	Chokolade- og sukkervarefabrikker	31	3 743	14
31211	Kartoffelmels- og andre stivelsesfabrikker	7	427	–
31219	Fremstilling af næringsmidler i øvrigt	48	1 786	10
31220	Fremstilling af færdige foderstoffer	49	1 005	3
31310	Sprit- og likørfabrikker	6	755	–
31330	Bryggerier og maltfabrikker	27	8 488	–
31340	Mineralvandsfabrikker	15	761	5
31400	Tobaksfabrikker	14	2 146	–
32	**Tekstil-, beklædnings- og læderindustri**	**717**	**29 512**	**222**
32111	Uldspinderier og -væverier	15	735	2
32112	Bomuldsspinderier og -væverier	14	1 064	2
32113	Fremstilling af garner og stoffer af kemofibre	12	1 774	–
32115–16	Andre spinderier og væverier i øvrigt	10	307	2
32117	Tekstilfarverier og -imprægneringsfabrikker	14	900	–
32123	Flag- og teltfabrikker (inkl. sejlmagerier)	27	648	4
32124	Fremstilling af gardiner, sengetæpper og linned	11	228	7
32121, 29	Tekstilvareindustri i øvrigt	41	1 226	7
32130	Trikotagefabrikker	164	5 609	73
32140	Tæppefabrikker	19	1 114	4
32151	Reblagerier	7	379	–
32152	Fiskenetfabrikker	18	378	2
32190	Anden tekstilindustri	7	265	–
32211	Herrekonfektionsfabrikker	54	3 081	10
32212	Kjolekonfektionsfabrikker	122	4 354	43
32213	Konfektionsfabrikker for dameovertøj	44	2 224	17
32214	Skjortefabrikker	6	238	–
32215, 19	Konfektionsindustri i øvrigt	45	1 175	20
32294	Buntmagerier	13	435	3
32293, 95–96, 99	Anden beklædningsindustri i øvrigt	7	123	3
32310	Garverier	7	360	2
32330	Lædervarefabrikker	26	732	9
32401	Skofabrikker	18	1 671	6
32403	Træskofabrikker	13	276	6
32409	Skoindustri i øvrigt	3	216	–

Anm. Antal virksomheder ekskl. hjælpeenheder. Antal beskæftigede og arbejdstimer inkl. hjælpeenheder, ekskl. hjemmearbejdere.
[1] Som følge af afrunding kan summen af de enkelte tal afvige fra de i tabellen anførte totaler. [2] Ekskl. olieudvinding og -efterforskning

Antal beskæftigede		Arbejdstimer for arbejdere[1]	Lønudgift			
Funktionærer	Arbejdere		I alt (8 + 9 + 10)	Funktionærer	Arbejdere	Hjemmearbejdere m.m.
4	5	6	7	8	9	10
		1 000	1 000 kr.			
286	821	1 510	164 327	49 291	114 365	671
187	575	1 058	110 745	30 475	79 660	610
99	246	451	53 582	18 816	34 705	61
110 968	267 065	446 025	55 761 781	20 279 342	35 160 322	322 117
16 720	58 498	97 189	11 135 466	3 040 023	8 079 050	16 393
2 323	14 526	24 159	2 569 733	398 680	2 170 954	99
611	3 149	5 542	620 982	147 484	473 169	329
138	692	1 235	145 215	25 793	119 113	309
208	1 463	2 289	191 915	34 787	156 894	234
1 200	5 968	11 298	1 090 958	203 883	883 575	3 500
109	591	1 025	90 676	18 108	72 022	546
462	968	1 802	224 041	80 223	143 749	69
364	774	1 399	176 347	61 541	114 609	197
1 018	1 737	3 001	395 437	173 727	220 465	1 245
116	500	779	77 373	21 343	55 767	263
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
188	494	999	121 950	35 782	85 875	313
76	294	562	65 150	14 291	50 826	33
480	734	1 270	187 772	87 101	100 019	652
318	1 417	2 565	279 911	56 810	221 193	1 908
434	1 909	2 939	291 486	75 329	215 920	237
607	1 744	3 010	328 174	112 846	215 328	-
1 378	2 351	3 752	515 904	235 517	277 619	2 768
209	218	372	76 182	40 606	35 499	77
819	957	1 631	261 169	140 892	119 973	304
351	651	1 243	158 078	63 535	93 927	516
351	404	652	123 968	64 470	58 495	1 003
2 122	6 366	10 255	1 485 131	465 405	1 019 718	8
206	550	933	117 228	35 178	81 950	100
508	1 638	2 587	294 114	94 737	199 334	43
5 969	23 321	36 266	3 464 885	995 267	2 397 720	71 898
112	621	1 042	102 936	19 483	83 356	97
274	788	1 224	139 700	48 385	91 251	64
459	1 315	2 201	249 034	82 173	166 490	371
84	221	351	37 720	14 901	22 175	644
181	719	1 245	124 730	33 897	90 567	266
191	453	704	78 562	31 559	46 703	300
50	171	293	27 772	7 334	20 115	323
282	937	1 405	141 587	45 702	93 403	2 482
1 040	4 496	6 950	631 562	177 652	428 133	25 777
360	750	1 314	176 596	74 759	101 531	306
107	272	453	52 705	20 255	32 450	-
82	294	510	52 599	14 650	37 583	366
72	193	346	43 342	13 378	29 955	9
532	2 539	3 813	333 545	82 115	248 660	2 770
723	3 588	5 250	441 727	110 645	315 978	15 104
392	1 815	2 664	231 964	58 086	167 764	6 114
44	194	282	24 190	6 899	17 129	162
195	960	1 487	126 143	29 593	85 328	11 118
129	303	471	51 096	19 062	30 780	1 254
36	84	129	12 540	5 160	6 899	481
92	266	437	47 739	15 803	31 742	124
160	563	878	82 029	23 299	56 475	2 255
293	1 372	2 157	196 453	45 530	149 653	1 270
45	225	373	30 047	7 279	22 914	54
34	182	288	28 567	7 692	20 688	187

Tabel 8 (fortsat). Antal virksomheder, antal beskæftigede (årsgennemsnit), antal arbejdstimer og lønudgift i industrien 1984

ISIC 1968	Industrigruppe	Antal virksomheder 1	Antal beskæftigede	
			I alt (3+4+5) 2	Indehavere 3
33	**Træ- og møbelindustri**	735	23 989	254
33111-12	Savværker og træimprægneringsanstalter	80	1 592	26
33113	Fremstilling af spånplader, finer m.v.	25	1 191	4
33114	Fremstilling af bygningsartikler	97	5 137	20
33121	Træemballagefabrikker	32	585	10
33191, 97	Trævare- og ligkistefabrikker	49	950	24
33192-93, 96	Træindustri i øvrigt	14	272	7
33201	Træ- og polstermøbelfabrikker	430	14 075	161
33203	Madrasfabrikker	8	187	2
34	**Papir- og grafisk industri**	831	33 507	247
34110	Papir- og papfabrikker	12	2 104	-
34120	Papir- og papemballagefabrikker	68	5 481	12
34191	Tapetfabrikker	3	95	-
34199	Papir- og papvareindustri i øvrigt	35	1 224	7
34211-12	Reproduktionsanstalter og sætterier	111	1 745	30
34221	Bogtrykkerier	265	4 897	101
34222	Offsettrykkerier (plantryk)	[illegible]	[illegible]	[illegible]
34223	Serigrafiske trykkerier	[illegible]	[illegible]	[illegible]
34224, 29	Anilintrykkerier og trykkerier i øvrigt	31	1 233	7
34230	Bogbinderier	79	1 872	35
34240	Dagblade	50	10 369	-
35	**Kemisk industri m.m.**	647	37 247	83
35111	Fremstilling af ilt og andre industrigasser	13	488	-
35119	Anden fremst. af kemiske grundstoffer og primære kemiske forbindelser	20	4 477	-
35121	Fremstilling af kunstgødning	4	1 171	-
35122	Fremstilling af færdigblandede bekæmpelsesmidler	5	146	-
35131	Fremstilling af basisplast	20	649	2
35132-33	Fremstilling af plader, folier og rør m.v. af plast samt klæbestrimler	61	4 225	4
35210	Farve- og lakfabrikker	34	2 749	1
35220	Medicinalvarefabrikker	43	8 816	-
35231	Sæbefabrikker	28	2 014	-
35232	Kosmetikfabrikker	11	317	-
35293	Fremstilling af stearinlys	17	323	3
35291-92, 94-95, 99	Anden kemisk industri	37	843	4
35300	Mineralolieraffinaderier	3	559	-
35401-02, 09	Fremstilling af asfalt, tagpap og andre olie- og kulprodukter	68	1 142	-
35510	Vulkaniseringsanstalter m.v.	22	527	7
35590	Gummifabrikker	24	1 964	1
35601	Fremstilling af plastemballage	70	3 935	5
35609	Anden fremstilling af plastvarer	167	4 902	36
36	**Sten-, ler- og glasindustri**	400	17 678	58
36101	Porcelæns- og fajancefabrikker	6	2 117	2
36102	Fremstilling af keramik og lervarer	22	453	13
36201-02	Glasværker og glasbearbejdning	36	2 302	7
36911	Teglværker	45	1 344	9
36912	Fremstilling af molerprodukter m.v.	4	264	-
36921-22	Cementfabrikker samt kalk- og kridtværker	5	1 547	-
36923	Mørtelfabrikker	15	91	-
36931	Stenhuggerier	16	170	3
36932	Fremstilling af færdigblandet beton	69	853	1
36933	Betonvarefabrikker	136	5 519	18
36994-96, 99	Fremstilling af andre sten-, ler- og glasprodukter	46	3 018	3
37	**Jern- og metalværker og støberier**	79	6 053	16
37101	Jern- og stålværker	12	2 105	3
37102	Jernstøberier	27	2 025	4
37201	Metalværker	14	781	1
37202	Metalstøberier	26	1 142	8

