WORKING FOR A HEALTHY FUTURE

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# Health, socio-economic and environmental aspects of possible amendments to the EU Directive on the protection of workers from the risks related to exposure to carcinogens and mutagens at work

## Acrylamide

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# SUMMARY

Acrylamide is classified as a group 2a (probably carcinogenic to humans) carcinogen by the IARC because of evidence that it may cause pancreatic cancer. It is on the Candidate List of Substances of Very High Concern for authorisation within the REACH Regulations and is classified as a Category 2 occupational carcinogen by the EU. Acrylamide is therefore already regulated as a carcinogen under the Carcinogens Directive. In this report we consider the likely health, socioeconomic and environmental impacts associated with introducing an OEL for acrylamide of 0.03 mg/m$^3$, which is considered typical of OELs currently in place in EU countries.

Up to 99.9% of acrylamide in the EU is used in the production of polyacrylamide (which, once produced, contains less than 0.1% acrylamide). Acrylamide monomer may also be sold for a small number of other uses. The three largest uses of polyacrylamide are in wastewater treatment, paper and pulp processing and mineral processing - estimated by Industry to be 80% of the market. Three companies are reported as producing acrylamide within the EU (in UK, Germany and the Netherlands) while a further two companies are involved in the import of acrylamide into the EU. The total plant capacity within the EU is estimated at between 80,000-150,000 tonnes per annum.

Approximately 53,000 workers in the EU are potentially exposed to acrylamide, based on 2006 employment data. We estimate that from this total about 12,000 are employed in the sector manufacturing chemicals and chemical products workers in (NACE Group 24), and of these about 1,220 are exposed during acrylamide manufacturing.

Measurement data from 1992 – 1995 and 2005 suggests that exposure in the manufacture of acrylamide and polyacrylamide have been decreasing by 10.5% per annum. Assuming this trend has continued as we have estimated, then our best estimate for the geometric (GM) exposure in 2010 is 0.008 mg/m$^3$, with 90% of exposures less than 0.038 mg/m$^3$. Steps continue to be taken to reduce exposures in the industry in relation to the requirements of the REACH Regulations and it is expected that by 2012 90% of all exposures will be less than 0.03 mg/m$^3$. Exposures in other sectors are considered already compliant with the suggested OEL.

It is not possible to calculate the temporal trend in dermal exposure based on the available data, although we consider that given the range of likely interventions to reduce inhalation exposure the corresponding dermal exposure will have also decreased and our best estimate is that the rate of decline is probably similar to that for inhalation exposure.

Given that exposures are either in compliance or are likely to become compliant in the near future we predicted that the health impacts are the same for the baseline and intervention (i.e. OEL introduction) scenarios. In 2010 it is estimated that there were seven deaths (six registrations) in the EU from pancreatic cancer that could be attributed to past acrylamide exposure. Over the coming years the number of attributable cancer deaths and registrations are predicted to decrease to about 3 or 4 per annum and remain at this figure from about 2030. Years of Life Lost (YLL) and Disability Adjusted Life Years (DALYs) per annum are predicted to be between about 40 and 50 from 2030 onwards.

Total health costs (2010 to 2069) for the baseline scenario are estimated to range from €156m to €326m. These costs will affect Member States differently depending upon the overall number of workers affected within industry groups, existing control measures and the proportion of males and females within these groups. We judge that the Czech Republic, France, Germany and the UK will have relatively high health costs. The only industrial sector affected is the manufacture of chemicals and chemical products (NACE Code 24).

We judge that there are no expected additional health benefits from introducing an OEL of 0.03 mg/m$^3$ and only minimal economic costs given that the industry has generally already invested to control exposure in connection with the REACH Regulations.

We do not envisage any social, macroeconomic or environmental impacts with introducing an OEL for acrylamide.

# 1 PROBLEM DEFINITION

## 1.1 OUTLINE OF THE INVESTIGATION

There is limited epidemiological evidence that acrylamide can cause pancreatic cancer. However, based on an evaluation of the available epidemiological literature, toxicology and other information, the IARC classified acrylamide as a group 2A (probably carcinogenic to humans) carcinogen[1]. It is on the Candidate List of Substances of Very High Concern for authorisation within the REACH Regulations. Under EU classification and labelling legislation it is classified Category 2 occupational carcinogen. Acrylamide is therefore already regulated as a carcinogen throughout the EU. In this assessment we consider the impacts of introducing an OEL for acrylamide within the Directive.

The key objectives of the present study are to identify the technical feasibility and the socioeconomic, health and environmental impacts of introducing a regulatory OEL for acrylamide of 0.03 mg/m$^3$ (30 µg/m$^3$).

## 1.2 OELS/EXPOSURE CONTROL

Existing national OELs (occupational exposure limits) in EU member states are presented in Table 1.1. These are expressed as long-term limits, averaged over an 8-hour working day or short-term exposure limits (STELs). i.e. 15 minutes. OELs from selected countries outside the EU are also presented for comparison.

**Table 1.1** Occupational exposure limits in various EU member states and selected countries outside the EU

| Country | OEL - long-term (mg/m$^3$) | OEL - STEL (mg/m$^3$) |
|---|---|---|
| Austria | 0.03 | 0.12 |
| Belgium | 0.03 | |
| Denmark | 0.03 | 0.06 |
| France | 0.3 | |
| Hungary | | 0.03 |
| Poland | 0.1 | |
| Spain | 0.03 | |
| Sweden | 0.03 | 0.1 |
| The Netherlands | 0.16 | |
| United Kingdom | 0.3 | |
| | | |
| Japan | 0.1 | |
| Switzerland | 0.03 (inhalable) | |
| USA - OSHA | 0.3 | |

Source: http://www.dguv.de/bgia/en/gestis/limit_values/index.jsp

[1] Available at: http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf

The long term OEL from the EU member states and outside jurisdictions ranges from 0.03 mg/m$^3$ to 0.3 mg/m$^3$. Austria, Denmark, Hungary and Sweden have STELs ranging from 0.03 mg/m$^3$ to 0.12 mg/m$^3$. For the purposes of this report an OEL of 0.03 mg/m$^3$, averaged over 8-hours, is considered typical for the EU.

## 1.3 DESCRIPTION OF DIFFERENT USES

Based on the 2002 EU Risk Assessment Report (RAR)[2] it is estimated that up to 99.9% of acrylamide in the EU is used in the production of polyacrylamide (which once produced contains less than 0.1% acrylamide).

Acrylamide monomer may also be sold for on-site preparation of polyacrylamide gels. About 0.1% of the acrylamide produced in the EU is used to produce polyacrylamide electrophoresis gels, which are used as a research tool for separating nucleic acids in research establishments, universities and hospitals.

Acrylamide can also be used in the formulation of grouting agents. Acrylamide grouts are no longer thought to be produced within the EU but are imported from outside the EU. The grouts are primarily used for salt damp inhibition and leak rehabilitation[3]. According to information from industry, there is relatively more frequent use in Belgium and the Netherlands, although the quantities are not large and the use is non-dispersive with no emissions to air, soil or water. The one known EU producer of an acrylamide grout stopped production at the end of 1997 and has no plans to restart production. The use of acrylamide grout is intermittent and infrequent. According to industry, worker exposure in these uses is very low, since there is practically no acrylamide in the air during handling and use (less than 0.01 mg/m$^3$) and personal protective equipment is very efficient at preventing dermal exposure[4]. As such, the use of acrylamide grout is not considered further in this document.

The three largest uses of polyacrylamide are in wastewater treatment, paper and pulp processing and mineral processing - estimated by industry to be 80% of the market. Detailed figures for the EU were not provided. In 1991, 65% of polyacrylamide used in the USA went into water treatment, with a further 20% used for paper and pulp processing and 5% for mineral processing (IARC, 1994). These industries generally dilute the polymer to give a stock solution of about 0.5% w/w, which may be further diluted (1:10) before use. Polyacrylamides may be supplied to formulators before reaching the end user. However in general, the largest industries purchase direct from the polymer manufacturer.

## 1.4 RISKS TO HUMAN HEALTH

### 1.4.1 Introduction

Cancer of the pancreas is a relatively common cancer that is generally diagnosed in people over 60 years of age. In the EU it comprises about 2.5% of all incident cancer

[2] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf
[3] IOM consultation with Polyelectrolyte Producers Group (PPG)
[4] Information form a PPG member company

cases (Ferlay *et al*, 2007). Key environmental risk factors are cigarette smoking, diet, other lifestyle factors and some medical conditions such as chronic inflammation in the pancreas.

The prognosis for people with pancreatic cancer is poor. Generally, by the time an individual is diagnosed the disease is quite advanced. Only about 15 - 20% of patients are suitable for surgery. Of those diagnosed with pancreatic cancer, about 20% survive 1 year later and less than 5% live for at least 5 years after diagnosis (Badger *et al*, 2010).

### 1.4.2 Summary of the available epidemiological literature on risk

The evidence of carcinogenicity in humans related to exposure to acrylamide is restricted to two cohort studies of occupationally exposed workers, one of which was updated twice (Sobel *et al* 1986, Collins *et al* 1989, Marsh *et al* 1999, Marsh *et al* 2007).

Sobel *et al* (1986) studied a small cohort of 371 workers (365 white males and 6 females) identified as being employed between 1955 and 1979 in acrylamide monomer or polymerisation operations. Exposure information was based on personal air monitoring data and job classification. Personal time-weighted average (TWA) exposure to acrylamide in the monomer production area was noted to have ranged from 0.1 to 1.0 mg/m$^3$ before 1957, while data for 1957 to 1970 showed that exposure was then 0.1 to 0.6 mg/m$^3$. The authors noted that a potential confounder was co-exposure to acrlyonitrile in the period up to 1973 (at <10 ppm TWA). Mortality up to 31$^{st}$ December 1983 was considered, with comparisons made against the general US white male population for major cause categories and site specific cancers. Risk for all causes of death was lower than expected for the total cohort with an SMR of 76 (95% CI 51 – 110) with a non-significant excess for all cancers (SMR = 139; CI 70 – 249), mainly attributable to tumours of the digestive and respiratory tracts. Swaen *et al* (2007) updated the study originally reported by Sobel *et al* (1986), extending the years of follow-up until 2001. The updated analysis was based on 141 deaths as compared to only 24 deaths in the original study. The results showed no increases in cause-specific cancer deaths other than for a non-statistically significant increase in pancreatic cancer (SMR = 222.2 95% CI: 72.1 – 518.5).

Collins *et al* (1989) studied a total cohort of 8854 workers employed at four plants (3 US, 1 Netherlands). Of the total cohort, 2293 men were identified as being occupationally-exposed to acrylamide in the period 1925 to 1983. The authors noted that, of the 8094 men originally classified as being non-exposed, 1533 were eventually exposed to acrylamide (i.e. at > 0.001 mg/m$^3$-years) during their careers and were therefore included in calculations for both unexposed and exposed groups. Exposure to acrylamide was estimated from monitoring data and through consultation with plant personnel on past jobs and processes. Those considered to have been exposed to acrylamide were defined as having a cumulative exposure greater than 0.001 mg/m$^3$-years (considered to be approximately equivalent to a one-day average exposure at the current permissible exposure limit of 0.3 mg/m$^3$). Smoking history was only available for 35% of the cohort. An SMR of 0.91 (based on 19 cases) for pancreatic cancer and cumulative exposure to acrylamide was estimated in the unexposed group, compared with 2.03 (8 cases) in the exposed group.

Marsh *et al* (1999) extended follow up of the 3 US plants to 1994. Marsh *et al* (2007) then extended follow up to 2002 for the established cohort of 8508 workers in three US plants and 344 workers in a plant in the Netherlands; this updated analysis included an additional 1093 deaths in the period 1925 – 2002. SMRs at both follow-ups showed no overall excess risk of cancer mortality and a non-significant excesses for cancer of the pancreas (1.79 (95% CI 0.98 – 3.01) in 1999 reducing to 1.41 (95% CI 0.81 – 2.29) in the 2007 analysis) for those exposed to acrylamide. For the US plants followed to 1999, an elevated risk of pancreatic cancer was found in workers with high cumulative exposures of 0.30 mg/m$^3$.yr or above (SMR = 2.26 CI 1.03 – 4.29) decreasing in the follow-up to 2002 to SMR = 1.71 (95%CI 0.78 - 2.35).

Table 1.2 and Table 1.3 summarise results for the Marsh *et al* 1999 and 2007 studies for the US segment of the cohort, when different measures of exposure are considered.

**Table 1.2** Cumulative exposure to acrylamide and risk of pancreatic cancer in US workers for periods between 1950 and 2002

| | **Pancreas– All US Workers, 1950-1994[1]** | | | **Pancreas– All US Workers, 1950-2002[2]** | | |
|---|---|---|---|---|---|---|
| Cumulative exposure (mg/m$^3$.y) | Observed deaths | SMR | 95 % CI | Observed deaths | SMR | 95 % CI |
| < 0.001 | 30 | 0.80 | 0.54 – 1.14 | 38 | 0.78 | 0.55 – 1.08 |
| 0.001-0.029 | 3 | 2.77 | 0.57 – 8.09 | 3 | 1.65 | 0.34 – 4.83 |
| 0.03-0.29 | 2 | 0.73 | 0.09 – 2.64 | 4 | 0.94 | 0.26 – 2.40 |
| ≥ 0.30 | 9 | 2.26 | 1.03 – 4.29 | 9 | 1.71 | 0.78 – 3.25 |

SMR – Standard Mortality Ratio; CI – Confidence Interval
[1] Adapted from Marsh *et al* (1999)
[2] Adapted from Marsh *et al* (2007)

**Table 1.3** Mean intensity of exposure to acrylamide and risk of pancreatic cancer in US workers, for periods between 1950 and 2002

| | **Cancer of the Pancreas– All US Workers, 1950-1994[1]** | | | **Cancer of the Pancreas– All US Workers, 1950-2002[2]** | | |
|---|---|---|---|---|---|---|
| Mean intensity of exposure (mg/m$^3$) | Observed deaths | SMR | 95 % CI | Observed deaths | SMR | 95 % CI |
| Unexposed | 30 | 0.80 | 0.54 – 1.14 | 38 | 0.78 | 0.55 – 1.08 |
| 0.001-0.019 | 4 | 1.69 | 0.46 – 4.32 | 5 | 1.34 | 0.44 – 3.14 |
| 0.02-0.29 | 5 | 1.50 | 0.49 – 3.49 | 5 | 1.11 | 0.36 – 2.60 |
| ≥ 0.30 | 5 | 2.31 | 0.75 – 5.40 | 6 | 1.85 | 0.68 – 4.03 |

SMR – Standard Mortality Ratio; CI – Confidence Interval
[1] Adapted from Marsh *et al* (1999)
[2] Adapted from Marsh *et al* (2007)

### 1.4.3 Choice of risk estimates to assess health impact

Only a limited number of epidemiological studies have evaluated the risk of various cancers in relation to occupational exposure to acrylamide, of which few have

specifically investigated the risk for cancer of the pancreas. The chosen study for the risk estimates is Marsh *et al* (2007). The SMR of 1.85 (95% CI 0.68 – 4.03) for mean intensity of exposure of 0.30 mg/m$^3$ or greater has been used for the high exposure category. An inverse-variance weighted pooled estimate of the SMRs for the mean intensities 0.001 – 0.029 and 0.03 – 0.29 mg/m$^3$ has been calculated by the research team (1.22; 95%CI 0.66 – 2.27) and has been used for the low exposure category. The risk for low cumulative exposures (i.e. less than 0.001 mg/m$^3$.y) was 0.8 (see Table 1.2); an SMR = 1 has thus been used for the background exposure category.

# 2 BASELINE SCENARIOS

## 2.1 STRUCTURE OF THE SECTOR

### 2.1.1 Acrylamide

Based on the 2002 EU RAR[5], three companies are reported as producing acrylamide within the EU (UK, Germany and the Netherlands) while a further two companies are involved in the import of acrylamide. The total plant capacity within the EU is estimated at between 80,000-150,000 tonnes per annum.

Individual plant capacities are in the range of 10,000-50,000 tonnes per annum. Total EU production is estimated at between 80,000-100,000 tonnes, the largest amount at a single plant being approximately 40,000 tonnes per annum. These production figures are calculated for acrylamide solids. Acrylamide is usually made as a 30-50% aqueous solution although a crystalline form of acrylamide is produced at one European production plant. German production in 1991 was 16,000 tonnes, of which 1,000 tonnes was exported (BUA, 1992). Acrylamide is imported primarily by the major manufacturers of polyacrylamides for their own use. Small amounts of acrylamide are also exported outside the EU. Figures were not available for these imports and exports, although it is understood that the majority of EU production is used within the EU.

