

An investigation of mortality and cancer incidence
in United Kingdom oil refinery workers,
1951 – 2011

AN INVESTIGATION OF MORTALITY AND CANCER INCIDENCE IN
UNITED KINGDOM OIL REFINERY WORKERS, 1951–2011

Third edition

October 2016

Published by

ENERGY INSTITUTE, LONDON

The Energy Institute is a professional membership body incorporated by Royal Charter 2003

Registered charity number 1097899

The Energy Institute (EI) is the chartered professional membership body for the energy industry, supporting over 23 000 individuals working in or studying energy and 250 energy companies worldwide. The EI provides learning and networking opportunities to support professional development, as well as professional recognition and technical and scientific knowledge resources on energy in all its forms and applications.

The EI's purpose is to develop and disseminate knowledge, skills and good practice towards a safe, secure and sustainable energy system. In fulfilling this mission, the EI addresses the depth and breadth of the energy sector, from fuels and fuels distribution to health and safety, sustainability and the environment. It also informs policy by providing a platform for debate and scientifically-sound information on energy issues.

The EI is licensed by:

- the Engineering Council to award Chartered, Incorporated and Engineering Technician status;
- the Science Council to award Chartered Scientist status, and
- the Society for the Environment to award Chartered Environmentalist status.

It also offers its own Chartered Energy Engineer, Chartered Petroleum Engineer and Chartered Energy Manager titles.

A registered charity, the EI serves society with independence, professionalism and a wealth of expertise in all energy matters.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit <http://www.energyinst.org>

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies

BP Exploration Operating Co Ltd	RWE npower
BP Oil UK Ltd	Saudi Aramco
Centrica	Scottish Power
Chevron	SGS
CLH	Shell UK Oil Products Limited
ConocoPhillips Ltd	Shell U.K. Exploration and Production Ltd
DCC Energy	SSE
DONG Energy	Statkraft
EDF Energy	Statoil
ENGIE	Talisman Sinopec Energy (UK) Ltd
ENI	Tesoro
E. ON UK	Total E&P UK Limited
ExxonMobil International Ltd	Total UK Limited
Kuwait Petroleum International Ltd	Tullow Oil
Maersk Oil North Sea UK Limited	Valero
Nexen	Vattenfall
Phillips 66	Vitol
Qatar Petroleum	World Fuel Services

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

Copyright © 2016 by the Energy Institute, London.

The Energy Institute is a professional membership body incorporated by Royal Charter 2003.

Registered charity number 1097899, England

All rights reserved

No part of this book may be reproduced by any means, or transmitted or translated into a machine language without the written permission of the publisher.

ISBN 978 0 85293 951 2

Published by the Energy Institute

The information contained in this publication is provided for general information purposes only. Whilst the Energy Institute and the contributors have applied reasonable care in developing this publication, no representations or warranties, express or implied, are made by the Energy Institute or any of the contributors concerning the applicability, suitability, accuracy or completeness of the information contained herein and the Energy Institute and the contributors accept no responsibility whatsoever for the use of this information. Neither the Energy Institute nor any of the contributors shall be liable in any way for any liability, loss, cost or damage incurred as a result of the receipt or use of the information contained herein.

Hard copy and electronic access to EI and IP publications is available via our website, <https://publishing.energyinst.org>.

Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.

For more information, contact the EI Publications Team.

e: pubs@energyinst.org

CONTENTS

	Page
Acknowledgements	6
Executive summary	7
1 Introduction	8
2 Materials and methods	9
3 Results	11
3.1 Detailed mortality findings.	12
3.2 Detailed cancer incidence findings.	13
4 Discussion	14
5 Tables 1 – 49	16
Annexes	
Annex A Abbreviations and acronyms	43
Annex B References	44

