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The foundry industry in Finland

A review

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Finland covers an area of 336,920 km^2, of which nearly 10 % consists of lakes and waterways and 60 % of forests. The population is about 4.7 million, and approximately one-third of the inhabitants lives in the coastal regions.

STRUCTURE OF FINNISH INDUSTRY

Before the Second World War, Finnish industry was comparatively limited to forestry and related activities. As late as 1938 they produced over 80 % of Finland's total export.

During the past two decades vigorous industrial expansion and a widening range of industrial products have been characteristic of the economic development in Finland. Particularly mechanical engineering and the chemical industry have increased their relative proportion. The metal and engineering industries have become by far the most important industrial employers. The major products of engineering are machines for the woodwork industry, agricultural and earthmoving machines, lifts, and cranes. The shipbuilding industry has specialized in producing icebreakers, luxury cruisers, car ferries, timber transport ships, etc. The gross value of industrial production in 1973 is shown in table 1.

FOUNDRY INDUSTRY

Most of the Finnish foundry industry is located in the southern and western parts of the country and is associated with the engineering centers (fig. 1). The total number of foundries is 127, i.e., 10 steel, 53 cast iron, and 64 nonferrous foundries according to their main product in 1974. Table 2 shows the annual production of the foundries in tons.

The total quantity of castings produced in Finland in 1974 was about 140,000 metric tons. The main part of this production consisted of castings for common engineering works and for papermaking machines, such as rolls and dryers. About 25 % of the production consisted of castings for buildings, central heating boilers, water and drain pipes, stoves, building accessories, etc. Since Finland has only one small car manufacturer, the amount of casting for the vehicle industry is not more

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Table 1. Gross value of production in the main industries and the number of workers in 1973.

Industry	Gross value		Employees	
	Million Fmk	%	Number	%
Metal	14,100	26.5	173,700	32
Wood and paper	12,900	23.8	105,300	20
Textile	3,800	6.9	74,100	14
Foodstuffs, etc.	9,500	17.6	56,000	10
Chemical	5,300	9.8	38,000	7
Other	8,400	15.4	89,800	17
Total	54,000	100.0	537,000	100

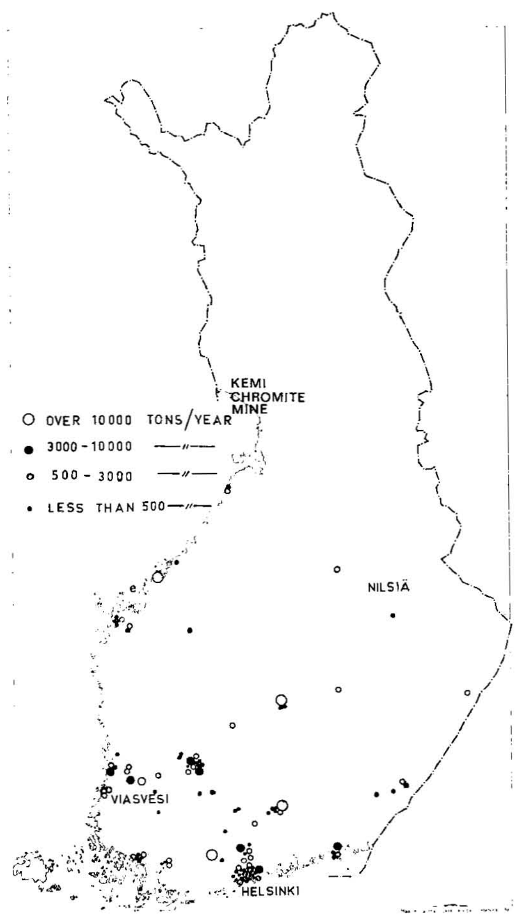

Fig. 1. The location of Finnish foundries and main sand deposits.

than 10 %. The use of nodular cast iron has increased very rapidly during the last decade.

Steel foundries produce a wide selection of acid-resistant and stainless steel parts for the cellulose and chemical industry and wear-resistant manganese steel

Table 2. Annual production of Finnish foundries.

Number of foundries	Annual production (tons/a)
5	>10,000
9	3,000—10,000
40	500— 3,000
73	< 500

Table 3. Average grain size of Viasvesi silica sands.