Based on ESIS (European chemical Substances Information System[6]) for acrylamide, which may potentially have more recent data then the RAR, there are also thought to be firms in Spain, Finland and Italy who either supply (from imports) or produce acrylamide[7].

### 2.1.2 Polyacrylamide

There are seven producers of polyacrylamide within the EU, two of which are also acrylamide manufacturers. The seven companies operating these plants form the Polyacrylamide Producers Group (PPG). There are also a number of smaller polyacrylamide producers throughout the EU. According to BUA (1992), there are a total of eight polyacrylamide manufacturing plants in Germany. Each producer

[5] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf
[6] Available at: http://ecb.jrc.ec.europa.eu/esis/
[7] Available at: http://ecb.jrc.ec.europa.eu/esis-pgm/popup_hpvlpv.php?no=2011737&type=HPV

generally has different product ranges, although the smaller producers are understood to concentrate on particular grades for particular applications.

## 2.2 PREVALENCE ACRYLAMIDE EXPOSURE IN EU

The estimated exposure prevalence for the EU member states based on 2006 employment data is shown in Table 2.1. We have estimated that approximately 53,426 workers in the EU were potentially exposed to acrylamide in 2006.

The prevalence of exposure to acrylamide was estimated from the Finnish CAREX estimate of 2007, the Spanish CAREX estimate of 2004 and the Italian CAREX estimate of 2000 – 2003 (Mirabelli and Kauppinen, 2005). The proportion of exposed workers in each industry was taken from each of these three CAREX estimates and the average proportion exposed across all three countries was found for each industry. The average proportion of exposed workers was applied to information on the number of employees in each industry obtained from the structural business statistics and the labour force survey available on the Eurostat database.[8] The average proportion of exposed workers was multiplied by the number of workers employed in each industry in each country. For Finland, Spain, and Italy the proportion of exposed workers from their respective CAREX updates was used rather than the average proportion.

The number of employees in some industry groups and countries was not available on the Eurostat database. Where possible, missing data have been substituted with 2005 data for the applicable industry and country. When the 2005 data were also unavailable we have indicated that data were unavailable for the industry and country.

The estimated number of male and female employees in each industry group in each EU member state is shown in Appendix 8.1. The estimates were obtained by applying the average male to female employee ratio for the industry group for each country to the total number of employees. Male to female employee ratios were calculated with data from the Labour Force Survey. Managers, salespeople and office clerks were excluded from these calculations as they were assumed to be unexposed.

[8] Available at: http://epp.eurostat.ec.europa.eu/

**Table 2.1** Number of workers exposed to acrylamide by country and NACE code

| | NACE Rev1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **24** | **25** | **73** | **74** | **75** | **80** | **85** | **Total** |
| Austria | 175 | 12 | 73 | 9 | 3 | 526 | 10 | 807 |
| Belgium | 456 | 12 | 84 | 13 | 4 | 903 | 14 | 1485 |
| Bulgaria | 169 | 10 | 5 | 4 | 2 | 519 | 5 | 714 |
| Cyprus | 12 | 1 | 0 | 0 | 0 | 54 | 0 | 68 |
| Czech Republic | 270 | 36 | 83 | 11 | 3 | 676 | 9 | 1089 |
| Denmark | 195 | 9 | 87 | 8 | 2 | 510 | 14 | 824 |
| Estonia | 19 | 2 | 6 | 1 | 0 | 141 | 1 | 171 |
| Finland | 125 | 0 | 31 | 0 | 0 | 433 | 36 | 625 |
| France | 1792 | 99 | 569 | 76 | 24 | 4265 | 83 | 6910 |
| Germany | 2984 | 163 | 1277 | 103 | 29 | 4995 | 114 | 9665 |
| Greece | 118 | 5 | 121 | 9 | 4 | 726 | 6 | 989 |
| Hungary | 209 | 18 | 87 | 10 | 3 | 764 | 8 | 1099 |
| Ireland | 161 | 4 | 33 | 4 | 1 | 311 | 6 | 521 |
| Italy | 789 | 0 | 236 | 0 | 0 | 1668 | 0 | 2693 |
| Latvia | 28 | 2 | 17 | 1 | 1 | 211 | 1 | 262 |
| Lithuania | 40 | 4 | 10 | 2 | 1 | 318 | 3 | 378 |
| Luxembourg | 7 | 3 | NK | 1 | 0 | 36 | 1 | 48 |
| Malta | NK[1] | NK | NK | NK | 0 | 29 | 0 | 30 |
| Netherlands | 415 | 14 | 460 | 39 | 6 | 1292 | 36 | 2262 |
| Poland | 704 | 65 | 56 | 21 | 9 | 2724 | 24 | 3603 |
| Portugal | 140 | 11 | 17 | 15 | 4 | 749 | 9 | 945 |
| Romania | 318 | 20 | 314 | 9 | 5 | 994 | 11 | 1671 |
| Slovakia | 84 | 9 | 61 | 2 | 2 | 399 | 4 | 561 |
| Slovenia | 91 | 6 | 35 | 2 | 1 | 181 | 2 | 317 |
| Spain | 1212 | 156 | 372 | 200 | 24 | 3793 | 0 | 5757 |
| Sweden | 283 | 12 | NK | 11 | 3 | 1165 | 21 | 1496 |
| UK | 1397 | 90 | 1403 | 102 | 20 | 6091 | 99 | 9201 |
| **TOTAL** | **12195** | **763** | **5436** | **656** | **150** | **34473** | **516** | **54189** |

[1] Indicates that the number of employee data were not available on the Eurostat database

### 2.2.1 Exposure in acrylamide and polyacrylamide manufacturing

We have estimated that 12,195 workers in NACE 24 (manufacture of chemicals and chemical products) are exposed to acrylamide. Although the structural business statistics do not provide detailed information about the type of chemical manufacturing in which the workers in NACE 24 are involved it is likely that the workers in that industry who are exposed to acrylamide are involved in acrylamide or polyacrylamide manufacturing. The 2002 EU RAR[9] estimated that there were about 360 people in the EU exposed to acrylamide during acrylamide manufacturing and 4,500 people exposed during polyacrylamide manufacturing. The EU RAR has estimated a lower number of exposed workers indicating that our figure of 12,195 may be an overestimate. Based

[9] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf

on the RAR estimates about 10% of all of the acrylamide exposed workers in NACE 24 are involved in acrylamide manufacturing and 90% are involved in polyacrylamide manufacturing. If these percentages are applied to our prevalence estimate then we can estimate that 10,976 workers are exposed to acrylamide during polyacrylamide manufacturing and 1,220 are exposed during acrylamide manufacturing.

*Classification of Industries by Exposure Level*

Industries in which exposure to acrylamide occurs have been classified as high or low (historical) exposure based on an evaluation of the peer-reviewed literature, information from industry and expert judgement. The industries, grouped by NACE code were identified from the CAREX data. The exposure classification by industry is presented in Table 2.2.

Currently exposure to acrylamide monomer residues is considered to be negligible in industries in which polyacrylamides are used. Prior to the implementation of EU Directive 1999/45/EC, exposures to acrylamide monomers may have occurred in these industries at low levels therefore these industries are included in the classification table. The prevalence of exposure to acrylamide monomer in 19 EU member states in the 1993 – 1997 CAREX estimates are provided in Appendix 8.2. These estimates demonstrate historical prevalence of exposure to acrylamide residue in industries in which polyacrylamides are used.

**Table 2.2** Classification of industries by exposure level

| Industry | NACE (rev 1.1) | Historical Exposure Classification[1] | Number of People Exposed 2006[2,3] |
|---|---|---|---|
| Manufacture of food products, beverages and tobacco | 15 | Low | 0 |
| Manufacture of textiles | 17 | Low | 0 |
| Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials | 20 | Low | 0 |
| Manufacture of coke, refined petroleum products and nuclear fuel | 23 | Low | 0 |
| Manufacture of chemicals and chemical products | 24 | **High** | 12195 |
| Manufacture of rubber products | 251 | Low | 0 |
| Manufacture of basic metals | 27 | Low | 0 |
| Manufacture of fabricated metal products, except machinery and equipment | 28 | Low | 0 |
| Manufacture of machinery and equipment n.e.c. | 29 | Low | 0 |
| Manufacture of radio, television and communication equipment and apparatus | 32 | Low | 0 |
| Manufacture of furniture | 361 | Low | 0 |
| Collection, purification and distribution of water | 41 | Low | 0 |
| Construction | 45 | Low | 0 |
| Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods | G (50, 51, 52, 55) | Low | 0 |
| Research and development | 73 | Low | 5436 |
| Other business activities | 74 | Low | 656 |
| Public Administration and Defence | 75 | Low | 150 |
| Education | 80 | Low | 34473 |
| Health and social work | 85 | Low | 516 |
| **TOTAL** | | | **53426** |

[1] Relevant to 1975 Exposure Levels

[2] Prevalence estimation methods are described in section 2.2

[3] Industries with zero exposure prevalence for 2006 use polyacrylamides. Exposure to acrylamide residues in these industries is now negligible however historically there may have been low levels of exposure.

## 2.3 LEVEL OF EXPOSURE TO ACRYLAMIDE

### 2.3.1 Estimation of exposure levels

*Acrylamide and polyacrylamide manufacturing (NACE 24)*

The available scientific literature was reviewed for acrylamide occupational exposure data. We searched for both dermal and inhalation exposure data as dermal absorption is a significant route of acrylamide exposure (Granath *et al*, 2001).

The most recent European data available was reported by Bull *et al* (2005) who monitored personal inhalation and dermal exposure at a UK acrylamide and

polyacrylamide manufacturing facility. The job processes at this facility are representative of the full range of acrylamide exposure scenarios within the chemical manufacturing industry (NACE 24).

Full shift (8-hour) air samples were taken for 68 workers at the facility. Multiple samples were taken for each worker and a total of 260 full-shift air samples were obtained. Over half of the samples had concentrations below the limit of detection of 0.014 mg/m$^3$. The geometric mean (GM) exposure concentration for all samples was 0.014 mg/m$^3$ and the geometric standard deviation (GSD) was 3.34 (range of measured exposure levels: <0.014 mg/m$^3$ to 0.282 mg/m$^3$). The geometric mean exposures were not reported separately for acrylamide manufacturing and polyacrylamide manufacturing; however, the arithmetic mean reported for acrylamide production (approximately 0.08 mg/m$^3$) was slightly higher than that reported for powder polymer production (approximately 0.05 mg/m$^3$) (Bull *et al*, 2005). These inhalation exposure estimates are likely to be representative of acrylamide exposures within NACE 24 across the EU.

Bull *et al* (2005) also collected and analyzed 54 cotton glove samples at the same UK facility to assess dermal exposure to acrylamide. Workers wore these gloves for the duration of the work day. When protective gloves were used they were worn over the cotton gloves. The mass of acrylamide measured on the gloves ranged from <0.107 µg to 40.7 mg per hand. The exposure was not normalised for surface area. In the EU RAR[10] dermal exposure masses measured on cotton glove samples were divided by 410 cm$^2$, which was considered to represent the typical surface area of a hand.2 If the dermal exposures reported by Bull *et al* (2005) are divided by 410 cm$^2$ the dermal exposures per hand range from <0.26 – 99 µg/cm$^2$. The EU RAR reports full shift GM exposures of 2 µg/cm$^2$ per hand for acrylamide and 0.01 – 4 µg/cm$^2$ per hand for polyacrylamide manufacturing at the same UK facility. The RAR does not report when these measurements were taken.

At the UK facility studied by Bull *et al* (2005), both dermal and inhalation exposures were highest in acrylamide production and powder work areas (including powder polymer production and packing of powder products).

*Preparation and use of polyacrylamide electrophoresis gels (NACE 73, 74, 75, 80, 85)*

Acrylamide for electrophoresis gels can be purchased either as pre-measured packs of acrylamide and cross-linker which are prepared by the user by the addition of the initiator and water or as ready-made gels which are prepared by laboratory suppliers.

When ready-made gels are used there is negligible acrylamide exposure for the user. When the user prepares the gel short term (task lasting 30 minute or less) exposures ranging from <0.005 to 0.067 mg/m$^3$ are reported in the RAR.[10] As these are short term task-based exposures, full shift exposures are expected to be lower and are likely below 0.03 mg/m$^3$ as this task is typically only performed intermittently. Laboratory technicians wear gloves during gel preparation to avoid contaminating the gel. While

[10] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf

these gloves may not be impermeable to acrylamide, the duration of the task is sufficiently short that significant acrylamide permeation is unlikely.[11]

When ready-made gels are prepared by laboratory suppliers, exposure can occur during the preparation of the gels. Results from measurements taken at a UK facility in 1993 and 1994 and reported in the RAR, range from <0.002 to 4.22 mg/m$^3$. At the facility in question the use of air-fed suits is mandatory therefore these measurements are not representative of actual exposure. Measurements taken inside the suits ranged from 0.002 – 0.012 mg/m$^3$.

Typical exposures in the use of polyacrylamide electrophoresis gels are expected to be below 0.03 mg/m$^3$.

### 2.3.2 Temporal change in exposure and estimates for exposures in 2010

Measurements taken at the UK facility studied by Bull *et al* (2005) between 1992 – 1995 showed GM exposures of 0.09 mg/m$^3$ for plant operators involved in acrylamide manufacture (N = 10) and a GM of 0.03 for workers involved in the manufacture of polyacrylamide (N=423). GM exposures for the entire facility were not reported. If it is assumed that the GM exposure for the whole facility including both acrylamide and polyacrylamide manufacture was 0.04 mg/m$^3$ in 1995 and that the Bull *et al* (2005) GM estimate of 0.014 mg/m$^3$ is representative of exposures in 2005 then we can estimate the temporal trend in acrylamide exposure levels by fitting an exponential regression of the form $y = a.e^{-bx}$ to the data. The regression coefficient can be used to calculate the average annual change in concentration between 1995 and 2005 (Equation 1)

(1) $$\% \text{ change per year} = 100 * (\exp[b] - 1)$$

An annual decline in acrylamide exposure concentrations of 10.5% between 1995 and 2005 was calculated.

It is not possible to calculate the temporal trend in dermal exposure based on the available data, although we consider that given the range of likely interventions to reduce inhalation exposure the corresponding dermal exposure will have also decreased and our best estimate is that the rate of decline is probably similar to that for inhalation exposure.

If we assume that the data from Bull *et al* (2005) are typical of 2005 and that the temporal changes have continued as we have estimated then our best estimate for GM exposure in 2010 is 0.008 mg/m$^3$ with 90% of exposures less than 0.038 mg/m$^3$. It is expected that by 2012 90% of all exposures will be less than 0.03 mg/m$^3$.

## 2.4 HEALTH IMPACT FROM CURRENT EXPOSURES

### 2.4.1 Background data

The occupational cancer associated with acrylamide exposure is shown in Table 2.3, along with a summary of the information used in the health impact assessment.

[11] IOM consultation with Polyelectrolyte Producers Group (PPG)

**Table 2.3** Occupational cancer associated with exposure to acrylamide

| **Cancer site**<br>**ICD-10 code** | **Pancreas**<br>C25 | |
|---|---|---|
| IARC group for carcinogen | 2A | |
| Strength of evidence for cancer site [1] | Suggestive | |
| Latency assumption | 10-50 yrs | |
| Source of forecast numbers - deaths | Eurostat, 2006 | |
| Source of forecast numbers - registrations | GLOBOCAN[12], 2002 | |
| Exposure levels | *Relative Risk (RR)* | *Source of RR* |
| "High" | 1.85 (0.68,4.03) | Mean intensity of exposure >=0.30 mg/m$^3$, (Marsh, 2007) |
| "Low" | 1.22 (0.66-2.27) | Inverse-variance weighted pooled estimate for 0.001-0.029 and 0.03-0.29 mg/m$^3$ |
| "Background" | 0.8, set to 1 | Cumulative exposure <0.001 mg/m$^3$ |

[1] Based on Siemiatycki *et al*, 2004

### 2.4.2 Exposed numbers and exposure levels

Industry sectors, their NACE codes, classifications to exposure categories High/Medium/Low/Background exposure as applicable for the mid 1970's and the numbers exposed in 2006 are given in Table 2.2 in the previous section on exposure. Estimated average exposure levels were only available for NACE 24, with an estimated GM exposure of 0.014 mg/m$^3$ and an estimated GSD of 3.34.