LIST OF TABLES

TABLES

Table 1	Mortality from main disease groupings in UK oil refinery workers, Institute of Petroleum cohort, 1951–2011	16
Table 2	Cancer mortality in UK oil refinery workers Institute of Petroleum cohort, 1951–2011	17
Table 3	Leukaemia mortality and related conditions, 1968–2011	18
Table 4	Cancer incidence in UK oil refinery workers, Institute of Petroleum cohort, 1971–2011	19
Table 5	Incidence of leukaemia and related conditions, 1971–2011	20
Table 6	Mortality from all causes in UK oil refinery workers, by year of death, 1951–2011 . .	21
Table 7	Mortality from all causes in UK oil refinery workers, by period from commencing employment, 1951–2011	21
Table 8	Mortality from all causes in UK oil refinery workers, by period of commencing employment, 1951–2011	22
Table 9	Mortality from all causes in UK oil refinery workers, by job codes, 1951–2011	22
Table 10	Mortality from melanoma in UK oil refinery workers, by year of death, 1951–2011	23
Table 11	Mortality from melanoma in UK oil refinery workers, by period from commencing employment, 1951–2011	23
Table 12	Mortality from melanoma in UK oil refinery workers, by period of commencing employment, 1951–2011	24
Table 13	Mortality from melanoma in UK oil refinery workers, by job codes, 1951–2011	24
Table 14	Mortality from mesothelioma in UK oil refinery workers, by year of death, 1951–2011	25
Table 15	Mortality from mesothelioma in UK oil refinery workers, by period from commencing employment, 1951–2011	25
Table 16	Mortality from mesothelioma in UK oil refinery workers, by period of commencing employment, 1951–2011	26
Table 17	Mortality from mesothelioma in UK oil refinery workers, by job codes, 1951–2011	26
Table 18	Mortality from leukaemia in UK oil refinery workers, by year of death, 1951–2011 .	27
Table 19	Mortality from leukaemia in UK oil refinery workers, by period from commencing employment, 1951–2011	27
Table 20	Mortality from leukaemia in UK oil refinery workers, by period of commencing employment, 1951–2011	28
Table 21	Mortality from leukaemia in UK oil refinery workers, by job codes, 1951–2011	28
Table 22	Mortality from all ANLL in UK oil refinery workers, by year of death, 1968–2011 . . .	29
Table 23	Mortality from ANLL in UK oil refinery workers, by period from commencing employment, 1968–2011	29
Table 24	Mortality from ANLL in UK oil refinery workers, by period of commencing employment, 1968–2011	30
Table 25	Mortality from ANLL in UK oil refinery workers, by job codes, 1968–2011	30
Table 26	Incidence of melanoma in UK oil refinery workers, by year of registration, 1971–2011	31
Table 27	Incidence of melanoma in UK oil refinery workers, by period from commencing employment, 1971–2011	31
Table 28	Incidence of melanoma in UK oil refinery workers, by period of commencing employment, 1971–2011	31