Antal beskæftigede		Arbejdstimer for arbejdere[1]	Lønudgift			
Funktionærer 4	Arbejdere 5	6	I alt (8 + 9 + 10) 7	Funktionærer 8	Arbejdere 9	Hjemmearbejdere m.m. 10
		1 000	1 000 kr.			
4 574	19 161	32 498	3 036 893	755 759	2 269 139	11 995
312	1 254	2 129	197 819	51 084	145 843	892
234	953	1 641	156 887	38 244	118 255	388
1 108	4 009	6 861	706 595	186 995	518 361	1 239
86	489	795	68 381	14 862	53 169	350
188	738	1 287	119 977	31 589	87 528	860
63	202	336	33 966	10 559	23 297	110
2 553	11 361	19 191	1 729 990	417 014	1 305 050	7 926
30	155	258	23 278	5 412	17 636	230
12 500	20 760	35 042	5 909 409	2 357 967	3 415 803	135 639
477	1 627	2 815	341 315	97 069	244 246	–
1 318	4 151	6 921	871 753	240 770	630 452	531
43	52	89	13 171	6 536	6 620	15
424	793	1 311	182 348	77 913	103 589	846
537	1 178	2 101	331 551	114 592	214 163	2 796
1 474	3 322	5 625	832 414	274 607	550 802	7 005
1 273	2 735	4 754	755 111	262 634	487 419	5 058
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
493	639	1 096	216 864	96 418	120 062	404
377	1 460	2 410	279 245	71 018	207 351	878
5 902	4 467	7 355	2 017 090	1 086 040	813 287	117 763
16 343	20 841	34 668	5 876 608	3 060 015	2 799 702	16 891
227	261	464	80 140	42 534	37 519	87
2 216	2 261	3 730	767 118	434 576	331 875	667
457	714	1 374	208 442	92 898	115 544	–
80	66	113	22 780	14 639	8 128	13
206	441	760	95 597	36 479	58 668	450
1 216	3 005	4 964	661 327	233 930	425 708	1 689
1 793	955	1 599	448 197	316 169	131 518	510
4 057	2 759	4 388	1 163 683	785 531	377 684	468
1 168	846	1 391	315 742	207 066	106 815	1 861
175	142	229	46 299	31 445	14 553	301
64	256	405	34 107	8 948	25 064	95
508	331	562	135 581	89 042	46 128	411
503	56	85	116 114	109 623	6 164	327
450	692	1 269	181 313	84 274	96 854	185
181	339	582	70 375	27 595	42 527	253
480	1 483	2 433	277 456	82 883	191 806	2 767
1 059	2 871	4 693	567 026	196 039	368 482	2 505
1 503	3 363	5 628	685 311	266 344	414 665	4 302
4 715	12 907	21 866	2 600 371	846 951	1 747 558	5 862
425	1 690	2 604	292 365	73 984	218 381	–
69	371	608	49 871	9 840	39 928	103
530	1 765	2 935	325 670	94 953	228 667	2 050
279	1 056	1 905	193 236	50 150	142 597	489
52	212	372	40 166	10 995	29 171	–
537	1 010	1 768	249 157	100 930	148 018	209
35	56	95	13 625	6 267	7 253	105
47	120	198	21 848	6 412	15 299	135
325	527	977	131 093	54 639	75 792	662
1 371	4 130	7 091	819 504	240 682	577 857	965
1 045	1 970	3 312	463 838	198 099	264 595	1 144
1 378	4 659	7 832	859 779	249 478	609 616	685
553	1 549	2 614	314 375	99 860	214 334	182
348	1 673	2 828	277 952	63 572	213 981	309
262	518	898	125 973	49 513	76 409	51
215	919	1 512	141 468	36 433	104 892	143

Tabel 8 (fortsat). Antal virksomheder, antal beskæftigede (årsgennemsnit), antal arbejdstimer og lønudgift i industrien 1984

ISIC 1968	Industrigruppe	Antal virk-som-heder 1	Antal beskæftigede I alt (3 + 4 + 5) 2	Antal beskæftigede Inde-havere 3
38	**Jern- og metalindustri**	**2 350**	**150 524**	**438**
38110	Fremstilling af værktøj, beslag samt bestik	79	2 990	20
38121	Metalmøbelfabrikker	84	3 971	16
38122	Lampefabrikker	27	965	6
38131	Fremstilling af jern- og metalkonstruktioner (ekskl. stationære tanke)	169	7 552	35
38132	Fremstilling af stationære beholdere	39	2 654	12
38133	Rørfabrikker	14	1 150	2
38190	Fremstilling af centralvarmekedler	13	802	4
38191	Metalemballagefabrikker	34	3 334	2
38192	Fremstilling af ovne og radiatorer m.m.	27	1 047	2
38193	Armaturfabrikker	39	3 205	-
38194	Fremstilling af bolte, skruer og søm	17	990	1
38195–96	Galvaniseringsanstalter og industrilakering	84	1 612	26
38197	Fremstilling af fjedre og kæder	11	295	3
38198	Fremstilling af tråd og trådvarer	22	576	7
38199	Fremstilling af andre jern- og metalvarer	101	2 478	14
38210	Fremstilling af motorer (bortset fra elektr. motorer og skibsmotorer)	6	219	3
38220	Fremstilling af landbrugsmaskiner	96	6 210	12
38231	Fremstilling af maskiner til træbearbejdning	20	415	11
[illegible]	Fremstilling af maskiner til metalforarbejdning	[illegible]	[illegible]	[illegible]
38233	Fremstilling af staberimaskiner og maskiner til valsning af metaller	5	[illegible]	[illegible]
38241	Fremstilling af tekstilmaskiner og tilbehør	7	533	4
38242	Fremstilling af maskiner og app. til næringsmiddel- og kemisk industri	117	6 079	27
38243	Fremstilling af maskiner til skotøjs-, papir- og papvareindustrien samt grafisk industri	15	570	3
38249	Fremstilling af industrimaskiner i øvrigt	41	2 998	6
38251	Fremstilling af kontormaskiner	15	1 775	3
38252	Vægtfabrikker	8	173	2
38292–93	Fremstilling af husholdningsmaskiner	12	2 298	-
38294	Fremstilling af internt transportmateriel	109	5 246	19
38296	Fremstilling af tandhjul og transmissionsaksler	16	587	7
38298	Underleverandørfabrikker med jern- og metalforarbejdning	80	1 771	27
38291, 95, 97, 99	Maskinfabrikker i øvrigt	266	24 289	32
38311	Fremstilling af el-motorer samt el-apparatur til maskiner	83	5 606	10
38321	Radio- og fjernsynsfabrikker	25	3 447	-
38329	Fremstilling af telemateriel i øvrigt	84	7 700	9
38331–32	Fremstilling af el-husholdningsartikler	16	1 419	4
38392	Akkumulator- og tørelementfabrikker	8	1 109	1
38391, 93, 99	Kabelfabrikker og fremstilling af elektrisk materiel i øvrigt	60	5 155	5
38411	Jernskibsværfter	22	12 124	-
38412	Træskibsværfter og bådebyggerier	82	1 872	47
38413	Skibsmotorfabrikker	14	3 282	1
38419–20	Fremstilling af skibs- og banemateriel i øvrigt	39	2 241	2
38432	Karrosserifabrikker m.v.	73	3 234	13
38439	Bilindustri i øvrigt	28	1 502	6
38440	Cykel- og knallertfabrikker m.v.	9	656	-
38491–92	Anden transportmiddelindustri	10	301	2
38511–12	Fremstilling af medicinske instrumenter og apparater m.v.	39	3 640	3
38513	Fremstilling af ikke-elektriske måleinstrumenter	20	1 049	3
38514	Fremstilling af elektriske måleinstrumenter	41	4 436	2
38520	Fremstilling af optisk og fotografisk udstyr	27	1 438	1
39	**Anden industri**	**135**	**5 636**	**35**
39011	Guld- og sølvvarefabrikker	22	549	7
39020	Fremstilling af musikinstrumenter	9	203	6
39030	Fremstilling af sportsrekvisitter	12	318	-
39091	Legetøjsfabrikker	11	2 112	3
39092	Fremstilling af børstevarer	10	422	2
39093	Pibefabrikker	5	105	3
39094–97, 99	Anden industri i øvrigt	66	1 927	12
2 + 3	**Råstofudvinding og industri i alt 1984**	**6 817**	**380 604**	**1 464**
2 + 3	**Råstofudvinding og industri i alt 1983**	**6 571**	**362 741**	**1 642**

