Supplementary material for Report no. 13/18: Review of Tier 1 Workplace Exposure Estimates for Petroleum Substances in REACH dossiers

ONLINE SUPPLEMENT 1A: SUMMARY OF AVAILABLE EXPOSURE DATA FOR CONCAWE CHEMICAL SAFETY ASSESSMENT VALIDATION

INTRODUCTION

The project requires the collection of suitable measurement data for comparison with modelled exposures to a range of petroleum substances.

The sections below give an overview of the data identified to date which have the potential to be used in this validation exercise. The data are described by source and substance. Gaps in the data set are also described, together with issues related to specific providers.

DATA SOURCES

i) NIOSH Data

We have considered the NIOSH data already provided for the Evaluation of Tier 1 Exposure Assessment Models (*eteam*) project undertaken by IOM and ITEM (www.eteam-project.eu) and have identified a number of downstream exposures to oil mist and naphthas in formulations that may be of interest. Data on gasoline exposures during vehicle fuelling by retail petrol station attendants are also available.

A summary of the situation types is given below in Table S.*1*1.

Table S.1 Summary of available NIOSH exposure data

Analyte	Situation	Description of task/ activity carried out	No. of measurements
Oil mist	use of metal working fluids in production/ reworking of steel coils	Grinding/ shaping	4
Naphtha	Use of naphtha in spray painting	Paint mixing	4
Naphtha (aromatic)	Use of naphtha in spray painting	Paint mixing	4
Naphtha	Manufacture of sintered metal components	Spraying of rust preventive oil	6
Oil mist	Manufacture of sintered metal components	Spraying of rust preventive oil	6
(MTBE (from gasoline)	Refuelling of domestic vehicles by petrol station attendants	Service station attendant activities	10
Total hydrocarbons (from gasoline) (same study as above)	Refuelling of domestic vehicles by petrol station attendants	Service station attendant activities	10
Total hydrocarbons	Aircraft parts repair	Cleaning and spray painting with enamel paints	2
Total hydrocarbons	Aircraft parts repair	Assembly and testing of parts	1

Total hydrocarbons	Aircraft parts repair	Cleaning of wheels with solvents	2
Benzene	Manufacture of metal castings	Painting	4
Total hydrocarbons	Manufacture of metal castings	Painting	4
Total Hydrocarbons (Naphthas)	Welding and painting during the manufacture of pre-engineered steel building structures.	Painting	5
Benzene solubles / naphthas (kerosine)	Aircraft refuelling with exposure to kerosine (Jet fuel A)	Refueller	32
Benzene solubles / naphthas (kerosine)	Aircraft refuelling with exposure to kerosine (Jet fuel A)	Shop mechanic	12
Benzene solubles / naphthas (kerosine)	Aircraft refuelling with exposure to kerosine (Jet fuel A)	Ramp mechanic	8
Benzene solubles / naphthas (kerosine)	Aircraft refuelling with exposure to kerosine (Jet fuel A)	Utility sump work	2

The NIOSH data are available publicly with no access restrictions. In general, the situations are well described with information given on RMMs, products and sampling techniques. Additional information can also be obtained via the original Health Hazard Evaluation report source documents. A limited number has already been collected and coded into the *eteam* database. In addition, as part of another model validation project, over early 2014 NIOSH will be collecting exposure data from a range of downstream sites, which will also be available for use in this project if relevant.

ii) Concawe Risk Assessment Reports

We have identified a large number of exposure measurements within the previously identified Concawe human exposure assessment reports. These data have been entered into the templates where possible, and summarised separately where potentially useful but incomplete data have been identified. The following reports were evaluated.

- Report no. 6/07 [5]: Human exposure information for EU substance risk assessment of kerosine
- Report no. 1/06 [6]: Human exposure information for EU substance risk assessment of gas oils
- Report no. 4/87 [7]: A survey of exposure to gasoline vapour
- Report no. 97/52 [8]: Exposure profile: gasoline
- Report no. 2/00 [9]: A review of european gasoline exposure data for the period 1993-1998
- Report no. 9/02 [10]: A survey of european gasoline exposures for the period 1999-2001
- Report no. 5/09 [11]: Additional human exposure information for gasoline substance risk assessment (period 2002-2007)
- Report no. 1/15 [12]: Risk assessment for emissions from hot heavy fuel oil during barge loading

The data within the reports have been entered into the relevant template for the substance, with a short summary given below.

a) Kerosine: Summary of data from Concawe Report no. 06/07 [5]: Human exposure information for EU substance risk assessment of kerosine

The majority of the measurement data selected from the report relate to the storage, sampling and transfer of aviation fuels, with small numbers of measurements relating to exposure during road construction work.

Table S1.2 Summary of data from Concawe report 6/07: kerosine

Source	Description of Task/ activity carried out	Personal/ Static	No. of samples	Analyte
Exposure to kerosine (as Total Hydrocarbons)				
page 12	Yard Operator filter inspection	Personal	2	total hydrocarbons
page 12	Yard Operator fuel sampling testing	Personal	2	total hydrocarbons
page 12	Yard Operator filter testing	Personal	2	total hydrocarbons
page 12	Replacement of storage vessel	Personal	2	total hydrocarbons
page 14	Aircraft tank repair	Personal	77	total hydrocarbons
page14	Aircraft maintenance	Personal	18	total hydrocarbons
page 12	vehicle mechanic hose repair and test	Personal	1	total hydrocarbons
page14	Fuel tank entry	Personal	248	total hydrocarbons
page 12	Top loading road tanker 10% Kerosine	Personal	2	total hydrocarbons
page 12	Spray bar operator	Personal	2	total hydrocarbons
page 12	Paving spreader driver	Personal	2	total hydrocarbons
page 12	top loading road tanker	Personal	1	total hydrocarbons
page 12	Off-loading tanker	Personal	1	total hydrocarbons
Exposure to kerosine (n-nonane)				
page 18	Tank farm operator	Personal	9	n-nonane equivalents
page 18	Tank farm operator/fuel sampling	Personal	5	n-nonane equivalents
page 18	Tank farm operator filter changing	Personal	5	n-nonane equivalents
page 18	Tank farm supervisor	Personal	3	n-nonane equivalents
page 18	Vehicle service bay and maintenance workers	Personal	12	n-nonane equivalents
page 18	Maintenance work on valves	Personal	3	n-nonane equivalents

b) Gas oils: Summary of data from Concawe Report 1/06 [6] Human exposure information for EU substance risk assessment of gas oils.

The summary table below includes the raw exposure data from Appendix 4 of Report 1/06 [6]. Compositional information on the components within the bulk products and vapour phase of gas oils is also given in the report.

Table S1.3 Summary of data from Concawe report 1/06: gas oils

Source	Description of Task/ activity carried out	Personal/ Static	Measurement Duration (min)	Name of Substance analysed (s)	Concentration	Units e.g. mg/m3	Measurement <LOD?
Appendix 4	Road tanker loading	personal	20	total hydrocarbons (as n-dodecane equivalent)	9.4	mg/m3	No
Appendix 4	Road tanker loading	personal	18	total hydrocarbons (as n-dodecane equivalent)	74.3	mg/m3	No
Appendix 4	Rail cars loading	personal	34	total hydrocarbons (as n-dodecane equivalent)	28.3	mg/m3	No
Appendix 4	Rail cars loading	personal	113	total hydrocarbons (as n-dodecane equivalent)	5.5	mg/m3	No
Appendix 4	Jetty crew ship loading	personal	120	total hydrocarbons (as n-dodecane equivalent)	3.2	mg/m3	No
Appendix 4	Road tanker driver	personal	26	total hydrocarbons (as n-dodecane equivalent)	0.9	mg/m3	No
Appendix 4	Bottom loading road tanker	personal	19	total hydrocarbons (as n-dodecane equivalent)	3.6	mg/m3	No
Appendix 4	Top loading road tanker	personal	11	total hydrocarbons (as n-dodecane equivalent)	2.2	mg/m3	No
Appendix 4	Top loading road tanker	personal	11	total hydrocarbons (as n-dodecane equivalent)	3.7	mg/m3	No
Appendix 4	Rail car loading	personal	105	total hydrocarbons (as n-dodecane equivalent)	2.1	mg/m3	No
Appendix 4	Tank farm sampling	personal	45	total hydrocarbons (as n-dodecane equivalent)	0.7	mg/m3	No
Appendix 4	Refinery lab technician (ULSD analysis)	personal	100	total hydrocarbons (as n-dodecane equivalent)	57.5	mg/m3	No
Appendix 4	Refuelling heavy goods vehicle (HGV)	personal	11	total hydrocarbons (as n-dodecane equivalent)	0.6	mg/m3	No
Appendix 4	Refuelling HGV	personal	13	total hydrocarbons (as n-dodecane equivalent)	0.2	mg/m3	No
Appendix 4	Refuelling HGV	personal	11	total hydrocarbons (as n-dodecane equivalent)	16.9	mg/m3	No
Appendix 4	Refuelling HGV	personal	13	total hydrocarbons (as n-dodecane equivalent)	5.3	mg/m3	No
Appendix 4	Refuelling HGV	personal	17	total hydrocarbons (as n-dodecane equivalent)	1.9	mg/m3	No

Source	Description of Task/ activity carried out	Personal/ Static	Measurement Duration (min)	Name of Substance analysed (s)	Concentration	Units e.g. mg/m3	Measurement <LOD?
Appendix 4	Refueling HGV	personal	12	total hydrocarbons (as n-dodecane equivalent)	5.6	mg/m3	No
Appendix 4	Refuelling HGV	personal	14	total hydrocarbons (as n-dodecane equivalent)	5.6	mg/m3	No
Appendix 4	Refuelling HGV	personal	12	total hydrocarbons (as n-dodecane equivalent)	4.7	mg/m3	No
Appendix 4	Refuelling HGV	personal	12	total hydrocarbons (as n-dodecane equivalent)	8.9	mg/m3	No
Appendix 4	Road tanker driver	personal	604	total hydrocarbons (as n-dodecane equivalent)	0.4	mg/m3	No
Appendix 4	Road tanker driver	personal	360	total hydrocarbons (as n-dodecane equivalent)	0.7	mg/m3	No
Appendix 4	Road tanker driver	personal	375	total hydrocarbons (as n-dodecane equivalent)	1.4	mg/m3	No
Appendix 4	Road tanker driver	personal	330	total hydrocarbons (as n-dodecane equivalent)	3.6	mg/m3	No
Appendix 4	Road tanker driver	personal	350	total hydrocarbons (as n-dodecane equivalent)	0.5	mg/m3	No
Appendix 4	Road tanker driver	personal	587	total hydrocarbons (as n-dodecane equivalent)	3.3	mg/m3	No
Appendix 4	Delivery	personal	26	total hydrocarbons (as n-dodecane equivalent)	nd	mg/m3	Yes
Appendix 4	Delivery	personal	9	total hydrocarbons (as n-dodecane equivalent)	1.2	mg/m3	No
Appendix 4	Delivery	personal	27	total hydrocarbons (as n-dodecane equivalent)	2.2	mg/m3	No
Appendix 4	Delivery	personal	25	total hydrocarbons (as n-dodecane equivalent)	0.1	mg/m3	No
Appendix 4	Delivery	personal	15	total hydrocarbons (as n-dodecane equivalent)	0.7	mg/m3	No
Appendix 4	Delivery	personal	15	total hydrocarbons (as n-dodecane equivalent)	5.4	mg/m3	No
Appendix 4	Delivery	personal	12	total hydrocarbons (as n-dodecane equivalent)	0.7	mg/m3	No
Appendix 4	Delivery	personal	45	total hydrocarbons (as n-dodecane equivalent)	0.7	mg/m3	No
Appendix 4	Delivery	personal	10	total hydrocarbons (as n-dodecane equivalent)	13.7	mg/m3	No

Source	Description of Task/ activity carried out	Personal/ Static	Measurement Duration (min)	Name of Substance analysed (s)	Concentration	Units e.g. mg/m3	Measurement <LOD?
Appendix 4	Delivery	personal	13	total hydrocarbons (as n-dodecane equivalent)	138.3	mg/m3	No
Appendix 4	Delivery	personal	15	total hydrocarbons (as n-dodecane equivalent)	34.3	mg/m3	No
Appendix 4	Delivery	personal	14	total hydrocarbons (as n-dodecane equivalent)	20.2	mg/m3	No
Appendix 4	Road tanker top loading	personal	19	total hydrocarbons (as n-dodecane equivalent)	2.5	mg/m3	No
Appendix 4	Road tanker top loading	personal	19	total hydrocarbons (as n-dodecane equivalent)	0.3	mg/m3	No
Appendix 4	Road tanker top loading	personal	15	total hydrocarbons (as n-dodecane equivalent)	3.0	mg/m3	No
Appendix 4	Road tanker top loading	personal	12	total hydrocarbons (as n-dodecane equivalent)	111.4	mg/m3	No
Appendix 4	Road tanker top loading	personal	20	total hydrocarbons (as n-dodecane equivalent)	1.6	mg/m3	No
Appendix 4	Road tanker top loading	personal	14	total hydrocarbons (as n-dodecane equivalent)	1.3	mg/m3	No
Appendix 4	Road tanker top loading	personal	26	total hydrocarbons (as n-dodecane equivalent)	6.3	mg/m3	No
Appendix 4	Road tanker top loading	personal	19	total hydrocarbons (as n-dodecane equivalent)	0.1	mg/m3	No
Appendix 4	Road tanker top loading	personal	14	total hydrocarbons (as n-dodecane equivalent)	5.8	mg/m3	No
Appendix 4	Road tanker top loading	personal	29	total hydrocarbons (as n-dodecane equivalent)	8.7	mg/m3	No
Appendix 4	Road tanker top loading	personal	11	total hydrocarbons (as n-dodecane equivalent)	1.0	mg/m3	No
Appendix 4	Tank farm - filter change	personal	43	total hydrocarbons (as n-dodecane equivalent)	6.2	mg/m3	No
Appendix 4	Tank farm - filter change	personal	43	total hydrocarbons (as n-dodecane equivalent)	4.6	mg/m3	No
Appendix 4	Tank farm - filter change	personal	47	total hydrocarbons (as n-dodecane equivalent)	4.0	mg/m3	No
Appendix 4	Tank farm - filter change	personal	47	total hydrocarbons (as n-dodecane equivalent)	4.2	mg/m3	No
Appendix 4	Tank farm - filter change	personal	50	total hydrocarbons (as n-dodecane equivalent)	20.4	mg/m3	No

Source	Description of Task/ activity carried out	Personal/ Static	Measurement Duration (min)	Name of Substance analysed (s)	Concentration	Units e.g. mg/m3	Measurement <LOD?
Appendix 4	Tank sampling	personal	16	total hydrocarbons (as n-dodecane equivalent)	10.8	mg/m3	No
Appendix 4	Tank sampling	personal	12	total hydrocarbons (as n-dodecane equivalent)	4.5	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	13	total hydrocarbons (as n-dodecane equivalent)	75.2	mg/m3	No
Appendix 4	Road tanker top loading- diesel fuel	personal	29	total hydrocarbons (as n-dodecane equivalent)	55.4	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	16	total hydrocarbons	7.2	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	8	total hydrocarbons	172.1	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	28	total hydrocarbons	14.4	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	19	total hydrocarbons	8.0	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	8	total hydrocarbons	3.1	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	14	total hydrocarbons	65.6	mg/m3	No
Appendix 4	Road tanker top loading- home heating oil	personal	22	total hydrocarbons	24.8	mg/m3	No
Appendix 4	Road tanker driver –industrial heating gas oil (bottom loading/vr at terminal, no vr at delivery site)	personal	360	total hydrocarbons	1.3	mg/m3	No
Appendix 4	Road tanker driver- industrial/ heating gas oil (bottom loading/vr)	personal	28	total hydrocarbons	0.5	mg/m3	No
Appendix 4	Road tanker driver –industrial/ heating gas oil (bottom loading/vr at terminal, no vr at delivery site)	personal	318	total hydrocarbons	11.0	mg/m3	No

Report 1/06 also includes summarised data from a number of generic job types; however, there is no associated information regarding exposure duration and limited description of sample type.

These data are shown in Table S1.4 below.

Table S1.4 Summarised data from Table 1: Report 1/06

Job title	No.	Median (mg/m3)	Min (mg/m3)	Max (mg/m3)	Typical duration
On-site analysers operator	1	5	-	-	480
Refinery lab worker	2	7	4	9.0	480
Production operator	1	1			480
Tank farm operator	4	4	2	18.0	480
Waste water treatment operator	1	6	-	-	480
Road tanker drivers	13	2	<1	6.0	480
Road tanker gantry operator	6	7	<1	120.0	480
Road tanker top loading	6	85	44	535.0	20
Road tanker deliveries	1	100	-	-	4
Service station, area near diesel pumps	114	0.9	0.02	103.0	240
Domestic heating oil tank cleaning	2	190	180	195.0	30

The nomenclature of gas oils reflects their final processing step. There were four templates/ ES which seemed relevant for these processes: those for cracked gas oils, vacuum cracked gas oils, straight-run gas oils and other gas oils. As little information was given in the report on the type of gas oil, with the exception of a limited number of references to home heating oil, it was however difficult to allocate the above data to a template. The above summary therefore provides an indication of the task types reported: guidance on the most appropriate template would be of assistance in completing the data assessment. The report is also limited in relation to contextual information relating to risk management measures.

c) Concawe Report no. 97/52 [8]: exposure profile: gasoline

This report reviews data on exposure to gasoline as used for automotive and aviation related purposes. Exposure data are given as personal 8hr time weighted average arithmetic mean exposures (mg/m^3), together with the range (min-max) and numbers of samples, where available. Data on exposure to benzene and total hydrocarbons are presented here, with additional concentrations of 1,3-butadiene, n-hexane, toluene, ethyl benzene and xylenes shown in the original document.

Information is given in the report on the typical control measures in place for the documented job types/tasks, with detail on the nature of exposure, e.g. tasks with the highest expected exposure potential also provided.

