CANADIAN REGISTRATION BOARD OF OCCUPATIONAL HYGIENISTS

ROH
(Registered Occupational Hygienist)

Examination Handbook

For additional information, contact:

The Registrar registrar@crboh.ca

PO Box 26125, Maryland Postal Outlet, Winnipeg, MB, R3G 3R3

www.crboh.ca

Updated March 2022

Table of Contents

1. Examination Eligibility

Eligibility for the examination is based on having one of the following combinations of academic qualifications and professional experience:

1.1. Academic Qualification Professional Experience

PhD (occupational hygiene or equivalent)	2	years
PhD (acceptable science or engineering)	3	years
Master (occupational hygiene or equivalent)	3	years
Master (acceptable science or engineering)	4	years
Bachelor (occupational hygiene or equivalent)	4	years
Bachelor (acceptable science or engineering)	5	years

Professional experience may only be claimed for periods in which the applicant was primarily (more than 50% of each year) engaged in the professional practice of occupational hygiene or closely related activities. Two references from ROH or other accredited individuals must be provided (e.g., CIH, CRSP, CSP).

1.2. Examination Format

The ROH examination process is predicated on the commonly accepted education principle that there is no single examination format which can assess competence in factual and technical knowledge, as well as communication, technical and problem-solving skills, professional judgment, and ethics.

The Examination is Divided into Two Parts:

Part I is a one-day written examination, one half of which is multiple-choice, one-half essay style questions. Equal weight is given to each of these components. The multiple-choice section of the examination consists of approximately 130 questions, all equal value. There is only one correct answer to each question and marks are given only for correct answers. In the essay-style component of the examination, candidates are presented with 5 questions of equal value. All 5 questions must be answered. Candidates must achieve a passing grade in each of the written examination components to successfully complete Part I.

[Note: Candidates who hold the CIH designation in Comprehensive Practice from the Board for Global EHS Credentialling (BGC) / American Board of Industrial Hygiene (ABIH) will be exempted from Part I].

Part II is an interview for those who successfully complete Part I. The interview is an assessment of the candidate's competence through evaluation of his or her verbal responses to questions or scenarios put forward by a group of examiners. The interview is used to evaluate the candidates' problem-solving skills, professional judgment, and communication skills and is approximately one hour in duration.

Candidates wishing to find out more about the CRBOH examination rationale and process should read the paper: *Verma et al (1994) Evaluation of Professional Competency in Occupational Hygiene in Canada-The CRBOH Program, American Industrial Hygiene Association Journal, Volume 55, pp. 364-369.*

2. Examination: General Content

Occupational hygiene involves the identification of existing and potential health hazards in, or arising from the workplace, the evaluation or assessment of the extent of risk posed by the hazards and the development of effective strategies to eliminate or control the risks. For the ROH examination, it is expected that candidates will be familiar with a broad range of occupational hygiene topics identified by the CRBOH, including:

- Air sampling, analysis, and control measures for chemical hazards.
- Physics, measurement, and control for physical agents such as noise, vibration, ionizing and non-ionizing radiation, temperature and pressure extremes, lighting.
- Industrial toxicology, the adverse health effects associated with the physical agents (as above).
- The rationale for occupational hygiene standard setting.
- Statistics, epidemiology, ergonomics, biohazards, hygiene program management, labour relations, safety and environmental issues, as they apply to the practice of occupational hygiene.
- Current topical issues in occupational hygiene.

3. Examination Preparation

Candidates should consider their knowledge and experience within the areas of competency outlined below. This process may assist candidates in identifying their strengths and weaknesses, thereby enabling them to focus their efforts appropriately during examination preparation. Sample questions (multiple-choice and essay style), and a representative listing of references, are provided.

3.1 Sample Multiple-Choice Questions

The following are examples of the type of questions that may be expected within the multiple-choice component of the examination. These examples are not necessarily indicative of the degree of difficulty of all multiple-choice questions.

Which of the following health effects is associated with chronic overexposure to ethylene oxide?

A) Colon tumors

B) Increased frequency of spontaneous abortions

C) Abdominal colic

D) Kidney failure

E) Aneurysm.

Two separate noise sources of 98 dBA and 96 dBA respectively are installed and operated together. What is the combined noise level?

A) 99 dBA

B) 100 dBA

C) 101 dBA

D) 123 dBA

E) 194 dBA

Which health hazard below is most likely to be found at an electroplating facility?

A) Exposure to extreme cold temperatures

B) Exposure to cyanide salt solutions

C) Exposure to heavy metal dusts

D) Exposure to volatile organic compounds

3.2 Sample Essay Style Questions

Candidates are reminded that essay questions are typically broad in nature and cover several of the required areas of competency in an overlapping manner. Candidates should provide sufficient information within their answers to demonstrate the depth and breadth of their knowledge within these areas of competency.

One of the plants for which you are responsible as an occupational hygienist is a freezer manufacturing plant which employs 300 people. During a recent walkthrough survey, you pinpointed one area of the assembly line for further investigation - the foam insulation injection step. The foam is prepared by mixing a **Toluene diisocyanate** (TDI) and a polyol through a hand-held injection molding gun. Methylene chloride is used for cleaning the gun.

1. **Briefly describe the major health effects associated with overexposure to Methylene chloride and Toluene diisocyanate (TDI)**

    - Outline the protocols you would use to assess worker exposures to these two chemicals. In your answer, include details regarding the sampling equipment and your strategy and, where appropriate, analytical methods.

    - Describe what steps you would take to reduce personal exposures in this situation.

    - Many workplace hazards require special health and safety procedures and/or control programs to be developed. In this scenario, you are responsible for health and safety at the largest laboratory facility for occupational health and hygiene analytical services in North America. Services of the facility include the entire range of traditional hygiene air sampling analyses as well as analyses of blood and urine. There are 75 employees working in the laboratories.