Contents continued

	Page
Table 29	Incidence of melanoma in UK oil refinery workers, by job codes, 1971–2011 32
Table 30	Incidence of mesothelioma in UK oil refinery workers, by year of registration, 1971–2011 32
Table 31	Incidence of mesothelioma in UK oil refinery workers, by period from commencing employment, 1971–2011 33
Table 32	Incidence of mesothelioma in UK oil refinery workers, by period of commencing employment, 1971–2011 33
Table 33	Incidence of mesothelioma in UK oil refinery workers, by job codes, 1971–2011 . . . 34
Table 34	Incidence of leukaemia in UK oil refinery workers, by year of registration, 1971–2011 34
Table 35	Incidence of leukaemia in UK oil refinery workers, by period from commencing employment, 1971–2011 35
Table 36	Incidence of leukaemia in UK oil refinery workers, by period of commencing employment, 1971–2011 35
Table 37	Incidence of leukaemia in UK oil refinery workers, by job codes, 1971–2011 36
Table 38	Incidence of all ANLL in UK oil refinery workers, by year of death, 1971–2011 36
Table 39	Incidence of ANLL in UK oil refinery workers, by period from commencing employment, 1971–2011 37
Table 40	Incidence of ANLL in UK oil refinery workers, by period of commencing employment, 1971–2011 37
Table 41	Incidence of ANLL in UK oil refinery workers, by job codes, 1971–2011 38
Table 42	Incidence of all skin cancer (excluding melanoma) in UK oil refinery workers, by year of death, 1971–2011 38
Table 43	Incidence of skin cancer (excluding melanoma) in UK oil refinery workers, by period from commencing employment, 1971–2011 39
Table 44	Incidence of skin cancer (excluding melanoma) in UK oil refinery workers, by period of commencing employment, 1971–2011 39
Table 45	Incidence of skin cancer (excluding melanoma) in UK oil refinery workers, by job codes, 1971–2011 40
Table 46	Incidence of all MDS in UK oil refinery workers, by year of death, 1995–2011 40
Table 47	Incidence of MDS in UK oil refinery workers, by period from commencing employment, 1995–2011 41
Table 48	Incidence of MDS in UK oil refinery workers, by period of commencing employment, 1995–2011 41
Table 49	Incidence of MDS in UK oil refinery workers, by job codes, 1995–2011 42

ACKNOWLEDGEMENTS

The Energy Institute (EI) would like to express its appreciation of the work carried out by Professor Tom Sorahan of the University of Birmingham as the author of the report.

The update of the report has been overseen by the EI's Health Technical Committee, and the EI wishes to record its gratitude for the valuable contributions of the committee's membership, including representatives from the following companies/organisations:

- Abermed/International SOS
- BG Group
- BOHRF
- BP
- Capita
- Centrica
- Chevron
- ConocoPhillips
- ExxonMobil
- Maersk Oil
- Oil & Gas UK
- RS Occupational Health
- Saudi Aramco
- Shell
- Talisman Energy
- University of Portsmouth

The author is grateful to the EI for its financial support in carrying out this work, the Office for National Statistics, the Health and Social Care Information Centre, the General Register Office for Scotland for the supply of follow-up particulars and the Vital Statistics Offices of England, Wales and Scotland for supplying anonymised historical cancer registration data for the generation of cancer incidence rates.

1 INTRODUCTION

The EI has developed an epidemiological cohort study into the mortality and cancer morbidity experience of male employees from eight oil refineries in the UK (Rushton and Alderson, 1981; Rushton, 1993a; Sorahan et al, 2001a; Sorahan et al, 2002; Sorahan, 2007). A separate cohort study is also available for UK petroleum distribution workers (Sorahan et al, 2002; Sorahan, 2007; Rushton and Alderson, 1983; Rushton, 1993b, Sorahan et al, 2001b).

The original cohort comprised 34 569 oil refinery workers (Rushton, 1993a). All these male employees had a minimum period of employment of 12 months in the period 1950–75; some study subjects were first employed around the turn of the century. The cohort was re-defined in 1995 so that findings would be relevant to more recent work conditions, which can be described with some confidence (Sorahan et al, 2001a; Sorahan et al, 2002; Sorahan, 2007). The updated analyses are now limited to those 28 554 workers first employed after 1 January 1946. The new findings refer in the main to an entry cohort (workers first employed in the period 1950–74). The extent of any 'survivor population effect' present in the sub-cohort of workers first employed in the period 1946–49 was judged likely to be modest (such workers would only appear in the study if they remained ('survived') in the industry until 1 January 1951).

A further eight years of mortality and cancer registration data (2004–2011) were available for analysis in the overall period of follow-up (1951–2011). The objectives of the study were to summarise available mortality and cancer registration data and to determine whether any part of the mortality and morbidity experience of the cohort might be related to occupational exposures; in which event, further analyses capable of investigating the potential role of specific occupational exposures might be needed.