Antal beskæftigede		Arbejdstimer for arbejdere[1]	Lønudgift			
Funktionærer	Arbejdere		I alt (8 + 9 + 10)	Funktionærer	Arbejdere	Hjemmearbejdere m.m.
4	5	6	7	8	9	10
		1 000	1 000 kr.			
47 007	103 079	174 448	22 116 685	8 679 739	13 388 147	48 799
685	2 285	3 865	400 000	120 349	278 717	934
1 079	2 876	4 863	549 148	192 017	355 859	1 270
317	642	1 028	125 756	53 528	70 802	1 426
1 870	5 647	10 236	1 176 852	347 508	826 874	2 270
798	1 844	3 135	400 017	148 441	251 308	268
326	822	1 451	176 350	58 643	117 649	58
178	620	1 023	105 296	30 100	75 157	39
766	2 586	4 282	497 427	152 643	344 334	450
244	801	1 336	140 166	39 743	100 382	41
824	2 381	3 976	445 013	144 473	300 076	464
211	778	1 300	137 085	37 777	98 883	425
324	1 262	2 321	242 877	57 765	184 212	900
80	212	360	44 360	15 757	27 746	857
160	409	712	79 100	26 942	51 676	482
579	1 885	3 149	322 754	96 640	224 314	1 800
90	126	224	35 501	17 409	18 092	–
1 685	4 513	7 812	839 005	284 240	553 191	1 574
116	288	523	51 924	19 080	32 793	51
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2 066	3 986	6 967	935 821	391 790	543 233	798
197	370	663	93 780	40 221	53 440	119
806	2 186	3 680	426 369	142 880	282 899	590
1 261	511	895	295 600	229 168	66 175	257
78	93	148	25 894	14 284	11 463	147
481	1 817	2 950	318 969	88 067	230 272	630
1 657	3 570	6 235	799 334	320 052	478 267	1 015
117	463	765	82 529	22 928	59 361	240
341	1 403	2 400	239 932	62 060	177 113	759
8 478	15 779	26 202	3 540 575	1 518 646	2 014 354	7 575
2 217	3 379	5 629	823 562	408 020	412 434	3 108
1 070	2 377	4 001	471 545	194 715	269 837	6 993
3 170	4 521	7 489	1 157 848	604 232	550 283	3 333
363	1 052	1 798	194 570	63 475	131 057	38
358	750	1 265	162 714	62 794	99 814	106
1 980	3 170	5 248	780 799	367 209	411 173	2 417
2 602	9 522	15 899	1 899 123	517 766	1 381 190	167
310	1 515	2 540	241 766	49 499	191 664	603
1 348	1 933	3 252	533 078	269 482	263 576	20
553	1 686	2 922	328 541	100 264	227 940	337
768	2 453	4 237	448 377	133 834	313 866	677
358	1 138	1 892	199 320	60 270	138 453	597
150	506	830	80 474	26 028	54 214	232
51	248	401	37 807	9 130	28 555	122
1 125	2 512	4 063	499 960	212 277	286 421	1 262
491	555	919	154 069	93 957	69 790	322
2 461	1 973	3 230	747 795	490 525	256 328	942
653	784	1 269	213 558	120 161	92 628	769
1 762	3 839	6 216	761 685	294 143	453 587	13 955
185	357	579	72 923	28 465	43 700	758
25	170	307	29 483	4 946	24 439	98
135	183	309	46 152	22 997	22 355	800
662	1 447	2 252	276 729	106 565	167 846	2 318
98	322	518	51 081	16 342	34 663	76
16	86	137	12 840	2 759	10 029	52
641	1 274	2 103	272 477	112 069	150 555	9 853
111 254	267 886	447 534	55 926 108	20 328 633	35 274 687	322 788
107 075	254 024	425 568	50 909 238	18 445 953	32 142 542	320 743

ANNEX 3

BRANCHES COVERED BY THE HEALTH SERVICE

Branches covered by the Health Service

Major Division 2

2901	Stone quarrying, clay and sand pits.
2902	Chemical and fertilizer mineral mining.
2903	Salt mining.
2909	Mining and quarrying not elsewhere classified.

Major Division 3

3111	Slaughtering, preparing and preserving meat.
3114	Canning, preserving and processing of fish, crustacea and similar foods.
3119	Manufacture of cocoa, chocolate and sugar confectionary.
3140	Tobacco manufacture.
3211	Spinning, weaving and finishing textiles.
3212	Manufacture of made-up textile goods, except wearing appareil.
3213	Knitting mills.
3214	Manufacturing of carpets and rugs.
3215	Cordage rope and twine industries.
3219	Manufacture of textiles not elsewhere classified.
3220	Manufacture of wearing appareil, except footwear.
3231	Manufacture off leather and products of leather, leather substitutes and fur, except footwear and wearing appareil.
3232	Fur dressing and dyeing industries.
3233	Manufacture of products of leather and leather substitutes, except footwear and wearing appareil.
3240	Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear.
3511	Manufacture of basic industrial chemicals except fertilizers.
3512	Manufacture of fertilizers and pesticides.
3513	Manufacture of synthetic resins, plastic materials and man-made fibres except glass.
3521	Manufacture of paints, varnishes and lacquers.
3522	Manufacture of drugs and medicine.
3523	Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations.

3529	Manufacture of chemical products not elsewhere classified.
3530	Petroleum refineries.
3540	Manufacture of miscellaneous products of petroleum and coal.
3551	Tyre and tube industry.
3559	Manufacture of rubber products not elsewhere classified.
3610	Manufacture of potting, china and earthenware.
3620	Manufacture of glass and glass products.
3691	Manufacture of structural clay products.
3699	Manufacture of non-metallic mineral products not elsewhere classified.
3710	Iron and steel basic industries.
3720	Non-ferrous metal basic industries.
3839	Manufacture of electrical apparatus and supplies not elsewhere classified.
3841	Shipbuilding and repair.
3843	Manufacture of motor vehicles.

Major Division 5

5000 Construction.

Major Division 9

9200 Sanitary and similar services.

9513 Repair of motor vehicles and motorcycles.

Arbejdsministeriets bekendtgørelse nr. 365 af 13. august 1980

Bekendtgørelse om ændring af bilag til bekendtgørelse om bedriftssundhedstjeneste

(Udbygning af bedriftssundhedstjeneste)

I henhold til bekendtgørelse nr. 288 af 22. juni 1978 § 2, fastsættes følgende:

Ved afgrænsning af brancher omfattet af pligten til at oprette bedriftssundhedstjeneste anvendes Danmarks Statistiks erhvervsgrupperingskode af 1. april 1977.

§ 1

I. Den 1. juli 1978 omfattes følgende virksomheder af bekendtgørelsen:

1. Læderindustri og garverier. 323

a. Garverier. 32310
1) herunder læderfarverier.

b. Pelsberedning m.v. 32320
1) herunder garvning, farvning, rensning og lignende af egne pelsskind samt slagtning af pelsdyr (pelsning). Fremstilling af beklædningsgenstande hører under anden beklædningsindustri 3229, 32294.

c. Lædervarefabrikker. 32330
1) herunder fremstilling af kufferter, tasker, mapper, punge, bælter og urremme m. m. af læder, plastic m.v. og maskindele af læder.
2) skotøjsfabrikker hører under fodtøjsindustri 324, 32401.

2. Gummiindustri. 355

1) herunder fremstilling og reparation af alle former af gummiprodukter på basis af såvel natur som syntetisk gummi, guttaperka, ballata og lignende.

a. Vulkaniseringsanstalter m.v. 35510

1) herunder fremstilling af slidbanedæk, gummidæk og gummislanger til hjul.

b. Gummifabrikker. 35590
1) herunder fremstilling af gummistøvler, gummifodtøj og gummilegetøj.

3. Jern- og metalværker, støberier. 37

Stålværker og jernstøberier 3710

a. Jern- og stålværker. 37101
1) herunder hærderier samt fremstilling af jern og stål i blokke, stænger og plader.

b. Jernstøberier. 37102
1) herunder fremstilling af maskinstøbegods, kloakstøbegods, smedegods og støbte rør. Andre rør er undtaget.

Metalværker og støberier 3720

c. Metalværker. 37201

d. Metalstøberier. 37202
1) herunder varmepresset metalgods.

4. Renovationsvirksomhed og kloakvæsen. 9201

Kloakvæsen og renovationsvæsen 9201

a. Kloakvæsen. 92011

b. Renovationsvirksomheder. 92012
1) herunder renholdningsselskaber, lossepladser og forbrændingsanstalter.

5. Skibsværfter og bådebyggeri. 3841

a. Jernskibsværfter. 38411
1) herunder stålskibe på 100 BRT og derover.

b. Træskibsværfter og bådebyggerier. 38412

c. Skibsmotorfabrikker. 38413
1) herunder forbrændingsmotorer, dampmaskiner og -turbiner til fremdrift af skibe.

d. Fremstilling af skibsmateriel i øvrigt. 38419
1) herunder fremstilling af flåder og lignende flydende materiel.
2) skibsophugning er undtaget.

6. Fodtøjsindustri. 324

a. Skotøjsfabrikker. 32401
1) herunder hjemmesko. Gummifodtøj hører under gummiindustri 355, 35590.

b. Håndskomagere. 32402
1) skotøjsreparationer er undtaget.

c. Træskofabrikker. 32403

d. Fodtøjsindustri i øvrigt. 32409
1) herunder hæle og andre dele til fodtøj.

7. Slagteri- og kødvaretilberedning. 3111

a. Svineslagterier. 31111
1) herunder slagteriernes kødkonservesafdelinger og pølsemagerier.

b. Kødvare- og kødkonservesfabrikker. 31112
1) herunder kødekstrakt, bouillonterninger, fedevarer, pølser og fars.

c. Kreaturslagterier. 31113

d. Offentlige slagtehuse. 31114

e. Talgsmelterier. 31115

f. Tarmrenserier. 31116
1) herunder enheder, der på slagterierne, men for tarmrenseriernes regning udfører forberedende tarmbehandling.

g. Fjerkræslagterier. 31117
1) herunder konservering af fjerkræ.

h. Kødtilberedning i øvrigt. 31119
1) herunder røgning og saltning af indleverede kødvarer. Hjemmeslagtere hører også under denne branche.