ASTM sieve number	Viasvesi sands		
	Fine	Medium	Coarse
12	—	—	—
20	—	—	—
30	< 1.0	< 1.0	< 2.0
50	7.0	11.0	84.0
70	15.0	57.0	13.0
140	57.0	25.0	< 1.0
270	19.0	6.0	—
Pan	1.0	< 1.0	—

castings for the mining industry. Some steel foundries have specialized in castings for the shipbuilding industry.

The foundry industry employs about 5,500 workers.[2] There has been a shortage of manpower lately.

Raw materials and energy

Pig iron. In northern Finland there are several iron mines, which produced about

2 This figure includes part of the supervising and office force.

1.9 million tons of iron concentrates in 1974. In addition iron ores were imported from Sweden, Norway, and the Soviet Union. The 1.4 million tons of pig iron is produced in four blast furnaces. One part of this production is used for foundry purposes; the rest is refined to constructional steel or exported.

Copper and other nonferrous metals. Finland is today one of the leading European producers of copper and nickel. Other ore resources are zinc, chromium, cobalt, and vanadium. Most of these metals are exported as different refined products.

Foundry sands. Sand deposits suitable for molding purposes are very limited in Finland. There are no naturally bonded sands, and the only big and useful quartz sand deposit is situated in Viasvesi (fig. 1) near the town of Pori. Most of the large iron foundries get their sands from this source.

The Viasvesi sand is very uniform. Its quartz content varies from 88 to 93 %. The grain size of the Viasvesi sands is presented in table 3. Viasvesi sands originate from the seabed, and a subangularly shaped grain is typical. The clay content is less than 1.0 %.

Some smaller iron foundries have their own local sand sources, which originate from the glacial epoch. The quality of the deposits is usually very poor because of the high clay and feldspar content and low percentage of quartz.

In Nilsiä (fig. 1) there is a big quartzite deposit which has a very high quartz content. After being crushed and sieved, the quartzite is widely used as a raw material in the glass industry; also some steel foundries are using it as molding sand. However its mechanical strength is not very good and it is easily split into fine dust.

One steel foundry is working with chromite sand and another with olivine sand. In addition many iron foundries are partly using these very expensive sands to improve their casting quality. The chromite sand is produced at the Kemi chromite

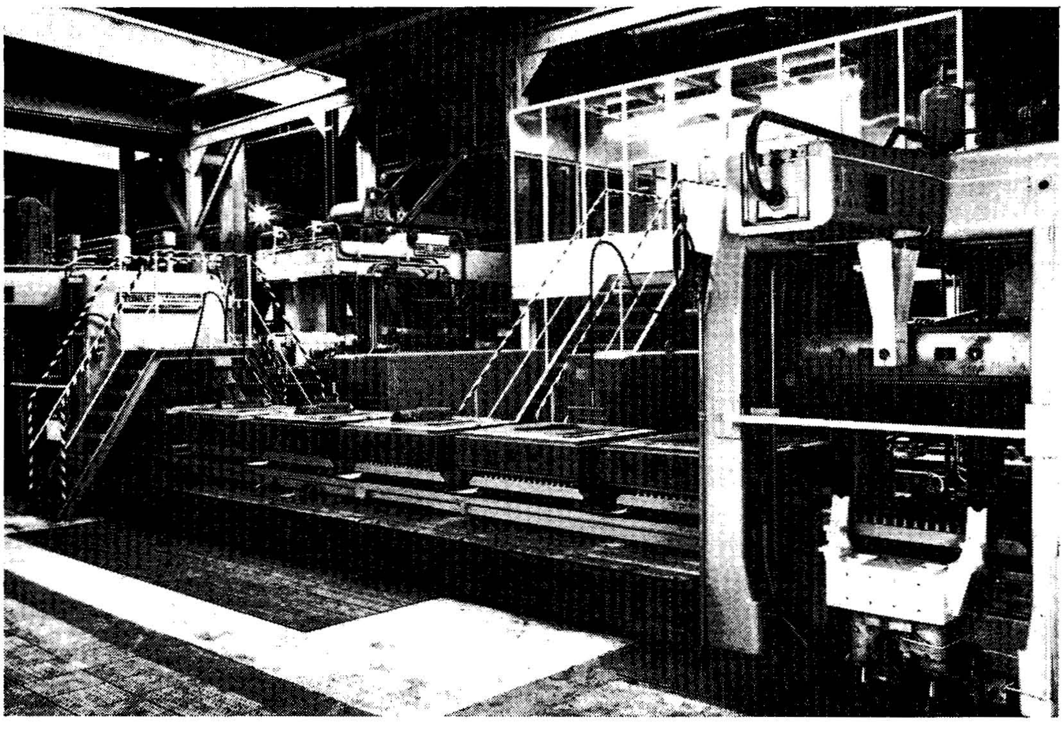

Fig. 2. The automatic molding line at the Högfors foundry. The standardized dimensions of the molding boxes are 900 × 720 × 300/300 mm. The maximum molding rate is 180 molds per hour.

