Annex 3 Epidemiological carcinogenicity studies in workers exposed to arsenic in the semiconductor industry

Design	Industry	Country	Study size	Adjusted for confounders	Risk estimate#, (95% confidence interval), no. of observations (IARC tumour sites* - lung, skin[1], urinary bladder, only these reported here)	Reference
Cohort mortality	IBM, Two semiconductor manufacturing facilities (East Fishkill (NY), Burlington (VT)), and one storage device (e.g. hard drives for computers) manufacturing facility (San Jose (CA)	USA	126 836	No	Overall mortality rate SMR 65 (CI=64-67), 6579, all cancers combined SMR 78 (CI= 75-81), 2159, lung cancer SMR 61 (men) SMR 98 (women) No estimates of exposure to specific agents developed within the analysis	Beall et al., 2005
Cohort morbidity, (Cancer incidence study) Additional investigation to the one cited in the previous row.	IBM, Two facilities - one semiconductor manufacturing (East Fishkill (NY), and one electronic storage device manufacturing (San Jose (CA)	USA	89 054	No	At the semiconductor facility - all cancers SIR was 81 (CI=77-85), 1541, SIR increased for some subgroups without consistent evidence of causal association with employment factors. lung cancer SIR 60/57 (men facility EF/SJ), 73/68 (women facility EF/SJ), bladder cancer SIR 93/85 (men + women EF/SJ) No estimates of employees´ exposure developed.	Bender et al., 2007
Cohort mortality (follow-up study)	Semiconductor wafer fabrication industry Two large semiconductor companies with fabrication facilities in 10 cities, five states. 12 300 long-term and short-term	USA	100 081	No, only for internal comparisons not external	No increased cancer mortality overall or from any specific form of cancer. All cancer SMR 0.78 (0.69-0.89) and 0.79 (0.62-0.98) for all clean-room workers and clean-room workers employed ≥10 years. For early fabrication era workers all cancer	Boice et al., 2010[2]

[1] non-melanoma skin cancers (IARC Mono Vol 84)
[2] Exposure data reported by Marano et al. 2010

Annex 3 Epidemiological carcinogenicity studies in workers exposed to arsenic in the semiconductor industry

	personal air samples, >98 % below current OELs, and >50 % below limit of detection				SMR was 0.80 (0.64-0.98). Internal comparison early era workers all cancer RR 1.05 (0.9-1.02).	
Cohort morbidity and mortality study (update, 2nd follow-up study)	A semiconductor factory in West Midlands	UK	1807		SMR 99 (CI= 79-122) males / 74 (CI= 65-85 females), all sites cancer SRR 130 (CI= 95-173) males / 94 (CI= 82-109) females. Elevated morbidity for a number of cancer sites but IARCTarget tumour sites not elevated Detailed work history data were unavailable for analysis.	Nichols and Sorahan, 2005
Published in HSE report. To be published in peer reviewed paper Cohort morbidity and mortality study Nested case-control study of lung cancer and breast cancer Follow-up of McElvenny et al., 2003	National Semiconductor UK Ltd (NSUK)	UK	4388	Cohorts adjusted for deprivation Case-control study adjusted for several confounders	Mortality from malignant neoplasms SMR 43.5 (CI= 22.5-75.9) males / 101 (CI=72.6-136.2) females. All malignant neoplasms SRR 90.2 (69.1-116) 12 in males / 102 (84.9-122) 42 in females Cancer registrations of malignant neoplasms of trachea, bronchus and lung SRR 45.1 (12.3-116) 4 in males / 144 (82.3-234) 16 in females	Darnton et al., 2010
Cohort morbidity and mortality study	National Semiconductor UK Ltd (NSUK)	UK	4388	Cohorts adjusted for deprivation	Mortality from malignant neoplasms SMR 47 (CI= 17-102) males / 110 (CI=69-164) females. All malignant neoplasms SRR 99 (64-147) 25 in males / 111 (83-145) 54 in females	McElvenny et al., 2003

Annex 3 Epidemiological carcinogenicity studies in workers exposed to arsenic in the semiconductor industry

		Cancer registrations of malignant neoplasms of trachea, bronchus and lung SRR 56 (7-202) 2 in males / 273 (136-488) 11 in females

**From Straif et al. (2009): Arsenic and inorganic arsenic compounds. Tumour sites (or types) for which there is sufficient evidence in humans: lung, skin, urinary bladder* (Other sites with limited evidence in humans: kidney, liver, prostate).