Table S1.5 Summary of data from Concawe Report 97/ 52: gasoline

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m³	Min mg/m³	Max mg/m³	No.	Sample Type
23	2.1.b	Europe	Refinery	onsite operator	1987	Benzene	0.9	0	23.8	62	8h TWA
23	2.1.b	Europe 1986-94	Refinery	onsite operator	1994	Benzene	0.6	0.2	25.3	449	8h TWA
23	2.1.b	USA	Refinery	onsite operator	1985	Benzene	0.17	0	1.17	56	8hTWA
23	2.1.b	Germany	Refinery	Reforming plants	1983-85	Benzene	0.62	0.01	39.7	183	8h TWA
23	2.1.b	Germany	Refinery	Cracking plants	1983-85	Benzene	0.96	0.01	14.4	46	8hTWA
23	2.1.b	Germany	Refinery	Ethylene plants	1983-85	Benzene	0.91	0.02	8.6	51	8h TWA
23	2.1.b	Europe	Refinery	Off site operator	1987	Benzene	1	0	14.1	27	8h TWA
23	2.1.b	Europe	Refinery	Off site operator	1986-94	Benzene	1.8	0.2	42.2	426	8h TWA
23	2.1.b	Germany	Refinery	Off site operator	1986-95	Benzene	2.11	0.03	21.1	54	8h TWA
23	2.1.b	Europe	Refinery	Laboratory Technician	1986-94	Benzene	1.2	0.2	35.5	218	8h TWA
23	2.1.b	USA	Refinery	Laboratory Technician	-	Benzene	0.34	0.08	0.8	19	8h TWA
23	2.1.b	Europe	Refinery	Bottle washer	1986-94	Benzene	5.2	0.2	42.6	75	8h TWA
24	2.1.b	Europe	Refinery	Maintenance worker	1986-94	Benzene	2.5	0.2	61.8	55	8h TWA
24	2.1.b	Germany	Refinery	maintenance worker	1983-85	Benzene	0.8	0.01	25.6	43	8h TWA
24	2.1.b	Europe	Refinery	Drum/Barrel filler	1987	Benzene	41.3	0	116.3	9	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: top loading	1987	Benzene	1.7	0	30.7	63	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: top loading	1986-94	Benzene	0.8	0.2	6.6	186	8h TWA
24	2.1.b	Germany	Distribution	Road Tanker driver: top loading	1983-85	Benzene	1.89	0.31	6.18	54	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: top loading	1986	Benzene	0.9	0.1	2.3	43	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: bottom loading	1987	Benzene	1.2	0	12	34	8h TWA
24	2.1.b	USA	Distribution	Road Tanker driver: bottom loading	1986	Benzene	1.1	0.2	5.9	38	8h TWA
24	2.1.b	USA	Distribution	Road Tanker driver: bottom loading	1986	Benzene	1	0.2	8.9	56	8h TWA
25	2.1.b	Europe	Distribution	Road Tanker driver: other measurements Delivery & driving	1987	Benzene	5.1	0	101.9	29	8h TWA

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m^3	Min mg/m^3	Max mg/m^3	No.	Sample Type
25	2.1.b	USA	Distribution	Road tanker drivers other measurements Loading delivery and driving	1985	Benzene	0.45	0	4.6	49	8h TWA
25	2.1.b	Canada	Distribution	Large storage facility loading delivery unloading return to storage	1992	Benzene	0.5	no data	-	38	8h TWA
25	2.1.b	Canada	Distribution	Large storage facility loading delivery unloading return to storage at agency facility	1992	Benzene	0.7	no data	-	21	8h TWA
25	2.1.b	Europe	Distribution	Rack operators and supervisors	1986-94	Benzene	1.9	0.16	60.5	40	8h TWA
25	2.1.b	Germany	Distribution	Rack operators and supervisors	1983-85	Benzene	1.13	0.17	7.11	50	8h TWA
25	2.1.b	Europe	Distribution	Rail car operator tope loading	1987	Benzene	1.5	0	9.5	32	8h TWA
25	2.1.b	Europe	Distribution	Rail car operator tope loading	1994	Benzene	5	0.2	133.1	183	8h TWA
25	2.1.b	Europe	Distribution	Marine Jetty staff	1987	Benzene	1.5	0	5.9	21	8h TWA
25	2.1.b	Europe	Distribution	Marine jetty staff	1994	Benzene	6.3	0.2	265.9	92	8h TWA
25	2.1.b	Europe	Distribution	Deck Crew Ships open loading	1987	Benzene	1.5	0.1	4.6	8	8h TWA
26	2.1.b	Europe	Distribution	Deck crew ships closed loading	1987	Benzene	4.6	0	21.9	9	8h TWA
26	2.1.b	Europe	Distribution	Deck crew barges closed loading	1986	Benzene	4.7	0	31.5	11	8h TWA
26	2.1.b	Europe	Distribution	Deck crew loading open/closed unknown	1994	Benzene	2.3	0.2	11.4	19	8h TWA
26	2.1.b	Germany	Distribution	Bridge crew barges closed loading	1994	Benzene	0.22	0.08	0.41	7	8h TWA
26	2.1.b	USA	Distribution	Marine loading other measurements	1986	Benzene	2.3	0.1	19.5	11	8h TWA
26	2.1.b	Europe	Distribution	Terminal operators off site operator	1987	Benzene	1	0	14.1	27	8h TWA
26	2.1.b	Canada	Distribution	Bulk terminal plant man sample collection, maintaining loading racks, general maintenance	1992	Benzene	0.4	NO DATA	-	23	8h TWA
26	2.1.b	UK	Distribution	8 hour exposure including ship-offloading sample collection, sample testing cleaning fuel filters	1990	Benzene	7.8	0.14	0.2	3	8h TWA
27	2.1.b	Europe	Service stations	Service station attendants	1987	Benzene	0.4	0	-	13	8h TWA
27	2.1.b	Europe	Service stations	Service station attendants	1986-94	Benzene	0.61	<0.2	1.3	82	8h TWA

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m^3	Min mg/m^3	Max mg/m^3	No.	Sample Type
27	2.1.b	Germany	Service stations	Service station attendants	1983-85	Benzene	0.52	0.01	10.7	351	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants	1992	Benzene	0.48	no data		639	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants Motorway	2996	Benzene	0.3	no data	-	108	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants extra urban	1996	Benzene	0.2	no data	-	36	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants urban	1996	Benzene	0.28	no data	-	36	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants All	1996	Benzene	0.25	no data	-	180	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1986	Benzene	1	0	4.2	21	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1985	Benzene	0.65	0.48	0.81	49	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1979	Benzene	0.32	<0.03	6.8	84	8h TWA
27	2.1.b	USA	Service stations	Service station mechanic	1986	Benzene	<0.2	-	-	24	8h TWA
28	2.1.b	France	Airports	Aircraft operator loading both Avgas (gasoline) and Jet A1 (kerosine)	-	Benzene	0.1	0.005	0.6	7	8h TWA
29	2.1.c	Europe	Refinery	Refinery Maintenance worker	1986-94	Benzene	44.08	0.15	202	15	30-265min
29	2.1.c	Europe	Refinery	Tank cleaners	1982	Benzene	no data	64	1680	10	4-8min
29	2.1.c	Europe	Distribution	Road tanker driver top loading	1987	Benzene	6.1	0	60.5	142	<1
29	2.1.c	Europe	Distribution	Road tanker driver bottom loading	1987	Benzene	1.4	0	5.5	59	<1
29	2.1.c	Europe	Distribution	Road tanker driver bottom loading	19994	Benzene	2.5	0.2	10.9	56	<1
29	2.1.c	USA	Distribution	Road tanker driver bottom loading	1979	Benzene	3.3	no data	-	-	18min
29	2.1.c	USA	Distribution	Road tanker driver bottom loading	1979	Benzene	1.9	no data	-	-	15min
29	2.1.c	Europe	Distribution	Road tanker driver other measurements Delivery only	1994	Benzene	no data	0.2	10.7	28	12-58min
30	2.1.c	Europe	Distribution	Road tanker driver other measurements Delivery and unloading	-	Benzene	0.26	0.06	0.7	7	81-271min
30	2.1.c	Europe	Distribution	Road tanker driver other measurements, Road tank compartment tipping	1995	Benzene	3.63	0.06	13.28	10	10-20 min
30	2.1.c	Europe	Distribution	Rail car operator top loading	1995	Benzene	5.1	no data	-	22	4 hours

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m^3	Min mg/m^3	Max mg/m^3	No.	Sample Type
30	2.1.c	Europe	Distribution	Rail car operator top loading	1996	Benzene	8	no data	-	17	5 hours
30	2.1.c	Germany	Distribution	Rail car operator top loading	1972	Benzene	2.53	0.03	40.4	102	loading duration
30	2.1.c	Europe	Distribution	Marine deck crew Ship loading open/closed unknown	1983-85	Benzene	2.8	0.2	11	6	15-70min
30	2.1.c	Germany	Distribution	Marine deck crew Ship open loading	1986-94	Benzene	15	0.5	63.6	22	2-5 hours
30	2.1.c	Germany	Distribution	Marine deck crew ship closed loading	1983-85	Benzene	1.72	0.27	2.91	8	2-5 hours
30	2.1.c	Germany	Distribution	Marine bridge crew Barges open and closed loading	1983-85	Benzene	1.67	0.07	10.06	44	2-5 hours
30	2.1.c	Europe	Distribution	Product storage tasks terminal operators Draining storage tank water bottoms	1995	Benzene	1.6	0.1	6.8	5	13-60min
30	2.1.c	Europe	Distribution	Product storage tasks filter cleaning	1995	Benzene	1	0.1	1.9	8	15-42min
31	2.1.c	Europe	Distribution	Terminal operators Fuel testing	1995	Benzene	1.3	3.4	1.8	2	26 min
31	2.1.c	Europe	Distribution	Terminal operators Fuel Sampling	1995	Benzene	1.37	0.54	2	4	9-29min
31	2.1.c	Europe	Distribution	Terminal operators sampling and testing	1995	Benzene	1.1	0.35	2.1	4	15-45min
31	2.1.c	Europe	Distribution	Terminal operators storage tank dipping	1995	Benzene	1.33	0.06	7.4	7	9-31min
23	2.1.b	Europe	Refinery	onsite operator	1987	Total hydrocarbons	52.8	0.7	1819	62	8h TWA
23	2.1.b	USA	Refinery	onsite operator	1985	Total hydrocarbons	18.9	0.1	191.6	56	8h TWA
23	2.1.b	Europe	Refinery	Off-site operator	1987	Total hydrocarbons	66	3.8	922.8	27	8h TWA
23	2.1.b	USA	Refinery	Laboratory Technician		Total hydrocarbons	22	2.33	51.46	19	8h TWA
24	2.1.b	Europe	Refinery	Drum/Barrel filler	1987	Total hydrocarbons	858.4	61.1	1748	9	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: top loading	1987	Total hydrocarbons	117.6	4.1	1229.4	63	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: top loading	1986	Total hydrocarbons	46.4	9.9	109	10	8h TWA
24	2.1.b	Europe	Distribution	Road Tanker driver: bottom loading	1987	Total hydrocarbons	65.6	0.5	728.63	34	8h TWA
24	2.1.b	USA	Distribution	Road Tanker driver: bottom loading	1986	Total hydrocarbons	89.8	21.9	184	7	8h TWA
24	2.1.b	USA	Distribution	Road Tanker driver: bottom loading	1986	Total hydrocarbons	39.6	9.4	195	8	8h TWA

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m^3	Min mg/m^3	Max mg/m^3	No.	Sample Type
25	2.1.b	Europe	Distribution	Road Tanker driver: other measurements Delivery & driving	1987	Total hydrocarbons	218.9	3.2	3615	29	8h TWA
25	2.1.b	USA	Distribution	Road tanker drivers other measurements Loading delivery and driving	1985	Total hydrocarbons	45.8	0.5	655.1	49	8h TWA
25	2.1.b	Canada	Distribution	Large storage facility loading delivery unloading return to storage	1992	Total hydrocarbons	37.9	no data	-	38	8h TWA
25	2.1.b	Canada	Distribution	Large storage facility loading delivery unloading return to storage at agency facility	1992	Total hydrocarbons	81.3	no data	-	21	8h TWA
25	2.1.b	Europe	Distribution	Rail car operator tope loading	1987	Total hydrocarbons	84.7	2	535.4	32	8h TWA
25	2.1.b	Europe	Distribution	Marine Jetty staff	1987	Total hydrocarbons	120.1	3.3	658.2	21	8h TWA
25	2.1.b	Europe	Distribution	Deck Crew Ships open loading	1987	Total hydrocarbons	118	2.4	322	8	8h TWA
26	2.1.b	Europe	Distribution	Deck crew ships closed loading	1987	Total hydrocarbons	339.7	2.4	1089	9	8h TWA
26	2.1.b	Europe	Distribution	Deck crew barges closed loading	1986	Total hydrocarbons	262.9	1.5	1750.4	11	8h TWA
26	2.1.b	USA	Distribution	Marine loading other measurements	1986	Total hydrocarbons	246	9.1	1580	11	8h TWA
26	2.1.b	Europe	Distribution	Terminal operators off site operator	1987	Total hydrocarbons	66	3.8	922.8	27	8h TWA
26	2.1.b	Canada	Distribution	Bulk terminal plant man sample collection, maintaining loading racks, general maintenance	1992	Total hydrocarbons	20.1	no data	-	23	8h TWA
26	2.1.b	UK	Distribution	8 hour exposure including ship-offloading sample collection, sample testing cleaning fuel filters	1990	Total hydrocarbons	18.3	15	22	3	8h TWA
27	2.1.b	Europe	Service stations	Service station attendants	1987	Total hydrocarbons	29.3	7.9	101	13	8h TWA
27	2.1.b	Italy	Service stations	Service station attendants All	1996	Total hydrocarbons	21.13	no data	-	-	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1986	Total hydrocarbons	17.9	1.1	130.3	180	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1985	Total hydrocarbons	70	53	86.8	21	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1979	Total hydrocarbons	28.8	1.3	343	49	8h TWA
27	2.1.b	USA	Service stations	Service station attendants	1986	Total hydrocarbons	no data	1.9	14.3	84	8h TWA

Page	Table	Region	Type of Work	Job Group	Ref Date	Analyte	AM mg/m^3	Min mg/m^3	Max mg/m^3	No.	Sample Type
27	2.1.b	Europe	Service stations	Cashiers	1994	Total hydrocarbons		-	-	8	8h TWA
27	2.1.b	USA	Service stations	Service station mechanic	1986	Total hydrocarbons	no data	1.1	22.3	4	8h TWA
28	2.1.b	Germany	Airports	Airport Aircraft operators light aircraft loading with aviation gasoline	1988	Total hydrocarbons	15.1	9.62	20.56	2	8h TWA
28	2.1.b	France	Airports	Aircraft operator loading both Avgas (gasoline) and Jet A1 (kerosine)		Total hydrocarbons	5.73	0.05	31	7	8h TWA
29	2.1.c	Europe	Distribution	Road tanker driver top loading	1987	Total hydrocarbons	450.8	6.4	3029.8	142	<1
29	2.1.c	Canada	Distribution	Road tanker driver top loading	1992	Total hydrocarbons	169.8	no data	-	-	10-20min
29	2.1.c	Canada	Distribution	Road tanker driver top loading	1992	Total hydrocarbons	277	no data	-	-	10-20min
29	2.1.c	Canada	Distribution	Road tanker driver bottom loading	1992	Total hydrocarbons	80.3	-	-	31	10-20min
31	2.1.c	USA	Service stations	Attendant vehicle tank refuelling	1986	Total hydrocarbons	no data	3.9	63.5	12	10 min
31	2.1.c	USA	Service stations	Attendant vehicle tank refuelling plus vehicle service	1986	Total hydrocarbons	no data	0	116.3	14	10 min
31	2.1.c	Germany	Airports	Airport operator	1988	Total hydrocarbons	190	4.42	682	5	2.5-19.5 min

d) Concawe Report 4/87 [7]: a survey of exposure to gasoline vapour

This document reports 540 personal gasoline exposure measurements from 13 European countries for workers involved in the manufacture and distribution of gasoline, with 15 job categories included. The report describes jobs and presents 8hr TWA exposures for various individual constituents and total hydrocarbons. The benzene concentration of the gasoline is not given; the data were entered into the template for naphtha (for 0-1% benzene content) to allow them to be linked to a (possible) ES description.

The Concawe survey report indicates that RMMs such as vapour recovery systems or remote venting systems were not present for any of the sampled (8 hr TWA) operations involving road tankers, railcars, open-loading of ships drum filling or service station tasks. Information on tasks with highest exposure potential is given for the different job groups. It should be noted that data were collected over the period 1984-1985, therefore they may not be fully representative of more recent work practices and the associated exposures.

The data presented include the Geometric Mean (GM), Geometric Standard Deviation (GSD), Arithmetic Mean (AM) and Standard Deviation (SD). The GM and GSD for total hydrocarbons have been given in the templates.

A summary of the templates/ ES used for the exposure data for the various job groups is given below.

Table S1.6 Summary of data from Concawe Report 4/ 87: gasoline vapour

Job group
Job group 1 – road top <1hr N
JG2 – road bottom <1hr
JG4 – road top >1hr
JG5 – road bottom <1hr
JG8 – ships closed
JG9 – ships open
JG10 – barges closed
JG11 – jettyman
JG12 - railcar top
JG14 – production – onsite -
JG15 – production – offsite

e) Concawe Report 9/02 [10]: A survey of European gasoline exposures for the period 1999-2001

This report summarises measured occupational exposures to gasoline vapour in EU countries over the period 1999-2001. The tasks/operations chosen for the survey were selected on the basis of past high exposures; implementation of new vapour recovery measures or paucity of information. The majority of the surveyed operations related to gasoline with a maximum benzene concentration of <1% v/v. Both full-shift and peak exposures were measured, with summaries of the relevant job groups, numbers of samples and exposure type given in Table S1.7 below.

Table S1.7 Summary of full shift and peak exposure measurement data from Concawe Report 9/02: gasoline

Job group	Number of samples (full-shift)	Number of samples (peak exposure)
On-site refinery operator	0	6
Off-site refinery operator	6	7
Laboratory technician testing gasoline for production	0	2
Laboratory technician blending test gasoline for research	7	0
Laboratory technician octane rating for production	0	4
Laboratory technician octane rating for research	3	0
Road tanker driver	33	0
Road tanker driver- lading at terminal	0	15
Road tanker driver- delivery to service station	0	7
Gantry man	3	0
Drum filler	2	10
Railcar top loading without vapour recovery	16	0
Railcar top loading with vapour recovery	21	3
Other railcar loading workers	5	0
Marine deck crew	0	6
Jetty staff	4	6
Miscellaneous ship personnel	0	4
Service station attendants- no vapour recovery	26	0
Service station attendant- with vapour recovery	7	0
Service station shop personnel	13	0
Miscellaneous service station personnel	6	1

f) Concawe Report 5/09 [11]: Additional human exposure information for gasoline substance risk assessment (period 2002-2007)

This report summarises updated exposure information for a number of activities which had previously been evaluated for earlier substance risk assessments, and which had been shown to require additional or more focussed measurement surveys.