8. Chokolade- og sukkervarefabrikker. 31190
1) herunder lakrids, tyggegummi og skumvarer.

II. Den 1. juli 1979 omfattes følgende virksomheder af bekendtgørelsen:

9. Kemisk industri. 35

Kemisk råstofindustri 351

a. Fremstilling af ilt og andre industrigasser. 35111
1) herunder andre komprimerede luftarter samt flydende og fast kulsyre.

b. Anden fremstilling af kemiske grundstoffer og primære kemiske forbindelser. 35119
1) herunder emulgatorer, enzymer, osteløbe, garveekstrakt, soda og farvestoffer. Endvidere sulfonamider, ikke doserede og ikke i detailpakninger, samt pesticider i form af isolerede kemiske forbindelser.

Fremstilling af kunstgødning og færdigblandede bekæmpelsesmidler 3512

c. Fremstilling af kunstgødning. 35121
1) herunder fremstilling af superfosfat.

d. Fremstilling af færdigblandede bekæmpelsesmidler. 35122
1) herunder træimprægneringsmidler uden bindemiddel.

Fremstilling af basisplast og plasthalvfabrikata m.v. 3513

e. Fremstilling af basisplast. 35131
1) herunder kunstharpiks.

f. Fremstilling af plader, folier, rør m.v. af plast. 35132
1) herunder fremstilling af dug, bånd, monofilamenter, slanger, stænger og profiler af plast.

g. Fremstilling af klæbestrimler. 35133

h. Fremstilling af plastemballage. 35601
1) herunder fremstilling af poser, spande, flasker, kasser æsker og anden emballage af plast.

i. Anden fremstilling af plastvarer. 35609
1) fremstilling af legetøj, skilte og navneplader samt lampeskærme er undtaget.

Fremstilling af andre kemiske produkter 352

j. Farve- og lakfabrikker. 35210
1) herunder fernis og fortynder. Kunstneres farver er undtaget.

k. Medicinalvarefabrikker. 35220
1) herunder hormoner, vitaminer og antibiotica uanset indpakning, endvidere andre lægemidler, doserede eller i detailpakninger.

Fremstilling af sæbe- og toiletmidler 3523

l. Sæbefabrikker. 35231

m. Kosmetikfabrikker. 35232
1) herunder parfume, tandpasta, barbersprit, shampoo og lignende.

Fremstilling af øvrige kemiske produkter 3529

n. Sprængstoffabrikker. 35291
1) patron- og granathylstre er undtaget.

o. Pudse- og rensemiddelfabrikker. 35292

1) herunder møbelpolitur, bonevoks, skosværte og ovnsværte.

p. Fremstilling af stearinlys. 35293

q. Limfabrikker. 35294

r. Fremstilling af lysfølsomt papir og pap. 35295

s. Kemisk industri i øvrigt. 35299

1) herunder tændsikker, trykfarver, blæk, tusch, antifrostpræparater samt organiske overfladeaktive stoffer.

10. Konfektionsfabrikation. 3221

1) omfattet er kun egentlig konfektion og således ikke fremstilling af tekstiler og tekstilvarer, skrædderi, buntmageri m. m. der hører under tekstilindustri 321 og anden beklædningsfremstilling 3229.

a. Herrekonfektionsfabrikker. 32211

1) herunder arbejdstøj.

b. Kjolekonfektionsfabrikker. 32212

1) herunder kjoler, bluser, nederdele og buksedragter.

c. Konfektionsfabrikker for dameovertøj. 32213

1) herunder dameyderbeklædning i øvrigt.

d. Skjortefabrikker. 32214

1) herunder herrepyjamas.

e. Fremstilling af korsetter m.v. 32215

f. Anden konfektionsindustri. 32219

1) herunder undertøj, nattøj til damer; badedragter, småbørnsbeklædning, kimonoer, slips og kitler.

11. Mineralolie- og asfaltindustri. 353, 354

Mineralolieindustri 353

a. Mineralolieraffinaderier. 35300

Fremstilling af asfalt, tagpap, smøremidler og andre kulprodukter 354

b. Asfaltfabrikker. 35401

1) herunder tjæreprodukter.

2) udlægning af asfalt samt asfaltfabrikkernes entreprenørafdelinger hører under bygge- og anlægsområdet 50.

c. Tagpapfabrikker. 35402

d. Anden fremstilling af olie og kulprodukter. 35409

1) herunder blanding og krakning af mineralolier.

12. Sten-, ler- og glasindustri. 36

1) herunder fremstilling af ikke-metalliske mineralprodukter.

Porcelænsindustri 361

a. Porcelæns- og fajancefabrikker. 36101

b. Fremstiling af keramik- og lervarer. 36102

c. Porcelænsmalere og -brænderier. 36103

1) herunder klinkerier.

Glas- og glasvareindustri 362

d. Glasværker. 36201

1) herunder vinduesglas, glasflasker, serviceglas m.v.

e. Glasbearbejdning. 36202

1) herunder slibning og mattering, spejlfabrikker samt fremstilling af isolationsruder på grundlag af indkøbt glas.

Fremstilling af tegl, cement og andre mineralske produkter 369

f. Teglværker. 36911

1) herunder fremstilling af mursten, tagsten, drænrør samt keramikfliser til vægbeklædning.

g. Fremstilling af molerprodukter m.v. 36912

1) herunder fremstilling af kiselgurprodukter samt ildfast mørtel.

2) udvinding af moler og kiselgur fra brud hører under anden råstofudvinding 29, 29090.

Cementfabrikker, kalk- og kridtværker, mørtelfabrikker 3692

h. Cementfabrikker. 36921

i. Kalk- og kridtværker. 36922

1) herunder fremstilling af brændt kalk. Rå kalk og jordbrugskalk hører under anden råstofudvinding 29, 29013.

2) kalkbrud, stenbrud, grusgravere og skærvefabrikker hører under 2901.

j. Mørtelfabrikker. 36923

Anden sten-, ler- og glasindustri 3699

k. Stenhuggerier. 36991

1) herunder stensliberier og fremstilling af gravmonumenter, marmorvarer og møllesten.

l. Fremstilling af færdigblandet beton. 36992

m. Betonvarefabrikker. 36993

1) herunder beton- og cementstøberier (cementvarefabrikker), fremstilling af betonmursten, -tagsten, -fliser, -trappesten og træbeton. Endvidere terrazzo-, klinke-, beton- (lecabeton), slaggebeton- og asbestcementfabrikker.

n. Fremstilling af glasuld og glasfiber. 36994

o. Fremstilling af kalksandsten og gipsplader. 36995

p. Fremstilling af slibematerialer. 36996

q. Fremstilling af andre sten-, ler- og glasprodukter. 36999

1) herunder bremseskiver, asbestvarer, pakninger med mineralske bestanddele, kryolitfabrikker, kunstgipserier, rockwool samt ekspanderet ler.

13. Tobaksindustri. 314

1) herunder fremstilling af alle former for tobaksvarer, cigarer, cigaretter, shagtobak og lignende.

2) tobaksfabrikkernes engrosoplag betragtes som lokale hjælpeenheder.

III. Den 1. juli 1980 omfattes følgende virksomheder af pligten til at oprette bedrifissundhedstjeneste:

14. Tekstilindustri. 321

Spinderier, væverier og efterbehandling af tekstiler 3211

a. Uldspinderier og -væverier. 32111

1) herunder uld sammen med korte kemofibre.

2) herunder konfektionerede boligtekstiler fremstillet af stoffer vævet i egen virksomhed.

b. Bomuldsspinderier og -væverier. 32112

1) herunder bomuld sammen med korte kemofibre.

2) herunder konfektionerede boligtekstiler fremstillet af stoffer vævet i egen virksomhed.

c. Fremstilling af garner og stoffer af kemofibre. 32113

1) fremstilling af garner og stoffer af korte kemofibre sammen med uld hører til 32111 og sammen med bomuld hører til 32112.

d. Håndværerier. 32114

e. Fremstilling af bånd, possement og elastik. 32115

1) herunder etiketter, tyl, blonder og kniplinger.

f. Andre spinderier og væverier. 32116

1) herunder hør og tynde garner af hamp og jute.

g. Tekstilfarverier og -imprægneringsfabrikker. 32117

1) herunder også virksomheder, der alene udfører mercericering, dekatering o. l. ikke synlig efterbehandling.

2) farvning, mercericering, dekatering o. efterbehandling i forbindelse med spindin vævning, strikning eller rebslagning henhør under virksomhedens hovedaktivitet.

3) imprægnering af stoffer med plast ell olie hører under 32190. Tekstilstoffer ove trukket med gummi hører under gummif brikker 35590.

4) garderoberenserier og garderobefarve er er undtaget.

Fremstilling af færdige tekstilvarer eksk beklædningsgenstande 3212

h. Fremstilling af broderier. 32121

i. Plissé- og hulsomforretninger. 32122

1) herunder fremstilling af stofknappe slåning af knaphuller samt kunststopning.

j. Flag- og teltfabrikker (incl. sejlmagerie 32123

1) herunder fremstilling af pressenning og markiser.

k. Fremstilling af gardiner, sengetæpper c linned. 32124

l. Anden tekstilvareindustri. 32129

1) herunder fremstilling af dyner, pude stoftryk, malerlærred, autoindtræk og mått samt sække.

m. Trikotagefabrikker. 32130

1) herunder fremstilling af stromper.

