Scand J Work Environ Health 1976;2(1):8-12

<https://doi.org/10.5271/sjweh.2837>

Issue date: 1976

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Key terms: [dust measurement](#); [Finland](#); [foundry chemical](#); [foundry project](#); [foundry work](#); [general methodology](#); [methodology](#); [morbidity](#); [mortality](#); [mortality study](#); [turnover](#)

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/184525

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The Finnish foundry project

Background and general methodology

by SVEN HERNBERG, M.D.

HERNBERG, S. The Finnish foundry project: Background and general methodology. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 8—12. The general methodology of the Finnish foundry project is presented. The project comprised dust measurements from all Finnish iron and steel foundries and a sample of nonferrous foundries, measurements of chemicals used in most foundries, and a mortality, morbidity and turnover study of active and retired foundry workers. The total budget of the project was Fmk 1,155,000 (\$ 305,000). It was started in April 1972 and completed in May 1975. The project had the practical objective of developing recommendations for improvements in work conditions in individual foundries. More specific details of the methodology are reported in other communications.

Key words: Foundry work, general methodology, dust measurements, foundry chemicals, mortality study, morbidity, turnover.

A strike lasting seven weeks paralyzed the entire Finnish metal industry early in 1971. When an agreement was finally reached between the labor market organizations, one of the conditions was that the Institute of Occupational Health perform a comprehensive survey of the work environment in all Finnish foundries and evaluate the health state of foundry workers. Closer consideration of the problem led to the conclusion that it was impossible practically to conduct a complete study of all health problems in all foundries. Instead it was decided that different statistical sampling procedures would be used in a concentration on typical hazards, such as silica dust, certain

chemicals, metal fumes, and carbon monoxide, and their ill effects. Even so, the foundry project became the most extensive single research project, in terms of manpower and funds, ever carried out by the Institute. The entire budget rose to Fmk 1,155,000 (\$ 305,000), and about 25 research workers and assistants were involved. The two employers' organizations concerned shouldered 60 % of the financial responsibility and the Finnish Metal Workers' Union, 40 % of it. However, during the course of the study, the Ministry of Commerce and Industry contributed Fmk 100,000; the Ministry of Social Affairs and Health, Fmk 200,000; and the National Pensions Fund, Fmk 230,000.

The project started in April 1972 and was completed in May 1975. It was divided into the following five subprojects: (a) a dust project, comprising measurements of total dust and respirable silica dust in all foundries using sand molding;

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(b) a chemical project, comprising measurements of carbon monoxide, metal fumes, organic solvents, and gases from sand binders; (c) a morbidity study of foundry workers; (d) a retrospective mortality study of active and retired workers; and (e) a study of the pattern of and reasons for the turnover among workers.

The project was not undertaken for scientific reasons only. The labor market organizations considered it equally important to obtain hygienic data and instructions for the improvement of individual foundries. This was one of the main reasons why dust levels were measured in all foundries instead of in a statistical sample of workplaces. Hence each foundry received a report of the measurements made in their own workplace, together with recommendations for improvements. The report was sent both to the employer and to the employees' representative. Similarly, each worker undergoing a health examination received a personal report of the results, but no individual data were given to any other party.

The entire study was performed in close collaboration with the sponsoring organizations and, at the workplace level, with representatives of both the employers and employees.

CHARACTERISTICS OF THE FOUNDRIES STUDIED

All Finnish iron and steel foundries were included in the project. In addition almost all the nonferrous foundries using molding sand were included. Those not included were mainly small metal foundries which employed a few workers only and did not belong to an employers' organization.

Fig. 1 shows the geographical location of the foundries included in the dust project. The vast majority of them were situated in the industrialized southwest part of the country. The number of iron foundries was 51; that of steel foundries, 9; and that of nonferrous foundries, 8. The number of foundries in the other investigations varied.

Table 1 shows the size distribution of the foundries (dust project) based on the number of workers employed. The iron

Fig. 1. Geographical location of the foundries included in the dust project.

Table 1. Size distribution of the foundries (dust project) according to number of workers employed.

Size	Number of foundries	Number of workers
1— 25	31	423
26— 50	17	520
51—100	11	712
> 100	9	2,661
Total	68	4,316

and steel foundries employed altogether about 4,000 workers. As can be seen from the table, most Finnish foundries are small. Only nine foundries employed more than 100 workers, but their share of the total number of workers was 62 %.

THE DUST PROJECT

As already mentioned, most iron and steel foundries and some nonferrous foundries using molding sand were studied. First

all foundries received information regarding the project, and they were asked when the measurements would be most representative. In addition information was sought about the work processes, the type of production, the machinery, and the raw materials used. The next step was an acquaintance visit to the large foundries during which the sampling program was planned and the exact date of investigation was agreed upon. The smaller foundries were informed 2 weeks in advance by mail.

The sites of measurements were chosen as uniformly as possible so that results from different foundries could be compared. All work processes were studied;

hence both dusty and less dusty sites were included by design. In the selection of measurement sites the size of the foundry, the process, the methods, and the distribution of workers between different work phases were all taken into account. Both stationary and personal dust samplers were used. In each foundry the sampling lasted at least two consecutive shifts or work days for all types of work. In some instances samples were taken for 5 days. Two investigators could handle maximally 10 stationary and 10 portable samplers. In the larger foundries 20—25 stationary and 20—30 personal samplers were used at the same time, and the number of investigators needed depended on the number of samplers used. Altogether about 3,200 dust samples were collected and analyzed during the study. The methods have been described in more detail elsewhere (3, 4, 7).