These tasks/activities are summarised below, together with information on RMMs stated in the report.

Table S1.8 Summary of data from Concawe Report 5/09: gasoline

Job type	Description of task/ activity	RMM information
Refinery maintenance	Disconnection of pumps and opening in workshops	Standard RMMs including remotely controlled drainage of pumps and connecting piping prior to disconnection and opening; forced ventilation for tank cleaning. General ventilation, permit to work system
Laboratory workers	Refinery based and R&D production laboratory activities: e.g. test fuel blending, quality control tasks, bottle washing	Closed system/ breakaway couplings for sampling, LEV, general ventilation and good laboratory practice (from Appendix 1.2)
Rail car operations	Loading/ transfers, handling of loading arms	Vapour recovery systems
Gasoline pump maintenance	Outdoor repairs at service station Indoor repairs in a workshop	No detailed information given on RMMs- possible use of LEV for indoor repair task
Gasoline pump calibration	Calibration of pumps for fiscal purposes	No information given on outdoor RMMs
Use of gasoline powered gardening equipment	Garden and lawn maintenance tasks: hedge cutters/ trimmers/ mowers	No information given on RMMs
Aircraft refuelling with aviaiton gasoline	Refuelling operations with a tanker (sampled during kerosine jet fuel refuelling)	No information given on RMMs

g) Concawe Report 1/15 [12]: Risk assessment for emissions from hot heavy fuel oil during barge loading

In this report exposure to HFO aerosol and vapour has been evaluated during barge loading. Results are summarised in Table S1.0 and Table S1.10.

Table S1.0 Total hydrocarbon exposures (8-hr TWA) for on-board workers*†

Site Code	Background conc. (mg/m^3)		8-hr TWA sample conc. (mg/m^3)		
	Aerosol conc.	Vapour conc.	Aerosol conc.	Vapour conc.	Total conc.
Red	<LOQ	<LOQ	0.01	0.60	0.61
Blue	0.009	0.037	0.00	7.34	7.34
Yellow	<LOQ	<LOQ	<LOQ	0.08	0.08
Pink	0.015	0.056	0.01	7.26	7.26
Green	<LOQ	0.109	<LOQ	2.60	2.60

* background measurements have been subtracted from the monitoring results

† values calculated as 8-hour time weighted averages

Table S1.10 Total hydrocarbon exposures (8-hr TWA) for onshore workers*†

Site Code	Background conc. (mg/m^3)		8-hr TWA sample conc. (mg/m^3)		
	Aerosol conc.	Vapour conc.	Aerosol conc.	Vapour conc.	Total conc.
Red	<LOQ	<LOQ	<LOQ	0.20	0.20
Blue	0.009	0.037	0.00	0.11	0.11
Yellow	<LOQ	<LOQ	<LOQ	0.04	0.04
Pink	0.015	0.056	<LOQ	0.01	0.01
Green	<LOQ	0.109	<LOQ	0.05	0.05

* background measurements have been subtracted from the monitoring results
† values calculated as 8-hour time weighted averages

iii) IOM Heavy fuel oil data

Data describing dermal exposures to heavy fuel oil were collected from IOM reports Research Report TM/07/05 and Research Report TM/08/05 [29, 30]. Field surveys had been carried out at one refinery, two fuel terminals, one power plant and a marine engineering company. A number of cleaning and maintenance tasks were assessed, together with laboratory based activities. Good contextual information on the activities and workplaces is presented. The AM, GM and median values are given for each task, with body part sampled indicated as well.

A brief summary of the numbers of measurements is shown overleaf.

These IOM data comprise the only dermal data that could be collected for the purposes of the validation exercise. Although of limited scope in terms of activities and substance type, they are of good quality with detailed contextual descriptions included.

It should be noted, however, that although the above IOM heavy fuel oil data are of appropriate quality and readily available, their use in the current CSA for the substance precludes their inclusion in the validation process.

Table S1.11 Summary of IOM dermal exposure data: heavy fuel oil

HFO Oil Refinery/ Power station	Number of measurements
Cleaning IOM TM/07/05	3
Cleaning IOM TM/07/05	3
Maintenance IOM TM/07/05	7
Maintenance IOM TM/07/05	7
Cleaning OilRefin IOM TM/08/05	10
Cleaning OilRefin IOM TM/08/05	10
Lab Analysis IOM TM/08/05	2
Lab Analysis IOM TM/08/05	2
Sampling IOM TM/08/05	3
Sampling IOM TM/08/05	3
Filter Changing IOM TM/08/05	2
Marine Engineering Company	
Cleaning IOM TM/08/05	1
Cleaning Work area/machines filter cleaning IOM TM/08/05	1
Maintenance: cleaning nozzles IOM TM/08/05	1
Maintenance: dismantling pumps IOM/08/05	1
Preparing for uncoupling IOM TM/08/05	1
Sampling IOM TM /08/05	1
Cleaning Work area/machines filter cleaning IOM TM/08/05	2
Cleaning Work area/machines filter cleaning IOM TM/08/05	2

iv) Benzene and total hydrocarbon exposure during vehicle maintenance and breaking - Auffarth J, Hebisch R, Johnen A (2002) BAuA report: Stoffbelastungen beim Kraftfahrzeugrecycling [13]

This report contains data for benzene and total hydrocarbons (including benzene exposures during motor vehicle recycling (fuel tank draining and vehicle disassembly/ breaking). The measurements are a combination of shift length and short term samples. Information is provided on the room sizes and room ventilation arrangements. The measurements were taken before and after 1 January 2000, when the concentration of benzene in gasoline was reduced from a maximum of 5%[1] to a maximum of 1%.

The relevant liquids concerning exposure were gasoline, i.e. naphtha with a certain benzene fraction or Diesel, oils, shock absorber oil, brake fluid, cryogenic agent (air conditioning) and window cleaning liquid.

No other solvents were mentioned to be used during the recycling process.

The relevant processes during the recycling process are as follows:

- receiving of vehicles
- draining (removal of gasoline and other liquids)
- storage
- disassembling

[1] Maximum concentration in reality mostly 3% benzene (J. Urbanus, personal communication; April 2015).

Table S1.12 Summary of BAuA vehicle recycling industry gasoline exposure data: tank draining

Site	Personal/ static	Analyte	Conc./ mg m^{-3}	Measurement type	Time period
A	Personal	Benzene	0.3	Shift average	Until 1999
A	Personal	Benzene	1.5	Shift average	Until 1999
C	Personal	Benzene	0.87	Shift average	Until 1999
C	Personal	Benzene	1.7	Shift average	Until 1999
C	Personal	Benzene	0.59	Shift average	Until 1999
C	personal	Benzene	0.52	Shift average	Until 1999
C	personal	Benzene	2.24	Shift average	Until 1999
C	personal	Benzene	0.63	Shift average	Until 1999
C	personal	Benzene	0.09	Shift average	Until 1999
C	personal	Benzene	0.12	Shift average	Until 1999
C	personal	Benzene	0.13	Shift average	Until 1999
C	personal	Benzene	0.19	Shift average	Until 1999
C	personal	Benzene	0.15	Shift average	Until 1999
D	personal	Benzene	0.42	Shift average	Until 1999
D	personal	Benzene	1.28	Shift average	Until 1999
D	personal	Benzene	0.78	Shift average	Until 1999
D	personal	Benzene	1.48	Shift average	Until 1999
D	personal	Benzene	0.77	Shift average	Until 1999
D	personal	Benzene	0.41	Short term	Until 1999
D	personal	Benzene	0.19	Short term	Until 1999
D	personal	Benzene	0.28	Short term	Until 1999
E	personal	Benzene	0.32	Short term	Until 1999
E	personal	Benzene	0.7	Short term	Until 1999
F	personal	Benzene	0.07	Shift average	After 2000
F	personal	Benzene	0.16	Shift average	After 2000
F	personal	Benzene	0.19	Shift average	After 2000
G	personal	Benzene	0.03	Shift average	After 2000
G	personal	Benzene	0.26	Shift average	After 2000
G	personal	Benzene	0.1	Shift average	After 2000
G	personal	Benzene	0.02	Shift average	After 2000
G	personal	Benzene	0.13	Shift average	After 2000
G	personal	Benzene	0.67	Shift average	After 2000
I	personal	Benzene	0.45	Shift average	After 2000
I	personal	Benzene	0.18	Shift average	After 2000
L	personal	Benzene	0.3	Shift average	After 2000
L	personal	Benzene	0.79	Shift average	After 2000
M	personal	Benzene	0.44	Shift average	After 2000
M	personal	Benzene	1.12	Shift average	After 2000
M	personal	Benzene	0.48	Shift average	After 2000
F	personal	Benzene	2.01	Short term	After 2000
J	personal	Benzene	0.28	Short term	After 2000
K	personal	Benzene	0.22	Short term	After 2000
L	personal	Benzene	·. 0.25	Short term	After 2000
L	personal	Benzene	0.22	Short term	After 2000
L	personal	Benzene	0.32	Short term	After 2000

Site	Personal/ static	Analyte	Conc./ mg m^{-3}	Measurement type	Time period
L	personal	Benzene	0.26	Short term	After 2000
L	personal	Benzene	0.18	Short term	After 2000
L	personal	Benzene	0.17	Short term	After 2000
M	personal	Benzene	0.09	Short term	After 2000
M	personal	Benzene	0.23	Short term	After 2000
A	personal	Hydrocarbons	22.3	Shift average	Until 1999
A	personal	Hydrocarbons	57.3	Shift average	Until 1999
C	personal	Hydrocarbons	38.4	Shift average	Until 1999
C	personal	Hydrocarbons	76.8	Shift average	Until 1999
C	personal	Hydrocarbons	11.4	Shift average	Until 1999
C	personal	Hydrocarbons	14.9	Shift average	Until 1999
C	personal	Hydrocarbons	177	Shift average	Until 1999
C	personal	Hydrocarbons	31.2	Shift average	Until 1999
C	personal	Hydrocarbons	0.09	Shift average	Until 1999
C	personal	Hydrocarbons	0.2	Shift average	Until 1999
C	personal	Hydrocarbons	1.43	Shift average	Until 1999
C	personal	Hydrocarbons	0.2	Shift average	Until 1999
C	personal	Hydrocarbons	0.2	Shift average	Until 1999
C	personal	Hydrocarbons	0.1	Shift average	Until 1999
D	personal	Hydrocarbons	8.05	Shift average	Until 1999
D	personal	Hydrocarbons	40.8	Shift average	Until 1999
D	personal	Hydrocarbons	.20.2	Shift average	Until 1999
D	personal	Hydrocarbons	39.6	Shift average	Until 1999
D	personal	Hydrocarbons	32.9	Shift average	Until 1999
F	personal	benzene and other components of gasoline	6.01	Shift average	After 1999
F	personal	benzene and other components of gasoline	9.58	Shift average	After 1999
F	personal	benzene and other components of gasoline	12.2	Shift average	After 1999
G	personal	benzene and other components of gasoline	2.8	Shift average	After 1999
G	personal	benzene and other components of gasoline	0.44	Shift average	After 1999
G	personal	benzene and other components of gasoline	24.3	Shift average	After 1999
G	personal	benzene and other components of gasoline	8.19	Shift average	After 1999
G	personal	benzene and other components of gasoline	1.69	Shift average	After 1999
G	personal	benzene and other components of gasoline	13.8	Shift average	After 1999
G	personal	benzene and other components of gasoline	29.3	Shift average	After 1999
H	personal	benzene and other components of gasoline	0.88	Shift average	After 1999
I	personal	benzene and other components of gasoline	28.9	Shift average	After 1999
I	personal	benzene and other components of gasoline	5.8	Shift average	After 1999

Site	Personal/ static	Analyte	Conc./ mg m^{-3}	Measurement type	Time period
I	personal	benzene and other components of gasoline	15.6	Shift average	After 1999
I	personal	benzene and other components of gasoline	6.64	Shift average	After 1999
L	personal	benzene and other components of gasoline	18.9	Shift average	After 1999
L	personal	benzene and other components of gasoline	46.4	Shift average	After 1999
L	personal	benzene and other components of gasoline	16	Shift average	After 1999
L	personal	benzene and other components of gasoline	30.7	Shift average	After 1999
M	personal	benzene and other components of gasoline	24.6	Shift average	After 1999
M	personal	benzene and other components of gasoline	67.1	Shift average	After 1999
M	personal	benzene and other components of gasoline	28.3	Shift average	After 1999
D	personal	hydrocarbons from gasoline	4.31	Short term	Until 1999
D	personal	hydrocarbons from gasoline	0.8	Short term	Until 1999
D	personal	hydrocarbons from gasoline	3.87	Short term	Until 1999
D	personal	hydrocarbons from gasoline	4.16	Short term	Until 1999
E	personal	hydrocarbons from gasoline	17.7	Short term	Until 1999
E	personal	hydrocarbons from gasoline	43.9	Short term	Until 1999
F	personal	gasoline including benzene	60.3	Shift average	After 1999
J	personal	gasoline including benzene	24.4	Shift average	After 1999
K	personal	gasoline including benzene	9.67	Shift average	After 1999
K	personal	gasoline including benzene	9.76	Shift average	After 1999
K	personal	gasoline including benzene	0.89	Shift average	After 1999
L	personal	gasoline including benzene	11.2	Shift average	After 1999
L	personal	gasoline including benzene	10.4	Shift average	After 1999
L	personal	gasoline including benzene	18.2	Shift average	After 1999
L	personal	gasoline including benzene	7.76	Shift average	After 1999
L	personal	gasoline including benzene	10.9	Shift average	After 1999
L	personal	gasoline including benzene	2.2	Shift average	After 1999
L	personal	gasoline including benzene	8.28	Shift average	After 1999
M	personal	gasoline including benzene	13.9	Shift average	After 1999
M	personal	gasoline including benzene	1.38	Shift average	After 1999
M	personal	gasoline including benzene	15.6	Shift average	After 1999

Table S1.13 Summary of BAuA vehicle recycling industry gasoline exposure data: disassembling of vehicles

Site	Personal/ static	Analyte	Conc./ mg m^{-3}	Measurement type	Time period
A	personal	Benzene	0.27	Shift average	Until 1999
A	personal	Benzene	0.22	Shift average	Until 1999
D	personal	Benzene	0.74	Shift average	Until 1999
D	personal	Benzene	0.66	Shift average	Until 1999
D	personal	Benzene	0.68	Shift average	Until 1999
D	personal	Benzene	0.52	Shift average	Until 1999
D	personal	Benzene	0.56	Shift average	Until 1999
F	personal	Benzene	0.1	Shift average	After 1999
F	personal	Benzene	0.04	Shift average	After 1999
F	personal	Benzene	0.32	Shift average	After 1999
F	personal	Benzene	0.08	Shift average	After 1999
F	personal	Benzene	0.09	Shift average	After 1999
F	personal	Benzene	0.08	Shift average	After 1999
G	personal	Benzene	0.02	Shift average	After 1999
G	personal	Benzene	0.01	Shift average	After 1999
G	personal	Benzene	0.07	Shift average	After 1999
G	personal	Benzene	0.05	Shift average	After 1999
G	personal	Benzene	0.05	Shift average	After 1999
G	personal	benzene	0.01	Shift average	After 1999
M	personal	benzene	0.02	Shift average	After 1999
M	personal	benzene	0.04	Shift average	After 1999
M	personal	benzene	0.02	Shift average	After 1999
M	personal	benzene	0.05	Shift average	After 1999
M	personal	benzene	0.03	Shift average	After 1999
A	personal	gasoline hydrocarbons	11.9	Shift average	Until 1999
A	personal	gasoline hydrocarbons	10.7	Shift average	Until 1999
D	personal	gasoline hydrocarbons	16.6	Shift average	Until 1999
D	personal	gasoline hydrocarbons	35.2	Shift average	Until 1999
D	personal	gasoline hydrocarbons	32.8	Shift average	Until 1999
D	personal	gasoline hydrocarbons	17.9	Shift average	Until 1999
D	personal	gasoline hydrocarbons	14.9	Shift average	Until 1999
F	personal	gasoline hydrocarbons	5.23	Shift average	After 1999
F	personal	gasoline hydrocarbons	2.55	Shift average	After 1999
F	personal	gasoline hydrocarbons	10.2	Shift average	After 1999
F	personal	gasoline hydrocarbons	2.79	Shift average	After 1999
F	personal	gasoline hydrocarbons	2.3	Shift average	After 1999
F	personal	gasoline hydrocarbons	3.74	Shift average	After 1999
G	personal	gasoline hydrocarbons	0.92	Shift average	After 1999
G	personal	gasoline hydrocarbons	0.72	Shift average	After 1999
G	personal	gasoline hydrocarbons	0.78	Shift average	After 1999
G	personal	gasoline hydrocarbons	5.36	Shift average	After 1999
G	personal	gasoline hydrocarbons	2.92	Shift average	After 1999
G ·	personal	gasoline hydrocarbons	4.52	Shift average	After 1999
G	personal	gasoline hydrocarbons	0.72	Shift average	After 1999

Site	Personal/ static	Analyte	Conc./ mg m^{-3}	Measurement type	Time period
M	personal	gasoline hydrocarbons	0.79	Shift average	After 1999
M	personal	gasoline hydrocarbons	4.87	Shift average	After 1999
M	personal	gasoline hydrocarbons	4.88	Shift average	After 1999
M	personal	gasoline hydrocarbons	4.91	Shift average	After 1999
M	personal	gasoline hydrocarbons	1.99	Shift average	After 1999
M	personal	gasoline inclusive benzene	7.2	Short term	After 1999
M	personal	gasoline inclusive benzene	3.38	Short term	After 1999

v) Literature search

a) Gasoline exposures

A number of papers were identified covering exposures to gasoline in filling stations, both for station attendants and for tanker drivers. These are summarised below.