2) konfektionering udelukkende eller na sten udelukkende på grundlag af indkøb trikotagestoffer hører under konfektionsfabr hetion 3221.

n. Tæppefabrikker. 32140

1) herunder fremstilling af måtter og løb re af jute, sisal og kokos.

o. Rebslagerier. 32151

p. Fiskenetfabrikker. 32152

q. Anden tekstilindustri. 32190

1) herunder halmvarefabrikker, fremstilling af rørvæv, opkradsning af gammelt ste shoddyfabrikker, tvistfabrikker, vatfabrikk samt filt- og krolhårsfabrikker.

2) herunder imprægnering af tekstilstoff med plast eller olie.

Anden beklædningsfremstilling 3229

r. Skrædderforretninger. 32291

1) herunder skræddermestre, som fremst ler damedragter og -frakker.

s. Kjolesyning m.v. 32292

1) herunder syersker.

2) fabriksmæssig fremstilling af kjoler h rer under konfektionsindustri 32212.

t. Hattefabrikker. 32293

u. Buntmagerier. 32294

1) pelsberedere og pelsfarvere hører und pelsberedning 32320.

w. Damehatte- og modevarefremstilling. 3229

x. Handskefabrikker. 32296

y. Beklædningsindustri i øvrigt. 32299

1) herunder fremstilling af indlæg o. l.

2) fremstilling af parasoller og paraply er undtaget.

15. Fiskeindustri. 3114

a. Røgning og saltning af fisk. 31141

b. Fiskehermetik-, fiskefars- og fiskefilet brikker. 31142

1) herunder dybfrysning af fisk.

16. Akkumulator- og tørelementfabrikke 38392

1) herunder fremstilling af tørelemente akkumulatorkasser og udskiftning af akk mulatorelementer med indbytning.

17. Stenbrud, skærvefabrikker, skærveknuserl, boring i granit og sandsten. 29 anden råstofudvinding.

Grusgrave, stenbrud, kalk- og kridtbrud 2901

a. Ler- og grusgrave samt stenbrud. 29011

b. Kalk- og kridtbrud. 29013

1) herunder udvinding af jordbrugskalk samt indsamling af kalkholdige skaller.

c. Udvinding af mineraler til gødnings- og kemisk brug. 29020

1) herunder kaliboring.

d. Saltudvinding. 29030

e. Anden ikke-metallisk råstofudvinding i øvrigt. 29090

1) herunder brydning af kiselgur, flint og moler. Endvidere henhører fremstilling af briketter og tørvestrøelse til denne branche.

18. Skorstensfejere. 92023

19. Autobranchen. 3843 karosserifabrikker, 9513 autoreperation.

a. Fremstilling af biler. 38431

1) samling af biler, lokalt kombineret med engroshandel, opfattes som en virksomhed men med udskillelse af bifunktion. En kombineret enhed henføres normalt til fremstilling, når mindst 30 pct. af omsætningen hidrører fra samling.

b. Karosserifabrikker. 38432

1) herunder fremstilling af påhængsvogne, landbrugsvogne, campingvogne, skurvogne, lad til biler og tippelad.

2) karosseriopretning hører under autoreparation 95132

c. Bilindustri i øvrigt. 38439

1) herunder motorer, bremser, gear, hjul o. l.

2) gummi hører under gummifabrikker 35590, plast hører under anden fremstilling af plastvarer 35609, glas til billygter o. l. hører under glasbearbejdning 36202.

3) elektrisk udstyr til biler er undtaget.

d. Autoreparationsværksteder. 95131

e. Karosseriværksteder. 95132

1) karosserifremstilling hører under karosserifabrikker. 38432

f. Autolakererier. 95133

g. Autoelektrikere. 95134

h. Autoservice i øvrigt. 95139

1) herunder autobugsering.

IV. Den 1. juli 1981 omfattes følgende virksomheder af pligten til at oprette bedriftssundhedstjeneste:

20. Bygge- og anlægsområdet. 50

a. Bygge- og anlægsvirksomhed uden nærmere angivelse. 50000

b. Offentlig bygge- og anlægsvirksomhed. 50110

1) herunder bygge- og anlægsvirksomhed, der udføres af offentlige (herunder koncessionerede) virksomheder eller forvaltningsorganers eget personale, men derimod ikke udliciteret arbejde.

c. Entreprenørvirksomheder m.v. 5012

1) læsseentreprenører og kørselsentreprenører er undtaget. Maskinstationer der udfører landbrugsarbejde er undtaget.

2) virksomheder, der ikke selv har arbejdskraft, men som indgår hovedentreprisekontrakter til udførelse af underentreprenører, medregnes.

d. Almindelige entreprenørforretninger. 50121

1) herunder entreprenørforretninger, der påtager sig arbejde inden for et videre felt af bygge- og anlægsarbejde.

2) anlægs- og byggeforretninger med mere specialiserede arbejdsområder henføres til en af grupperne 50122–50199.

e. Dræningsmestre. 50122

f. Brolæggermestre. 50123

g. Kloakmestre. 50124

h. Murerforretninger. 50130

i. Tømrer- og snedkerforretninger. 50140

1) herunder maskinsnedkerier, der selv opstiller de fremstillede bygningsmaterialer. Snedkerier og fabrikker, der fremstiller bygningssnedkerartikler til salg, er undtaget.

j. Malerforretninger. 50150

1) herunder bygningstapetserere.

2) skiltemalere, møbellakererier og industrilakering er undtaget. Autolakerier hører under autoreparation 95133.

k. Blikkenslagerforretninger. 50160

l. Elektroinstallationsforretninger. 50170

1) herunder også el-installatører m[illegible] tikshandel.

2) reparation af elektriske husholdning[illegible] maskiner er undtaget.

m. Glarmesterforretninger. 50180

1) herunder også glarmestre med [illegible] handel.

2) rammelistefabrikker er undtaget.

n. Gulvbelægnings- og terrazzoforretn[illegible]g 50191

1) herunder gulvafhøvling o. l.

o. Isoleringsforretninger. 50192

p. Tagtækkere og tagpapdækkere. 50193

q. Brøndborere. 50194

r. Ovnsætning. 50195

1) herunder reparation af kakkelovne.

s. Stilladsforretninger. 50196

t. Byggevirksomhed i øvrigt. 50199

1) herunder stukkatører, facadesan[illegible]a ning, lynafledersopsætning og møllebyggere.

V. Vejledende retningslinier om afgræns[illegible] problemer.

På virksomheder, hvis hovedaktivitet [illegible] under de ovennævnte brancher m.v., s[illegible] samtlige ansatte omfattes af bedriftssun hedstjenesten, uanset om de pågældend[illegible] sonalegrupper beskæftiges ved egentli[illegible] duktion eller ved diverse servicefunk[illegible] såsom administration, kantine, rengør[illegible] kørsel m.v.

Ved virksomhed forstås i denne for[illegible] se den lokaløkonomiske enhed. Ved [illegible] aktivitet forstås i denne forbindelse de[illegible] af den egentlige produktion, hvorved flest beskæftiget.

På virksomheder, hvor der i en afg[illegible] del af virksomheden udføres en produ[illegible] der hører under de ovennævnte br[illegible] m.v., men hvor denne produktion ikke hovedaktiviteten, skal kun de i denne del virksomheden beskæftigede omfattes [illegible] driftssundhedstjenesten.

VI. I supplerende bilag vil blive fastsat h[illegible] ke virksomheder, der bliver omfattet af kendtgørelsen i senere etaper af udb[illegible] gen.

§ 2

Bekendtgørelsen træder i kraft ve[illegible] kendtgørelsen i Lovtidende.

Arbejdsministeriet, den 13. august 1980

SVEND ALKEN

Ulrich Burg

ANNEX 4

QUESTIONNAIRE USED FOR THE HEALTH SERVICE

Aerosol[x] Exposure in the Working Environment

As part of a project the Danish Toxicology Centre is trying to make a survey of aerosol exposure in the Danish working environment. The aim of the project is to form a basis for correct selection and use of respiratory protective devices. As we are convinced that the Health Service Centres, due to their close and frequent contact to factories, workshops and undertakings in general, have acquired specially important knowledge about workplace exposure, we hereby ask you to share this know-how with us.

Three questionnaires have been elaborated (annexes 2, 3 and 4) which you are requested to fill in as detailed as possible. We are well aware that it will be time consuming, but we expect that the result of our investigation will lead to improvements in the working environment.

Annex 2 is intended to give a general description of your health Service Centre and the undertakings in your local community.

Annex 3 is intended to give your subjective evaluation of the presence of solid and liquid, incl. water based, aerosols in the undertakings. The answers given in this annex shall be based on your own experiences from visiting the different work places.

Annex 4 is intended listing of measurements of aerosols carried out by your centre or on behalf of your centre.

We are aware that some of the Health Service Centres have conducted a substantial number of measurements and suggest that in Annex 3 information is given, as far as possible, for all undertakings, and that the results of the measurements are grouped in such a way that information given in Annex 4 supports the information given in Annex 3, as far as possible.

[x] See Definition

We would like to stress that information on factories, workshops, etc. where the presence of aerosols do not constitute a problem is valuable.

The participating Health Service Centres will be informed on the results of our investigation as far as possible, and reference will be made to their participation.

In case any information is confidential, we will ensure its confidentiality.

Further questions can be adressed to either Erik Balieu or Lisbeth Valentin Hansen at the Danish Toxicology Centre.

The questionnaires shall be returned not later than September 24, 1986.