We present data for a "baseline" scenario, which for NACE 24 industries assumes a 10.5% annual decline in exposure levels and no annual decline for NACE 73, 74, 75, 80 and 85 industries. The baseline scenario assumes standard change in employed numbers up to the 2021-30 estimation interval and constant levels thereafter.

### 2.4.3 Forecast cancer numbers

Separate estimates for total numbers of deaths for pancreatic cancer by age band are available from EUROSTAT for the 27 countries of the EU, for 2006, and for registrations from GLOBOCAN for 2002. The forecast numbers of deaths and registrations by country used to estimate attributable numbers are in Appendix 8.3.

### 2.4.4 Results

The cancer deaths and registrations attributed to occupational exposure to acrylamide for the baseline scenario are presented per year for the target years given and are based on the working age cohort of currently (2006) exposed workers. Attributable fractions and numbers of deaths and registrations, and Years of Life Lost (YLLs), Years Lived with Disability (YLDs) and Disability Adjusted Life Years (DALYs), are estimated.

[12] IARC, GLOBOCAN database, available at: http://globocan.iarc.fr/

As the exposure data suggests that exposure declines over time, a dynamic baseline scenario has been used.

A summary of the baseline scenario results for pancreatic cancer for the total EU is in Table 2.4 below.

**Table 2.4** Results for the baseline forecast scenario, total EU (27 countries), men plus women

| **Scenario**[1] | **All scenarios** | | **Baseline scenario (2) - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter** | | | |
|---|---|---|---|---|---|---|
| **EU Total** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| *Numbers ever exposed* | 176,407 | 204,673 | 244,048 | 282,515 | 309,769 | 326,421 |
| *Proportion of the population exposed* | 0.05% | 0.05% | 0.06% | 0.07% | 0.08% | 0.08% |
| **Pancreatic cancer** | | | | | | |
| *Attributable Fraction* | 0.009% | 0.006% | 0.003% | 0.003% | 0.003% | 0.003% |
| *Attributable deaths* | 7 | 5 | 3 | 3 | 3 | 4 |
| *Attributable registrations 'Avoided' cancers* | 6 | 5 | 3 | 3 | 3 | 3 |
| *YLLs* | 97 | 74 | 46 | 41 | 41 | 42 |
| *DALYs* | 99 | 75 | 47 | 42 | 42 | 43 |

The attributable deaths in the EU 2010 from previous acrylamide exposure were small: 7 deaths from pancreatic cancer. The estimated deaths and cancer registrations decrease slightly over the following 50 years so that by 2060 there are only 4 cancer deaths from acrylamide exposure predicted to occur. The corresponding estimated attributable fraction (AF) for pancreatic cancer decreases from 0.01% in 2010 to 0.003% in 2060. DALYs also decrease in the baseline scenario – from 99 years in 2010 to 43 years in 2060.

## 2.5 POSSIBLE COSTS ASSOCIATED WITH NOT MODIFYING THE DIRECTTIVE

### 2.5.1 Health impacts – possible costs under the baseline scenario

*Introduction*

The health data (cancer registrations and Years of Life Lost - 'YLL') for the baseline in which there are no further modifications to the Carcinogens Directive are shown in section 2.4 of this report. These data show that there are predicted to be a significant number of cancer registrations and YLLs from pancreatic cancer resulting from

predicted future exposure to acrylamide. There is predicted to be a decline in registrations and YLLs over time as a result of predicted exposure reduction owing to implementation of existing and ongoing risk management measures across the EU.

*Method in brief*

Using these heath data, it is possible to monetise the costs under the baseline by estimating:

- Life years lost – This is calculated by using the YLL and multiplying this by a valuation of the Value of Life Year Lost (VLYL). This gives a value for the time (in years) lost as a result of premature death.
- Cost of Illness (COI) –This is a monetary cost of the time spent with cancer. In this study, a unit COI estimate is multiplied by the number of cancer registrations, to give a total value for COI. (COI is often the main market-based approach in relation to health impact.[13] COI includes the direct and indirect costs of cancer but not the intangible costs (see below).
- Willingness to Pay (WTP) to avoid cancer – WTP in this study is used as an alternative method (high cost scenario) based on publicly available, peer reviewed studies on what people would be willing to pay to avoid having cancer. This includes various intangible costs (such as disfigurement, functional limitations, pain and fear) and includes the costs associated with life years lost.

The cost variables used in this study are presented in Table 2.5 in 2010 prices. For the purposes of this study, valuations are increased by 2% each year in the future in part to present costs in real terms (i.e. adjusting for inflation in prices) and to reflect the increasing value society attaches to its health (as economic growth typically increases over a long period of time)[14].

**Table 2.5** Summary of cost variables used in this study (€ 2010 prices)

| Cost/benefit elements | Low scenario | High scenario |
|---|---|---|
| VLYL - Each year lost | € 50,393 | € 0 (note 1) |
| COI or WTP - Unit cost (per cancer registration) | € 49,302 (COI) | € 1,793,776 (WTP) |
| (Note 1) – By using WTP (€1.8m) in the high scenario instead of COI, the WTP can include the costs of premature death and therefore there was a risk of double counting benefits if VLYL costs were included. | | |

All costs and benefits over time in this study are discounted using a 4% discount rate as recommended by the European Commission's Impact Guidelines[15]. In order to assess the effect that discounting has on the results ('sensitivity analysis'), we have

[13] ECHA (2008) "Applying SEA as part of restriction proposals under REACH" Available at: http://echa.europa.eu/doc/reach/sea_workshop_proceedings_20081021.pdf

[14] This is consistent with some other European Commission studies and is standard practice for air quality under the Clean Air for Europe (CAFE) programme.

[15] European Commission Impact Assessment Guidelines (Jan 2009) - http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf

also presented estimates that take into consideration a declining discount rate for impacts occurring after 30 years and no discounting.

The health data shown in section 2.4 are 'snap-shots' (i.e. an estimation for the initial year of a ten year period) of the number of cancer registrations, deaths, YLLs in future years at 10 year intervals. In calculating the costs associated with these effects, each 'snap-shot' result is multiplied by 10 in order to derive an estimate for the whole assessment time period (for example, 2020 results are multiplied by 10 to give results over the period 2020-2029). This assumes that each snap-shot year is representative of the following 10 years.

The method to valuing health benefits is explained in more detail in the method paper titled *"Valuing health benefits – Method paper".*

*Results*

The health costs under the baseline scenario are presented in Table 2.6. Health-related costs are predicted to decline over time and are predominately the result of past exposure. In section 2.4 the number of cancer registrations and YLLs are estimated to decline over time, accounted for by risk management measures (RMMs) already imposed (as applied at production and end use) over the past 10-20 years.

The introduction of an EU-wide OEL is not expected to have a significant impact in the short term given that the main Member States already have a national OEL in place (the stringency varies amongst member states). Table 2.6 sets out the ranges of health costs for each representative decade. The ranges are based on the high and low cost scenarios (see Table 2.5). The results are also illustrated in Figure 2.1.

**Table 2.6** Health costs - baseline scenario – 2010 to 2070 (Present Value – 2010 €m prices)

| Costs by Gender (€m) | 2010-2019 | 2020-2029 | 2030-2039 | 2040-2049 | 2050-2059 | 2060-2069 | Total |
|---|---|---|---|---|---|---|---|
| Female | 22 to 42 | 13 to 25 | 6 to 13 | 5 to 9 | 4 to 8 | 3 to 6 | 52 to 103 |
| Male | 42 to 88 | 26 to 55 | 13 to 28 | 9 to 20 | 7 to 17 | 6 to 14 | 104 to 223 |
| Total | 64 to 131 | 39 to 80 | 19 to 41 | 14 to 29 | 11 to 24 | 9 to 20 | 156 to 326 |

Notes:
- All costs are presented in present value using a discount rate of 4%. The low range is based on low estimates for costs of illness and life years lost. The upper range of costs relate to WTP estimates to avoid having cancer, which include intangible costs associated with having cancer.
- Totals may not match to sums of females and male costs due to underlying small differences in raw data and rounding to whole number

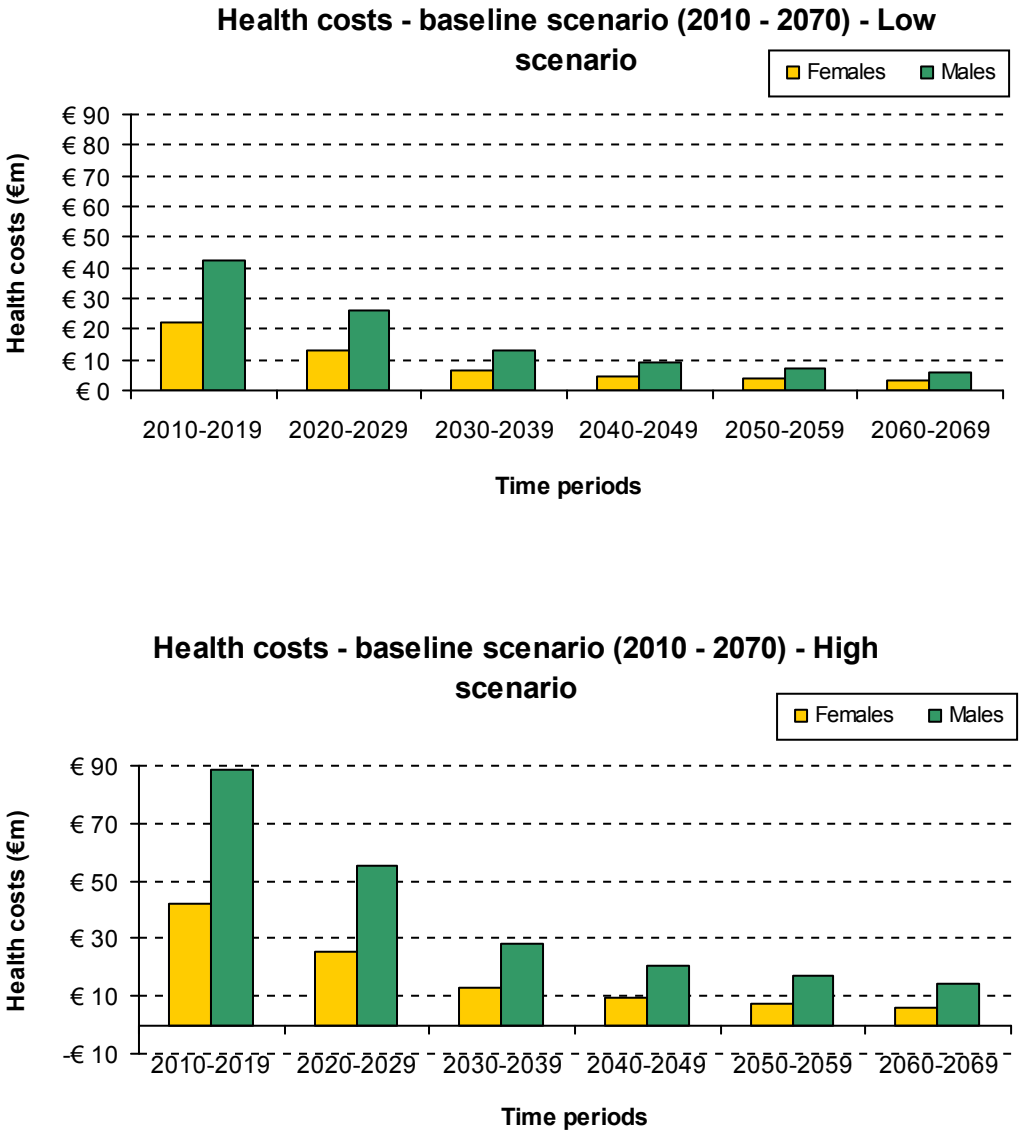


**Figure 2.1** Health costs - baseline scenario – 2010 to 2070 (Present Value – 2010 €m prices)

These costs will affect Member States differently depending upon the overall number of workers affected within industry groups, existing RMMs and the proportion of males and females within these groups. Figure 2.2 shows that the Czech Republic, France, Germany and the UK predicted to have relatively high health costs. The only industrial sector estimated to be affected under the baseline is the manufacture of basic chemicals and chemical products (NACE code 24). This is shown in Figure 2.3.

Detailed tables are included in Appendix 8.4.