- Saarinen L, Hakkola M, Kangas J (2000): Comparison of tanker drivers' occupational exposures before and after the installation of a vapour recovery system. J. Environ. Monit. 2000, 2, 662-665 [14]

The paper contains the following personal measurements for tanker drivers, taken prior to and after installation of vapour recovery equipment, thus provides a useful indicator of the efficiency of the recovery system.

Table S1.14 Summary of tanker driver benzene exposure data (Finland)

Analyte/ units	units	GM	Min	Max	Time
C3-C11 hydrocarbons	mg m^{-3}	65	6.2	645	before installation
MTBE	mg m^{-3}	8.6	1.1	67	before installation
Benzene	mg m^{-3}	0.41	<0.1	2.1	before installation
C3-C11 hydrocarbons	mg m^{-3}	8.3	<1.0	79	after installation
MTBE	mg m^{-3}	1.5	<0.1	10	after installation
Benzene	mg m^{-3}	0.13	<0.1	0.3	after installation

- Periago J, Prado C (2005) Evolution of Occupational Exposure to Environmental levels of Aromatic Hydrocarbons in Service Stations Ann. Occup. Hyg., Vol 49, No. 3, pp. 233- 240 [15]

This paper details the changes in occupational exposures of filling station attendants to gasoline vapours over time from 1995 until 2003. Time weighted average exposures (8 hr) are presented for benzene, toluene and xylenes.

The 2003 values relate to exposures where the maximum benzene concentration in the gasoline was 1% v/v and following installation of vapour recovery systems to reduce emissions during tanker deliveries.

Table S1.15 Summary of filling station attendant gasoline component exposure data

Period	No. of samples	Analyte	mean (µg m^{-3})	SD	GM (µg m^{-3})	GSD	Median (µg m^{-3})	Range (µg m^{-3})
1995	21	benzene	736	346	667	1.6	701	272-1603
1995	21	toluene	1168	475	1091	1.4	1100	597-2324
1995	21	xylenes	531	209	497	1.4	480	26-5119
2000	28	benzene	241	87	226	1.4	240	114-452
2000	28	toluene	580	269	519	1.6	558	194-1141
2000	28	xylenes	216	110	190	1.7	168	91-411
2003	19	benzene	163	132	124	2.1	106	35-564
2003	19	toluene	753	551	601	2.0	607	172-2142
2003	19	xylenes	316	84	280	1.6	259	125-871

b) Non-gasoline exposure data

One paper of interest and applicability relating to exposures to metal working fluids was identified, as detailed below.

- Simpson AT, Stear M, Groves JA, Piney M, Bradley SD, Stagg S and Crook B (2003) Occupational exposure to metal working fluid mist and sump fluid contaminants Ann. Occup. Hyg Vol 47. No.1, pp 17-30.

Table S1.16 Summary of exposure to metal working fluids

Period	No. of samples	Analyte	Minimum (mg m^{-3})	Maximum (mg m^{-3})	Median (mg m^{-3})	Mean (mg m^{-3})	GM	GSD
2003	45	Mineral oil total inhalable particulate	0.06	4.38	0.55	1.11	0.61	3.26

Additional literature relating to use of non-gasoline/kerosine petroleum substances was identified and evaluated, including reports associated to the use, measurement and assessment of exposure to metal-working fluids and other complex hydrocarbon-containing mixtures, such as dielectrics, release agents and lubricants. The descriptive information within these reports is limited in relation to the required model parameters, in particular in relation to the specific control measures used; however there is a substantial amount of data. In addition, the sampling methods used were variable preventing straightforward comparisons between data sources and with the estimates. A number of assumptions about activities would therefore be required, and it is felt that this precludes the use of such data in the exercise.

ONLINE SUPPLEMENT 1B: MEASURED DATASETS AND ASSIGNED SCENARIOS

KEROSINE

Table S1.17 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and comparison results for kerosine

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_1	52.35	Concawe Report 6/07		Maintenance during turn around	Total hydrocarbons	28.00	aggregate	AM	11	0.535	1
ES_K_27	155.75	NIOSH	Ramp Mechanic 1 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is ramp mechanic.	Naphtha	2.10	individual		1	0.013	0
ES_K_27	155.75	NIOSH	Ramp Mechanic 1 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is ramp mechanic.	Naphtha	1.10	individual		1	0.007	0
ES_K_27	155.75	NIOSH	Ramp Mechanic 2 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is ramp mechanic.	Naphtha	1.00	individual		1	0.006	0
ES_K_27	155.75	NIOSH	Ramp Mechanic 2 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is ramp mechanic.	Naphtha	0.70	individual		1	0.004	0
ES_K_27	155.75	NIOSH	Refueller 1 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	7.70	individual		1	0.049	0
ES_K_27	155.75	NIOSH	Refueller 1 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	3.80	individual		1	0.024	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	NIOSH	Refueller 2 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	4.80	individual		1	0.031	0
ES_K_27	155.75	NIOSH	Refueller 2 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	3.60	individual		1	0.023	0
ES_K_27	155.75	NIOSH	Refueller 3 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.00	individual		1	0.006	0
ES_K_27	155.75	NIOSH	Refueller 3 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.40	individual		1	0.009	0
ES_K_27	155.75	NIOSH	Refueller 4 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	0.40	individual		1	0.003	0
ES_K_27	155.75	NIOSH	Refueller 4 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	0.90	individual		1	0.006	0
ES_K_27	155.75	NIOSH	Refueller 5 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	0.60	individual		1	0.004	0
ES_K_27	155.75	NIOSH	Refueller 5 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.30	individual		1	0.008	0
ES_K_27	155.75	NIOSH	Refueller 6 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.40	individual		1	0.009	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	NIOSH	Refueller 6 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	2.30	individual		1	0.015	0
ES_K_27	155.75	NIOSH	Refueller 7 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.20	individual		1	0.008	0
ES_K_27	155.75	NIOSH	Refueller 7 - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	1.60	individual		1	0.010	0
ES_K_27	155.75	NIOSH	Refueller 8 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	2.60	individual		1	0.017	0
ES_K_27	155.75	NIOSH	Refueller 8 - Term A	Exposure to VOCs during refuelling of aircraft- this scenario is refueller	Naphtha	2.00	individual		1	0.013	0
ES_K_27	155.75	NIOSH	Shop Mechanic 1 - Pump rm	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic pump room.	Naphtha	7.40	individual		1	0.048	0
ES_K_27	155.75	NIOSH	Shop Mechanic 1 - Pump rm	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic pump room.	Naphtha	3.00	individual		1	0.019	0
ES_K_27	155.75	NIOSH	Shop Mechanic 2 - Maintenance bay	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic maintenance bay.	Naphtha	5.40	individual		1	0.035	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	NIOSH	Shop Mechanic 2 - Maintenance bay	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic maintenance bay.	Naphtha	5.50	individual		1	0.035	0
ES_K_27	155.75	NIOSH	Shop Mechanic 3 - Maintenance bay	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic maintenance bay.	Naphtha	5.70	individual		1	0.037	0
ES_K_27	155.75	NIOSH	Shop Mechanic 3 - Maintenance bay	Exposure to VOCs during refuelling of aircraft- this scenario is shop mechanic maintenance bay.	Naphtha	7.70	individual		1	0.049	0
ES_K_27	155.75	NIOSH	Utility sumper - Term C	Exposure to VOCs during refuelling of aircraft- this scenario is utility sumper	Naphtha	5.90	individual		1	0.038	0
ES_K_27	155.75	Concawe Report 6/07	Tanker filter maintenance aircraft refueling	Tanker filter maintenance refuelling	Nonane	4.90	individual		1	0.031	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.07	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.09	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.07	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operation (single plane)	kerosine as n-nonane equivalent	0.00	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operation (single plane)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operation (single plane)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operation (single plane)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operation (single plane)	kerosine as n-nonane equivalent	0.00	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: hydrant operations	kerosine as n-nonane equivalent	1.00	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 6 planes by tanker - fill and drain one tank	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 10 planes by tanker - fill and drain one tank	kerosine as n-nonane equivalent	0.00	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 1 plane by tanker; 11 planes by hydrant - fill up tanker	kerosine as n-nonane equivalent	0.00	individual		1	0.000	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 11 planes by tanker; 2 planes by hydrant	kerosine as n-nonane equivalent	0.00	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 3 planes by tanker; 2 tanks drained and filled	kerosine as n-nonane equivalent	0.00	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 8 planes by tanker; 1 plane by hydrant	kerosine as n-nonane equivalent	0.14	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 18 planes by tanker	kerosine as n-nonane equivalent	0.20	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 17 planes by tanker; drain and fill one tank; assists with filter change	kerosine as n-nonane equivalent	0.27	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 16 planes by tanker; refill 3 tanks	kerosine as n-nonane equivalent	0.30	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 4 planes by tanker; 1 tank drained and filled	kerosine as n-nonane equivalent	1.00	individual		1	0.006	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 2 planes by hydrant; unspecified number of planes by tanker; 4 tanks drained and filled	kerosine as n-nonane equivalent	0.19	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 18 planes by tanker; 4 tanks drained and filled	kerosine as n-nonane equivalent	0.16	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 16 planes by tanker; 1 tank drained and filled; checked drain sumps	kerosine as n-nonane equivalent	0.65	individual		1	0.004	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff: 20 planes by tanker; 2 tanks drained and filled; tanker refuelled	kerosine as n-nonane equivalent	0.21	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling F50 by tanker	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling A320 by hydrant	kerosine as n-nonane equivalent	0.40	individual		1	0.003	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling metro 3 by tanker over wing	kerosine as n-nonane equivalent	0.31	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Loading 2 tankers	kerosine as n-nonane equivalent	1.60	individual		1	0.010	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling ATR and CRJ by tanker	kerosine as n-nonane equivalent	0.05	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling CRJ by tanker	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling A319 by hydrant	kerosine as n-nonane equivalent	3.40	individual		1	0.022	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling B737 by hydrant	kerosine as n-nonane equivalent	0.08	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling B737 by hydrant	kerosine as n-nonane equivalent	0.58	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling B737 by hydrant	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Tanker filling and vehicle refuelling	kerosine as n-nonane equivalent	1.70	individual		1	0.011	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Refuelling DH3-tanker-long wait for plane	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling A320 by tanker	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 2 planes by tanker; discharging bridger tanker	kerosine as n-nonane equivalent	3.50	individual		1	0.022	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 6 planes by tanker	kerosine as n-nonane equivalent	3.10	individual		1	0.020	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 4 planes by tanker	kerosine as n-nonane equivalent	3.40	individual		1	0.022	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 2 planes by tanker	kerosine as n-nonane equivalent	1.50	individual		1	0.010	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 2 planes by tanker	kerosine as n-nonane equivalent	1.00	individual		1	0.006	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 5 planes by tanker	kerosine as n-nonane equivalent	0.69	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 6 planes by tanker	kerosine as n-nonane equivalent	1.50	individual		1	0.010	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 13 planes and 2 helicopters by tanker	kerosine as n-nonane equivalent	1.80	individual		1	0.012	0
ES_K_27	155.75	Concawe Report 6/07		Bridger tanker driver - unloading into airport fuel tanks	kerosine as n-nonane equivalent	0.30	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling staff: changing fuel filters on tanker, filling tanker, taking and testing sample	kerosine as n-nonane equivalent	4.90	individual		1	0.031	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Refuelling 3 planes by tanker	kerosine as n-nonane equivalent	2.20	individual		1	0.014	0
ES_K_27	155.75	Concawe Report 6/07		Bridger tanker driver - unloading into airport fuel tanks	kerosine as n-nonane equivalent	2.30	individual		1	0.015	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 13 planes by tanker	kerosine as n-nonane equivalent	2.00	individual		1	0.013	0
ES_K_27	155.75	Concawe Report 6/07		Bridger tanker driver - unloading into airport fuel tanks	kerosine as n-nonane equivalent	0.56	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 2 planes by tanker; uplifting and transferring fuel between tanks	kerosine as n-nonane equivalent	5.60	individual		1	0.036	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling 6 planes by tanker	kerosine as n-nonane equivalent	1.70	individual		1	0.011	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 10 deliv. Kerosine (15 m3 total), 3 deliv. gas oil (15 m3 total)	kerosine as n-nonane equivalent	3.40	individual		1	0.022	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 12 deliv. Kerosine (16 m3 total), 1 deliv. gas oil (1.3 m3)	kerosine as n-nonane equivalent	15.20	individual		1	0.098	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 9 deliv. Kerosine (15 m3 total), 3 deliv. gas oil (10 m3 total)	kerosine as n-nonane equivalent	14.20	individual		1	0.091	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 9 deliv. Kerosine (11 m3 total), 2 deliv. gas oil (6 m3 total)	kerosine as n-nonane equivalent	33.10	individual		1	0.213	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Depot supervisor	kerosine as n-nonane equivalent	1.10	individual		1	0.007	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 16 deliv. Kerosine (14 m3 total), 2 deliv. gas oil (3 m3 total)	kerosine as n-nonane equivalent	41.00	individual		1	0.263	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 4 deliv. Kerosine (7 m3 total), 2 deliv. gas oil (2 m3 total) - small spillage	kerosine as n-nonane equivalent	5.40	individual		1	0.035	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 9 deliv. Kerosine (10 m3 total), 4 deliv. gas oil (6 m3 total)	kerosine as n-nonane equivalent	5.20	individual		1	0.033	0
ES_K_27	155.75	Concawe Report 6/07		Depot supervisor	kerosine as n-nonane equivalent	0.68	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 5 deliv. Kerosine (5 m3 total), 4 deliv. gas oil (12 m3 total)	kerosine as n-nonane equivalent	3.90	individual		1	0.025	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 3 loadings, 2 deliv. gas oil (48 m3 total)	kerosine as n-nonane equivalent	1.30	individual		1	0.008	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (15 m3 gasoil)	kerosine as n-nonane equivalent	0.47	individual		1	0.003	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (7 m3 kerosine)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 5 deliv. gas oil (18 m3 total)	kerosine as n-nonane equivalent	10.90	individual		1	0.070	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 8 deliv. Kerosine (8 m3 total), 3 deliv. gas oil (9 m3 total)	kerosine as n-nonane equivalent	8.20	individual		1	0.053	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 17 deliv. Kerosine (18 m3 total)	kerosine as n-nonane equivalent	70.10	individual		1	0.450	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (18 m3 kerosine)	kerosine as n-nonane equivalent	0.27	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 4 deliv. Kerosine (8 m3 total), 4 deliv. gas oil (9 m3 total)	kerosine as n-nonane equivalent	1.00	individual		1	0.006	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 2 deliv. Kerosine (12 m3 total), 3 deliv. gas oil (9 m3 total)	kerosine as n-nonane equivalent	2.30	individual		1	0.015	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (3 m3 kerosine and 7 m3 gas oil)	kerosine as n-nonane equivalent	0.12	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 14 deliv. Kerosine (20 m3 total), 1 deliv. gas oil (1 m3)	kerosine as n-nonane equivalent	60.00	individual		1	0.385	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 5 deliv. Kerosine (14 m3 total), 5 deliv. gas oil (16 m3 total)	kerosine as n-nonane equivalent	1.10	individual		1	0.007	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 12 deliv. Kerosine (15 m3 total), 1 deliv. gas oil (3 m3)	kerosine as n-nonane equivalent	6.00	individual		1	0.039	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Tanker delivery to depot (38 m3 kerosine)	kerosine as n-nonane equivalent	0.14	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Depot supervisor	kerosine as n-nonane equivalent	0.43	individual		1	0.003	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 4 deliv. Kerosine (4 m3 total), 4 deliv. gas oil (13 m3 total)	kerosine as n-nonane equivalent	5.50	individual		1	0.035	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (5 m3 kerosine and 12 m3 gas oil)	kerosine as n-nonane equivalent	3.40	individual		1	0.022	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (8 m3 kerosine and 5 m3 gas oil)	kerosine as n-nonane equivalent	5.20	individual		1	0.033	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (7 m3 kerosine and 4 m3 gas oil)	kerosine as n-nonane equivalent	3.10	individual		1	0.020	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 5 deliv. Kerosine (5 m3 total), 5 deliv. gas oil (12 m3 total)	kerosine as n-nonane equivalent	5.50	individual		1	0.035	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 1 deliv. Kerosine (1 m3), 5 deliv. gas oil (17 m3 total)	kerosine as n-nonane equivalent	3.30	individual		1	0.021	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (11 m3 kerosine)	kerosine as n-nonane equivalent	15.00	individual		1	0.096	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 2 deliv. Kerosine (16 m3 total)	kerosine as n-nonane equivalent	4.70	individual		1	0.030	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 6 deliv. Kerosine (11 m3 total), 3 deliv. gas oil (4 m3 total)	kerosine as n-nonane equivalent	4.60	individual		1	0.030	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (11 m3 kerosine and 4 m3 gas oil)	kerosine as n-nonane equivalent	10.00	individual		1	0.064	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver- 2 Loadings (total 11 m3 kerosine and 6 m3 gas oil)	kerosine as n-nonane equivalent	6.80	individual		1	0.044	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 2 loadings, 10 deliv. Kerosine (11 m3 total), 4 deliv. gas oil (6 m3 total)	kerosine as n-nonane equivalent	2.60	individual		1	0.017	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (7 m3 kerosine and 1 m3 gas oil)	kerosine as n-nonane equivalent	10.40	individual		1	0.067	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, no loading, 9 deliv. Kerosine (14 m3 total), 2 deliv. gas oil (4 m3 total)	kerosine as n-nonane equivalent	0.18	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 11 deliv. Kerosine (12 m3 total), 1 deliv. gas oil (5 m3 total)	kerosine as n-nonane equivalent	4.20	individual		1	0.027	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (12 m3 kerosine and 5 m3 gas oil)	kerosine as n-nonane equivalent	5.60	individual		1	0.036	0
ES_K_27	155.75	Concawe Report 6/07		Tanker delivery to depot (37 m3 kerosine or gas oil)	kerosine as n-nonane equivalent	4.90	individual		1	0.031	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, no loading, 9 deliv. Kerosine (10 m3 total), 1 deliv. gas oil (6 m3)	kerosine as n-nonane equivalent	0.85	individual		1	0.005	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (8 m3 kerosine and 2 m3 gas oil)	kerosine as n-nonane equivalent	1.10	individual		1	0.007	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 5 deliv. Kerosine (8 m3 total), 1 deliv. gas oil (2 m3)	kerosine as n-nonane equivalent	2.00	individual		1	0.013	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 2 deliv. Kerosine (2 m3 total), 2 deliv. gas oil (15 m3 total)	kerosine as n-nonane equivalent	10.00	individual		1	0.064	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (2 m3 kerosine and 15 m3 gas oil)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (6 m3 kerosine and 5 m3 gas oil)	kerosine as n-nonane equivalent	2.00	individual		1	0.013	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 3 deliv. Kerosine (5 m3 total), 2 deliv. gas oil (2 m3 total)	kerosine as n-nonane equivalent	0.79	individual		1	0.005	0
ES_K_27	155.75	Concawe Report 6/07		Tanker Driver-Loading only (3 m3 kerosine and 10 m3 gas oil)	kerosine as n-nonane equivalent	3.70	individual		1	0.024	0
ES_K_27	155.75	Concawe Report 6/07		Tanker driver, 1 loading, 1 deliv. Kerosine (3 m3), 2 deliv. gas oil (10 m3 total)	kerosine as n-nonane equivalent	4.00	individual		1	0.026	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.10	individual		1	0.001	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Depot activities	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Filling tanker and refuelling airplanes	kerosine as n-nonane equivalent	0.04	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Depot activities	kerosine as n-nonane equivalent	0.64	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.34	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Depot activities and airplane refuelling	kerosine as n-nonane equivalent	4.80	individual		1	0.031	0
ES_K_27	155.75	Concawe Report 6/07		Depot activities and airplane refuelling	kerosine as n-nonane equivalent	0.06	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	1.30	individual		1	0.008	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.33	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Morning shift Jet A1	kerosine as n-nonane equivalent	0.61	individual		1	0.004	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.23	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.27	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.21	individual		1	0.001	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.41	individual		1	0.003	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.20	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.91	individual		1	0.006	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling airplanes	kerosine as n-nonane equivalent	0.14	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Jet A1 purging	kerosine as n-nonane equivalent	6.84	individual		1	0.044	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling station supervisor	kerosine as n-nonane equivalent	0.76	individual		1	0.005	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling station supervisor	kerosine as n-nonane equivalent	0.31	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Jet A1 purging	kerosine as n-nonane equivalent	13.50	individual		1	0.087	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A340,C8, venting)	kerosine as n-nonane equivalent	0.33	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A319,A330,A320,F68, venting)	kerosine as n-nonane equivalent	0.34	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A320,D12,venting)	kerosine as n-nonane equivalent	0.44	individual		1	0.003	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (777)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A319)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A319)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A320)	kerosine as n-nonane equivalent	ND	individual		1	0.000	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	0.23	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A319,A320,BAE146,B777,145)	kerosine as n-nonane equivalent	1.11	individual		1	0.007	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A318,B777)	kerosine as n-nonane equivalent	0.12	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff (A320,BAE)	kerosine as n-nonane equivalent	0.88	individual		1	0.006	0
ES_K_27	155.75	Concawe Report 6/07		Refuelling station supervisor	kerosine as n-nonane equivalent	2.43	individual		1	0.016	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	0.33	individual		1	0.002	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	4.08	individual		1	0.026	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	3.68	individual		1	0.024	0
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	2.86	individual		1	0.018	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_27	155.75	Concawe Report 6/07		Plane refuelling staff	kerosine as n-nonane equivalent	0.22	individual		1	0.001	0
ES_K_27	155.75	Concawe Report 6/07		Jet A1 purging	kerosine as n-nonane equivalent	22.80	individual		1	0.146	0
ES_K_28	104.70	Concawe Report 6/07	Vehicle mechanic	hose repair and test	total hydrocarbons	6.40	individual		1	0.061	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: full shift	kerosine as n-nonane equivalent	1.20	individual		1	0.011	0
ES_K_28	104.70	Concawe Report 6/07		Vehicle service bay staff: full shift	kerosine as n-nonane equivalent	3.10	individual		1	0.030	0
ES_K_28	104.70	Concawe Report 6/07		Vehicle service bay staff: full shift	kerosine as n-nonane equivalent	4.90	individual		1	0.047	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: hydrant pit maintenance	kerosine as n-nonane equivalent	1.00	individual		1	0.010	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: hydrant pit maintenance	kerosine as n-nonane equivalent	0.37	individual		1	0.004	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator (sample code 1): Jet A1 sampling	kerosine as n-nonane equivalent	2.50	individual		1	0.024	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator (sample code 1): Jet A1 sampling	kerosine as n-nonane equivalent	4.60	individual		1	0.044	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: Millipore testing into one aircraft	kerosine as n-nonane equivalent	3.00	individual		1	0.029	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator (sample code 1): Jet A1 sampling	kerosine as n-nonane equivalent	3.20	individual		1	0.031	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: check valve chambers at airfield	kerosine as n-nonane equivalent	0.19	individual		1	0.002	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator (Sample code 1): transfer of Jet A1 filters to waste container	kerosine as n-nonane equivalent	2.40	individual		1	0.023	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator (sample code 1): Jet A1 sampling	kerosine as n-nonane equivalent	2.80	individual		1	0.027	0
ES_K_28	104.70	Concawe Report 6/07		Vehicle service bay: drainage vehicle pipework prior to repair work	kerosine as n-nonane equivalent	31.20	individual		1	0.298	0
ES_K_28	104.70	Concawe Report 6/07		Vehicle service bay staff: full shift	kerosine as n-nonane equivalent	0.46	individual		1	0.004	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: hydrant pit maintenance	kerosine as n-nonane equivalent	ND	individual		1	<0.001	0
ES_K_28	104.70	Concawe Report 6/07		Vehicle service bay staff: full shift	kerosine as n-nonane equivalent	2.40	individual		1	0.023	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: change of Jet A1 in-line filters	kerosine as n-nonane equivalent	21.40	individual		1	0.204	0
ES_K_28	104.70	Concawe Report 6/07		Tank farm operator: change of Jet A1 in-line filters	kerosine as n-nonane equivalent	24.80	individual		1	0.237	0
ES_K_28	104.70	Concawe Report 6/07		Filter change on dispenser	kerosine as n-nonane equivalent	19.70	individual		1	0.188	0
ES_K_28	104.70	Concawe Report 6/07		Filter change on dispenser-continued	kerosine as n-nonane equivalent	19.00	individual		1	0.181	0
ES_K_28	104.70	Concawe Report 6/07		Yard maintenance and administration duties	kerosine as n-nonane equivalent	2.20	individual		1	0.021	0
ES_K_28	104.70	Concawe Report 6/07		Filter inspection	kerosine as n-nonane equivalent	34.50	individual		1	0.330	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker	kerosine as n-nonane equivalent	9.36	individual		1	0.089	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker	kerosine as n-nonane equivalent	1.44	individual		1	0.014	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: Vehicle test outside (e.g. pressure test)	kerosine as n-nonane equivalent	2.60	individual		1	0.025	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: valve dismantling (in garage)	kerosine as n-nonane equivalent	290.00	individual		1	2.770	1
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: assembling valve (in garage)	kerosine as n-nonane equivalent	18.80	individual		1	0.180	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: dumping Jet A1 in tank & other mechanical tasks	kerosine as n-nonane equivalent	2.16	individual		1	0.021	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: several minor maintenance tasks	kerosine as n-nonane equivalent	1.08	individual		1	0.010	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker: several maintenance tasks	kerosine as n-nonane equivalent	0.97	individual		1	0.009	0
ES_K_28	104.70	Concawe Report 6/07		Maintenance worker	kerosine as n-nonane equivalent	2.42	individual		1	0.023	0
ES_K_38	327.85	Concawe Report 6/07		Top loading road tanker	Total hydrocarbons	19.00	individual		1	0.058	0
ES_K_38	327.85	Concawe Report 6/07		Off loading tanker	Total hydrocarbons	24.00	individual		1	0.073	0
ES_K_38	327.85	Concawe Report 6/07		Top loading road tanker 10% Kerosine	Total hydrocarbons	240.00	aggregate	AM	2	0.732	1
ES_K_38	327.85	Concawe Report 6/07		Spray bar operator	Total hydrocarbons	216.00	aggregate	AM	2	0.659	0
ES_K_38	327.85	Concawe Report 6/07		Paving spreader driver	Total hydrocarbons	27.00	aggregate	AM	2	0.082	0