Sincerely yours,
DANISH TOXICOLOGY CENTRE

Erik Balieu
M.Sc.

Enclosure

Enclosure 1

DEFINITION

In the present context an aerosol is defined as particles, solid or liquid, suspended in the air.

Further description

Aerosols are formed in connection with numerous industrial processes, and may consist of particles of different sizes. Generally, particle sizes will be in range of 1000 µ - 0.001 µ.

Solid particles can either be pure chemical substances or mixtures.

Liquid particles can either be pure chemical substances or mixtures, incl. solutions and suspensions.

In the present investigation it will be important to make a distinction between liquid particles consisting of water (e.g. high pressure cleaning with cleaning agents) and liquid particles of other liquid substances (e.g. oil mist or spray painting aerosol).

Enclosure 2

GENERAL DESCRIPTION OF THE HEALTH SERVICE CENTRE.

1. Name of the health service centre: .....

Address of the health service centre: .....

.....

Staff employed with measurements in the working environment:

Number: .....

Educational background: .....

GENERAL DESCRIPTION OF THE UNDERTAKINGS IN YOUR LOCAL COMMUNITY.

2. In order to give a description of the local community of your Health Service Centre you are asked to give an estimate of the number of undertakings belonging to your Centre.

Number of undertakings: .....

Approx. number of employees: .....

2.1 Describe the more important factories/production facilities in your local community:

.....

.....

2.2 Number of measurements on aerosols[x] carried out in the undertakings during 1984 - 1986:

.....

In case information is available from earlier than 1984, please state:

.....

2.3 Number of planned measurements on aerosols in 1986 - 1987:

.....

3. Any other information:

.....

.....

.....

Date: Signed:

[x] See definition

Enclosure 3

SUBJECTIVE EVALUATION AND DESCRIPTION OF THE PRESENCE OF AEROSOLS[x] IN THE WORKING ENVIRONMENT

In addition to the measurements reported in enclosure 4, it will be of great importance to have your personal evaluation and description of aerosols[x] present in the working environment of the undertakings in your local community. As the presence of liquid aerosols is generally less frequently described and only supported by measurements in relatively few cases, it will be of special importance to obtain information on such types of aerosols.

We ask you to give a short description of the working process, the number of people employed and your personal evaluation of the magnitude of the problem, and last but not least, a description of the type of aerosol, whether it is solid or liquid, and if possible its chemical composition.

1. Industry/workshop: .....
2. Process: .....
3. Product manufactured: .....
4. Type of aerosol[x]:

   4.1: Solid: .... 4.2: Liquid .... 4.3: Water based: .....

   4.4: Chemical composition: .....

   4.5: Evaluation of the exposure: Important problem: .....

   Problem: .....

   Less important: .....
5. Are gases/vapours present additionally: (Yes/no, description

   .....

   .....
6. Number of people exposed: .....
7. Time for observation of the exposure: .....
8. Statement of whether the observed exposure is supported by measurements reported in enclosure 4:

   .....

   .....
9. Other information:

   .....

   .....
10. Name of contact person at your Centre: .....

Date: Signed:

[x]See definition

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Community, social and personal services

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
9200	Sanitary and similar services	Waste water cleaning and treatment	Bacteria	+			
			Fungi	+			
93	Social and related community services	Pest control (spraying of pesticides)	Pesticides	+			
9513	Repair of motor vehicles	Rust prevention work	Paints and laquers	+		+	Organic vapours
		Brake and clutch work	Asbestos	+			
		Spray painting	Spray painting aerosol	+		+	Organic vapours
			(isocyanates i.a.)			+	

5b

Results from AMF-reports and Monographs

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 321 Manufacture of textiles

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3219	Manufacture of clothing	Sewing/cutting	Various	+	-	-	No statement might be e.g formaldehyde

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 311-312 Food, manufacturing

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3111	Slaughtering	Handling cutting, sawing	Cleaning agents Various dust	+	+		
3112	Man. of food products (not elsewhere classified)	Frying, cooking	Cooking fumes			+	
3116	Man. of grain mill products	Mixing, filling	Flour dust	+			
3117	Man. of bakery	Cutting grinding, mixing	Flour dust	+			
3140	Man. of tobacco	Handling, mixing	Tobacco dust	+			?

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 324 Textile, Wearing Apparel and Leather Industries

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3240	Manufacture of footware	Sewing, cutting, gluing	Various dust and vapours	+		+ ?	+

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 352 Manufacture of Chemicals etc.

SIC code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3523	Manufacture of soap etc.	Mixing filling	Dust	+	+ ?	+ ?	?

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 361 Manufacture of Non-metallic Mineral Products

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3610	Manufacture of pottery	Painting, grinding			+		-

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 369 Manufacture of Non-mineral Products

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3699	Manufacture of non-metallic mineral (not elsewhere classified)	Stone-masoning	Quartz, various dust	+	(+) x)		

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of Machinery, except electrical

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3825	Manufacture of electronics	Joining, soldering, gluing	Dust Soldering smoke	+ +	 -		+
3829	Manufacture of machinery	Welding, cutting, grinding	Metal dust, soldering smoke, welding fumes, organic vapours, cleaning agents	+	+	+	+

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 4. Electricity, Gas and Steam. 41 Electricity, Gas and Water

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
1101	Electric light and power	Handling	Coal dust combustion residuals Welding fumes SO_2, CO Other vapours and gases	+	?	+	+x)
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	x) [redacted] so[redacted] cases

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 5. Construction

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
50	Insulation	Handling / insulation	Dust + manmade min.fibres	+			
	Construction	Handling / building	Dust	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 7. Transport, Storage and Communication

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
7111	Railway transportation	Transportation	Various dust and vapours	+x)			+
7192	Storage and warehousing	Fork-lift transportation	Various dust and vapours	+			+
7192	Storage and warehousing	Handling of grain-products	Grain-dust	+			

x) Low concentration

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 8. Financing, Insurance, Real Estate and Business Services

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
8329	Technical services	Cleaning, repair of photocopying machines	Various dust and vapours	+			+

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 9. Community, Social and Pers. Services

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
9200	Chimney cleaning	Sweeping, cleaning	Coal dust, soot various dust	+		+	?
9200	Cleaning	Cleaning	Various cleaning agents		+		
9200	Disinfection	Disinfection	Various cleaning and disinfectant agents		+		

5c

Results from Questionnaires

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 311-312 Food manufacturing.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3111	Slaughtering, preparing and preserving meat	High pressure cleaning	Cleaning agents, sodium hydroxide, tenside, glycol ethers, EDTA		+		
		Weighing and handling of spices, etc.	Various dust	+			-
		Surface treatment of tiles	Mineral oil			+	-
3114	Canning, preserving and processing of fish, crustacea and similar foods	High pressure cleaning	Cleaning agents		+		
		Preservation of lobsters	Sodium hydrogen sulfite		+		Sulfur-dioxide

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 311-312 Food manufacturing.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3119	Manufacture of cocoa, chocolate and sugar confectionary	Packing etc.	Enzymes	+			Organic solvents

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 314 Tobacco manufacturers.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3140	Tobacco manufacturers	Handling and processing	Tobacco dust	+			(Flavour)

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 321 Manufacture of textiles.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3211	Spinning, weaving and finishing textiles	Weaving	Acrylates	+			-

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 33 Manufacture of wood and wood products, including furniture.

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
33	Manufacture of wood and wood products etc.	Spray painting	Paints and lacquers	(+)		+	Organic solvents
		Sawing and cutting	Wood dust	+			
311	Sawmills, planing and and other wood mills	Wood preservation	Arsenicats, cupper, chromates	(+)	+		
320	Manufacture of furniture and fixtures, except primarily of metal	Cutting and sawing	Fumes	+			Formalde-hyde, phenol

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 351 Manufacture of industrial chemicals.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
351	Manufacture of industrial chemicals	Spray painting	Paints and lacquers	(+)		+	+
3512	Manufacture of fertilizers and pesticides	Handling and processing	Pesticides etc.	+		+	+
		Handling, milling and grinding	Dust, fluorides, sulfuric acid	+	+		

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 352 Manufacture of other chemical products.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3522	Manufacture of drugs and medicine	Handling and filling operations	Drugs, raw materials etc.	+			-
		Handling, filling and manufacture	Raw materials, numerous chemical compounds	+			Isopropa-nol
3523	Manufacture of soap and cleaning preparations, perfumes, cosmetics and other toilet preparations	Handling, filling and manufacture	Fatty acids		+		

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 352 Manufacture of other chemical products.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3529	Manufacture of chemical products, not elsewhere classified	Filling, handling and casting of ammunition	Trinitrotoluene	+			(+)
		Manufacturing processes	Dusts of glues	+			
		Drilling in PC-boards	Cupper, organic dust	+			
		Galvanizing PC-boards	Sulfuric and hydrochloric acid		+		Sulfur dioxide

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 356 Manufacture of plastic products, not elsewhere classified.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3560	Manufacture of plastic products, not elsewhere classified	Dying of plastic products	Lead, chromium, copper, iron, calcium, titanium etc.	+			(+) (polyethylene and polypropylene ?)
		Manufacture of non-wowen textiles	Polypropylene	+			
		Handling, filling and casting operations	Raw materials	+			
		Welding	Welding smoke	+			Nitrogen oxides
		Cutting	PVC-dust	+			
		Die casting of plastic products	?	+			Aldehydes, hydrocarbons acrylonitril free radicals