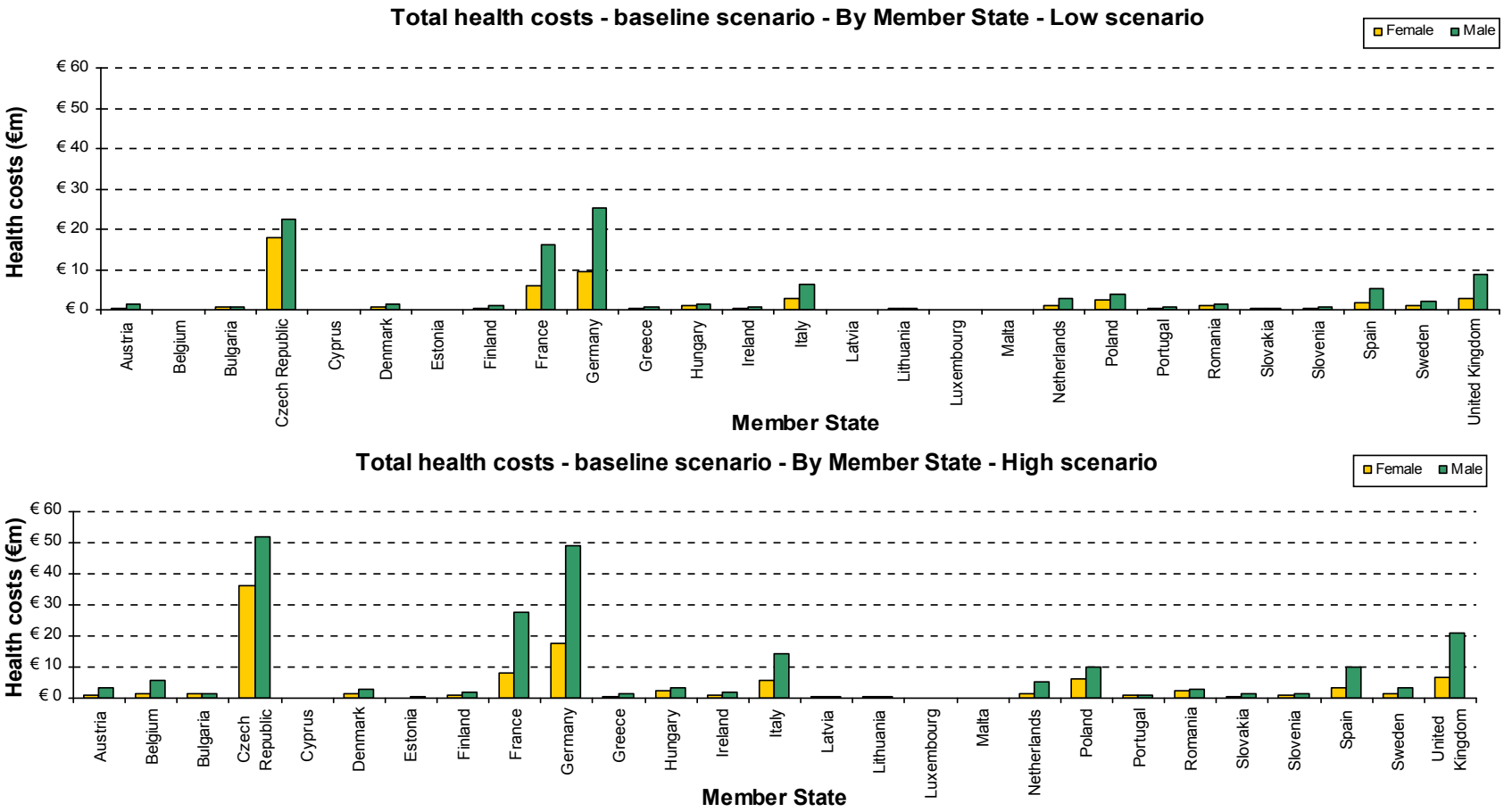


**Figure 2.2** Total health costs- baseline scenario – By Member State (Present Value – 2010 €m prices)

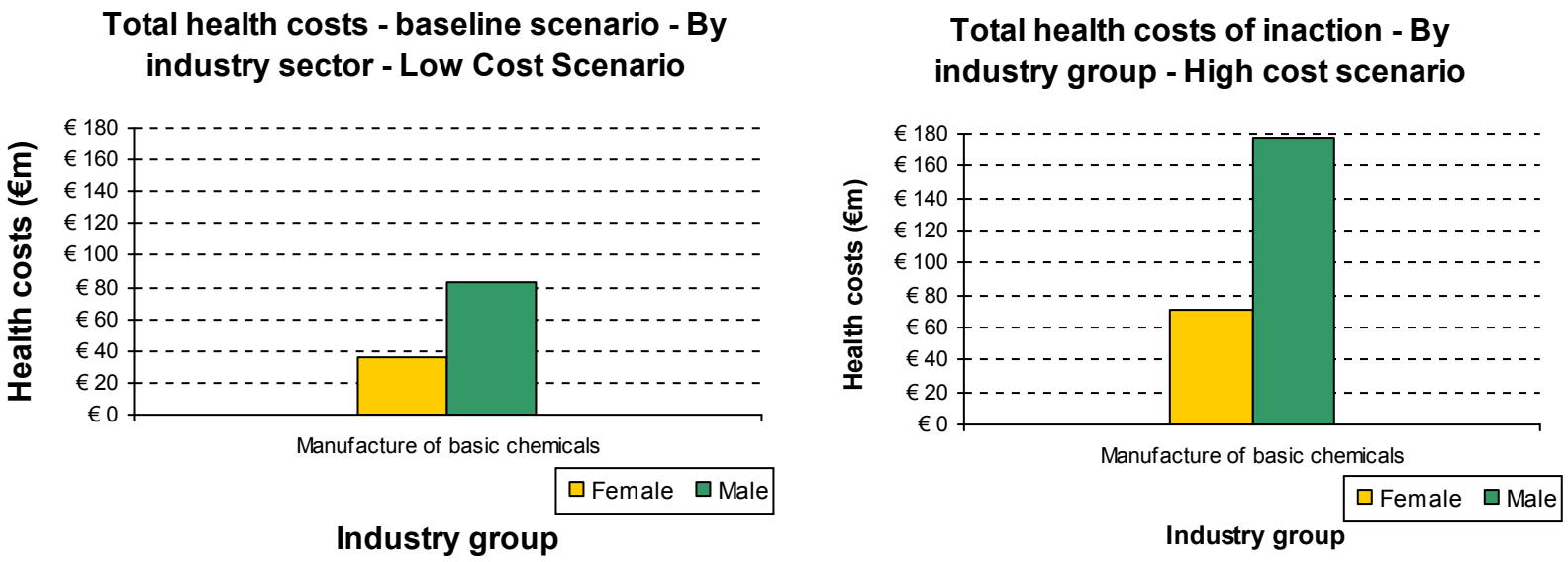


**Figure 2.3** Total health costs - baseline scenario - by industry group (Present Value – 2010 €m prices) [16]

[16] Charts exclude industries for which zero costs are estimated.

In order to present all socio-economic costs and benefits consistently in present value terms, all future costs and benefits have been discounted. The primary approach was to apply the European Commission IA recommended 4% discount rate. Since most health impacts occur over a long period of time relative to costs, the impacts of discounting are significant. In Figure 2.4, the effects of different discount rates on the overall results are shown, indicating that the impacts of discounting become more pronounced the further in the future that the impact occurs.

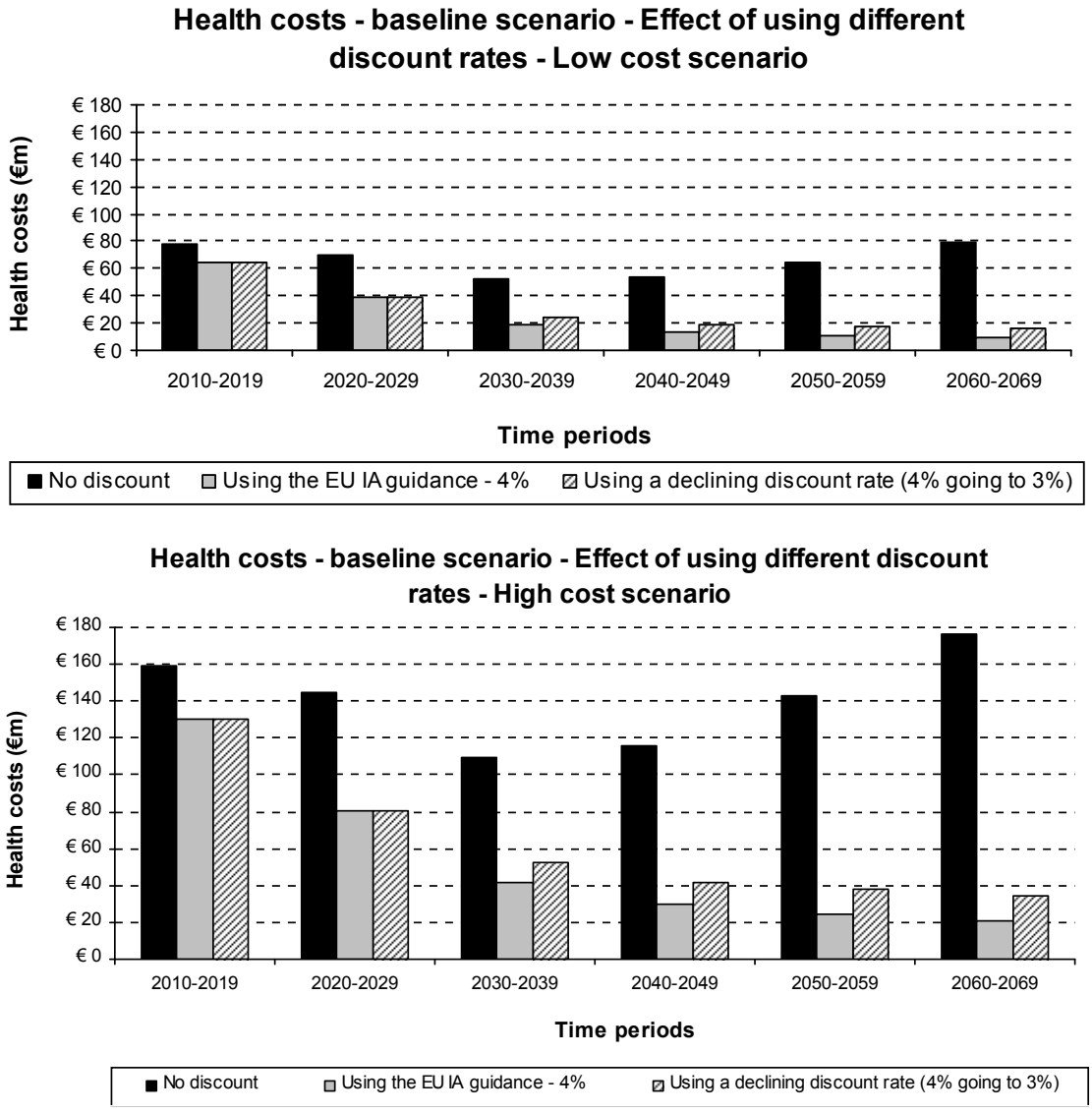


**Figure 2.4** Impacts of discounting

# 3 POLICY OPTIONS

## 3.1 DESCRIPTION OF MEASURES

The options investigated in this report concern the potential implementation of an EU-wide OEL of 0.03 mg/m$^3$.

Reduction in exposure to acrylamide can be achieved by a combination of the factors described in the following section (section 3.2). No additional measures to reduce exposure to acrylamide, other than those described in the following section, were found.

## 3.2 LEVEL OF PROTECTION ACHIEVED (OELS)

### 3.2.1 Acrylamide and polyacrylamide manufacturing (NACE 24)

Based on the available evidence it appears that the controls used during the manufacture and uses of polyacrylamide gels are sufficient to maintain exposures below 0.03 mg/m$^3$. The estimated GM exposure for acrylamide and polyacrylamide manufacturing in 2005 (NACE 24 – manufacture of chemicals and chemical products) was 0.014 mg/m$^3$ (with an estimated GSD of 3.34). The exposure distribution was simulated using Monte Carlo simulation based on a GM of 0.014 mg/m$^3$ and a GSD of 3.34 and it was estimated that 26% of acrylamide and polyacrylamide manufacturers were exposed above the typical OEL (0.03 mg/m$^3$). However, given the rate of reduction in exposure estimated for this sector (10.5% per annum) we judge that current exposures (2010) are probably such that 90% of exposures are less than 0.038 mg/m$^3$. These estimates indicate that some exposure reductions would be required in NACE 24 to fully meet an OEL of 0.03 mg/m$^3$.

During the manufacture of aqueous acrylamide solutions workers can be exposed to acrylamide vapours. At the acrylamide manufacturing facilities in the UK, Germany and the Netherlands the majority of delivery and processing is done in closed pipelines and vessels. Exposures occur primarily during maintenance work, material sampling, or entry to automated bagging areas. Enclosed automation is also used to control exposures in polyacrylamide manufacturing and again exposures occur intermittently during maintenance, material sampling and entry to bagging or bag opening areas. The Polyelectrolyte Producers Group (PPG) has produced a Generic Exposure Scenario for Strictly Controlled Conditions, which is intended to assist acrylamide and polyacrylamide manufacturers to comply with the European Union REACH Regulations.[17] The PPG reports that the companies within their group work according to the conditions outlined in the Generic Exposure Scenario. The controls described in the Generic Exposure Scenario are expected to maintain exposures below 0.03 mg/m$^3$. This procedure outlines control conditions for each of the seven defined lifecycle stages of acrylamide used in the manufacture of polyacrylamide. The seven lifecycle stages are as follows:

1. Manufacture, including purification, cleaning and maintenance of equipment
2. Analysis

[17] PPPG (Polyelectrolyte Producers Group) Specialty Monomers (2010). Generic Exopsure Scenario for Strictly Controlled Conditions.

3. Onsite transfer
4. Offsite transfer (including loading/unloading)
5. Storage
6. Waste
7. Polymerisation

The controls fall into the following categories:

1. Rigorous containment by technical means
2. Procedural control technologies to minimise emission from containment and resulting exposure (e.g. emission monitoring, alarms, leak testing, local exhaust ventilation etc.)
3. Training and authorisation of personnel handling the substance (e.g. batch log sheets, training documentation, safety instructions)
4. Special procedures for cleaning and purging before system is opened and entered (e.g. confined space entry procedures, equipment decontamination procedures, lock-out/tag-out isolation)
5. Procedures and control technologies to minimise emissions and exposure in accidents and where waste is generated (e.g. spill containment, emergency response, waste disposal, high efficiency scrubbers to minimise displacement emissions during tank transfers, storage of monomers under stabilised conditions to prevent uncontrolled polymerisation and chemical release)
6. Well documented and strictly supervised substance handling procedures
7. Monitoring to confirm that controls are working

### 3.2.2 Preparation and use of polyacrylamide electrophoresis gels (NACE 73, 74, 75, 80, 85)

When electrophoresis gels are prepared by the user, within a fume hood exposures should be within acceptable levels.

At the laboratory supply facility described in the EU RAR[18], exposure to acrylamide during the production of polyacrylamide electrophoresis gels was maintained at levels below 0.03 mg/m$^3$ through the use of air fed suits during periods of acrylamide exposure. Prior to 1995 many of the exposures occurred during re-crystallisation of acrylamide with ethyl acetate to increase purity. Since 1995 these exposures have been eliminated by purchasing acrylamide of the desired purity. Packing and blending of purified acrylamide were carried out in down draught booths; however, exposures over 1 mg/m$^3$ were measured during these tasks necessitating the use of air fed suits. Automation of this process can significantly reduce exposure.

[18] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf

# 4 ANALYSIS OF IMPACTS

## 4.1 HEALTH IMPACTS FROM CHANGES TO THE EU DIRECTIVE

### 4.1.1 Health information

The evidence we have suggests that exposures in all sectors with the exception of NACE 24 are in compliance with the typical OEL identified in this study. For NACE 24 we consider that steps being taken to comply with the requirements of the REACH Regulations will reduce exposure below the identified OEL value. Under the baseline assumptions we expect that all acrylamide and polyacrylamide manufacturers either comply or will shortly comply with the OEL.

We have not considered dermal exposure but we consider that the steps being taken to control exposure will have a corresponding impact on dermal exposure. Dermal exposure is not explicitly considered in the health impact assessment but it is equally not included in the epidemiological studies and so we are confident that the omission in this respect does not result in any important bias in our estimates.

For acrylamide, the existing OEL of 0.03 mg/m$^3$ is the only OEL that will be tested. Pancreatic cancer numbers will be estimated given current (baseline) and full compliance[19] to the current OEL for NACE 24 industries.

Data are presented for the "intervention" scenario as described in Table 4.1 below.

**Table 4.1** Baseline and intervention scenarios

| ***Intervention scenarios***[1] | |
|---|---|
| *Baseline scenario (2)* | Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter |
| *Intervention scenario (3)* | Full compliance for current OEL for NACE 24 |

[1] All intervention scenarios are estimated as change to (2) the baseline scenario

Results for the baseline scenario (2) and the intervention scenario (3) compared to the baseline scenario are in Figure 4.1 (for attributable registrations), Figure 4.2 (for attributable fractions) and Figure 4.3 (for DALYs) for men plus women for the total EU (27 countries) for pancreatic cancer. A summary of the results for pancreatic cancer for the total EU is in Table 4.2 below. Due to cancer latency, no effect would be expected from the intervention between 2010 and 2030.

Introducing full compliance with the current OEL in 2010 will avoid cancers occurring but only from 2040 onwards (Figure 4.1 and Figure 4.2).

[19] Full compliance is assumed in the intervention scenarios; however, due to modelling restrictions full compliance is modelled as 99% compliance.

Figure 4.1 shows the number of registrations for pancreatic cancer attributable to acrylamide exposure decreasing steadily for the baseline scenario and the intervention scenario over the next 50 years.

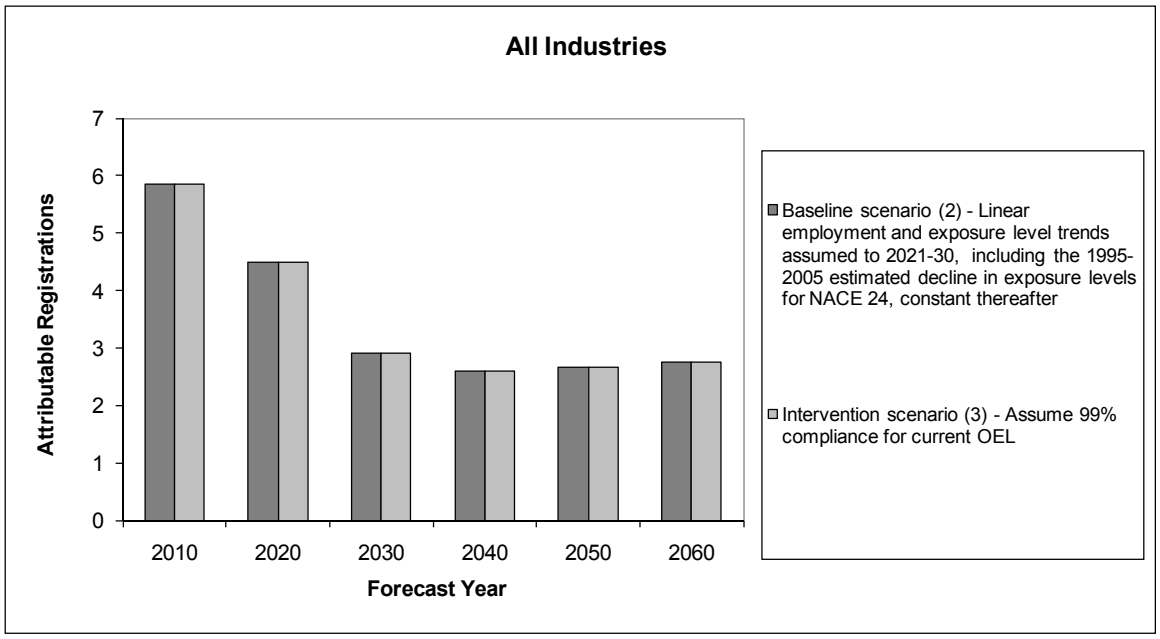


**Figure 4.1** Results for baseline (2) and intervention (3) scenarios compared to the baseline scenario – Occupation Attributable cancer registrations, Pancreatic cancer, men plus women

Figure 4.2 shows that the attributable fraction for pancreatic cancer decreases for both scenarios from just over 0.009% in 2010 to approximately 0.003% in 2060.