Es_id=scenario identity; n=number of measurements in measurement series; nm>t= number of measurements that exceeded the relevant exposure estimate

HEAVY FUEL OILS

Table S1.18 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and comparison results for heavy fuel oil[2]

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
HFO_1	0.07	Concawe Report 1/15		Barge loader (onboard)	HFO,THC	<0.058	individual		1	0.829	0
HFO_1	0.07	Concawe Report 1/15		Barge loader (onboard)	HFO,THC	<0.123	individual		1	1.757	1
HFO_1	0.07	Concawe Report 1/15		Barge loader (onboard)	HFO,THC	<0.305	individual		1	4.357	1
HFO_1	0.07	Concawe Report 1/15		Barge loader (onboard)	HFO,THC	<0.073	individual		1	1.043	1
HFO_1	0.07	Concawe Report 1/15		Barge loader (onboard)	HFO,THC	<0.067	individual		1	0.957	0

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

[2] HFO model estimates were obtained with ART

LOW-BOILING POINT NAPHTHA (0-1% BENZENE) – RESTRICTED DATASET[3]

Table S1.19 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and comparison results for naphtha (0-1% benzene) - restricted dataset

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_1	0.80	Concawe Report 5/09		Maintenance naphtha pump	Benzene	0.006	individual		1	0.008	0
N_0-1p_1	0.80	Concawe Report 5/09		Maintenance naphtha pump	Benzene	0.006	individual		1	0.008	0
N_0-1p_1	0.80	Concawe Report 5/09		Replacement benzene heartcut pump	Benzene	0.026	individual		1	0.033	0
N_0-1p_1	0.80	Concawe Report 5/09		Replacement benzene heartcut pump	Benzene	0.032	individual		1	0.040	0
N_0-1p_1	0.80	Concawe Report 5/09		Valve repair	Benzene	0.099	individual		1	0.124	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.300	individual		1	0.375	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.300	individual		1	0.375	0
N_0-1p_1	0.80	Concawe Report 09/02		gauger	Benzene	0.600	individual		1	0.750	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading	Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02		Railcar loading, in control room (except 5 mins in loading area), remainder of the day other fuel loaded	Benzene	0.100	individual		1	0.208	0

[3] Dataset comprising only of relevant measurement data collected post-2000

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_10	0.48	Concawe Report 09/02		Railcar loading, in control room (except 10 mins in loading area), remainder of the day other fuel loaded	Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02	Marine Jetty Crew		Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02	Marine Jetty Crew		Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02		Connect/disconnect loading arms, take samples and supervise loading operations, tanks blanketed with nitrogen	Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02		Connect/disconnect loading arms, take samples and supervise loading operations, tanks blanketed with nitrogen	Benzene	0.100	individual		1	0.208	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading with aviation fuel (5), diesel(3) and UL gasoline 5*100tGantryman	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading half time in room, half time in loading area, 20 railcars 65m3 each (*10 oxygenated,10 not)	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading half time in room, half time in loading area, 15 railcars 65m3 each (*5 oxygenated,10 not)	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 11 premium, 5 LVN, 4 jet	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Operator (mainly console operation) Railcars 11 premium, 5 LVN, 4 Jet	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Operator mainly console operation, railcars 3 premium, 12 regular	Benzene	0.200	individual		1	0.417	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_10	0.48	Concawe Report 09/02		Operator mainly console operation, railcars 5 premium, 10 LVN,15 diesel	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Railcar loading, in control room, remainder of the day other fuel loaded	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Railcar loading, in control room (except 5 mins in loading area), remainder of the day other fuel loaded	Benzene	0.200	individual		1	0.417	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading half time in room, half time in loading area,, 14 railcars 65m3 each (*4 oxygenated,10 not)	Benzene	0.300	individual		1	0.625	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading half time in room, half time in loading area, 16 railcars 65m3 each (all oxygenated)	Benzene	0.300	individual		1	0.625	0
N_0-1p_10	0.48	Concawe Report 09/02		Railcar loading, in control room, remainder of the day other fuel loaded	Benzene	0.300	individual		1	0.625	0
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 3 premium, 12 regular	Benzene	0.400	individual		1	0.833	0
N_0-1p_10	0.48	Concawe Report 09/02		Operator mainly console operation, railcars 17 premium	Benzene	0.400	individual		1	0.833	0
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading half time in room, half time in loading area, 10 railcars 60-75m3 (each oxygenated)	Benzene	0.500	individual		1	1.042	1
N_0-1p_10	0.48	Concawe Report 09/02		Operator (mainly console operation) Railcars 7 premium, 9 LVN	Benzene	0.500	individual		1	1.042	1
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading carried out other duties than railcar loading	Benzene	0.600	individual		1	1.250	1

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 6 regular	Benzene	0.600	individual		1	1.250	1
N_0-1p_10	0.48	Concawe Report 09/02		Operator mainly console operation, railcars 6 regular	Benzene	0.600	individual		1	1.250	1
N_0-1p_10	0.48	Concawe Report 09/02		Rail car loading	Benzene	0.700	individual		1	1.458	1
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 6 premium, 9 LVN	Benzene	0.700	individual		1	1.458	1
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 5 premium, 10LVN, 15 DIESEL	Benzene	0.700	individual		1	1.458	1
N_0-1p_10	0.48	Concawe Report 09/02		Operator opening and closing railcar lid, 6 premium, 9 LVN	Benzene	1.600	individual		1	3.333	1
N_0-1p_11	0.48	Concawe Report 5/09		hatch opening, sampling	Benzene	0.017	individual		1	0.035	0
N_0-1p_11	0.48	Concawe Report 5/09		hatch closing, sampling	Benzene	0.020	individual		1	0.042	0
N_0-1p_11	0.48	Concawe Report 5/09		Loading	Benzene	0.030	individual		1	0.063	0
N_0-1p_11	0.48	Concawe Report 5/09		hatch closing, sampling	Benzene	0.096	individual		1	0.200	
N_0-1p_13	2.72	Concawe Report 5/09		Lawn mowing	benzene	0.001	individual		1	0.000	0
N_0-1p_13	2.72	Concawe Report 5/09		Line trimming	benzene	0.002	individual		1	0.001	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.002	individual		1	0.001	0
N_0-1p_13	2.72	Concawe Report 5/09		Hedge cutting	benzene	0.002	individual		1	0.001	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.002	individual		1	0.001	0
N_0-1p_13	2.72	Concawe Report 5/09		4-stroke lawn mower	benzene	0.005	individual		1	0.002	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.010	individual		1	0.004	0
N_0-1p_13	2.72	Concawe Report 5/09		Line trimming	benzene	0.010	individual		1	0.004	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.010	individual		1	0.004	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.010	individual		1	0.004	0
N_0-1p_13	2.72	Concawe Report 5/09		Lawn mowing	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Concawe Report 5/09		Bush cutting	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.020	individual		1	0.007	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.030	individual		1	0.011	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.030	individual		1	0.011	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.040	individual		1	0.015	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.040	individual		1	0.015	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.050	individual		1	0.018	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.050	individual		1	0.018	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.050	individual		1	0.018	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Concawe Report 5/09		Calibration of fuel pumps outdoors	Benzene	0.060	individual		1	0.022	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.070	individual		1	0.026	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.070	individual		1	0.026	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.080	individual		1	0.029	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.080	individual		1	0.029	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.090	individual		1	0.033	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.100	individual		1	0.037	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.100	individual		1	0.037	0
N_0-1p_13	2.72	Concawe 5/09		Outdoors gauge repair	Benzene	0.110	individual		1	0.040	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.130	individual		1	0.048	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.160	individual		1	0.059	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.180	individual		1	0.066	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.190	individual		1	0.070	0
N_0-1p_13	2.72	Concawe Report 5/09		Outdoors hose replacement	Benzene	0.240	individual		1	0.088	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.250	individual		1	0.092	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Concawe Report 5/09		Calibration of fuel pumps outdoors	Benzene	0.250	individual		1	0.092	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.260	individual		1	0.096	0
N_0-1p_13	2.72	Concawe Report 5/09		Outdoors hose replacement	Benzene	0.260	individual		1	0.096	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.300	individual		1	0.110	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles after 1999	benzene	0.320	individual		1	0.118	0
N_0-1p_13	2.72	Concawe Report 5/09		Calibration of fuel pumps outdoors	Benzene	0.400	individual		1	0.147	0
N_0-1p_13	2.72	Concawe Report 5/09		Calibration of fuel pumps outdoors	Benzene	0.420	individual		1	0.154	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.440	individual		1	0.162	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.450	individual		1	0.165	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.480	individual		1	0.177	
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.490	individual		1	0.180	
N_0-1p_13	2.72	Concawe Report 5/09		Indoors gauge repair and test	Benzene	0.630	individual		1	0.232	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.670	individual		1	0.246	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	0.790	individual		1	0.290	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Concawe Report 5/09		Calibration of fuel pumps outdoors	Benzene	0.920	individual		1	0.338	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities after 1999	benzene	1.120	individual		1	0.412	0
N_0-1p_13	2.72	Concawe Report 5/09		Indoors gauge repair	Benzene	2.900	individual		1	1.066	1
N_0-1p_15	0.16	Concawe Report 5/09		Fuel testing and gas lab	Benzene	0.006	individual		1	0.038	0
N_0-1p_15	0.16	Concawe Report 5/09		Fuel testing	Benzene	0.010	individual		1	0.063	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.029	individual		1	0.181	
N_0-1p_15	0.16	Concawe Report 5/09		Fuel testing	Benzene	0.038	individual		1	0.238	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.038	individual		1	0.238	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.054	individual		1	0.338	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.064	individual		1	0.400	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.074	individual		1	0.463	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.090	individual		1	0.563	0
N_0-1p_15	0.16	Concawe Report 9/02		oxygenated gasoline blending (Bz<0.6%), only in blending room with fumehood	Benzene	0.100	individual		1	0.625	0
N_0-1p_15	0.16	Concawe Report 9/02		Engine Repair	Benzene	0.100	individual		1	0.625	0
N_0-1p_15	0.16	Concawe Report 9/02		Engine Repair	Benzene	0.100	individual		1	0.625	0
N_0-1p_15	0.16	Concawe Report 5/09		Fuel testing and gas lab	Benzene	0.133	individual		1	0.831	0
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.147	individual		1	0.919	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_15	0.16	Concawe Report 5/09		Blending operator	Benzene	0.170	individual		1	1.063	1
N_0-1p_15	0.16	Concawe Report 9/02		oxygenated gasoline blending, inside blending room , no ventilation used	Benzene	0.200	individual		1	1.250	1
N_0-1p_15	0.16	Concawe Report 9/02		octane number, small fumehood on test machine,6L iso-octane, 1L toluene, 1L n-heptane, 1L round test sample	Benzene	0.200	individual		1	1.250	1
N_0-1p_15	0.16	Concawe Report 9/02		octane number determination, small fumehood on test machine,0.3L iso-octane, 0.1L n-heptane, 1.5L round test sample	Benzene	0.300	individual		1	1.875	1
N_0-1p_15	0.16	Concawe Report 9/02		octane number determination of oxygenated gasolines (Bz<0.6%), fumehood	Benzene	0.500	individual		1	3.125	1
N_0-1p_15	0.16	Concawe Report 5/09		Fuel dispensing	Benzene	0.726	individual		1	4.538	1
N_0-1p_15	0.16	Concawe Report 9/02		Oxygenated Gasoline Blending (Bz<0.6%), partly in blending room with fumehood,	Benzene	1.600	individual		1	10.000	1
N_0-1p_15	0.16	Concawe Report 9/02		Blending 1500L gasoline in blending room under movable hoods (2.5 hr) and gasoline handling in open air (1.5 hr)	Benzene	2.000	individual		1	12.500	1
N_0-1p_15	0.16	Concawe Report 5/09		No details available	Benzene	2.280	individual		1	14.250	1
N_0-1p_15	0.16	Concawe Report 9/02		Blending 3800L gasoline in blending room under movable hoods (2.5 hr) and gasoline handling in open air (2 hr)-remaining time paper work	Benzene	4.800	individual		1	30.000	1
N_0-1p_15	0.16	Concawe Report 9/02		Blending 4100L gasoline in blending room under movable hoods (3 hr) and gasoline handling in open air (2 hr)-remaining time paper work	Benzene	7.700	individual		1	48.125	1