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 356 Manufacture of plastic products, not elsewhere classified.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3560	Manufacture of plastic products, not elsewhere classified	Casting of melamine plast products	Melamine plast	+			Formaldehyde

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 36 Manufacture of non-metallic mineral products, except products of petroleum and coal.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3610	Manufacture of pottery, china and earthenware	Spraying of ceramic dyes and pigments	Cobalt aluminate (20% Cobalt)	+	+		
		Cleaning of filter press	Ceramic material	(+)	+		
3691	Manufacture of structural clay products	Burning of e.g.tiles	Dust Oil mist	+		+ +	(Nitrogen (oxides, (carbon (monoxide, (carbondi- (oxide
3699	Manufacture of non-metallic mineral products, not elsewhere classified	Surface treatment of concrete elements	C_9-C_{11} oils and Silicone oils			+	+
		Stone cutting	Dust, quartz	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 36 Manufacture of non-metallic mineral products, except products of petroleum and coal.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3699	Manufacture of non-metallic mineral products, not elsewhere classified	Binding of steel re-inforcements	Iron oxide	+			
		Mineral wool manufacture	MMMF (fibres)	+			
		Grinding of concrete elements	Concrete dust	+	+		
		Concrete mixing and preparation	Cement, fly ash, quartz, metals	+			Oil vapours?
		Cutting of wood (chipboards)	Wood and glue dust	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 36 Manufacture of non-metallic products, except products of petroleum and coal.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3699	Manufacture of non-metallic mineral products, not elsewhere classified	Casting of concrete elements	Mineral oils (incl. petroleum)			+	(-)
		Handling and filling of raw materials	Dust	+			
		Cutting of gas concrete elements	Dust	+			(+)
		Welding of steel reinforcements	Welding smoke	+			+

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 37 Basic metal industries.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3720	Non-ferrous basic metal industries	Casting of noble metals	Gold, silver and metal oxides	+			Sulfur-dioxide

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
381	Manufacture of fabricated metal products, except machinery and equipment	Surface coating	Epoxy dust	+			
		Turning and cutting	Mineral oils			+	
		Cutting of metal parts	Inert dust	+		+	Oil and white spirit
		Forging of brass	Oil and smoke, incl. lead	+		+	Carbon monoxide
		Spray painting	Paints and lacquers	(+)		+	Organic solvents
		Casting	Iron, copper, aluminium oxide and lead oxide	+			Carbon monoxide

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
381	Manufacture of fabricated metal products, except	Casting	Silicondioxide (α-quartz)	+			Carbon monoxide, hydrocarbons, benzene, sulfur dioxide
		Casting	Silicondioxide (quartz)	+			Isopropanol
			Metal oxides				
		Welding	Dust, welding fume	+			Nitrogen oxides, ozone carbon monoxide, carbon dioxide
		Cleaning and cold degreasing	Hydrochloric acid		+		Hydrogen choloride

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3819	Manufacture of fabricated metal products, except machinery and equipment, not elsewhere classified	Cleaning	Cleaning agents, organic solvents			+	+
		Galvanizing	Ammonium chloride, hydrochloric acid	+	+		Hydrogen chloride

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
382	Manufacture of machinery, except electrical						
3821	Manufacture of engines	Cutting, grinding, forging, drilling etc.	Dust	+			(+) phosphine and formaldehyde
3829	Machinery and equipment, except electrical, not elsewhere classified	High pressure cleaning	Cleaning agents		+		+

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
383	Manufacture of electrical machinery apparatus, appliances and supplies						
3831	Manufacture of electrical industrial machinery and apparatus	Spray painting	Paints and lacquers	(+)		+	Organic solvents
3832	Manufacture of radio, television and communication equipment and apparatus	Grinding and polishing of aluminium profiles	Aluminium dust and mineral oil	+		+	

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3839	Manufacture of electrical apparatus and supplies, not elsewhere classified	Manufacturing of lead batteries	Sulfuric acid (15%)		+		Vapours?
			Lead oxide	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
384	Manufacture of transport equipment						
3841	Shipbuilding and repairing	Steam cleaning of tubes	Oil?		+		Oil?
		Cutting of tubes	Iron, zinc	+			
		Welding of steel (not stainless)	Welding smoke	+			+
		Flame cutting	Welding smoke	+			Nitrogen oxides, carbonmonoxide
		Cleaning processes	Cleaning agents		+		
		Grinding	Dust	+			Styrene, acetone etc.

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 3. Manufacturing. 38 Manufacture of fabricated metal products, machinery and equipment.

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3841	Shipbuilding and repairing	Painting (spray?)	Paints and lacquers	+		+	+
		Cutting of gasket materials	Asbestos fibres	+			
		Shotblasting and priming	Iron and iron oxide	+			Organic solvents

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 5. Construction

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
5000	Construction	Demolishion	Asbestos fibres	+			
			MMMF	+			
		Insulation work	Polyurethanes	(+)		+	Isocyanates, amines
		Spray painting	Paints & lacquers	(+)	+	+	(org.solvents (+)
		Washing and cleaning of vehicles and machines	Cleaning agents		+		
		Shuttering work	Mineral oils?			+	
		Demolishion	Cement dust				
			Wood dust				

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 7. Transport, storage and communication.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
71	Transport and storage						
7111	Railway transport	Welding (Repair and maintenance work)	Welding fume	+			+
		Washing and cleaning operations	Cleaning agents		+		
			Organic solvents			+	Organic solvents
			Oxalic acid			+	(+)
7116	Supporting services to land transport	Painting (road stripes)	Paints and lacquers	+		+	Organic solvents

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 9. Community, social and personal services.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
9200	Sanitary and similar services	Aeration and other treatment of sewage effluents	Bacteria and viruses	(+)	+		(+)
		Cleaning of incinera-tors	Dust, soot	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: 9. Community, social and personal services.

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
95	Personal and household services	Spray painting (rust prevention)	Mineral oil, waxes, bitumen, paraffine waxes			+	Organic solvents 30-60% white spirits
9513	Repair of motor vehicles and motorcycles	Cleaning operations	Hydrocarbon solvents chlorothene			+	+
		Spray painting	Paints and lacquers			+	+
		Grinding and polishing	Dust	+			
		Engine washing and cleaning	Mineral oil and dust			+	+

Enclosure 4

MEASUREMENTS CARRIED OUT ON AEROSOLS[x]

1. Industrial branch/category: .....
2. Work process: .....
3. Product: .....
4. Type of aerosol[x]:
   4.1: Solid: .... 4.2: Liquid: .... 4.3: Water based: .....
   4.4: Particle size: .....
   4.5: Particle size distribution: .....
   4.6: Chemical composition or content: .....
   .....
   4.7: Concentration: .....
   .....
5. Are gases/vapours present additionally: (Yes/no, description)
   .....
   .....
6. Number of people exposed: .....
7. Number of measurements taken: .....
8. Sampling method: .....
9. Sampling place: .....
10. Analytical method: .....
11. Time when measurements were taken: .....
12. In case measurements and analysis were carried out by other laboratories, please state which:
    .....
13. Any other information:
    .....
    .....
14. Name of contact person at your Centre: .....

Date: Signed:

[x]See definition

ANNEX 5

SUPPLEMENTARY TABLES ON BRANCHES, OCCURRENCE OF AEROSOLS AND WORKING PROCESSES

5a

Results from Literature

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Agriculture, Hunting, Forestry and Fishing. 1

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
1110	Agriculture and hunting	Cleaning stables, poultry confinement buildings etc.	Spores, microorganisms, antigens, "organic dust" etc.	x			
		Handling of crops, corn etc.	"dust", Aflatoxins	x			
		Spraying with pesticides	Insecticides, pesticides etc.	x	(x)		can be predicted in some cases
		Harvesting	Pesticide contaminated dust	x			
		Cotton ginning					

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Agriculture, Hunting, Forestry and Fishing. 1.

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
12	Forestry and logging	Sawing and cutting	Wood dust	x			
		Impregnation	Wood dust contaminated with chlorophenols and chlorophenol solutions	x	x		x

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Mining and Quarrying. 2.

SIC 'ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
100	Coal mining	Mining, drilling and heading machine operation	Coal dust	x			
200	Crude petroleum and	Retorting of oil shale	Dust PAH "Toxic metals"	x x x		(x)	x i.a. CO, NO_x, NH_3, H_2S, CS_2, SO_2, HCN, HNO_3, HCHO, CO_2

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Mining and Quarrying. 2.

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
230	Metal ore mining	Mining and drilling	Radioactive aerosol of uranium, incl. radon and thoron daughters	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Mining and Quarrying. 2.

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
290	Other mining						
2901	Stone quarrying	Mining and drilling	Granite dust	x			
2902	Chemical and fertilizer mineral mining	Mining and drilling	Potash dust	x			
2909	Mining and quarrying not elsewhere classified	Mining and drilling	Talc dust	x			
		Mining and drilling	Asbestos fibres	x			
			Silica	x			
			Mica	x			

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing. 3. 31 Food, Beverages and Tobacco.

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
11-12	Food manufacturing	Handling	Tea dust	x			
114	Canning, preserving and processing of fish, crustacea and similar foods	Smoking of fish	PAH	x		(x)	
115	Manufacture of vegetable and animal oils and fats	Cleaning and transportation	Cotton dust	x			

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 32 Textile, Wearing Apparel and Leather Industries.