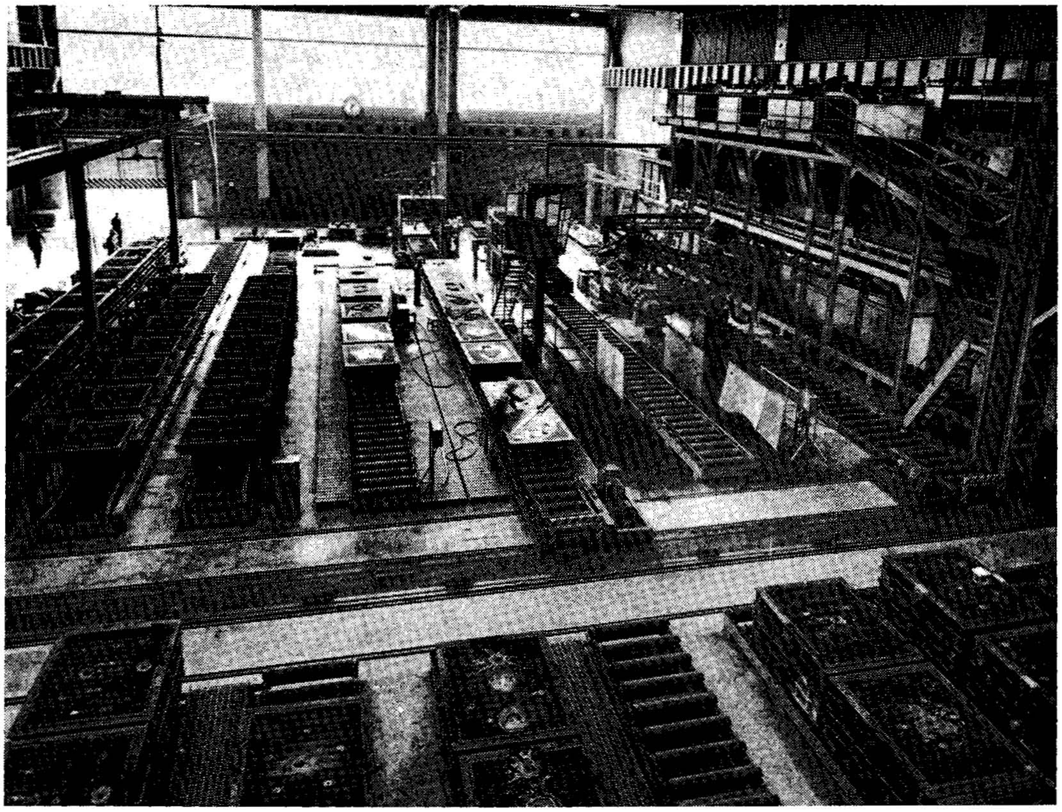

Fig. 3. Mechanized sandslinger molding line for molds 1,200 × 1,500 × 400/400 mm in size — installed in 1972. (Courtesy of Rauma Repola Oy)

mine owned by Outokumpu Oy (fig. 1). It is made by crushing the chromite ore. Olivine sand is imported from Norway. It is a crushed product from olivine rock.

Refractories and fluxes. There are no fireclay deposits of really good quality in Finland, and most of the raw materials needed for the manufacturing of cupola patching or other refractory materials have to be imported. Small quartz deposits occur around the country, but most of them are not important to the foundry industry. Supplies of limestone and dolomite stone for fluxing materials are located close to all the major industrial centers, and they are easy to obtain.

Oil, coke and electric power. There are no coal mines or oil wells in Finland; therefore these important fuels have to be imported. Raw oil is bought and refined to naphta and gasoline by two oil refineries situated in southern Finland.

The coke situation in foundries has sometimes been very serious because the quality or size of the coke available has not been satisfactory.

The use of electric power is increasing fast. From a total power consumption in 1974 of 29,000 GWh, about 42 % was generated by hydroelectric power stations. Now that almost all natural power resources have been tapped, there are four nuclear power plants under construction.