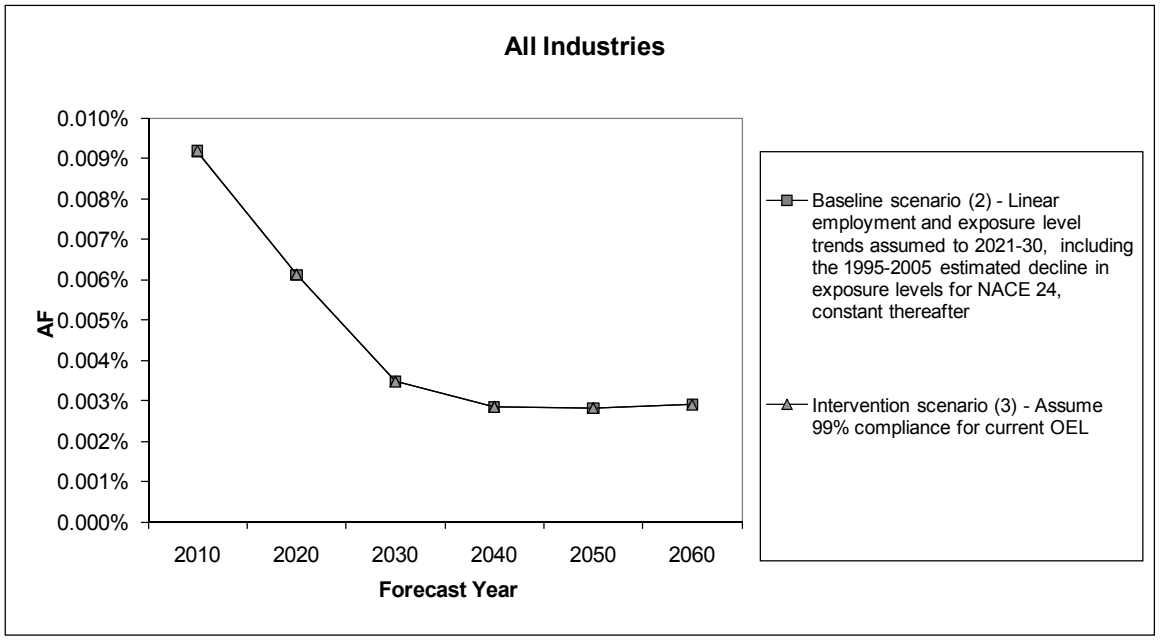


**Figure 4.2** Occupation Attributable Fractions, Pancreatic cancer

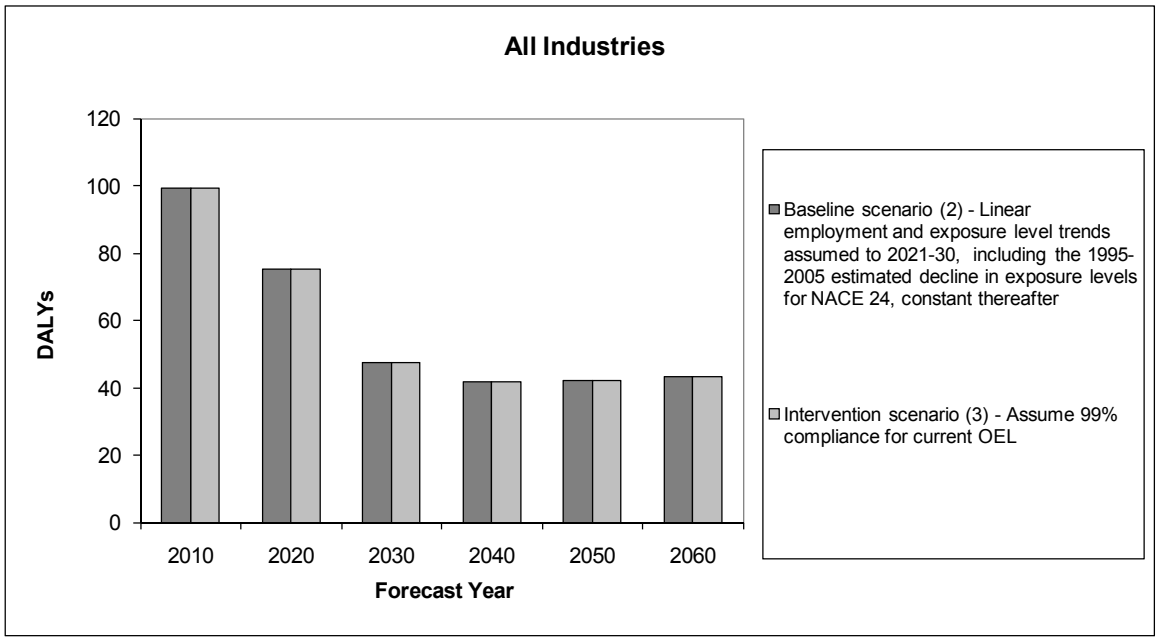


**Figure 4.3** Occupation Attributable DALYs, Pancreatic cancer

The estimated DALYs decrease from about 100 years in 2010 to approximately 45 years in 2060 in both the baseline scenario and the intervention scenario.

Table 4.2 summarises the data shown in the previous figures. The data for the first two time periods (2010, 2020) are identical to the baseline scenario, and then the data specific to the intervention scenario are shown in the next group of four columns (2030-2060). Attributable deaths for pancreatic cancer decreases from 7 deaths in 2010 to 4 deaths in 2060 for the intervention scenario (3) (maintain current OEL of 0.03 mg/m$^3$ with full compliance). These data are in fact identical to the baseline scenario (Table 2.4).

In Table 5.8.1 in Appendix 8.5 are the estimated proportions exposed above the OEL to be tested, currently and as estimated under the baseline forecast scenario (2). Under the alternative change scenario, the estimated proportions behave as determined by the scenarios.

Full results are given in Appendix 8.5 for men plus women by country in Table 8.5.3. A breakdown of attributable numbers by industry is in Table 8.5.5. Estimates of numbers of cancer registrations 'avoided' in each of the forecast target years from 2030 onwards relative to the baseline scenario can be obtained by subtraction. Data for men and women separately, and by industry within country, are available in the supplementary spreadsheets (*Acrylamide Report Tables_allNACEcodes.xls*) if required.

**Table 4.2** Results for intervention scenario (3), total EU (27 countries), men plus women

| Scenario | All scenarios | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|
| **EU Total** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| *Numbers ever exposed* | 176,407 | 204,673 | 232,747 | 254,545 | 265,801 | 265,801 |
| *Proportion of the population exposed* | 0.05% | 0.05% | 0.06% | 0.06% | 0.07% | 0.07% |
| **Pancreatic cancer** | | | | | | |
| *Attributable Fraction* | 0.009% | 0.006% | 0.003% | 0.003% | 0.003% | 0.003% |
| *Attributable deaths* | 7 | 5 | 3 | 3 | 3 | 4 |
| *Attributable registrations* | 6 | 5 | 3 | 3 | 3 | 3 |
| *'Avoided' cancers* | | | | | | |
| *YLLs* | 97 | 74 | 46 | 41 | 41 | 42 |
| *DALYs* | 99 | 75 | 47 | 42 | 42 | 43 |

### 4.1.2 Monetised health benefits

As indicated in section 4.1.1 there are not estimated to be any human health benefits of introducing an OEL from 2010 at 0.03 mg/m$^3$ as there is already estimated to be a reduction towards 0.03 mg/m$^3$ and below under the baseline scenario. Therefore no monetised health benefits are expected.

## 4.2 ECONOMIC IMPACTS

### 4.2.1 Operating costs and conduct of business

*Compliance costs*

The exposure assessment presented in section 2 indicated that the only workers who might be exposed above the possible OEL (0.03mg/m$^3$) are involved in the manufacture of acrylamide and polyacrylamide, which falls within NACE 24 (manufacture of basic chemicals). The geometric mean exposure for these manufacturers is 0.014 mg/m$^3$ (in 2005), which indicates that the majority of workers are exposed to levels that comply with the possible OEL which sets maximum exposure levels.

The estimated geometric standard deviation (GSD of 3.34) suggests that up to 26% of workers may have exposure levels above the proposed OEL in 2005. Under the baseline scenario, it was assumed (based on past trends) that the numbers exposed will continue to fall by 10.5% per year. Therefore as shown in section 4.1.1 no health benefits are expected from the introduction of an OEL of 0.03mg/m$^3$ (we expect compliance by 2012 – full compliance by about 2021-30).

The costs of compliance above that being spent under the baseline is therefore expected to be minimal especially given there are only a small number of manufacturers of acrylamide and/or polyacrylamide. Based on consultation[20] with the Polyelectrolyte Producers Group (PPG)[21] the vast majority of investment required to control exposure associated with the manufacture of acrylamide and polyacrylamide has already occurred in the last 20 years. Therefore no quantification was deemed necessary.

*Conduct of employers*

Based on consultation[20] with the PPG, companies are already working according to strictly controlled conditions[22]. The introduction of an EU-wide OEL of 0.03mg/m$^3$ may require companies not adhering to these strict control conditions, to reorganise their workplace to ensure that exposure to airborne particulates is minimised. There may also be additional training and authorisation of personnel handling the substance (e.g. batch log sheets, training documentation, cleaning procedures and safety instructions).

*Potential for closure of companies*

Based on consultation[20] with the PPG, they suggest there are no substitutes for acrylamide available and that production is expected to increase in the future (but with no increase in exposure in polymer use or in acrylamide production). Therefore there is not expected to be any potential closure of companies as a result of introducing the OEL, even if there might be a minimal increase in compliance costs relative to the baseline scenario.

*Potential impacts for specific types of companies*

There are a limited number of EU companies involved in the manufacture of acrylamide and/or polyacrylamide. The EU RAR (2002)[23] indicated that the typical individual plant capacities range from 10,000-15,000 tonnes per annum (the maximum being 40,000). Given the typical size of firms, any potential increase in compliance costs (if any relative to the baseline) is unlikely to have any significant impacts, since firms maybe able to pass through costs (given there may not be any substitutes). Having an EU-wide OEL level should remove any EU competitive distortions between EU Member States with different OELs.

*Administrative costs to employers and public authorities*

The following table (Table 4.3) describes the administrative burden to employers already subject to the Carcinogens Directive but will now incur costs of introducing an EU wide OEL on to Annex III.

[20] Email communications (dated 16th Feb 2010)
[21] http://www.polyelectrolyte.org/index.php?rub=1
[22] *"Generic exposure scenario for strictly controlled conditions"* – PPG (Polyelectrolyte Producers Group) Speciality Monomers
[23] *"European Union Risk Assessment Report – ACRYLAMIDE"* Available at: http://ecb.jrc.ec.europa.eu/documents/Existing-Chemicals/RISK_ASSESSMENT/REPORT/acrylamidereport011.pdf

**Table 4.3** Administrative burdens to employers

| Type of administrative cost | Relevant article(s) | Type of cost | Significance |
|---|---|---|---|
| 1. Change in practice to use closed systems when using the substance. | 5 – Prevention and reduction of exposure | These costs are already estimated in the cost of compliance section - This will only affect those firms that do not have or use closed systems | Estimated elsewhere |
| 2. Develop/update health and safety and best practice guidance for:<br>○ Minimising use and exposure to workers to the substance<br>○ Redesign work processes and engineering controls to avoid/minimise release of carcinogens or mutagens<br>○ Hygiene measures, in particular regular cleaning of floors, walls and other surfaces<br>○ Information for workers<br>○ Warnings and safety signs<br>○ Drawing up plans to deal with emergencies likely to result in abnormally high exposure | 5 – Prevention and reduction of exposure<br>7 – Unforeseen exposure<br>8 – Foreseeable exposure<br>9 – Access to risk areas<br>10 – Hygiene and individual protection | Firms will already have been required to develop/update health and safety and best practice guidance.<br>The guidance and procedures may be required to be updated as control measures may change in light of a more stringent OEL.<br>Some firms may need to redesign work practices to minimise exposure to workers and the number of workers exposed.<br>The costs of implementing controls on exposure (such as LEV or PPE) are already estimated in the costs of compliance section. | Low |
| 3. Additional costs of training new and existing staff in line with requirements of the Directive<br>4. Additional costs of making information available to employees<br>5. Consultation with employees on compliance with the Directive | 11 – Information and training of workers<br>12 – Information for workers<br>13 – Consultation and participation with workers | Firms will already have been required to ensure training and adequate aware of risks and control measures to reduce/minimise exposure.<br>Largely one-off cost if the revised OEL requires a change in control measures/working practice. | Low |

Note: Readers should consult the Directive for the official wording around specific requirements. This table provides only a summary of what are perceived to be the most significant administrative requirements of the Directive. Grading of the significance of impacts is subjective and is based on professional judgement.

The following table (Table 4.4) describes the administrative burden to competent authorities already enforcing the Carcinogens Directive but will now incur costs of introducing an EU wide OEL on to Annex III.

**Table 4.4** Administrative burdens to Competent Authorities

| Type of administrative cost | Relevant article(s) | Type of cost | Significance |
|---|---|---|---|
| 1. Communication with the Commission on provisions in national law to enforce the revised OEL.<br>2. Time and costs of implementing revised OEL into national law (consultation process) | 19 – Notifying the commission<br>20 – Repeal | Largely one-off cost of transposing the revised OEL into national law | Low - Medium (one-off cost) |

Note: Readers should consult the Directive for the official wording around specific requirements. This table provides only a summary of what are perceived to be the most significant administrative requirements of the Directive. Grading of the significance of impacts is subjective and is based on professional judgement.

### 4.2.2 Impact on innovation and research

Based on consultation[Error! Bookmark not defined.] with the PPG, the vast majority of investment required to control exposure from the manufacture of acrylamide and polyacrylamide has already occurred in the last 20 years. Therefore the impacts on innovation and research from introducing an EU-wide OEL are estimated to be minimal.

### 4.2.3 Macroeconomic impact

Since there are not expected to be any significant economic or health impacts, there is not expected to be any significant change in macroeconomic impacts relative to the baseline scenario from introducing an EU-wide OEL.

## 4.3 SOCIAL IMPACTS

### 4.3.1 Employment and labour markets

Under the baseline scenario, production is expected to increase over time, which may indicate that the employment should at least be relatively stable or that it may increase. Since there are not expected to be any significant economic costs to manufacturers of acrylamide and polyacrylamide from the introduction of an EU-wide OEL, there is unlikely to be any significant change in employment.

### 4.3.2 Changes in end products

The majority (99.9%) of acrylamide is used in the production of polyacrylamide. This is not expected to change from the introduction of an EU-wide OEL relative the baseline scenario.

## 4.4 ENVIRONMENTAL IMPACTS

Since the vast majority of manufacturers of acrylamide and polyacrylamide already comply with the proposed OEL and those that do not currently, are expected to comply without further intervention, there are not expected to be any significant change in environmental impacts from the introduction of an EU-wide OEL.

# 5 COMPARISON OF OPTIONS

The main identified impacts of introducing an OEL of 0.03mg/m$^3$ relative to the baseline scenario are shown in Table 5.1.

**Table 5.1** Comparison of options (Present Value – 2010 €m prices)

| | **Introduce OEL=0.03 mg/m$^3$** | |
|---|---|---|
| **Type of impact** | **Costs** | **Benefits** |
| Health | **No change -** There are not expected to any additional health costs relative to the baseline scenarios. | **No change** – There are not expected to any additional health benefits relative to the baseline scenarios, since manufacturers of acrylamide and polyacrylamide are expected to already comply with the proposed 0.03mg/m$^3$ OEL. |
| Economic | **Minimal** - Based on consultation with the Polyelectrolyte Producers Group (PPG) the vast majority of investment required to control exposure associated with the manufacture of acrylamide and polyacrylamide has already occurred in the last 20 years. | **Minimal** - Having an EU-wide OEL level will remove any competitive distortions between EU Member States with different OELs. |
| Social | **No change -** Since there are not expected to be any significant economic costs to manufacturers of acrylamide and polyacrylamide from the introduction of an EU-wide OEL, there is unlikely to be any significant change in employment. | **No change** - Under the baseline scenario, production is expected to increase over time, which may indicate that employment should at least be relatively stable or may increase. This is not expected to change with the introduction of an EU-wide OEL. |
| Marco-economic | **No change -** Since there are not expected to be any significant economic or health impacts, there is not expected to be any significant change in macroeconomic impacts relative the baseline scenario from introducing an EU-wide OEL. | |
| Environmental | **No change -** Since the vast majority of manufacturers of acrylamide and polyacrylamide already comply with the proposed OEL and those that do not currently, are expected to comply without further intervention, there are not expected to be any significant change in environmental impacts from the introduction of an EU-wide OEL. | |

# 6 CONCLUSIONS

Acrylamide is categorised as probably carcinogenic to humans by the IARC, causing cancer of the pancreas, and is a Category 2 occupational carcinogen under EU Classification and Labelling legislation. It is therefore already regulated as an occupational carcinogen throughout the EU. This assessment considered the impacts of introducing an occupational exposure limit (OEL) for acrylamide within the Directive of 0.03 mg/m$^3$ (30 µg/m$^3$). We note that acrylamide may be absorbed through the skin and so it is appropriate that in addition to an inhalation exposure limit steps are taken to control dermal exposures. In this report we assume that such measures will be put in place alongside the OEL.