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_15	0.16	Concawe Report 9/02		oxygenated gasoline blending (Bz<0.6%), partly in blending room with fumehood	Benzene	9.200	individual		1	57.500	1
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Driver full trip (loading, driving and delivery) return to terminal	Benzene	0.100	individual		1	0.125	0
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Driver full trip (loading, driving and delivery) return to terminal	Benzene	0.100	individual		1	0.125	0
N_0-1p_16	0.8	Saarinen et al 2000		tanker loading after vapour recovery used	benzene	0.130	aggregate	GM	14	0.171	0
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Drivers 1st Part of shift	Benzene	0.500	individual		1	0.625	0
N_0-1p_16	0.8	Saarinen et al 2000		tanker loading before vapour recovery used	benzene	0.410	aggregate	GM	14	0.775	3
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Driver 2nd Part of shift	Benzene	0.700	individual		1	0.875	0
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Driver 1st Part of shift	Benzene	1.300	individual		1	1.625	1
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Drivers 1st Part of shift	Benzene	1.600	individual		1	2.000	1
N_0-1p_16	0.80	Concawe Report 9/02		Road Tanker Driver 2nd Part of shift	Benzene	4.600	individual		1	5.750	1
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 1 plane with Jet A1, 1 with aviation gasoline, by tanker	Benzene	0.020	individual		1	0.025	0
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 4 planes with jet A1, 1 with aviation gasoline, by tanker	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 2 planes with Jet A1, 2 with aviation gasoline, by tanker	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 1 plane with Jet A1, 1 with aviation gasoline, by tanker	Benzene	0.030	individual		1	0.038	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 2 planes with Jet A1, 1 (or more) with aviation gasoline, by tanker	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		VLE1 (aviation gasoline)	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		VLE4 (aviation gasoline)	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		VME1 (jet and aviation gasoline)	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		VME2 (jet and aviation gasoline)	Benzene	0.030	individual		1	0.038	0
N_0-1p_17	0.80	Concawe Report 5/09		Refuelling 2 planes with Jet A1, 1 with aviation gasoline, by tanker	Benzene	0.040	individual		1	0.050	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon day throughput: L95: 2.5m3, L98:0.5m3, UL96:1.5m3	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	Throughput 6500L Gasoline	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	Throughput 6500L Gasoline	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	Throughput 6500L Gasoline	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station handled approximately 200 gasoline cars, average fill 35 litres (<1% Benzene 1/10 leaded/unleaded) no bulk delivery	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station handled approximately 200 gasoline cars, average fill 35 litres (<1% Benzene 1/10 leaded/unleaded) no bulk delivery	Benzene	0.100	individual		1	0.125	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station handled approximately 200 gasoline cars, average fill 35 litres (<1% Benzene 1/10 leaded/unleaded) no bulk delivery	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station handled approximately 200 gasoline cars, average fill 35 litres (<1% Benzene 1/10 leaded/unleaded) no bulk delivery	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	1 bulk delivery during shift	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	1 bulk delivery during shift	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	Duplicate	Benzene	0.100	individual		1	0.125	0
N_0-1p_17	0.8	Periago et al 2005		filling vehicles in service station	benzene	0.124	aggregate	GM	19	0.204	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	morning	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	morning	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	afternoon	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	afternoon	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	morning	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service station attendant	morning	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.200	individual		1	0.250	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station throughput: 5m3 L95: 2.5m3, L96:0.5m3, UL98:-corresponding samples 6632	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station throughput: 5m3 L95: 2.5m3, L96:0.5m3, UL98:-corresponding samples 6602	Benzene	0.200	individual		1	0.250	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.5m3, L98:0.5m3, UL96:1.5m3-corrsponding samples 7146	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.2m3, L98:0.7m3, UL96:1m3-corrsponding samples 6638	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 6633	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 6688	Benzene	0.300	individual		1	0.375	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 7139	Benzene	0.300	individual		1	0.375	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station throughput: 5m3 L95: 2.5m3, L96:0.5m3, UL98:-corresponding samples 6680	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.5m3, L98:0.5m3, UL96:1.5m3-corrsponding samples 7262	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.5m3, L98:0.5m3, UL96:1.5m3-corrsponding samples 6641	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon day throughput: L95: 2.2m3, L98:0.75m3, UL96:1m3-corrsponding samples 6606	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.2m3, L98:0.7m3, UL96:1m3-corrsponding samples 6601	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 6617	Benzene	0.400	individual		1	0.500	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 6625	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon day throughput: L95: 2.9m3, L98:0.3m3, UL96:1.8m3-corrsponding samples 6694	Benzene	0.400	individual		1	0.500	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	station throughput: 5m3 L95: 2.5m3, L96:0.5m3, UL98:-corresponding samples 6697	Benzene	0.500	individual		1	0.625	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	afternoon, day throughput: L95: 2.5m3, L98:0.5m3, UL96:1.5m3-corrsponding samples 6630	Benzene	0.500	individual		1	0.625	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	morning day throughput: L95: 2.2m3, L98:0.7m3, UL96:1m3-corrsponding samples 6608	Benzene	0.500	individual		1	0.625	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	refuelling vehicles, typical daily throughput: L95:4m3, L97:3m3, diesel (gas oil A):6m3	Benzene	0.600	individual		1	0.750	0
N_0-1p_17	0.80	Concawe Report 9/02	Service Station Attendant	attendant/cashier shift throughput: L95:1.4m3, L98:0.5m3, L97:2.4m3,GOA chub oil: 6.1m3	Benzene	0.600	individual		1	0.750	0

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

NAPHTHA (1-5% BENZENE) – RESTRICTED DATASET[4]

Table S1.20 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and comparison results for naphtha (1-5% benzene) - restricted dataset

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_1	0.16	Concawe Report 97/52		production on site	Benzene	0.90	aggregate	AM	62	5.625	43
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Onsite Operator (Europe) 1986-94	Benzene	0.60	aggregate	AM	449	3.750	449
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Onsite Operator (USA) 1985	Benzene	0.17	aggregate	AM	56	1.063	19
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Reforming plants (Germany) 1983/1985	Benzene	0.62	aggregate	AM	183	3.875	173
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Cracking plants (Germany) 1983/1985	Benzene	0.96	aggregate	AM	46	6.000	32
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Ethylene plants (Germany) 1983/1985	Benzene	0.91	aggregate	AM	51	5.688	42
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Offsite operator (Europe)	Benzene	1.00	aggregate	AM	27	6.250	13
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Offsite operator (Europe) 1986-94	Benzene	1.80	aggregate	AM	426	11.250	426
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Offsite operator (Germany) 1983/1985	Benzene	2.11	aggregate	AM	54	13.188	49
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Laboratory Technician (Europe) 1986-94	Benzene	1.20	aggregate	AM	218	7.500	218
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Laboratory Technician (US) 1985	Benzene	0.34	aggregate	AM	18	2.125	14
N_1-5p_1	0.16	Concawe Report 97/52		Refinery Bottle washer (Europe) 1986-94	Benzene	5.20	aggregate	AM	75	32.500	75
N_1-5p_13	1.60	Concawe Report 2/00		Petrol pump maintenance workers	Benzene	0.55	aggregate	AM	2	0.344	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Mixed Loads95,97,98, GOA	Benzene	0.80	individual		1	0.833	0

[4] Dataset comprises of measurements collected prior to the year 2000 (i.e. historic)

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Mixed Loads95,97,98, GOA	Benzene	0.20	individual		1	0.208	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	mixed loads 95, 98	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Road Tanker Driver mixed loads 95, 97, 98, GOA	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02		Road Tanker Driver mixed loads 95, 97, GOA	Benzene	0.40	individual		1	0.417	0
N_1-5p_14	0.96	Concawe Report 9/02		1 load GOB + 1 Load gasoline	Benzene	0.20	individual		1	0.208	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	grade 95, 97, GOA	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	mixed loads 95, 97, 98, GOA	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	mixed loads 95, 97, 98, GOA	Benzene	0.90	individual		1	0.938	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	mixed loads 95, 97, 98, GOA	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	mixed loads 95, 97, 98, GOA	Benzene	0.20	individual		1	0.208	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades 95, 97, 98, GOA	Benzene	0.20	individual		1	0.208	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades 95, 97, 98, GOA	Benzene	1.20	individual		1	1.250	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades 95, 97, 98, GOA	Benzene	0.20	individual		1	0.208	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades 95, 97, 98, GOA	Benzene	0.80	individual		1	0.833	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades UL95, L96, UL98, Diesel	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades UL95, L96, UL98, Diesel	Benzene	0.60	individual		1	0.625	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades 95, 96, 98, Diesel	Benzene	0.80	individual		1	0.833	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all grades UL95, L96, UL98, Diesel, possible sample pump problem	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all gasoline grades	Benzene	0.30	individual		1	0.313	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all gasoline grades	Benzene	1.20	individual		1	1.250	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	all gasoline grades	Benzene	0.80	individual		1	0.833	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	2nd delivery of the day all gasolines	Benzene	0.40	individual		1	0.417	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	2nd delivery of the day all gasolines	Benzene	0.60	individual		1	0.625	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	2nd delivery of the day all gasolines	Benzene	0.50	individual		1	0.521	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	UL 95, UL 98, L96, diesel	Benzene	0.60	individual		1	0.625	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	UL 95, UL 98, L96, diesel	Benzene	1.30	individual		1	1.354	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	UL 95, UL 98, L96, diesel	Benzene	0.40	individual		1	0.417	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	bottom loading W,Y G95	Benzene	3.60	individual		1	3.750	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	delivering at service station	Benzene	0.80	individual		1	0.833	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	bottom loading W, Y, G95	Benzene	5.40	individual		1	5.625	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	bottom loading W, Y, G95	Benzene	0.80	individual		1	0.833	0
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	driver making delivery at station	Benzene	2.80	individual		1	2.917	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Loading 95, 97, GOA	Benzene	1.10	individual		1	1.146	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Loading 95, 97, GOA	Benzene	2.30	individual		1	2.396	1
N_1-5p_14	0.96	Concawe Report 9/02	Road Tanker Driver	Loading 95, 97, GOA	Benzene	1.60	individual		1	1.667	1
N_1-5p_14	0.96	Concawe Report 9/02	Gantry man	bottom loading	Benzene	0.50	individual		1	0.521	0
N_1-5p_14	0.96	Concawe Report 9/02	Gantry man	on duty during all loading of UL, SUL, L, ADO	Benzene	0.50	individual		1	0.521	0
N_1-5p_14	0.96	Concawe Report 9/02	Gantry man	UL 95, UL 98, L96, Diesel	Benzene	0.30	individual		1	0.313	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 4/87		1. road top <1hr	benzene	1.60	aggregate	GM	142	2.938	97
N_1-5p_14	0.96	Concawe Report 4/87		2. road bottom <1hr	benzene	0.27	aggregate	GM	59	0.444	5
N_1-5p_14	0.96	Concawe Report 4/87		4. road top >1hr	benzene	0.30	aggregate	GM	63	0.969	14
N_1-5p_14	0.96	Concawe Report 4/87		5. road bottom >1hr	benzene	0.18	aggregate	GM	34	0.802	6
N_1-5p_14	0.96	Concawe Report 4/87		8. ships closed	benzene	2.20	aggregate	GM	9	6.418	7
N_1-5p_14	0.96	Concawe Report 4/87		9. ships open	benzene	1.30	aggregate	GM	8	3.665	5
N_1-5p_14	0.96	Concawe Report 4/87		10. barge closed	benzene	0.14	aggregate	GM	11	431.606	4
N_1-5p_14	0.96	Concawe Report 4/87		11. jettyman	benzene	0.43	aggregate	GM	21	1.435	6
N_1-5p_14	0.96	Concawe Report 4/87		12. rail car top	benzene	0.15	aggregate	GM	32	0.608	4
N_1-5p_14	0.96	Concawe Report 97/52		Road tanker driver top loading (Europe) 1986-94	Benzene	0.80	aggregate	AM	186	0.833	41
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker driver: Top Loading (Germany) 1983/1985	Benzene	1.89	aggregate	AM	54	1.969	45
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker driver: Top loading (USA)	Benzene	0.90	aggregate	AM	43	0.938	15
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1986	Benzene	1.10	aggregate	AM	38	1.146	16
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1987	Benzene	1.00	aggregate	AM	56	1.042	22
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker drivers other measurements (Delivery and Driving; Europe)	Benzene	5.10	aggregate	AM	29	5.313	9
N_1-5p_14	0.96	Concawe Report 97/52		Road Tanker drivers other measurements (Loading, Delivery and Driving; USA)	Benzene	0.45	aggregate	AM	49	0.469	5

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 97/52		Rack operators and supervisors (Europe) 1986-94	Benzene	1.90	aggregate	AM	40	1.979	19
N_1-5p_14	0.96	Concawe Report 97/52		Rack operators and supervisors (Germany) 1983-85	Benzene	1.13	aggregate	AM	50	1.177	22
N_1-5p_14	0.96	Concawe Report 97/52		Rail car operator, top loading (Europe) 1986-94	Benzene	5.00	aggregate	AM	183	5.208	182
N_1-5p_14	0.96	Concawe Report 97/52		Jetty staff (Europe)1986-94	Benzene	6.30	aggregate	AM	92	6.563	85
N_1-5p_14	0.96	Concawe Report 97/52		Deck Crew Loading open/closed unknown-(Europe) 1986-94	Benzene	2.30	aggregate	AM	19	2.396	11
N_1-5p_14	0.96	Concawe Report 97/52		Bridge Crew, Barges closed loading (Germany) 1983/1985	Benzene	0.22	aggregate	AM	7	0.229	0
N_1-5p_14	0.96	Concawe Report 97/52		Marine loading other measurements (USA)	Benzene	2.30	aggregate	AM	11	2.396	4
N_1-5p_14	0.96	Concawe Report 97/52		Product storage tasks Terminal operators- Offsite operator (Europe)	Benzene	1.00	aggregate	AM	27	1.042	5
N_1-5p_14	0.96	Concawe Report 97/52		Product storage tasks Bulk terminal plant man sample collection; maintaining loading racks; general maintenance e.g. grass cutting, painting and paint work	Benzene	0.40	aggregate	AM	23	0.417	0
N_1-5p_14	0.96	Concawe Report 2/00		Road Tanker Drivers Top loading	Benzene	2.07	aggregate	AM	69	2.156	37
N_1-5p_14	0.96	Concawe Report 2/00		Road Tanker Drivers bottom loading	Benzene	0.82	aggregate	AM	223	0.854	64
N_1-5p_14	0.96	Concawe Report 2/00		Road Tanker Drivers bottom loading	Benzene	0.37	aggregate	AM	137	0.385	1
N_1-5p_14	0.96	Concawe Report 2/00		Drivers Other category or unspecified	Benzene	1.26	aggregate	AM	56	1.313	23