Processes

Melting. Cupolas are the most commonly used melting furnaces for cast iron. Some foundries have fitted their cupolas with hot-blast equipment, and, to produce higher cast iron grades or nodular cast iron, 11 foundries have installed induction furnaces. Also electric holding furnaces have been installed in many foundries.

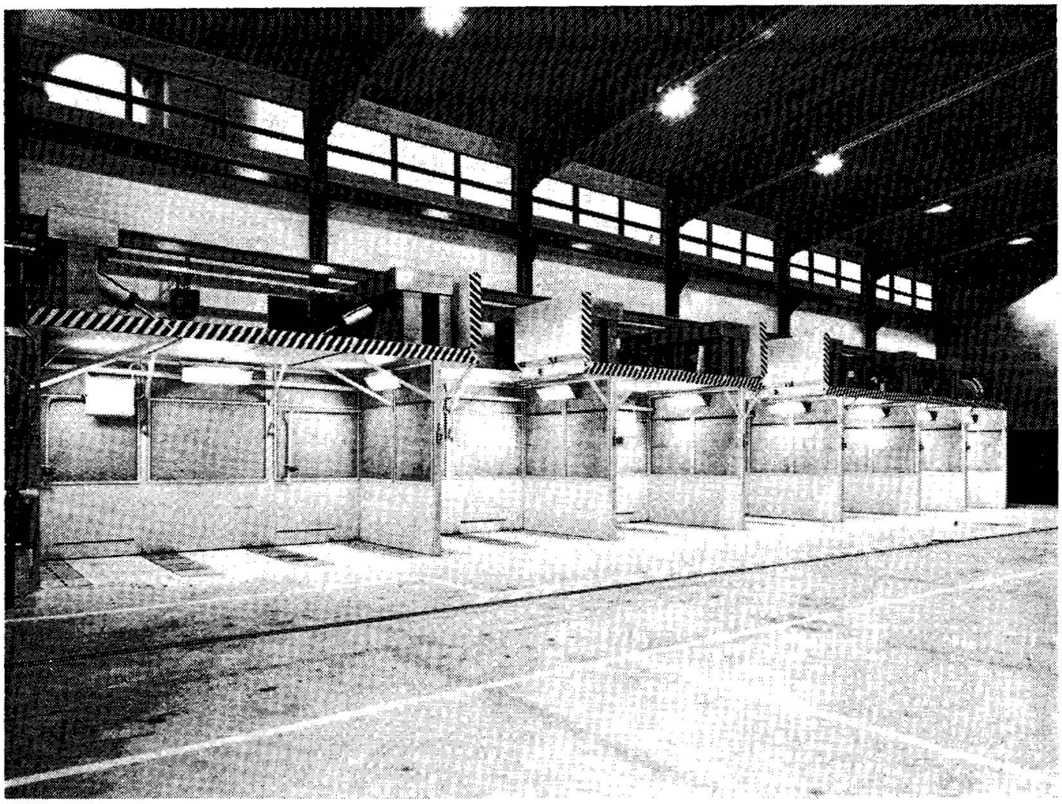

Fig. 4. A new fettling shop for medium castings. Each cabinet has an exhaust through the floor, back walls and roof of about 10,000 m^3/h. Cabinets are insulated against noise; the illumination can be raised to 1,000—1,500 lux. (Courtesy of Tampella Oy).

Steel foundries are usually equipped with direct arc furnaces or high frequency induction furnaces.

Molding and coremaking. Many of the large foundries have wholly mechanized sandpreparing systems, the mixing being normally carried out in Simpson mixers or in Speedmullers. In molding lines the gravity roller conveyor system is often utilized, but power-driven mold conveyors are also used in some foundries. The greatest advance in mechanization has been made in the repetition-production foundries. There is only one fully automated molding line, but many foundries are working with semiautomated production lines. Especially flaskless molding has in recent years gained increased popularity.

Greensand molding is still the most common form of molding. Many foundries also use sandslingers for moldmaking in addition to ordinary molding machines. Three of the bigger foundries make the molds with cement sand. However many jobbing foundries are using self-setting sands based on furan resin or sodium silicate. The smaller foundries are only semimechanized, or they are operating without any mechanization. Figs. 2—4 show some plant installations in the most modern foundries. In contrast figs. 5—7 show some work environments in older-type foundries. Shell molding on a bigger scale is used in only three foundries.