Pancreatic cancer is highly fatal and less than 5% of people diagnosed with the disease survive for more than 5 years. Key environmental risk factors for this disease include cigarette smoking, diet and other lifestyle factors. Medical conditions such as chronic inflammation of the pancreas may also increase risks of cancer.

Almost all acrylamide produced in Europe is used to make polyacrylamide, which contains less than 0.1% free acrylamide. The main uses of polyacrylamide are in wastewater treatment, paper and pulp processing and mineral processing. We estimate that there were about 53,000 people exposed to acrylamide in the EU in 2006, of whom about 12,000 were exposed in the chemical manufacturing industry (NACE Code 24), where exposures were probably highest.

Exposures in acrylamide and polyacrylamide manufacturing (NACE Code 24) in 2005 were generally below the possible OEL value, although it was judged that about 26% of exposures might still exceed the limit. However, exposures have been decreasing over time at about 10.5% per annum and we expect that this trend has continued. In this case we expect that this sector of the industry will comply with the OEL in 2012. Other uses are considered to already comply with the limit.

Seven deaths (six registrations) from pancreatic cancer in the EU in 2010 are considered attributable to past exposure to acrylamide (an attributable fraction of 0.009%). For both the baseline and the intervention scenario the predicted future deaths and registrations decrease in the same way. By 2060 it is estimated that three cancer registrations and four cancer deaths will occur from future exposure to acrylamide exposure.

We judge that there are no expected additional health benefits from introducing an OEL of 0.03 mg/m$^3$ and only minimal economic costs given that the industry has generally already invested to control exposure in connection with the REACH Regulations.

We do not envisage any social, macroeconomic or environmental impacts with introducing an OEL for acrylamide.

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# 8 APPENDIX

## 8.1 ESTIMATED NUMBER OF EMPLOYEES IN EACH INDUSTRY GROUP – MEMBER STATE BREAKDOWN – MALES AND FEMALES

**Table 8.1.1** Number of workers exposed to acrylamide by Member State and NACE code – males and females

| | NACE CODE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 24 | | | 25 | | | 73 | | | 74 | | |
| | Total | Males | Females | Total | Males | Females | Total | Males | Females | Total | Males | Females |
| Austria | 175 | 142 | 33 | 12 | 10 | 2 | 73 | 49 | 23 | 9 | 6 | 3 |
| Belgium | 456 | 369 | 87 | 12 | 9 | 2 | 84 | 56 | 28 | 13 | 9 | 4 |
| Bulgaria | 169 | 88 | 81 | 10 | 5 | 5 | 5 | 3 | 1 | 4 | 3 | 1 |
| Cyprus | 12 | 9 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 270 | 175 | 94 | 36 | 24 | 13 | 83 | 50 | 33 | 11 | 7 | 4 |
| Denmark | 195 | 142 | 53 | 9 | 7 | 2 | 87 | 56 | 30 | 8 | 5 | 3 |
| Estonia | 19 | 11 | 9 | 2 | 1 | 1 | 6 | 3 | 3 | 1 | 1 | 1 |
| Finland | 125 | 92 | 32 | 0 | 0 | 0 | 31 | 18 | 13 | 0 | 0 | 0 |
| France | 1792 | 1380 | 412 | 99 | 77 | 23 | 569 | 376 | 194 | 76 | 50 | 26 |
| Germany | 2984 | 2327 | 656 | 163 | 127 | 36 | 1277 | 817 | 460 | 103 | 66 | 37 |
| Greece | 118 | 90 | 28 | 5 | 4 | 1 | 121 | 72 | 50 | 9 | 5 | 4 |
| Hungary | 209 | 131 | 77 | 18 | 11 | 7 | 87 | 58 | 30 | 10 | 7 | 3 |
| Ireland | 161 | 121 | 40 | 4 | 3 | 1 | 33 | 22 | 11 | 4 | 3 | 1 |
| Italy | 789 | 592 | 197 | 0 | 0 | 0 | 236 | 149 | 87 | 0 | 0 | 0 |
| Latvia | 28 | 17 | 12 | 2 | 1 | 1 | 17 | 9 | 8 | 1 | 1 | 1 |
| Lithuania | 40 | 21 | 19 | 4 | 2 | 2 | 10 | 5 | 5 | 2 | 1 | 1 |
| Luxembourg | 7 | 6 | 1 | 3 | 2 | 0 | | Not Available | | 1 | 1 | 0 |
| Malta | | Not Available[1] | | | Not Available | | | Not Available | | | Not Available | |
| Netherlands | 415 | 345 | 71 | 14 | 12 | 2 | 460 | 326 | 133 | 39 | 28 | 11 |
| Poland | 704 | 472 | 232 | 65 | 43 | 21 | 56 | 36 | 20 | 21 | 14 | 8 |
| Portugal | 140 | 83 | 57 | 11 | 7 | 5 | 17 | 10 | 7 | 15 | 9 | 6 |
| Romania | 318 | 172 | 146 | 20 | 11 | 9 | 314 | 204 | 110 | 9 | 6 | 3 |

| | NACE CODE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 24 | | | 25 | | | 73 | | | 74 | |
| | Total | Males | Females | Total | Males | Females | Total | Males | Females | Total | Males | Females |
| Slovakia | 84 | 54 | 30 | 9 | 6 | 3 | 61 | 36 | 25 | 2 | 1 | 1 |
| Slovenia | 91 | 60 | 31 | 6 | 4 | 2 | 35 | 22 | 14 | 2 | 1 | 1 |
| Spain | 1212 | 945 | 267 | 156 | 122 | 34 | 372 | 242 | 130 | 200 | 130 | 70 |
| Sweden | 283 | 221 | 62 | 12 | 10 | 3 | | Not Available | | 11 | 8 | 4 |
| UK | 1397 | 1131 | 265 | 90 | 73 | 17 | 1403 | 954 | 449 | 102 | 70 | 33 |
| **TOTAL** | **12195** | **9196** | **2998** | **763** | **570** | **193** | **5436** | **3573** | **1863** | **656** | **430** | **226** |

[1] indicates that the number of employee data were not available on the Eurostat database

| | NACE CODE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 75 | | | 80 | | | 85 | | | Total | |
| | Total | Males | Females | Total | Males | Females | Total | Males | Females | Total | Males | Females |
| Austria | 3 | 2 | 1 | 526 | 152 | 373 | 10 | 2 | 7 | 807 | 364 | 443 |
| Belgium | 4 | 3 | 2 | 903 | 280 | 623 | 14 | 3 | 10 | 1485 | 730 | 756 |
| Bulgaria | 2 | 2 | 1 | 519 | 166 | 353 | 5 | 1 | 3 | 714 | 268 | 446 |
| Cyprus | 0 | 0 | 0 | 54 | 17 | 37 | 0 | 0 | 0 | 68 | 27 | 41 |
| Czech Republic | 3 | 2 | 2 | 676 | 169 | 507 | 9 | 2 | 7 | 1089 | 428 | 660 |
| Denmark | 2 | 1 | 1 | 510 | 214 | 296 | 14 | 3 | 12 | 824 | 428 | 396 |
| Estonia | 0 | 0 | 0 | 141 | 21 | 120 | 1 | 0 | 1 | 171 | 37 | 134 |
| Finland | 0 | 0 | 0 | 433 | 143 | 290 | 36 | 4 | 32 | 625 | 258 | 367 |
| France | 24 | 13 | 11 | 4265 | 1450 | 2815 | 83 | 20 | 63 | 6910 | 3366 | 3544 |
| Germany | 29 | 15 | 14 | 4995 | 999 | 3996 | 114 | 22 | 93 | 9665 | 4373 | 5292 |
| Greece | 4 | 3 | 1 | 726 | 269 | 457 | 6 | 2 | 4 | 989 | 444 | 545 |
| Hungary | 3 | 1 | 1 | 764 | 191 | 573 | 8 | 2 | 6 | 1099 | 401 | 697 |
| Ireland | 1 | 1 | 0 | 311 | 84 | 227 | 6 | 1 | 5 | 521 | 235 | 286 |
| Italy | 0 | 0 | 0 | 1668 | 400 | 1268 | 0 | 0 | 0 | 2693 | 1141 | 1552 |
| Latvia | 1 | 0 | 0 | 211 | 38 | 173 | 1 | 0 | 1 | 262 | 66 | 196 |
| Lithuania | 1 | 0 | 0 | 318 | 57 | 261 | 3 | 0 | 3 | 378 | 87 | 291 |
| Luxembourg | 0 | 0 | 0 | 36 | 12 | 24 | 1 | 0 | 0 | 48 | 22 | 26 |
| Malta | 0 | 0 | 0 | 29 | 8 | 21 | 0 | 0 | 0 | 30 | 8 | 21 |
| Netherlands | 6 | 4 | 2 | 1292 | 517 | 775 | 36 | 6 | 29 | 2262 | 1238 | 1024 |
| Poland | 9 | 5 | 4 | 2724 | 654 | 2070 | 24 | 5 | 19 | 3603 | 1228 | 2375 |
| Portugal | 4 | 2 | 1 | 749 | 202 | 547 | 9 | 2 | 8 | 945 | 314 | 631 |
| Romania | 5 | 3 | 2 | 994 | 268 | 726 | 11 | 3 | 8 | 1671 | 666 | 1005 |
| Slovakia | 2 | 1 | 1 | 399 | 80 | 320 | 4 | 1 | 4 | 561 | 178 | 383 |
| Slovenia | 1 | 0 | 0 | 181 | 40 | 141 | 2 | 0 | 1 | 317 | 127 | 190 |
| Spain | 24 | 16 | 9 | 3793 | 1403 | 2390 | 0 | 0 | 0 | 5757 | 2858 | 2899 |
| Sweden | 3 | 1 | 1 | 1165 | 291 | 874 | 21 | 4 | 17 | 1496 | 534 | 961 |
| UK | 20 | 12 | 9 | 6091 | 1766 | 4324 | 99 | 21 | 78 | 9201 | 4026 | 5175 |
| **TOTAL** | **150** | **86** | **64** | **34473** | **9893** | **24580** | **516** | **104** | **412** | **54189** | **23852** | **30337** |

## 8.2 PAST EXPOSURE TO ACRYLAMIDE IN 19 EU MEMBER STATES

**Table 8.2.1** Prevalence of exposure to acrylamide in 19 member states based on the 1993-1997 CAREX estimates

| Industry | NACE (rev 1.1) | EU (19 countries) Number of People Exposed 1993 – 1997[1] |
|---|---|---|
| Manufacture of food products, beverages and tobacco | 15 | 215 |
| Manufacture of textiles | 17 | 730 |
| Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials | 20 | 92 |
| Manufacture of furniture | 361 | 50 |
| Manufacture of chemicals and chemical products | 24 | 8058 |
| Manufacture of coke, refined petroleum products and nuclear fuel | 23 | 45 |
| Manufacture of rubber products | 251 | 686 |
| Manufacture of basic metals | 27 | 84 |
| Manufacture of fabricated metal products, except machinery and equipment | 28 | 195 |
| Manufacture of machinery and equipment n.e.c. | 29 | 130 |
| Manufacture of radio, television and communication equipment and apparatus | 32 | 185 |
| Collection, purification and distribution of water | 41 | 610 |
| Construction | 45 | 330 |
| Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods | G (50, 51, 52, 55) | 1350 |
| Education | 80 | 9398 |
| Research and development | 73 | 6417 |
| Health and social work | 85 | 1489 |
| Other business activities | 74 | 390 |
| Public Administration and Defence | 75 | 0 |
| **TOTAL** | | **30454** |

## 8.3 ESTIMATED DEATHS AND REGISTRATIONS IN THE EU FROM NASOPHARYNGEAL CANCER AND SINONASAL CANCER

**Table 8.3.1** Forecast number of pancreatic cancers in ages 25+ (ages 15+ for registrations), based on projected EU country populations

| Pancreatic cancer Deaths FTY | MEN 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | WOMEN 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 689 | 853 | 1028 | 1179 | 1276 | 1282 | 705 | 792 | 938 | 1085 | 1209 | 1200 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulgaria | 518 | 535 | 572 | 609 | 625 | 611 | 386 | 410 | 438 | 455 | 467 | 468 |
| Cyprus | 24 | 32 | 41 | 52 | 61 | 72 | 22 | 29 | 39 | 49 | 61 | 71 |
| Czech Republic | 968 | 1196 | 1427 | 1597 | 1750 | 1840 | 1023 | 1189 | 1393 | 1520 | 1625 | 1722 |
| Denmark | 476 | 575 | 672 | 718 | 747 | 760 | 417 | 489 | 572 | 620 | 645 | 650 |
| Estonia | 117 | 128 | 145 | 166 | 182 | 194 | 117 | 129 | 134 | 146 | 151 | 152 |
| Finland | 486 | 613 | 710 | 748 | 759 | 780 | 488 | 581 | 686 | 732 | 730 | 730 |
| France | 4586 | 5491 | 6464 | 7177 | 7582 | 7895 | 4249 | 4887 | 5726 | 6584 | 6959 | 7029 |
| Germany (including ex-GDR from 1991) | 7376 | 8910 | 10056 | 11036 | 11269 | 10721 | 7588 | 8637 | 9448 | 10502 | 10928 | 10264 |
| Greece | 769 | 883 | 1008 | 1150 | 1249 | 1270 | 682 | 807 | 895 | 1016 | 1116 | 1146 |
| Hungary | 845 | 940 | 1056 | 1170 | 1273 | 1301 | 913 | 1009 | 1114 | 1191 | 1251 | 1314 |
| Ireland | 221 | 296 | 385 | 485 | 582 | 648 | 237 | 304 | 401 | 511 | 624 | 725 |
| Italy | 5151 | 6023 | 6960 | 7883 | 8428 | 8354 | 5195 | 5940 | 6688 | 7581 | 8384 | 8386 |
| Latvia | 143 | 154 | 171 | 193 | 208 | 215 | 193 | 204 | 212 | 228 | 237 | 239 |
| Lithuania | 241 | 267 | 304 | 343 | 371 | 384 | 229 | 255 | 277 | 313 | 336 | 332 |
| Luxembourg | 24 | 31 | 38 | 45 | 53 | 57 | 19 | 23 | 29 | 37 | 44 | 47 |
| Malta | 27 | 36 | 47 | 51 | 54 | 61 | 26 | 33 | 41 | 46 | 48 | 52 |
| Netherlands | 1108 | 1415 | 1710 | 1864 | 1902 | 1888 | 1204 | 1444 | 1753 | 1970 | 2036 | 1986 |
| Poland | 2257 | 2724 | 3254 | 3677 | 3963 | 4171 | 2292 | 2690 | 3185 | 3557 | 3708 | 3875 |

| Pancreatic cancer Deaths | MEN | | | | | | WOMEN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FTY | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Portugal | 624 | 732 | 857 | 989 | 1092 | 1155 | 474 | 561 | 646 | 747 | 834 | 883 |
| Romania | 1434 | 1583 | 1830 | 2073 | 2249 | 2283 | 1069 | 1173 | 1327 | 1468 | 1590 | 1615 |
| Slovakia | 371 | 464 | 582 | 681 | 758 | 800 | 350 | 424 | 521 | 601 | 660 | 701 |
| Slovenia | 161 | 209 | 251 | 293 | 309 | 312 | 174 | 202 | 231 | 259 | 269 | 265 |
| Spain | 2780 | 3419 | 4224 | 5081 | 5688 | 5829 | 2523 | 2987 | 3577 | 4313 | 4933 | 5155 |
| Sweden | 796 | 959 | 1097 | 1186 | 1268 | 1337 | 862 | 979 | 1135 | 1233 | 1316 | 1381 |
| UNITED KINGDOM | 3900 | 4618 | 5391 | 6051 | 6649 | 7135 | 3852 | 4299 | 5043 | 5748 | 6359 | 6735 |
| European Union (27 countries) | 36311 | 43235 | 50472 | 56834 | 60832 | 62193 | 35826 | 41088 | 47373 | 53801 | 57948 | 58976 |