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_14	0.96	Concawe Report 2/00		Road tanker terminal rack operators	Benzene	0.64	aggregate	AM	126	0.667	23
N_1-5p_14	0.96	Concawe Report 2/00		Rail car terminal operators Top loading	Benzene	1.34	aggregate	AM	69	1.396	25
N_1-5p_14	0.96	Concawe Report 2/00		Rail car terminal Operators Off loading	Benzene	1.29	aggregate	AM	43	1.344	16
N_1-5p_14	0.96	Concawe Report 2/00		Rail car terminal workers miscellaneous	Benzene	1.19	aggregate	AM	35	1.240	8
N_1-5p_14	0.96	Concawe Report 2/00		Ship deck crew, open loading	Benzene	0.56	aggregate	AM	41	0.583	6
N_1-5p_14	0.96	Concawe Report 2/00		Ship deck crew unloading	Benzene	0.51	aggregate	AM	32	0.531	4
N_1-5p_14	0.96	Concawe Report 2/00		Ship deck crew closed loading	Benzene	0.56	aggregate	AM	2	0.583	0
N_1-5p_14	0.96	Concawe Report 2/00		Jetty staff	Benzene	0.37	aggregate	AM	46	0.385	3
N_1-5p_14	0.96	Concawe Report 2/00		Ship distribution workers miscellaneous	Benzene	1.41	aggregate	AM	69	1.469	27
N_1-5p_15	0.32	Concawe Report 2/00		Refinery Laboratory Technicians	Benzene	0.30	aggregate	AM	628	0.938	220
N_1-5p_2	1.60	Concawe Report 97/52		Refinery Maintenance worker (Europe) 1986-94	Benzene	2.50	aggregate	AM	55	1.563	25
N_1-5p_2	1.60	Concawe Report 97/52		Refinery Maintenance worker (Germany) 1983/1985	Benzene	0.80	aggregate	AM	43	0.500	5
N_1-5p_2	1.60	Concawe Report 2/00		Tank Cleaners	Benzene	2.10	aggregate	AM	49	1.313	12
N_1-5p_2	1.60	Concawe Report 2/00		Refinery workers miscellaneous/Unspecified	Benzene	1.12	aggregate	AM	10	0.700	2
N_1-5p_3	0.16	Concawe Report 97/52		production offsite	benzene	1.00	aggregate	AM	27	6.250	14
N_1-5p_9	1.60	Concawe Report 2/00		Road Tanker Terminal Maintenance	Benzene	0.52	aggregate	AM	52	0.325	4
N_1-5p_9	1.60	Concawe Report 2/00		Road Tanker Terminal Workers	Benzene	0.18	aggregate	AM	12	0.113	0

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

OTHER LUBRICANT BASE OILS

Table S1.21 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and comparison results for other lubricant base oils (as metal working fluids)

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_OLBO_16+17	7.50	NIOSH	Shaver	use of metal working fluids in production/ reworking of steel coils	Oil Mist (CAS number 8012-95-1)	0.30	individual		1	0.040	0
ES_OLBO_16+17	7.50	NIOSH	Shaver	use of metal working fluids in production/ reworking of steel coils	Oil Mist (CAS number 8012-95-1)	1.00	individual		1	0.133	0
ES_OLBO_16+17	7.50	NIOSH	Grinder	use of metal working fluids in production/ reworking of steel coils	Oil Mist (CAS number 8012-95-1)	2.30	individual		1	0.307	0
ES_OLBO_16+17	7.50	NIOSH	Grinder	use of metal working fluids in production/ reworking of steel coils	Oil Mist (CAS number 8012-95-1)	1.00	individual		1	0.133	0
ES_OLBO_16+17	7.50	Simpson et al 2002		machining	aerosol	0.67	aggregate	GM	40	0.215	1
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Grinding	aerosol	0.43	aggregate	GM	119	0.098	1
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Hobbing	aerosol	0.43	aggregate	GM	37	0.075	0
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Turning - lathes	aerosol	0.21	aggregate	GM	152	0.040	0
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Turning-screws	aerosol	0.39	aggregate	GM	260	0.071	0
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Sawing	aerosol	0.17	aggregate	GM	16	0.045	0
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Milling	aerosol	0.18	aggregate	GM	192	0.031	0
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Drilling	aerosol	0.13	aggregate	GM	21	0.037	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
ES_OLBO_16+17	7.50	Piacitelli et al, 2001		Stamping	aerosol	0.18	aggregate	GM	19	0.036	0
ES_OLBO_16+17	60.00	Breuer et al, 2006		Sawing	vapour	2.30	aggregate	Median	131	0.046	0
ES_OLBO_16+17	60.00	Breuer et al, 2006		Milling	vapour	4.10	aggregate	Median	645	0.112	2
ES_OLBO_16+17	60.00	Breuer et al, 2006		Drilling	vapour	4.30	aggregate	Median	232	0.110	1
ES_OLBO_16+17	60.00	Breuer et al, 2006		Lathing, planing	vapour	5.10	aggregate	Median	1236	0.133	6
ES_OLBO_16+17	60.00	Breuer et al, 2006		Grinding	vapour	6.50	aggregate	Median	1728	0.180	23
ES_OLBO_16+17	60.00	Breuer et al, 2006		Punching, cutting	vapour	2.70	aggregate	Median	103	0.092	1
ES_OLBO_16+17	60.00	Breuer et al, 2006		NC processing machines	vapour	5.70	aggregate	Median	113	0.137	0
ES_OLBO_16+17	60.00	Breuer et al, 2006		CNC processing machines	vapour	4.40	aggregate	Median	1812	0.112	4
ES_OLBO_16+17	60.00	Breuer et al, 2006		Rolling	vapour	4.20	aggregate	Median	103	0.084	0
ES_OLBO_16+17	60.00	Breuer et al, 2006		Processing center	vapour	3.70	aggregate	Median	213	0.093	0
ES_OLBO_16+17	60.00	BIA report 5/99		Milling	vapour	4.50	aggregate	Median	64	0.118	0
ES_OLBO_16+17	60.00	BIA report 5/99		Drilling	vapour	4.10	aggregate	Median	21	0.107	0
ES_OLBO_16+17	60.00	BIA report 5/99		Lathing/planing	vapour	5.90	aggregate	Median	79	0.347	6
ES_OLBO_16+17	60.00	BIA report 5/99		Grinding	vapour	6.70	aggregate	Median	85	0.169	1
ES_OLBO_16+17	60.00	BIA report 5/99		NC/CNC machines	vapour	5.60	aggregate	Median	36	0.107	0

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

NAPHTHA (0-1% BENZENE) ADDITIONAL DATA[5]

Table S1.22 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and related comparison results for naphtha (0-1% benzene) - additional data only

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_1	0.80	Concawe Report 97/52		Refinery Maintenance worker (Europe) 1986-94	Benzene	2.500	aggregate	AM	55	1.563	25
N_0-1p_1	0.80	Concawe Report 97/52		Refinery Maintenance worker (Germany) 1983/1985	Benzene	0.800	aggregate	AM	43	0.500	5
N_0-1p_1	0.80	Concawe Report 2/00		Tank Cleaners	Benzene	2.100	aggregate	AM	49	1.313	12
N_0-1p_1	0.80	Concawe Report 2/00		Refinery workers miscellaneous/Unspecified	Benzene	1.120	aggregate	AM	10	0.700	2
N_0-1p_3	0.80	Concawe Report 2/00		Road Tanker Terminal Maintenance	Benzene	0.520	aggregate	AM	52	0.325	4
N_0-1p_3	0.80	Concawe Report 2/00		Road Tanker Terminal Workers	Benzene	0.180	aggregate	AM	12	0.113	0
N_0-1p_8	0.16	Concawe Report 4/87		14. Production - onsite	Benzene	0.011	aggregate	GM	62	1.938	9
N_0-1p_8	0.16	Concawe Report 4/87		15. Production - offsite	Benzene	0.035	aggregate	GM	27	1.250	6
N_0-1p_11	0.48	Concawe Report 4/87		1. road top <1hr	benzene	1.600	aggregate	GM	142	2.938	97
N_0-1p_11	0.48	Concawe Report 4/87		2. road bottom <1hr	benzene	0.270	aggregate	GM	59	0.444	5
N_0-1p_11	0.48	Concawe Report 4/87		4. road top >1hr	benzene	0.300	aggregate	GM	63	0.969	14
N_0-1p_11	0.48	Concawe Report 4/87		5. road bottom >1hr	benzene	0.180	aggregate	GM	34	0.802	6
N_0-1p_11	0.48	Concawe Report 4/87		8. ships closed	benzene	2.200	aggregate	GM	9	6.417	7
N_0-1p_11	0.48	Concawe Report 4/87		9. ships open	benzene	1.300	aggregate	GM	8	3.665	5

[5] Data from measurements series performed prior to the year 2000 (i.e. historic) for which measured concentrations were corrected for the content of benzene by applying date-related modifiers

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_11	0.48	Concawe Report 4/87		10. barge closed	benzene	0.140	aggregate	GM	11	431.606	3
N_0-1p_11	0.48	Concawe Report 4/87		11. jettyman	benzene	0.430	aggregate	GM	21	1.435	6
N_0-1p_11	0.48	Concawe Report 4/87		12. rail car top	benzene	0.150	aggregate	GM	32	0.608	4
N_0-1p_11	0.48	Concawe Report 97/52		Road tanker driver top loading (Europe) 1986-94	Benzene	0.800	aggregate	AM	186	0.833	41
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker driver: Top Loading (Germany) 1983/1985	Benzene	1.890	aggregate	AM	54	1.969	46
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker driver: Top loading (USA)	Benzene	0.900	aggregate	AM	43	0.938	14
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1986	Benzene	1.100	aggregate	AM	38	1.146	16
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1987	Benzene	1.000	aggregate	AM	56	1.042	22
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker drivers other measurements (Delivery and Driving; Europe)	Benzene	5.100	aggregate	AM	29	5.313	6
N_0-1p_11	0.48	Concawe Report 97/52		Road Tanker drivers other measurements (Loading, Delivery and Driving; USA)	Benzene	0.450	aggregate	AM	49	0.469	5
N_0-1p_11	0.48	Concawe Report 97/52		Rack operators and supervisors (Europe) 1986-94	Benzene	1.900	aggregate	AM	40	1.979	19
N_0-1p_11	0.48	Concawe Report 97/52		Rack operators and supervisors (Germany) 1983-85	Benzene	1.130	aggregate	AM	50	1.177	22
N_0-1p_11	0.48	Concawe Report 97/52		Rail car operator, top loading (Europe) 1986-94	Benzene	5.000	aggregate	AM	183	5.208	182
N_0-1p_11	0.48	Concawe Report 97/52		Jetty staff (Europe)1986-94	Benzene	6.300	aggregate	AM	92	6.563	85
N_0-1p_11	0.48	Concawe Report 97/52		Deck Crew Loading open/closed unknown-(Europe) 1986-94	Benzene	2.300	aggregate	AM	19	2.396	11

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_11	0.48	Concawe Report 97/52		Bridge Crew, Barges closed loading (Germany) 1983/1985	Benzene	0.220	aggregate	AM	7	0.229	0
N_0-1p_11	0.48	Concawe Report 97/52		Marine loading other measurements (USA)	Benzene	2.300	aggregate	AM	11	2.396	4
N_0-1p_11	0.48	Concawe Report 97/52		Product storage tasks Terminal operators- Offsite operator (Europe)	Benzene	1.000	aggregate	AM	27	1.042	3
N_0-1p_11	0.48	Concawe Report 97/52		Product storage tasks 8 hour exposure involving ship offloading, sample collection, sample testing, cleaning fuel filters	Benzene	0.160	aggregate	AM	3	0.167	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.300	individual		1	0.110	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	1.500	individual		1	0.276	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.260	individual		1	0.048	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	1.010	individual		1	0.186	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.330	individual		1	0.061	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.780	individual		1	0.143	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.870	individual		1	0.160	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	1.700	individual		1	0.313	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.590	individual		1	0.108	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.520	individual		1	0.096	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.810	individual		1	0.149	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	2.240	individual		1	0.412	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.630	individual		1	0.116	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.090	individual		1	0.017	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.120	individual		1	0.022	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.130	individual		1	0.024	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.190	individual		1	0.035	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.150	individual		1	0.028	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.420	individual		1	0.077	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	1.280	individual		1	0.235	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.780	individual		1	0.143	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	1.480	individual		1	0.272	0
N_0-1p_13	2.72	Auffarth et al 2002		draining of fuel tanks in motor vehicle recycling facilities pre 1999	benzene	0.770	individual		1	0.142	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.270	individual		1	0.050	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.220	individual		1	0.040	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.740	individual		1	0.136	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.660	individual		1	0.121	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.680	individual		1	0.125	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.520	individual		1	0.096	0
N_0-1p_13	2.72	Auffarth et al 2002		disassembly of vehicles pre 1999	benzene	0.560	individual		1	0.103	0
N_0-1p_13	2.72	Concawe Report 2/00		Petrol pump maintenance workers	Benzene	0.550	aggregate	AM	2	0.101	0
N_0-1p_15	0.16	Concawe Report 2/00		Refinery Laboratory Technicians	Benzene	0.300	aggregate	AM	628	0.938	220
N_0-1p_16	0.80	Concawe Report 4/87		1. road top <1hr	benzene	1.600	aggregate	GM	142	1.763	71
N_0-1p_16	0.80	Concawe Report 4/87		2. road bottom <1hr	benzene	0.270	aggregate	GM	59	0.266	2
N_0-1p_16	0.80	Concawe Report 4/87		4. road top >1hr	benzene	0.300	aggregate	GM	63	0.581	8
N_0-1p_16	0.80	Concawe Report 4/87		5. road bottom >1hr	benzene	0.180	aggregate	GM	34	0.481	3
N_0-1p_16	0.80	Concawe Report 97/52		Road tanker driver top loading (Europe) 1986-94	Benzene	0.800	aggregate	AM	186	0.500	1

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker driver: Top Loading (Germany) 1983/1985	Benzene	1.890	aggregate	AM	54	1.181	27
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker driver: Top loading (USA)	Benzene	0.900	aggregate	AM	43	0.563	5
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1986	Benzene	1.100	aggregate	AM	38	0.688	7
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker Driver bottom loading (USA) 1987	Benzene	1.000	aggregate	AM	56	0.625	9
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker drivers other measurements (Delivery and Driving; Europe)	Benzene	5.100	aggregate	AM	29	3.188	5
N_0-1p_16	0.80	Concawe Report 97/52		Road Tanker drivers other measurements (Loading, Delivery and Driving; USA)	Benzene	0.450	aggregate	AM	49	0.281	3
N_0-1p_16	0.80	Concawe Report 2/00		Road Tanker Drivers Top loading	Benzene	2.070	aggregate	AM	69	1.294	25
N_0-1p_16	0.80	Concawe Report 2/00		Road Tanker Drivers bottom loading	Benzene	0.820	aggregate	AM	223	0.513	15
N_0-1p_16	0.80	Concawe Report 2/00		Road Tanker Drivers bottom loading	Benzene	0.370	aggregate	AM	137	0.231	0
N_0-1p_16	0.80	Concawe Report 2/00		Drivers Other category or unspecified	Benzene	1.260	aggregate	AM	56	0.788	13
N_0-1p_16	0.80	Concawe Report 2/00		Road tanker terminal rack operators	Benzene	0.640	aggregate	AM	126	0.400	8
N_0-1p_17	0.80	Periago et al 2005		filling vehicles in service station	benzene	0.667	aggregate	GM	21	0.466	1
N_0-1p_17	0.80	Periago et al 2005		filling vehicles in service station	benzene	0.226	aggregate	GM	28	0.149	0
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (Europe)	Benzene	0.400	aggregate	AM	13	0.250	0
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (Europe) 1986-94	Benzene	0.610	aggregate	AM	82	0.381	2
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (Germany) 1983-1985	Benzene	0.520	aggregate	AM	351	0.325	0
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (USA)	Benzene	1.000	aggregate	AM	21	0.625	2

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (USA)	Benzene	0.650	aggregate	AM	49	0.406	0
N_0-1p_17	0.80	Concawe Report 97/52		Service station attendants (USA)	Benzene	0.320	aggregate	AM	84	0.200	2
N_0-1p_19	1.60	Concawe Report 97/52		Production on site operator	benzene	0.900	aggregate	AM	62	0.281	3
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Onsite Operator (Europe) 1986-94	Benzene	0.600	aggregate	AM	449	0.188	0
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Onsite Operator (USA) 1985	Benzene	0.170	aggregate	AM	56	0.053	0
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Reforming plants (Germany) 1983/1985	Benzene	0.620	aggregate	AM	183	0.194	1
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Cracking plants (Germany) 1983/1985	Benzene	0.960	aggregate	AM	46	0.300	3
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Ethylene plants (Germany) 1983/1985	Benzene	0.910	aggregate	AM	51	0.284	2
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Offsite operator (Europe)	Benzene	1.000	aggregate	AM	27	0.313	1
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Offsite operator (Europe) 1986-94	Benzene	1.800	aggregate	AM	426	0.563	2
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Offsite operator (Germany) 1983/1985	Benzene	2.110	aggregate	AM	54	0.659	9
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Laboratory Technician (Europe) 1986-94	Benzene	1.200	aggregate	AM	218	0.375	1
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Laboratory Technician (US) 1985	Benzene	0.340	aggregate	AM	18	0.106	0
N_0-1p_19	1.60	Concawe Report 97/52		Refinery Bottle washer (Europe) 1986-94	Benzene	5.200	aggregate	AM	75	1.625	42
N_0-1p_20	1.12	Concawe Report 97/52		Production offsite	benzene	1.000	aggregate	AM	27	0.446	2

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

NAPHTHA (1-5% BENZENE) ADDITIONAL DATA[6]

Table S1.23 Overview of the original measurement data used for comparisons with the exposure estimates from the CSA and related comparison results for naphtha (1-5% benzene) – additional data only

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_2	1.60	Concawe Report 5/09		Replacement benzene heartcut pump	Benzene	0.032	individual		1	0.040	0
N_1-5p_2	1.60	Concawe Report 5/09		Replacement benzene heartcut pump	Benzene	0.026	individual		1	0.033	0
N_1-5p_2	1.60	Concawe Report 5/09		Valve repair	Benzene	0.099	individual		1	0.124	0
N_1-5p_2	1.60	Concawe Report 5/09		Maintenance naphtha pump	Benzene	0.006	individual		1	0.008	0
N_1-5p_2	1.60	Concawe Report 5/09		Maintenance naphtha pump	Benzene	0.006	individual		1	0.008	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.300	individual		1	0.375	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.600	individual		1	0.750	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.100	individual		1	0.125	0
N_1-5p_2	1.60	Concawe Report 09/02		gauger	Benzene	0.300	individual		1	0.375	0
N_1-5p_15	0.32	Concawe Report 5/09		Fuel testing	Benzene	0.038	individual		1	0.238	0
N_1-5p_15	0.32	Concawe Report 5/09		Fuel testing and gas lab	Benzene	0.006	individual		1	0.038	0
N_1-5p_15	0.32	Concawe Report 5/09		Fuel testing	Benzene	0.010	individual		1	0.063	0

[6] Data from measurements series performed after the year 2000 for which measured concentrations were corrected for the content of benzene by applying date-related modifiers