For coremaking, the sodium silicate, hot-box, cold-box, and croning methods are common.

Environment and health of workers

In Finland air pollution problems are as serious as in other countries. To minimize

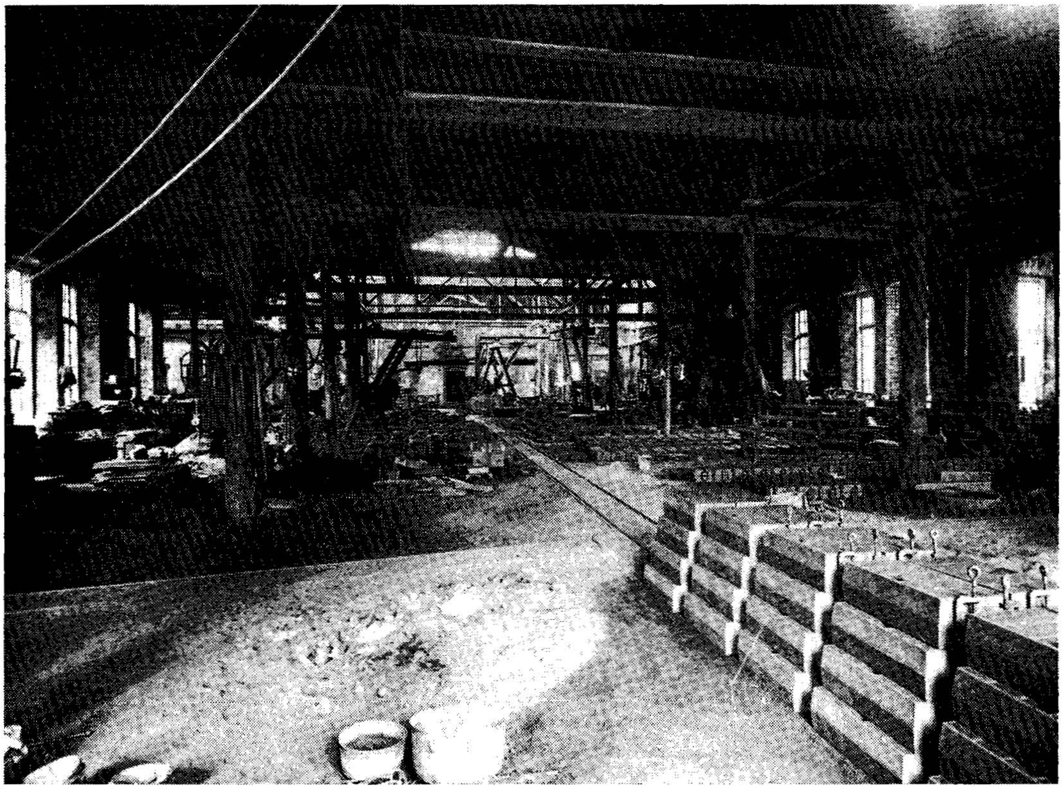

Fig. 5. The interior of the foundry in fig. 2 at the beginning of the 20th century.