| Pancreatic Cancer Registrations | MEN | | | | | | WOMEN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FTY | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Austria | 687 | 825 | 987 | 1098 | 1134 | 1148 | 748 | 837 | 997 | 1121 | 1158 | 1160 |
| Belgium | 566 | 665 | 762 | 825 | 854 | 882 | 492 | 559 | 636 | 692 | 716 | 731 |
| Bulgaria | 469 | 482 | 509 | 535 | 541 | 523 | 352 | 372 | 387 | 397 | 400 | 387 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 892 | 1096 | 1246 | 1379 | 1482 | 1487 | 844 | 997 | 1096 | 1186 | 1264 | 1271 |
| Denmark | 407 | 486 | 538 | 561 | 565 | 582 | 400 | 465 | 517 | 549 | 553 | 561 |
| Estonia | 102 | 110 | 121 | 134 | 143 | 147 | 92 | 97 | 102 | 105 | 107 | 107 |
| Finland | 390 | 484 | 531 | 541 | 549 | 561 | 414 | 501 | 554 | 565 | 561 | 563 |
| France | 3565 | 4110 | 4528 | 4799 | 4955 | 5131 | 2484 | 2870 | 3197 | 3428 | 3486 | 3516 |
| Germany (including ex-GDR from 1991) | 6132 | 6982 | 7739 | 8059 | 7878 | 7546 | 5685 | 6165 | 6802 | 7098 | 6955 | 6645 |
| Greece | 742 | 844 | 963 | 1086 | 1148 | 1124 | 616 | 699 | 780 | 869 | 911 | 884 |
| Hungary | 852 | 941 | 1040 | 1151 | 1241 | 1264 | 845 | 921 | 974 | 1028 | 1075 | 1077 |
| Ireland | 210 | 282 | 362 | 450 | 535 | 575 | 195 | 256 | 331 | 414 | 506 | 552 |
| Italy | 5042 | 5829 | 6672 | 7413 | 7596 | 7453 | 4714 | 5296 | 5967 | 6646 | 6821 | 6605 |
| Latvia | 188 | 197 | 215 | 236 | 244 | 243 | 172 | 175 | 184 | 190 | 195 | 194 |
| Lithuania | 226 | 247 | 281 | 315 | 336 | 343 | 187 | 200 | 221 | 236 | 240 | 238 |
| Luxembourg | 29 | 38 | 47 | 54 | 59 | 63 | 24 | 29 | 36 | 42 | 46 | 50 |
| Malta | 25 | 33 | 38 | 40 | 43 | 46 | 29 | 36 | 41 | 43 | 45 | 48 |
| Netherlands | 856 | 1071 | 1228 | 1294 | 1279 | 1287 | 869 | 1050 | 1212 | 1297 | 1286 | 1273 |
| Poland | 2559 | 3048 | 3487 | 3819 | 4095 | 4130 | 2368 | 2823 | 3205 | 3446 | 3644 | 3644 |
| Portugal | 531 | 614 | 714 | 807 | 871 | 883 | 444 | 511 | 584 | 654 | 701 | 699 |
| Romania | 1262 | 1384 | 1565 | 1764 | 1867 | 1847 | 887 | 972 | 1072 | 1196 | 1267 | 1258 |
| Slovakia | 406 | 502 | 601 | 684 | 744 | 747 | 294 | 356 | 418 | 465 | 502 | 505 |
| Slovenia | 153 | 189 | 223 | 242 | 249 | 240 | 134 | 153 | 172 | 183 | 185 | 178 |

| Pancreatic Cancer Registrations | MEN | | | | | | WOMEN | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FTY | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Spain | 2488 | 3060 | 3761 | 4396 | 4707 | 4611 | 1985 | 2360 | 2844 | 3350 | 3658 | 3599 |
| Sweden | 504 | 590 | 653 | 698 | 734 | 774 | 496 | 558 | 615 | 657 | 685 | 716 |
| UNITED KINGDOM | 3941 | 4635 | 5281 | 5807 | 6205 | 6738 | 3946 | 4474 | 5128 | 5711 | 6067 | 6501 |
| European Union (27 countries) | 33108 | 38698 | 44077 | 48165 | 50031 | 50387 | 29599 | 33751 | 38182 | 41705 | 43167 | 43087 |

## 8.4 SUPPLEMENTARY TABLES - COSTS UNDER THE BASELINE SCENARIO

**Table 8.4.1** Health costs (€m) under the baseline scenario – Member State breakdown - Based on a 4% discount rate

| Low | Female | Male | Total | High | Female | Male | Total |
|---|---|---|---|---|---|---|---|
| Austria | € 0 | € 1 | € 2 | Austria | € 1 | € 3 | € 5 |
| Belgium | € 0 | € 0 | € 0 | Belgium | € 2 | € 6 | € 7 |
| Bulgaria | € 1 | € 1 | € 1 | Bulgaria | € 1 | € 2 | € 3 |
| Czech Republic | € 18 | € 22 | € 40 | Czech Republic | € 36 | € 52 | € 88 |
| Cyprus | € 0 | € 0 | € 0 | Cyprus | € 0 | € 0 | € 0 |
| Denmark | € 1 | € 1 | € 2 | Denmark | € 2 | € 3 | € 5 |
| Estonia | € 0 | € 0 | € 0 | Estonia | € 0 | € 0 | € 0 |
| Finland | € 1 | € 1 | € 2 | Finland | € 1 | € 2 | € 3 |
| France | € 6 | € 16 | € 22 | France | € 8 | € 28 | € 35 |
| Germany | € 10 | € 25 | € 35 | Germany | € 18 | € 49 | € 67 |
| Greece | € 0 | € 1 | € 1 | Greece | € 1 | € 2 | € 2 |
| Hungary | € 1 | € 1 | € 2 | Hungary | € 2 | € 3 | € 6 |
| Ireland | € 0 | € 1 | € 1 | Ireland | € 1 | € 2 | € 3 |
| Italy | € 3 | € 6 | € 9 | Italy | € 6 | € 14 | € 20 |
| Latvia | € 0 | € 0 | € 0 | Latvia | € 0 | € 0 | € 1 |
| Lithuania | € 0 | € 0 | € 0 | Lithuania | € 0 | € 0 | € 1 |
| Luxembourg | € 0 | € 0 | € 0 | Luxembourg | € 0 | € 0 | € 0 |
| Malta | € 0 | € 0 | € 0 | Malta | € 0 | € 0 | € 0 |
| Netherlands | € 1 | € 3 | € 4 | Netherlands | € 2 | € 5 | € 7 |
| Poland | € 3 | € 4 | € 6 | Poland | € 6 | € 10 | € 16 |
| Portugal | € 0 | € 1 | € 1 | Portugal | € 1 | € 1 | € 2 |
| Romania | € 1 | € 1 | € 3 | Romania | € 2 | € 3 | € 6 |
| Slovakia | € 0 | € 0 | € 1 | Slovakia | € 1 | € 1 | € 2 |
| Slovenia | € 0 | € 1 | € 1 | Slovenia | € 1 | € 1 | € 2 |
| Spain | € 2 | € 5 | € 7 | Spain | € 3 | € 10 | € 13 |
| Sweden | € 1 | € 2 | € 3 | Sweden | € 1 | € 3 | € 5 |
| United Kingdom | € 3 | € 9 | € 11 | United Kingdom | € 7 | € 21 | € 28 |
| **TOTAL** | € 52 | € 104 | € 156 | **TOTAL** | € 103 | € 223 | € 326 |

**Table 8.4.2** Health costs (€m) under the baseline scenario – Industry group breakdown - Based on a 4% discount rate

| Low | Female | Male | Total |
|---|---|---|---|
| Manufacture of basic chemicals | € 36 | € 84 | € 86 |
| **TOTAL** | € 36 | € 84 | € 86 |

| High | Female | Male | Total |
|---|---|---|---|
| Manufacture of basic chemicals | € 71 | € 178 | € 248 |
| **TOTAL** | € 71 | € 178 | € 248 |

**Note:** Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.

**Table 8.4.3** Health costs (€m) – baseline scenario – Member State breakdown - Based on a declining discount rate

| Low | Female | Male | Total | High | Female | Male | Total |
|---|---|---|---|---|---|---|---|
| Austria | € 1 | € 2 | € 2 | Austria | € 1 | € 4 | € 5 |
| Belgium | € 0 | € 0 | € 0 | Belgium | € 2 | € 7 | € 8 |
| Bulgaria | € 1 | € 1 | € 1 | Bulgaria | € 2 | € 2 | € 3 |
| Czech Republic | € 20 | € 25 | € 45 | Czech Republic | € 41 | € 59 | € 100 |
| Cyprus | € 0 | € 0 | € 0 | Cyprus | € 0 | € 0 | € 0 |
| Denmark | € 1 | € 2 | € 2 | Denmark | € 2 | € 4 | € 5 |
| Estonia | € 0 | € 0 | € 0 | Estonia | € 0 | € 0 | € 1 |
| Finland | € 1 | € 1 | € 2 | Finland | € 1 | € 2 | € 4 |
| France | € 7 | € 18 | € 25 | France | € 9 | € 31 | € 40 |
| Germany | € 11 | € 29 | € 41 | Germany | € 20 | € 57 | € 77 |
| Greece | € 0 | € 1 | € 1 | Greece | € 1 | € 2 | € 3 |
| Hungary | € 1 | € 2 | € 3 | Hungary | € 3 | € 4 | € 7 |
| Ireland | € 1 | € 1 | € 2 | Ireland | € 1 | € 2 | € 3 |
| Italy | € 3 | € 7 | € 10 | Italy | € 7 | € 16 | € 23 |
| Latvia | € 0 | € 0 | € 0 | Latvia | € 0 | € 0 | € 1 |
| Lithuania | € 0 | € 0 | € 0 | Lithuania | € 0 | € 1 | € 1 |
| Luxembourg | € 0 | € 0 | € 0 | Luxembourg | € 0 | € 0 | € 0 |
| Malta | € 0 | € 0 | € 0 | Malta | € 0 | € 0 | € 0 |
| Netherlands | € 1 | € 3 | € 4 | Netherlands | € 2 | € 6 | € 8 |
| Poland | € 3 | € 4 | € 7 | Poland | € 7 | € 12 | € 19 |
| Portugal | € 0 | € 1 | € 1 | Portugal | € 1 | € 1 | € 2 |
| Romania | € 1 | € 2 | € 3 | Romania | € 3 | € 4 | € 7 |
| Slovakia | € 0 | € 1 | € 1 | Slovakia | € 1 | € 2 | € 2 |
| Slovenia | € 1 | € 1 | € 1 | Slovenia | € 1 | € 2 | € 3 |
| Spain | € 2 | € 6 | € 9 | Spain | € 4 | € 13 | € 17 |
| Sweden | € 1 | € 2 | € 4 | Sweden | € 2 | € 4 | € 5 |
| United Kingdom | € 3 | € 10 | € 13 | United Kingdom | € 8 | € 24 | € 32 |
| **TOTAL** | € 60 | € 120 | € 180 | **TOTAL** | € 119 | € 258 | € 377 |

**Table 8.4.4** Health costs (€m) – baseline scenario – Industry group breakdown - Based on a declining discount rate

| Low | Female | Male | Total |
|---|---|---|---|
| Manufacture of basic chemicals | € 42 | € 97 | € 99 |
| **TOTAL** | € 42 | € 97 | € 99 |
| **High** | **Female** | **Male** | **Total** |
| Manufacture of basic chemicals | € 82 | € 207 | € 289 |
| **TOTAL** | € 82 | € 207 | € 289 |

**Note:** Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.

**Table 8.4.5** Summary

| Costs by Gender (€m) | 2010-2019 | 2020-2029 | 2030-2039 | 2040-2049 | 2050-2059 | 2060-2069 |
|---|---|---|---|---|---|---|
| Female | 22 to 42 | 13 to 25 | 8 to 16 | 6 to 13 | 6 to 12 | 5 to 11 |
| Male | 42 to 88 | 26 to 55 | 17 to 36 | 13 to 28 | 11 to 26 | 10 to 24 |
| Total | 64 to 131 | 39 to 80 | 25 to 52 | 19 to 41 | 17 to 38 | 16 to 35 |

**Table 8.4.6** Health costs (€m) – baseline scenario – Member State breakdown - Based on a no discounting

| Low | Female | Male | Total | High | Female | Male | Total |
|---|---|---|---|---|---|---|---|
| Austria | € 1 | € 4 | € 5 | Austria | € 3 | € 9 | € 12 |
| Belgium | € 0 | € 0 | € 1 | Belgium | € 4 | € 15 | € 19 |
| Bulgaria | € 2 | € 2 | € 3 | Bulgaria | € 4 | € 4 | € 8 |
| Czech Republic | € 41 | € 52 | € 94 | Czech Republic | € 87 | € 126 | € 212 |
| Cyprus | € 0 | € 0 | € 0 | Cyprus | € 0 | € 0 | € 0 |
| Denmark | € 2 | € 4 | € 6 | Denmark | € 4 | € 8 | € 12 |
| Estonia | € 0 | € 0 | € 1 | Estonia | € 1 | € 1 | € 1 |
| Finland | € 1 | € 3 | € 4 | Finland | € 3 | € 5 | € 8 |
| France | € 15 | € 38 | € 53 | France | € 19 | € 65 | € 84 |
| Germany | € 25 | € 66 | € 91 | Germany | € 46 | € 129 | € 176 |
| Greece | € 1 | € 2 | € 3 | Greece | € 2 | € 4 | € 6 |
| Hungary | € 3 | € 4 | € 6 | Hungary | € 7 | € 9 | € 16 |
| Ireland | € 1 | € 2 | € 3 | Ireland | € 2 | € 5 | € 8 |
| Italy | € 7 | € 16 | € 23 | Italy | € 16 | € 38 | € 54 |
| Latvia | € 0 | € 0 | € 1 | Latvia | € 1 | € 1 | € 2 |
| Lithuania | € 0 | € 1 | € 1 | Lithuania | € 1 | € 1 | € 2 |
| Luxembourg | € 0 | € 0 | € 0 | Luxembourg | € 0 | € 0 | € 0 |
| Malta | € 0 | € 0 | € 0 | Malta | € 0 | € 0 | € 0 |
| Netherlands | € 2 | € 7 | € 10 | Netherlands | € 4 | € 14 | € 19 |
| Poland | € 7 | € 10 | € 17 | Poland | € 17 | € 28 | € 45 |
| Portugal | € 1 | € 2 | € 3 | Portugal | € 2 | € 3 | € 6 |
| Romania | € 3 | € 4 | € 7 | Romania | € 7 | € 9 | € 15 |
| Slovakia | € 1 | € 1 | € 2 | Slovakia | € 2 | € 4 | € 6 |
| Slovenia | € 1 | € 2 | € 3 | Slovenia | € 2 | € 4 | € 6 |

| Low | Female | Male | Total | High | Female | Male | Total |
|---|---|---|---|---|---|---|---|
| Spain | € 6 | € 18 | € 24 | Spain | € 12 | € 37 | € 49 |
| Sweden | € 2 | € 5 | € 8 | Sweden | € 3 | € 9 | € 12 |
| United Kingdom | € 7 | € 22 | € 29 | United Kingdom | € 18 | € 54 | € 72 |
| **TOTAL** | € 132 | € 265 | € 398 | **TOTAL** | € 266 | € 584 | € 849 |

**Table 8.4.7** Health costs (€m) – baseline scenario – Industry group breakdown - Based on a declining discount rate

| Low | Female | Male | Total |
|---|---|---|---|
| Manufacture of basic chemicals | € 96 | € 220 | € 225 |
| **TOTAL** | € 96 | € 220 | € 225 |
| **High** | **Female** | **Male** | **Total** |
| Manufacture of basic chemicals | € 190 | € 478 | € 667 |
| **TOTAL** | € 190 | € 478 | € 667 |

**Note:** Industry breakdown results may not equate exactly to Member State breakdown due to differences in underlying health data.