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
21	Manufacture of textiles	Handling, transportation	Cotton dust	x			
			organic dust	x			
211	Spinning, weaving and finishing textiles	Picking, carding and spinning	Endotoxins (lipopolysaccharide)	x			
			Bacteria	x			
			Vegetable fibres	x			
			Cotton dust				
			Flax				
			Jute				
			Hemp				
219	Manufacture of textiles not elsewhere classified. Manufacture of insulation boards		Asbestos fibres	x			

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 32 Textile, Wearing appareil and Leather Industry

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
231	Tanneries and leather finishing	Tanning	Arsenicals	+			+
		Dying	Chromium	+			+
			Dyers				
		Dressing					

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 32 Textile, Wearing Appareil and Leather Industry

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
240	Manufacture of footwear, except of moulded or vulcanized rubber or plastic	Manufacture	Dust of leather containing contaminated with chromates	x			

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 33 Manufacture of Wood and Wood Products, incl. Furnitu:

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
31	Manufacture of wood and wood- and cork products, except furniture	Sawing, grinding etc.	Wood dust	x			
		Plywood production (sawing, gluing)	Wood dust				Terpenes, PAH, formaldehyde phenol, tributyltin-oxide etc.
32	Manufacture of furniture and fixtures, except primarity of metal		Wood dust				

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 341 Manufacture of Paper and Paper Products

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
411	Manufacture of pulp, paper and paperboard	Chipping, transportation	Dust	x			x
			Mold spores	x			
411	Wine filter production	Addition of fibres	Asbestos fibres	x			
420	Printing, publishing and allied industry	Newspaper printing	Ink mist			x	

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 351 Manufacture of Industrial Chemicals

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3511	Manufacture of basic industrial chemicals, except fertilizers	Handling and processing	Pentachlorophenol dust	x			x
			PAH	x			
3512	Manufacture of fertilizers and pesticides	Handling and processing	Dust containing nitrates	x			
3513	Manufacture of synthetic resins, plastic materials and manmade fibres, except glass	High temperature fusing of quartz and carbon	Silicon carbide fibres	x			x (CO and SO_2)
			Quartz	x			
			PAH	x			

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 351 Manufacture of Industrial Chemicals

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
513	Manufacture of synthetic resins, plastics etc	Synthesis	Phtalic anhydride	x			
		Di-(2-ethylhexyl)-phthalate				x	
521	Manufacture of paints, varnisters and laquers	Handling and processing	Titaniumdioxide dust	x			
		Filling operations, milling, crushing and weighing	Cadmium sulfide dust	x			
			Cadmium seleno-sulfide dust	x			
		Handling and processing	Benzidine sulfate dust	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 351 Manufacture of Industrial Chemicals

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3522	Manufacture of drugs and medicines	Filling operations, handling	Ispagula powder	x			
3529	Manufacture of chemical products, not elsewhere classified	Production of ammonium-perfluorooctanoate	Ammoniumperfluoro-octanoate	x			
		Production of carbon black	Carbon black dust	x			
		Production of benzene diols	Hydroquinone	x			+
			Catechol	x			Quinone vapours may be present
			Resorcinol	x			

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 352 Manufacture of other Chemical Products

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
529	Manufacture of chemical products, not elsewhere classified	Filling and packing of munition	TNT-dust	+			
		Handling and processing	Carbon black dust	+			
		Production of fluoro-chemicals	Ammoniumperfluoro-octanoic acid	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 354 Manufacture of miscellaneous Products of Petroleum and Coal

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3540	Manufacture of miscellaneous products of petroleum and coal	Coke oven work	PAH	+			
		Handling and processing	Fly ash	+			

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 355 Manufacture of Rubber Products

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
551	Tyre and tube industry	Tyre manufacturing	Dust containing hexamethylene-tetramine-resorcinol	x			x Formaldehyde and ammonia in small amounts
559	Manufacture of rubber products, not elsewhere	Includes more than ten different processes	Carbon black	x			x During some processes, organic solvent vapours are present
			Talc	x			
			Cured rubber dust	x			
			Silicone oil mist			x	

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 356 Manufacture of Plastic Products, not elsewhere classified

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3560	Manufacture of plastic products, not elsewhere classified	Blowing of hollow articles	Dust	x			x Numerous gases and vapours
		Manufacture of polypropylene and polypropylene products. Heating processes	Decomposition products	x		(x) possible	x Numerous gases and vapours of all classes
		Production of polyethylene bags	Soot	+			Numerous irritant gases
		Production of fibrous materials	MMMF and other fibres	+			

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 36 Manufacture of non-metallic Products, except Products of Petroleum and Coal

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
610	Manufacture of pottery, china and earthenware	Production	Lead containing dust	x			
699	Manufacture of non-metallic mineral products not elsewhere classified	Mixing and grinding of asbestos cement	Asbestos fibres	x			
			Dust	x			
		Glass fibre, paper manufacturing	MMMF	x			
	Stone product manufacturing	Cutting, grinding etc.	Dust	x			
		Production of rock wool	Man-made mineral fibres	x			
		Asbestos textile production	Asbestos fibres	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 37 Basic Metal Industries

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3710	Iron and steel basic industries	Casting, moulding, smelting	Silica (quartz)	x			
			PAH, incl. BAP	x			
			Metals	x			
	Ferro-alloy manufacture		Vanadium dust	x			
	Steel rolling plant	Tandem mill operators	Oil mist			x	
			Asbestos	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 37 Basic Metal Industries

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3720	Non-ferrous metal basic industries						
	Aluminium plant	Electrolysis	PAH	x			x (PAH-vapours
			Lead	x			
			Fluorides	x			x (CO, CO_2, SO_2)
			Dust	x			
			Aluminium oxide	x			
			Sodium, aluminium fluoride fibres	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 37 Basic Metal Industries

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3720	Beryllium plant	Melting and pouring	Beryllium dust	x			
	Brass foundry	Melting and casting	Lead	x			
			Copper	x			
			Zinc	x			
	Cadmium refining	Handling, filtration, melting and casting	Cadmium containing dust	x			
	Copper smelting	Handling, smelting	Arsenic oxide	x			(x) (possibly also ASH_3)

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 37 Basic metal Industries

SIC 'ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3720	Copper smelter	Roasting and electro-lysis	Dust containing arsenic, copper and lead	x			
	Hard metal	Smelting	Cobalt containing dust	x			
			Tungsten carbide	x			
	Lead smelter	Smelting	Lead	x			
	Nickel refining	Smelting, electrolysis	Nickel	x			x $Ni(CO)_4$
			Nickel oxide	x			
			Nickel sulfide	x			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 37 Basic Metal Industries

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3720	Vanadium factory		Vanadium dust	x			
	Zinc plant		Cadmium dust	x			

able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3. 38 Manufacture of fabricated metal products, machinery and equipment

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
381	Manufacture of fabricated metal products, except machinery and equipment	Metal machining, cutting	Cutting oils			x	
			Lubricant oils			x	
		Metal cleaning and degreasing	Organic solvents			x	
			Aquous solutions of e.g. Friethanol amine Boron compounds Nitrilotriacetic acid EDTA		x		
		Sand blasting	Quartz dust	x			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3819	Manufacture of fabricated metal products, except machinery and equipment not elsewhere classified	Sanitary whiteware production	Pottery dust	+			
		High speed can making	Lead	+			
3829	Machinery and equipment except electrical not elsewhere classified	Hot forging (artillery shells)	Oil, soot metal	+		+	Nitrogen oxides, Sulfur oxides, Aldehydes, Carbonmon-oxide

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionall present
					Water based	Other	
3832	Manufacture of radio, television and communication equipment	Manufacture of semi-conductors	Silica dust	+			Numerous gases
			Caustics				
			Arsenicals	+			+
3839	Manufacture of electrical apparatus and supplies not elsewhere classified	Manufacture of batteries (alkaline)	Cadmium	+			
		Manufacture of lead-acid batteries	Arsenic dust (arsenic oxide)	+			Arsine

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3

SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
3841	Shipbuilding and repairing	Boatbuilding and repairing	Asbestos	+			
			MMMF	+			
		Cutting, drilling, grinding etc.	Paints and laquers		+	+	+
			Lead	+			
			Wood dust	+			
		Welding	Welding smoke				

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Manufacturing 3

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionall present
					Water based	Other	
3843	Manufacture of motor vehicles	Automobile assembly (grinding, soldering)	Lead dust	+			
		Brake and clutch factory	Asbestos fibres (chrysotile)	+			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Electricity, gas and water 4

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
1101	Electric light and power	Cleaning and handling	Fly ash (containing nickel, cadmium, lead and zink)	+			
		Handling of fuel oil	PAH	+			
		Insulation work	Asbestos	+			
		Maintenance work	PCB			+	
			Metals (e.g. Cr.Ni.Be)				

'able

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Electricity, Gas and Water. 4

SIC ode	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionall present
					Water based	Other	
1102	Gas manufacture and distribution	Coke oven work	PAH	+			Various gases
			Coal tar fumes	+			
			Coal dust	+			

Table IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Construction 5

[SIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
5000	Construction	Building etc.	Asbestos fibres	+			

Table

IMPORTANT WORKING PROCESSES AND OPERATIONS.

Major Division: Transport, storage and communication 7

ISIC Code	Divisions, major groups or groups	Processes and/or operations	Aerosols	Solid aerosol	Liquid aerosols		Vapours additionally present
					Water based	Other	
7111	Railway transport	Railway workshop (maintenance work)	Asbestos	+			
		Cleaning operations	Dust	+			
			Oxalic acid		+		
7191	Services incidental to transport	Dockyard workers	Alfatoxins	+			
			Lead	+			
			PAH	+			
			Dust	+			
		Operation of grain elevators	Grain dust	+			