Table 2. Classification of groups of chemicals used in Finnish foundries.

Group of chemicals	Number of commercial products
Raw materials: metals, alloys, inoculants	140
Lining materials for ovens and pouring ladles	50
Molding and coremaking sands	20
Binders and additives for molds and cores	65
Blackening and stripping agents, oil dressings	60
Exothermics	30
Materials used in welding, fettling and painting	25
Materials used in the pattern shop	40
Total	430

Table 3. Structure of the sample of foundries selected for study according to number of workers employed.

Number of workers employed	Type of foundry			Total
	Iron	Steel	Non-ferrous	
≤30	3	—	3	6
31—100	3	2	3	8
≥101	3	3	1	6
Total	9	4	7	20

THE CHEMICAL PROJECT.

This project started with an inquiry concerning the foundry's main type and methods of production, along with all the raw materials, additives and other chemicals used. The inquiry was sent to all the foundries operating in the beginning of 1972, and its purpose was to obtain a preliminary view of the possible chemical risks arising from the work processes used. Altogether 91 foundries responded, and from them 46 iron foundries, 9 steel foundries, and 8 copper alloy foundries were selected for further study. Those light metal foundries using only ingot or pressure casting were omitted since their methods more closely resembled mechanical engineering activities than ordinary foundry work. Thus almost all iron and steel foundries and a sample of nonferrous foundries were included in the study.

The preliminary inquiry revealed that altogether 430 different commercial products were used. Table 2 shows their distribution.

The measurements performed in the 63 foundries concerned the following groups of chemicals: metal fumes and dust arising

Fig. 2. Flow-chart of the morbidity, mortality and turnover projects.

ing from melting, welding of cast metal articles, flame cutting and fettling; carbon monoxide from melting and casting; gases formed from sand binders during molding, coremaking and casting; solvent vapors released during spirit blacking and the painting of cast materials; and other chemicals, if special indications existed.

The samples were taken during at least one entire work shift, and both stationary and portable samplers were used. In all, 1,100 gas samples were collected and analyzed, and, from the 700 dust samples taken, about 10,000 elemental analyses were performed. More details are given elsewhere (8, 9, 10).

MORBIDITY, MORTALITY AND TURNOVER OF FOUNDRY WORKERS

A representative sample of 20 foundries was selected from the 91 foundries which responded to the previously mentioned inquiry. Factors determining representativeness were site, age, and size of the foundry and age structure, occupational distribution and turnover of the workers. For practical reasons the possibility to use a foundry's personnel register also determined the selection. Table 3 shows how the selected foundries were distributed with regard to size and type of activity.

A summary of the research strategy is given in fig. 2.

The survey comprised three steps. The first one was an inquiry that was sent to all those 1,789 men employed by the 20 foundries on 31 December 1972. The men were asked about occupational history, work conditions, occupational health problems, fitness, and health state. The response rate was 91 %. Similar questions were also sent to a sample of ex-foundry workers (fig. 2).

The second step was a health survey of those 1,000 still active foundry workers with the longest exposure time. This restriction resulted in a minimum exposure time of 4.2 years (mean 17, SD 9 years) for the 931 men who responded. The health survey was carried out during the fall of 1973 and the winter of 1974 by the mobile unit of the Institute. The survey comprised a number of examinations directed at revealing respiratory disease, coronary heart disease, and some other illnesses (1, 2).

The third stage was a study of the mortality and turnover among all those 15,401 workers who had been employed by the 20 foundries during 1950 to 1972. A detailed description of the procedures involved is given elsewhere in this issue (5, 6).

REFERENCES

1. HERNBERG, S., KÄRÄVÄ, R., KOSKELA, R.-S. and LUOMA, K. Angina pectoris, ECG findings and blood pressure of foundry workers in relation to carbon monoxide exposure. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 54—63.
2. KÄRÄVÄ, R., HERNBERG, S., KOSKELA, R.-S. and LUOMA, K. Prevalence of pneumoconiosis and chronic bronchitis in foundry workers. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 64—72.
3. KOPONEN, M., SILTANEN, E., KOKKO, A., ENGSTRÖM, B. and REPONEN, J. Effect of foundry size on the dust concentration of different work phases. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 32—36.
4. KOSKELA, R.-S., HERNBERG, S., KÄRÄVÄ, R., JÄRVINEN, E. and NURMINEN, M. A mortality study of foundry workers. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 73—89.
5. KOSKELA, R.-S., LUOMA, K. and HERNBERG, S. Turnover and health selection among foundry workers. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 90—105.
6. SILTANEN, E., KOPONEN, M., KOKKO, A., ENGSTRÖM, B. and REPONEN, J. Dust exposure in Finnish foundries. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 19—31.
7. TOSSAVAINEN, A. Metal fumes in foundries. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 42—49.
8. TOSSAVAINEN, A. and KOKKO, A. Precision and accuracy of foundry dust exposure estimates from air sampling data. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 13—18.
9. VIRTAMO, M. and TOSSAVAINEN, A. Carbon monoxide in foundry air. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 37—41.
10. VIRTAMO, M. and TOSSAVAINEN, A. Gases formed from furan binding agents. *Scand. j. work environ. & health* 2 (1976): suppl. 1, 50—53.