**Table 8.4.8** Summary

| Costs by Gender (€m) | 2010-2019 | 2020-2029 | 2030-2039 | 2040-2049 | 2050-2059 | 2060-2069 |
|---|---|---|---|---|---|---|
| Female | 27 to 51 | 23 to 45 | 17 to 34 | 18 to 36 | 22 to 44 | 26 to 55 |
| Male | 51 to 108 | 47 to 99 | 35 to 76 | 36 to 80 | 43 to 99 | 53 to 122 |
| Total | 78 to 159 | 70 to 145 | 52 to 110 | 54 to 116 | 65 to 143 | 79 to 177 |

## 8.5 VALUING HEALTH BENEFITS – INTERVENTION SCENARIOS

**Table 8.5.1** Proportions exposed above the exposure limits being tested by country, forecast scenario

| Forecast Scenario | *1975* | *1985* | *1995* | *2005* | *2015* | *2025* |
|---|---|---|---|---|---|---|
| **OEL:** | **0.03 mg/m$^3$** | | | | | |
| Austria | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Belgium | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Bulgaria | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Cyprus | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Czech Republic | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Denmark | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Estonia | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Finland | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| France | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Germany | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Greece | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |

| Forecast Scenario | *1975* | *1985* | *1995* | *2005* | *2015* | *2025* |
|---|---|---|---|---|---|---|
| Hungary | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Ireland | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Italy | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Latvia | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Lithuania | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Luxembourg | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Malta | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Netherlands | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Poland | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Portugal | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Romania | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Slovakia | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Slovenia | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Spain | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| Sweden | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| United Kingdom | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |
| TOTAL | 0.98 | 0.89 | 0.61 | 0.26 | 0.06 | 0.01 |

**Table 8.5.2** Numbers and proportions of the population ever exposed for baseline and intervention [1] scenarios (2) and (3), by country, men plus women

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | ***Numbers ever exposed in the REP*** | | | | | | | | | |
| Austria | 2,611 | 3,033 | 3,620 | 4,189 | 4,593 | 4,838 | 3,620 | 4,189 | 4,593 | 4,838 |
| Belgium | 4,908 | 5,617 | 6,596 | 7,530 | 8,193 | 8,596 | 6,596 | 7,530 | 8,193 | 8,596 |
| Bulgaria | 2,411 | 2,780 | 3,292 | 3,784 | 4,134 | 4,346 | 3,292 | 3,784 | 4,134 | 4,346 |
| Cyprus | 223 | 260 | 312 | 363 | 400 | 422 | 312 | 363 | 400 | 422 |
| Czech Republic | 3,587 | 4,134 | 4,891 | 5,620 | 6,137 | 6,451 | 4,891 | 5,620 | 6,137 | 6,451 |
| Denmark | 2,653 | 3,065 | 3,637 | 4,190 | 4,583 | 4,822 | 3,637 | 4,190 | 4,583 | 4,822 |
| Estonia | 577 | 682 | 828 | 972 | 1,074 | 1,136 | 828 | 972 | 1,074 | 1,136 |
| Finland | 2,065 | 2,406 | 2,879 | 3,339 | 3,666 | 3,865 | 2,879 | 3,339 | 3,666 | 3,865 |
| France | 23,909 | 26,818 | 30,998 | 35,210 | 38,082 | 39,883 | 30,998 | 35,210 | 38,082 | 39,883 |
| Germany | 32,126 | 36,737 | 43,111 | 49,174 | 53,481 | 56,095 | 43,111 | 49,174 | 53,481 | 56,095 |
| Greece | 3,140 | 3,709 | 4,501 | 5,282 | 5,837 | 6,175 | 4,501 | 5,282 | 5,837 | 6,175 |
| Hungary | 3,635 | 4,235 | 5,069 | 5,879 | 6,456 | 6,805 | 5,069 | 5,879 | 6,456 | 6,805 |
| Ireland | 1,749 | 1,999 | 2,345 | 2,674 | 2,907 | 3,049 | 2,345 | 2,674 | 2,907 | 3,049 |
| Italy | 9,124 | 10,466 | 12,323 | 14,096 | 15,356 | 16,121 | 12,323 | 14,096 | 15,356 | 16,121 |
| Latvia | 877 | 1,038 | 1,261 | 1,482 | 1,638 | 1,733 | 1,261 | 1,482 | 1,638 | 1,733 |
| Lithuania | 1,270 | 1,502 | 1,826 | 2,145 | 2,372 | 2,509 | 1,826 | 2,145 | 2,372 | 2,509 |
| Luxembourg | 146 | 171 | 207 | 242 | 267 | 282 | 207 | 242 | 267 | 282 |
| Malta | 95 | 115 | 143 | 170 | 190 | 202 | 143 | 170 | 190 | 202 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Netherlands | 7,097 | 8,287 | 9,943 | 11,560 | 12,710 | 13,410 | 9,943 | 11,560 | 12,710 | 13,410 |
| Poland | 11,980 | 13,958 | 16,701 | 19,368 | 21,262 | 22,411 | 16,701 | 19,368 | 21,262 | 22,411 |
| Portugal | 3,127 | 3,670 | 4,426 | 5,167 | 5,693 | 6,012 | 4,426 | 5,167 | 5,693 | 6,012 |
| Romania | 5,522 | 6,424 | 7,676 | 8,893 | 9,757 | 10,283 | 7,676 | 8,893 | 9,757 | 10,283 |
| Slovakia | 1,854 | 2,177 | 2,626 | 3,067 | 3,380 | 3,569 | 2,626 | 3,067 | 3,380 | 3,569 |
| Slovenia | 1,069 | 1,225 | 1,440 | 1,645 | 1,791 | 1,879 | 1,440 | 1,645 | 1,791 | 1,879 |
| Spain | 16,268 | 19,792 | 24,699 | 29,614 | 33,146 | 35,339 | 24,699 | 29,614 | 33,146 | 35,339 |
| Sweden | 4,958 | 5,792 | 6,950 | 8,079 | 8,880 | 9,367 | 6,950 | 8,079 | 8,880 | 9,367 |
| United Kingdom | 29,427 | 34,579 | 41,748 | 48,784 | 53,784 | 56,822 | 41,748 | 48,784 | 53,784 | 56,822 |
| TOTAL | 176,407 | 204,673 | 244,048 | 282,515 | 309,769 | 326,421 | 244,048 | 282,515 | 309,769 | 326,421 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Proportion of the population exposed* | | | | | | | | | |
| Austria | 0.04 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 | 0.05 | 0.06 | 0.07 | 0.07 |
| Belgium | 0.06 | 0.07 | 0.08 | 0.09 | 0.09 | 0.10 | 0.08 | 0.09 | 0.09 | 0.10 |
| Bulgaria | 0.04 | 0.05 | 0.06 | 0.08 | 0.09 | 0.10 | 0.06 | 0.08 | 0.09 | 0.10 |
| Cyprus | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 |
| Czech Republic | 0.64 | 0.61 | 0.64 | 0.66 | 0.66 | 0.66 | 0.64 | 0.66 | 0.66 | 0.66 |
| Denmark | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.11 | 0.09 | 0.10 | 0.11 | 0.11 |
| Estonia | 0.06 | 0.07 | 0.09 | 0.11 | 0.12 | 0.13 | 0.09 | 0.11 | 0.12 | 0.13 |
| Finland | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.07 | 0.08 | 0.09 | 0.10 |
| France | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.08 | 0.06 | 0.07 | 0.07 | 0.08 |
| Germany | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.07 | 0.08 | 0.09 | 0.10 |
| Greece | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.07 | 0.05 | 0.06 | 0.07 | 0.07 |
| Hungary | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.07 | 0.08 | 0.09 | 0.10 |
| Ireland | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| Italy | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Latvia | 0.05 | 0.06 | 0.08 | 0.10 | 0.12 | 0.13 | 0.08 | 0.10 | 0.12 | 0.13 |
| Lithuania | 0.05 | 0.06 | 0.08 | 0.10 | 0.11 | 0.12 | 0.08 | 0.10 | 0.11 | 0.12 |
| Luxembourg | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Malta | 0.03 | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.04 | 0.05 | 0.06 | 0.06 |
| Netherlands | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.11 | 0.08 | 0.09 | 0.10 | 0.11 |
| Poland | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.06 | 0.07 | 0.08 | 0.09 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Portugal | 0.04 | 0.04 | 0.05 | 0.06 | 0.06 | 0.07 | 0.05 | 0.06 | 0.06 | 0.07 |
| Romania | 0.04 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.05 | 0.06 | 0.07 | 0.08 |
| Slovakia | 0.05 | 0.05 | 0.06 | 0.08 | 0.09 | 0.10 | 0.06 | 0.08 | 0.09 | 0.10 |
| Slovenia | 0.07 | 0.08 | 0.09 | 0.11 | 0.12 | 0.14 | 0.09 | 0.11 | 0.12 | 0.14 |
| Spain | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 | 0.06 | 0.07 | 0.08 | 0.09 |
| Sweden | 0.08 | 0.08 | 0.10 | 0.11 | 0.11 | 0.12 | 0.10 | 0.11 | 0.11 | 0.12 |
| United Kingdom | 0.07 | 0.07 | 0.09 | 0.09 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 | 0.10 |
| TOTAL | 0.05 | 0.05 | 0.06 | 0.07 | 0.08 | 0.08 | 0.06 | 0.07 | 0.08 | 0.08 |

**Table 8.5.3** Results for baseline and intervention [1] scenarios (2) and (3) for pancreatic cancer, by country, men plus women

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Attributable Fraction* | | | | | | | | | |
| Austria | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Belgium | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Bulgaria | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cyprus | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Czech Republic | 0.14 | 0.08 | 0.04 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 |
| Denmark | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Estonia | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Finland | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| France | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Germany | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| Greece | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Hungary | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Ireland | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Italy | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Latvia | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Lithuania | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Luxembourg | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Malta | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Netherlands | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Poland | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Portugal | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Romania | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Slovakia | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Slovenia | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Spain | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sweden | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| United Kingdom | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| TOTAL | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Attributable Deaths* | | | | | | | | | |
| Austria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulgaria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Denmark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Germany | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Greece | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hungary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Portugal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Romania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovakia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovenia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sweden | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| United Kingdom | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 7 | 5 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Attributable Registrations* | | | | | | | | | |
| Austria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulgaria | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Denmark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| France | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Germany | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Greece | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hungary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ireland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Italy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Poland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Portugal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Romania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovakia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovenia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sweden | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| United Kingdom | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 6 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Attributable Years of Life Lost (YLLs)* | | | | | | | | | |
| Austria | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulgaria | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 38 | 25 | 14 | 11 | 10 | 9 | 14 | 11 | 10 | 9 |
| Denmark | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 |
| France | 21 | 15 | 8 | 6 | 6 | 6 | 8 | 6 | 6 | 6 |
| Germany | 28 | 22 | 14 | 12 | 12 | 12 | 14 | 12 | 12 | 12 |
| Greece | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hungary | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ireland | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Italy | 7 | 6 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 3 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Poland | 5 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Portugal | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Romania | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Slovakia | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovenia | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 4 | 3 | 3 | 4 | 4 | 5 | 3 | 4 | 4 | 5 |
| Sweden | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| United Kingdom | 10 | 7 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| TOTAL | 97 | 74 | 46 | 41 | 41 | 42 | 46 | 41 | 41 | 42 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | *Attributable Years of Life Lived with Disability (DALYs)* | | | | | | | | | |
| Austria | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Belgium | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bulgaria | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Cyprus | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Czech Republic | 39 | 26 | 15 | 11 | 10 | 10 | 15 | 11 | 10 | 10 |
| Denmark | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Estonia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Finland | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| France | 21 | 15 | 8 | 7 | 6 | 6 | 8 | 7 | 6 | 6 |
| Germany | 29 | 23 | 14 | 12 | 12 | 12 | 14 | 12 | 12 | 12 |
| Greece | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hungary | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Ireland | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Italy | 7 | 6 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 3 |
| Latvia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lithuania | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Luxembourg | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Malta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Netherlands | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| Poland | 5 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| Portugal | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Romania | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Slovakia | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Slovenia | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spain | 4 | 3 | 3 | 4 | 4 | 5 | 3 | 4 | 4 | 5 |
| Sweden | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| United Kingdom | 10 | 7 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| TOTAL | 99 | 75 | 47 | 42 | 42 | 43 | 47 | 42 | 42 | 43 |

[1] Intervention scenarios have been estimated assuming baseline exposure and employment levels
[2] Change from 2010 in baseline scenario is due to trends in 'historic' (pre 2005) part of REP

Note: numbers and proportions ever exposed remain constant across the baseline and intervention scenarios

**Table 8.5.4** Numbers and proportions of the EU population ever exposed, by industry, men plus women

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry sector** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | **2030** | **2040** | **2050** | **2060** |
| | ***Numbers ever exposed*** | | | | | | | | | |
| Manufacture of basic chemicals | 30,690 | 31,507 | 32,598 | 33,034 | 33,284 | 33,511 | 32,598 | 33,034 | 33,284 | 33,511 |
| Research and development | 9,207 | 11,098 | 13,757 | 16,438 | 18,352 | 19,529 | 13,757 | 16,438 | 18,352 | 19,529 |
| Other business activities | 1,107 | 1,334 | 1,654 | 1,976 | 2,206 | 2,348 | 1,654 | 1,976 | 2,206 | 2,348 |
| Public Administration and defence | 222 | 267 | 332 | 396 | 442 | 471 | 332 | 396 | 442 | 471 |
| Education | 25,493 | 30,729 | 38,091 | 45,513 | 50,815 | 54,072 | 38,091 | 45,513 | 50,815 | 54,072 |
| Health and Social Work | 268 | 323 | 400 | 478 | 534 | 568 | 400 | 478 | 534 | 568 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Industry sector | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | ***Proportion of the population exposed*** | | | | | | | | | |
| Manufacture of basic chemicals | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% | 0.02% |
| Research and development | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% |
| Other business activities | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Public Administration and defence | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Education | 0.01% | 0.02% | 0.02% | 0.02% | 0.03% | 0.03% | 0.02% | 0.02% | 0.03% | 0.03% |
| Health and Social Work | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

**Table 8.5.5** Occupation attributable fractions, deaths, registrations, YLLs and DALYs for pancreatic cancer by industry, men plus women

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry sector** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | **2030** | **2040** | **2050** | **2060** |
| | ***Attributable Fraction*** | | | | | | | | | |
| Manufacture of basic chemicals | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Research and development | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Other business activities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Public Administration and defence | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Education | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Health and Social Work | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Industry sector | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2030 | 2040 | 2050 | 2060 |
| | ***Attributable Deaths*** | | | | | | | | | |
| Manufacture of basic chemicals | 7 | 5 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 |
| Research and development | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other business activities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Public Administration and defence | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health and Social Work | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry sector** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | **2030** | **2040** | **2050** | **2060** |
| | ***Attributable Registrations*** | | | | | | | | | |
| Manufacture of basic chemicals | 6 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Research and development | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other business activities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Public Administration and defence | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health and Social Work | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry sector** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | **2030** | **2040** | **2050** | **2060** |
| | ***Attributable Years of Life Lost (YLLs)*** | | | | | | | | | |
| Manufacture of basic chemicals | 97 | 74 | 46 | 41 | 41 | 42 | 46 | 41 | 41 | 42 |
| Research and development | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other business activities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Public Administration and defence | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health and Social Work | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Scenario[1] | All Scenarios | | Baseline scenario (2)[2] - Linear employment and exposure level trends assumed to 2021-30, including the 1995-2005 estimated decline in exposure levels for NACE 24, constant thereafter | | | | Intervention scenario (3) - Full compliance for current OEL | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Industry sector** | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** | **2030** | **2040** | **2050** | **2060** |
| | ***Attributable Years of Life Lived with Disability (DALYs)*** | | | | | | | | | |
| Manufacture of basic chemicals | 99 | 75 | 47 | 42 | 42 | 43 | 47 | 42 | 42 | 43 |
| Research and development | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other business activities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Public Administration and defence | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Education | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Health and Social Work | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

[1] Intervention scenarios have been estimated assuming baseline exposure and employment levels
[2] Change from 2010 in baseline scenario is due to trends in 'historic' (pre 2005) part of REP

Note: numbers and proportions ever exposed remain constant across the baseline and intervention scenarios

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