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_15	0.32	Concawe Report 5/09		Fuel testing and gas lab	Benzene	0.133	individual		1	0.831	0
N_1-5p_15	0.32	Concawe Report 5/09		No details available	Benzene	2.280	individual		1	14.250	1
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.054	individual		1	0.338	0
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.170	individual		1	1.063	1
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.038	individual		1	0.238	0
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.064	individual		1	0.400	0
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.074	individual		1	0.463	0
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.029	individual		1	0.181	0
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.147	individual		1	0.919	0
N_1-5p_15	0.32	Concawe Report 5/09		Fuel dispensing	Benzene	0.726	individual		1	4.538	1
N_1-5p_15	0.32	Concawe Report 5/09		Blending operator	Benzene	0.090	individual		1	0.563	0
N_1-5p_15	0.32	Concawe Report 09/02		oxygenated Gasoline Blending (Bz<0.6%), partly in blending room with fumehood,	Benzene	1.600	individual		1	10.000	1
N_1-5p_15	0.32	Concawe Report 09/02		octane number determination of oxygenated gasolines (Bz<0.6%), fumehood	Benzene	0.500	individual		1	3.125	1
N_1-5p_15	0.32	Concawe Report 09/02		oxygenated gasoline blending (Bz<0.6%), partly in blending room with fumehood	Benzene	9.200	individual		1	57.500	1
N_1-5p_15	0.32	Concawe Report 09/02		oxygenated gasoline blending (Bz<0.6%), only in blending room with fumehood	Benzene	0.100	individual		1	0.625	0
N_1-5p_15	0.32	Concawe Report 09/02		Engine Repair	Benzene	0.100	individual		1	0.625	0

ES_ID	Exposure estimate (mg/m3)	Source of measurement	Worker job title	Involved task	Measured substance	Measured concentration (mg/m3)	Type of estimate	Form of aggregate	n	M/T ratio	nM>T
N_1-5p_15	0.32	Concawe Report 09/02		Engine Repair	Benzene	0.100	individual		1	0.625	0
N_1-5p_15	0.32	Concawe Report 09/02		oxygenated gasoline blending, inside blending room , no ventilation used	Benzene	0.200	individual		1	1.250	1
N_1-5p_15	0.32	Concawe Report 09/02		octane number, small fumehood on test machine,6L iso-octane, 1L toluene, 1L n-heptane, 1L round test sample	Benzene	0.200	individual		1	1.250	1
N_1-5p_15	0.32	Concawe Report 09/02		Blending 3800L gasoline in blending room under movable hoods (2.5 hr) and gasoline handling in open air (2 hr)-remaining time paper work	Benzene	4.800	individual		1	30.000	1
N_1-5p_15	0.32	Concawe Report 09/02		Blending 4100L gasoline in blending room under movable hoods (3 hr) and gasoline handling in open air (2 hr)-remaining time paper work	Benzene	7.700	individual		1	48.125	1
N_1-5p_15	0.32	Concawe Report 09/02		Blending 1500L gasoline in blending room under movable hoods (2.5 hr) and gasoline handling in open air (1.5 hr)	Benzene	2.000	individual		1	12.500	1
N_1-5p_15	0.32	Concawe Report 09/02		octane number determination, small fumehood on test machine,0.3L iso-octane, 0.1L n-heptane, 1.5L round test sample	Benzene	0.300	individual		1	1.875	1

ES_ID=scenario identity; n=number of measurements in measurement series; nM>T= number of measurements that exceeded the relevant exposure estimate

ONLINE SUPPLEMENT 2: PHRASES FOR COMMUNICATION

Table S2.1 Evaluated scenarios: RMMs for communication

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Kerosine	ES_K_27	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS14 Bulk transfers	use as fuel / professional	No other specific measures identified. EI20 Ensure operation is undertaken outdoors E69. Ensure material transfers are under containment or extract ventilation E66. Clear lines prior to decoupling E39. Ensure operatives are trained to minimise exposures. EI19.		
Kerosine	ES_K_1	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance	Manufacture of substance	No other specific measures identified. EI20. Drain down system prior to equipment break-in or maintenance. E65. Retain drain down in sealed storage pending disposal or for subsequent recycle. ENVT4. Deal with spills immediately. C&H13.		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Kerosine	ES_K_28	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance. Equipment maintenance e.g. Vehicle, boiler, pump maintenance, pump calibration.	use as fuel / professional	No other specific measures identified. EI20 Drain down system prior to equipment break-in or maintenance. E65. Retain drain down in sealed storage pending disposal or for subsequent recycle. ENVT4. Deal with spills immediately. C&H13.		
Kerosine	ES_K_38	PROC 13 Treatment of articles by dipping and pouring	CS4 Dipping, immersion and pouring	use in road and construction applications / professional	No other specific measures identified. EI20 Ensure operation is undertaken outdoors E69. Avoid carrying out operation for more than 4 hours OC12. Ensure operatives are trained to minimise exposures. EI19.		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Kerosine	ES_K_29	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS103 Vessel and container cleaning	use as fuel / professional	No other specific measures identified. EI20 Apply vessel entry procedures including use of forced supplied air. AP15 Drain down system prior to equipment break-in or maintenance. E65 Transfer via enclosed lines E52. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4.		
					Risk Management Measures Semi-quantitative RMMs		
Heavy fuel oil	ES_HFO_1	PROC8b Transfer of substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities.	CS_new Marine vessel/barge (un)loading	ES2 - Distribution of substance - industrial	Avoid carrying out activities involving exposure for more than 4 hours OC28. Transfer via enclosed lines E52. Clear transfer lines prior to de-coupling E39. Retain drain downs in sealed storage pending disposal or for subsequent recycle ENVT4. Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training PPE16.		
					Quantitative RMMs	**Qualitative Specific Measures**	**Consolidated RMMs for communication in Exposure Scenarios.**

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Naphtha 0-1% benzene	N_0-1p_1	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance	Manufacture of substance - Industrial	Drain down and flush system prior to equipment break-in or maintenance. E55. Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16. Wear suitable coveralls to prevent exposure to the skin. PPE27.
Naphtha 0-1% benzene	N_0-1p_3	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance	Distribution of substance - Industrial	Drain down and flush system prior to equipment break-in or maintenance. E55. Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16. Wear suitable coveralls to

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
					Wear suitable coveralls to prevent exposure to the skin. PPE27.		prevent exposure to the skin. PPE27.
Naphtha 0-1% benzene	N_0-1p_11	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS501 Bulk closed loading and unloading. Bulk closed loading (e.g. road/rail car bottom loading; marine vessel/barge loading)	Distribution of substance - Industrial	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.	Ensure material transfers are under containment or extract ventilation. E66.	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Naphtha 0-1% benzene	N_0-1p_13	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS5 Equipment maintenance. Equipment maintenance e.g. Vehicle, boiler, pump maintenance, pump calibration	Use as a fuel - Professional	Drain down system prior to equipment break-in or maintenance. E65. Provide a good standard of general ventilation. Natural ventilation is from doors, windows etc. Controlled ventilation means air is supplied or removed by a powered fan. E1. Ensure operatives are trained to minimise exposures. EI19. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Drain down system prior to equipment break-in or maintenance. E65. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Provide a good standard of general ventilation. Natural ventilation is from doors, windows etc. Controlled ventilation means air is supplied or removed by a powered fan. E1.	Drain down system prior to equipment break-in or maintenance. E65. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Provide a good standard of general ventilation. Natural ventilation is from doors, windows etc. Controlled ventilation means air is supplied or removed by a powered fan. E1. Ensure operatives are trained to minimise exposures. EI19. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Wear suitable coveralls to prevent exposure to the skin. PPE27.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Naphtha 0-1% benzene	N_0-1p_15	PROC 15 Use as laboratory reagent	CS36 Laboratory activities	manufacture of substance - industrial	Handle in a fume cupboard or under extract ventilation. E83. Wear suitable gloves tested to EN374. PPE15. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. E12.	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. E12. Wear suitable gloves tested to EN374. PPE15. Wear suitable coveralls to prevent exposure to the skin. PPE27.
Naphtha 0-1% benzene	N_0-1p_16	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS502 Bulk closed unloading. Bulk delivery (closed) (e.g. heating oil, diesel, bunker fuel deliveries)	Use as a fuel - Professional	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.	Ensure material transfers are under containment or extract ventilation. E66.	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.
Naphtha 0-1% benzene	N_0-1p_17	PROC 8b Transfer of a substance or preparation (charging/ discharging) from/to vessels/large	CS507 Refuelling. Refueling vehicles, light aircraft or marine	Use as a fuel - Professional	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15.	Ensure material transfers are under containment or extract ventilation. E66.	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
		containers at dedicated facilities					Clear transfer lines prior to de-coupling. E39.
Naphtha 0-1% benzene	N_0-1p_19	PROC 2 Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	CS15 General exposures (closed systems). + CS56 With sample collection.	Manufacture of substance - Industrial	Wear suitable gloves tested to EN374. PPE15. Handle substance within a closed system. E47. Ensure samples are collected under containment or extract ventilation. E76.	Handle substance within a closed system. E47. Sample via a closed loop or other system intended to avoid exposure. E8.	Handle substance within closed systems. E47. Sample via a closed loop or other system intended to avoid exposure. E8. Wear suitable gloves tested to EN374. PPE15.
Naphtha 0-1% benzene	N_0-1p_20	PROC 2 Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	CS67 Storage.	Manufacture of substance - Industrial	Ensure operation is undertaken outdoors. E69. Store substance within a closed system. E84. Avoid dip samples. E42.	Store substance within a closed system. E84.	Ensure operation is undertaken outdoors. E69. Store substance within a closed system. E84. Avoid dip samples. E42.
Naphtha 0-1% benzene	N_0-1p_8	PROC 3 Use in closed batch process (synthesis or formulation)	CS2 Process sampling	Distribution of substance - Industrial	Sample via a closed loop or other system intended to avoid exposure. E8. Wear suitable gloves tested to EN374. PPE15.	Sample via a closed loop or other system intended to avoid exposure. E8.	Sample via a closed loop or other system intended to avoid exposure. E8. Wear suitable gloves tested to EN374. PPE15.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Naphtha 0-1% benzene	N_0-1p_10	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS500 Bulk closed loading.. Bulk closed loading and unloading (e.g. road/rail car bottom loading/ unloading; marine vessel/barge loading/unloading)	Distribution of substance - Industrial	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.	Ensure material transfers are under containment or extract ventilation. E66.	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.
					Quantitative RMMs	**Qualitative Specific Measures**	**Consolidated RMMs for communication in Exposure Scenarios.**
Naphtha 1-5% benzene	N_1-5p_1	PROC 2 Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	CS15 General exposures (closed systems). + CS56 With	Manufacture of substance – Industrial	Wear suitable gloves tested to EN374. PPE15. Sample via a closed loop system. E8. Handle substance within a closed system. E47.	Handle substance within closed systems. E47. Sample via a closed loop or other system intended to avoid exposure. E8.	Handle substance within closed systems. E47. Sample via a closed loop or other system intended to avoid exposure. E8. Wear suitable gloves tested to EN374. PPE15.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
			sample collection.				
Naphtha 1-5% benzene	N_1-5p_13	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance	Formulation & (re)packing of substances and mixtures - Industrial	Drain down and flush system prior to equipment break-in or maintenance. E55. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Wear suitable coveralls to prevent exposure to the skin. PPE27.
Naphtha 1-5% benzene	N_1-5p_2	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large	CS39 Equipment cleaning and maintenance	Manufacture of substance – Industrial	Drain down and flush system prior to equipment break-in or maintenance. E55. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
		containers at non-dedicated facilities.			Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear suitable coveralls to prevent exposure to the skin. PPE27.	recycle. ENVT4. Clear spills immediately. C&H13.	C&H13. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Wear suitable coveralls to prevent exposure to the skin. PPE27.
Naphtha 1-5% benzene	N_1-5p_9	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	CS39 Equipment cleaning and maintenance	Distribution of substance - Industrial	Drain down and flush system prior to equipment break-in or maintenance. E55. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13.	Drain down and flush system prior to equipment break-in or maintenance. E55. Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4. Clear spills immediately. C&H13. Wear chemically resistant gloves (tested to EN374) in combination with intensive management supervision controls. PPE18. Wear suitable coveralls to prevent exposure to the skin. PPE27.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Naphtha 1-5% benzene	N_1-5p_14	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS501 Bulk closed loading and unloading. Bulk closed loading (e.g. road/rail car bottom loading; marine vessel/barge loading)	Distribution of substance - Industrial	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.	Ensure material transfers are under containment or extract ventilation. E66.	Ensure material transfers are under containment or extract ventilation. E66. Wear suitable gloves tested to EN374. PPE15. Avoid splashing. C&H15. Clear transfer lines prior to de-coupling. E39.
Naphtha 1-5% benzene	N_1-5p_15	PROC 15 Use as laboratory reagent	CS36 Laboratory activities	Manufacture of substance - Industrial	Handle in a fume cupboard or under extract ventilation. E83. Wear suitable gloves tested to EN374. PPE15. Wear suitable coveralls to prevent exposure to the skin. PPE27.	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. E12.	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. E12. Wear suitable gloves tested to EN374. PPE15. Wear suitable coveralls to prevent exposure to the skin. PPE27.
Naphtha 1-5% benzene	N_1-5p_3	PROC 2 Use in closed, continuous process with occasional	CS67 Storage	Manufacture of substance - Industrial	Wear suitable gloves tested to EN374. PPE15. Store substance within a closed system. E84. Avoid dip samples. E42.	Store substance within a closed system. E84.	Wear suitable gloves tested to EN374. PPE15. Store substance within a closed system. E84. Avoid dip samples. E42.

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
		controlled exposure (e.g. sampling)					
					RMMs for communication - Consolidate into GES or e-SDS (Black text REACH advised; Blue text recommended)		
Vacuum gas oils	ES_vcgo_1	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	Clean down and Maintenance	Manufacture of substance	Drain down system prior to equipment break-in or maintenance. E65. Retain drain down in sealed storage pending disposal or for subsequent recycle ENVT4. Deal with spills immediately. C&H13. Wear chemically resistant gloves (tested to EN374). PPE16 Wear suitable coveralls to prevent exposure to the skin PPE27		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Vacuum gas oils	ES_vcgo_28	PROC 8a Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities.	Maintenance of equipment	Water treatment applications, industrial	Apply vessel entry procedures including use of forced supplied air. AP15 Drain down system prior to equipment break-in or maintenance E65 Transfer via enclosed lines E52 Wear suitable gloves tested to EN374 PPE16 Wear suitable coveralls to prevent exposure to the skin PPE27 Retain drain downs in sealed storage pending disposal or for subsequent recycle. ENVT4		
Vacuum gas oils	ES_vcgo_29	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS503. Bulk closed loading and unloading NEW CS (e.g. road/rail car bottom loading/unloading; marine vessel/barge loading/unloading;)	Distribution of substance	Ensure material transfers are under containment or extract ventilation E66 Clear transfer lines prior to decoupling E38 Ensure operation is undertaken outdoors E69 Wear suitable gloves tested to EN374. PPE15.		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Vacuum gas oils	ES_vcgo_30	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS503. Bulk open loading NEW CS (e.g. road/rail car top loading, may involve LEV)	Distribution of substance	Ensure material transfers are under containment or extract ventilation E66 Clear transfer lines prior to decoupling E38 Ensure operation is undertaken outdoors E69 Wear suitable gloves tested to EN374. PPE15.		
Vacuum gas oils	ES_vcgo_31	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS501. Bulk transfers (closed systems) e.g bottom loading	Manufacture of substance	Handle substance within a closed system E47 Wear chemically resistant gloves (tested to EN374) PPE15 Ensure material transfers are under containment or extract ventilation. E56 Avoid splashing C&H15 Operate activity from way from sources of substance emission or release E77		
Vacuum gas oils	ES_vcgo_32	PROC 2 Use in closed, continuous process with occasional controlled exposure (e.g. sampling)	CS85. Bulk Storage	Manufacture of substance	Store substance within a closed system. E84 Avoid dip samples E42		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Vacuum gas oils	ES_vcgo_33	PROC 15 Use as laboratory reagent	CS36. Laboratory activities	Manufacture of substance	Use in fume cupboard E83 Wear suitable gloves tested to EN374 PPE15		
Vacuum gas oils	ES_vcgo_34	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS507 Use as a fuel	Use as a fuel	Use drum pumps or carefully pour from container. E64 Wear suitable gloves tested to EN374 PPE16 Avoid spillage when withdrawing pump. C&H16 Deal with spills immediately. C&H13		
Vacuum gas oils	ES_vcgo_35	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS14 Bulk transfers (barge, rail and road)	Use as a fuel Industrial	Handle substance within a closed system. E47 Operate activity from way from sources of substance emission or release E77 Ensure material transfers are under containment or extract ventilation. E56. Wear chemically resistant gloves (tested to EN374) PPE15 Avoid splashing C&H15		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Vacuum gas oils	ES_vcgo_36	PROC 8b Transfer of a substance or preparation (charging /discharging) from/to vessels/large containers at dedicated facilities	CS14 Bulk transfers (e.g. heating oil and diesel deliveries)	Use as a fuel professional	Provide a good standard of general ventilation (3 to 5 air changes per hour) E40 **or** Ensure operation is undertaken outdoors E69 Clear lines prior to decoupling. E39 Wear suitable gloves tested to EN374. PPE15		
					RMMs for communication - Consolidate into GES or e-SDS (Black text REACH advised; Blue text recommended)		
Other lubricant base oils - aerosol	ES_OLBO_16+17	PROC 17 Lubrication at high energy conditions and in partly open process	CS79 Metal machining operations	Metal working fluids / rolling oils professional	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) E40 Avoid carrying out activities involving exposure for more than 4 hours OC28 Limit the substance content in the product to 25 % OC18 Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16 Ensure operatives are trained to minimise exposures EI19		

Substance	ES_ID	PROC	Situation	General description of situation	RMMs for communication - Consolidate into narrative or e-SDS (Black text REACH advised; Blue text recommended)		
Other lubricant base oils - vapour	ES_OLBO_16+17	PROC 17 Lubrication at high energy conditions and in partly open process	CS79 Metal machining operations	Metal working fluids / rolling oils professional	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) E40 Avoid carrying out activities involving exposure for more than 4 hours OC28 Limit the substance content in the product to 25 % OC18 Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. PPE16 Ensure operatives are trained to minimise exposures EI19		