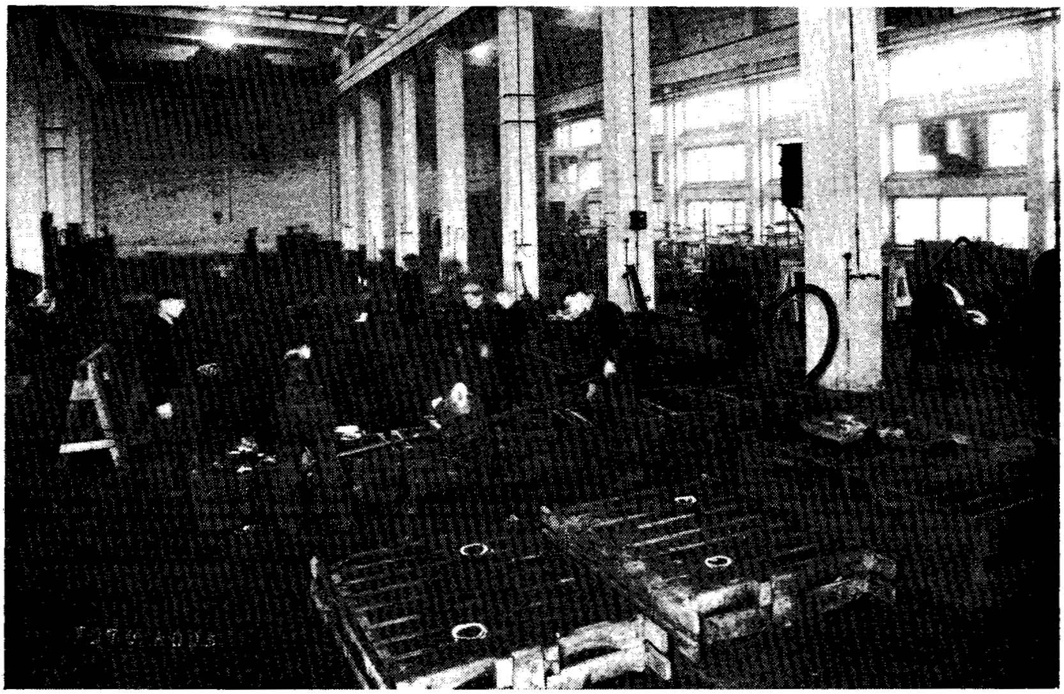

Fig. 6. Pouring molds in an older type foundry.

Fig. 7. In many small foundries the shake-out of molds is still done by hand.

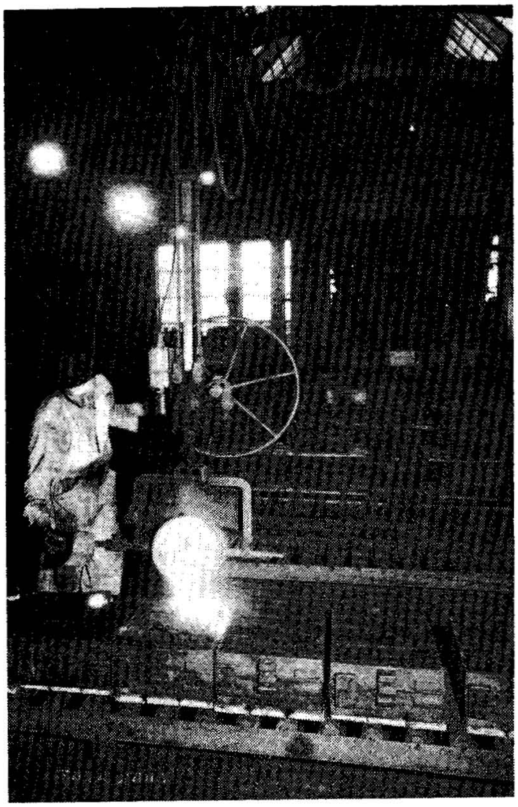

Fig. 8. A roller conveyer foundry typical of those still widely used in Finland. It is difficult to arrange sufficient ventilation in such a foundry.

the risk of silicosis, the National Board of Labor Protection has issued regulations with regard to the permitted dust content in foundries. The regulations are very detailed and describe pollution control methods and precautions, which must be taken into consideration to keep the dust below a certain level. The foundry industry should make all necessary improvements in ventilation by the end of 1976. In special cases the time may be prolonged to 1978.

Each year the dust content must be measured in every foundry. The foundries will also have to change work methods and raw materials to obtain lower dust levels. Threshold limit values for respirable quartz content are presented in table 4. The total dust level must never exceed 10 mg/Nm^3, and the noise level should be under 85 dB.

Table 4. Threshold limit values (TLV) for respirable quartz content.

Compound	TLV (mg/Nm^3)
Quartz	0.2
Christobalite	0.1
Tridymite	0.1

There is no legislation concerning the environmental control of foundries at this time. However the Air Protection Act should be passed in 1976 or 1977. All foundries will be subject to the law, as well as a number of other industries generating dust, poisonous gases, etc. The emission standards have not yet been issued.

During 1972—1975 almost every foundry in Finland was extensively surveyed for dust and other dangerous materials. The health situation of the foundry workers was investigated too.

It is calculated that during the last 5 years the foundry industry has invested about 40 million marks in ventilation improvements only, and it must still spend about 100 million marks ($ 26 million) before the pollution situation in the foundries will be satisfactory. At the same time foundries must partly replace production machinery in order to make the ventilation arrangement reasonable. Such a renovation will require an additional 200—300 million marks. The estimated annual ventilating costs will be about 35 million marks, and therefore production costs will increase about 10 %.