    - What process would you follow in designing and implementing an effective control program for chemical management and associated safety procedures in this environment?

    - What key elements would be included in your control program?

4. Examination Grading Process and Appeals

The CRBOH Administrative Office is responsible for ALL contact with examination candidates. This includes the receipt of application forms, review and decision-making regarding eligibility, exam location/date/time and selection of proctors. The Administrative Office handles all inquiries from candidates. The Administrative Office assigns each candidate a Candidate Identification Number. To ensure that marking is carried out "blind", Examination Committee members do not have access to these identifiers.

Written examinations are marked by the ROH Examination Committee. Multiple choice questions are marked by the Chair of the Examination Committee. The essay style questions are marked independently by at least two members of the Committee. The results are collated by the Chair and any anomalies or inconsistencies are reviewed. The minimum grade necessary for successful completion is set prior to the exam. The chair of the Committee forwards the results to the Board of Directors with the recommendation of the Committee as to whether the candidate should be granted a pass or fail. Only those candidates granted a pass on the written examination will proceed to the interview.

Candidates who wish to appeal the results of an examination must provide their appeal in writing to the Registrar within 30 days of receiving the examination results.

5. Useful References in Occupational Hygiene

The following list of texts, manuals, journals, regulations, standards, and guidelines are provided to give candidates examples of the types of materials they should be reviewing in preparation for the examination. The list is not meant to be complete or exhaustive.

Candidates are expected to use professional judgment in selection of other reading material for exam preparation. Candidates are expected to use the most recent edition available; as a guide, dates as of late 2009 are provided.

5.1 Texts

- Casarette and Doull's Toxicology: The Basic Science of Poisons (Latest Edition); C.D. Klaassen, editor.
- Ergonomic Design for People at Work, Volumes I and II; Eastman Kodak Company, New York, 1983 (Volume I), 1986 (Volume II)
- Fundamentals of Industrial Hygiene (Latest Edition); B.A. Plog and T. Hogan, editors
- The Occupational Environment: Its Evaluation and Control (Latest Edition); S. DiNardi, editor
- In-Plant Practices for Job-related Health Hazards Control, Volumes I and II (Latest Edition); L.V Cralley and L.J Cralley, editor
- Industrial Hygiene Management; J. T. Garrett, L.J. Cralley and L.V. Cralley, editors
- Patty's Industrial Hygiene and Toxicology, Volumes IA & IB, IIA to IIC, IIIA & IIIB (Latest Edition); G.D. Clayton and F.E. Clayton, editors (Vols. I & II), L.J. Cralley and L.V. Cralley, editors (Vol. III)
- Recognition of Health Hazards in Industry: A Review of Materials and Processes; W.A.Burgess

- Industrial Toxicology: Safety and Health Applications in the Workplace; P.L. Williams and J.L. Burson, editors
- Noise and Noise Control; M.J. Crocker and F.M. Kessler, editors
- Air Monitoring for Toxic Substances, S. Ness, editor
- Air Monitoring Instrumentation; C.J. Maslansky and S.P. Maslansky, editors
- Applications and Occupational Elements of Industrial Hygiene; M.B. Stern and S.Z. Mansdorf, editors
- Air Sampling Instruments, ACGIH, 1995
- Bioaerosols: Assessment and Control; ACGIH Bioaerosols Committee, J. Macher, editor, 1998
- Building Air Quality; U.S. EPA and NIOSH, 1991

5.2 Manuals (latest editions)

- Handbook of Chemistry and Physics
- ACGIH Industrial Ventilation: A Manual of Recommended Practice
- NIOSH Guide to Industrial Respiratory Protection
- NIOSH Manual of Analytical Methods
- ACGIH Air Sampling Instruments Handbook
- AIHA The Noise Manual

5.3 Journals

- American Industrial Hygiene Association Journal
- Applied Occupational and Environmental Hygiene
- Annals of Occupational Hygiene
- Scandinavian Journal of Work, Environment and Health
- Journal of Toxicology and Environmental Health
- Archives of Environmental Health
- Health Physics
- Journal of Occupational and Environmental Medicine
- Acoustic Journal

5.4 Regulations, Standards, Guidelines

- Workplace Hazardous Materials Information System Regulation
- Transportation of Dangerous Goods Act (federal)
- Criteria for a Recommended Standard

- ACGIH: The Documentation of TLVs and BEIs
- ACGIH: TLVs: Threshold Limit Values and Biological Exposure Indices
- AIHA Workplace Environmental Exposure Levels (WEELs) Guides.

6. Areas of Competency

6.1 Basic Science

General concepts within chemistry, biology, physiology, physics, biochemistry, anatomy, and psychology which form the underlying basis for the science of occupational hygiene.

6.2 Chemical Hazards

Understanding of the toxicology and potential health effects of exposure to chemical substances (symptoms, modes of action, routes of entry, absorption, metabolism, distribution and excretion), methods of evaluation of chemical exposure (air sampling and biological monitoring techniques), analytical methods, and controls (engineering controls such as ventilation, isolation, and process change; administrative controls; personal protective equipment selection, use and limitations).

6.3 Physical Hazards: Noise

Health effects arising from exposure to noise, the physics of noise, methods of measuring and evaluating noise exposure, engineering controls to reduce noise exposure, selection, and use of hearing protection.

6.4 Physical Hazards: Other

Physical characteristics, potential health effects of exposure, evaluation and measurement of exposure, and control methods for ionizing radiation, non-ionizing radiation, thermal and pressure stressors, and vibration.

6.5 Biological Hazards

Potential and actual health effects of exposure to biological agents (bacteria, allergens, toxins, moulds, fungi, viruses, bloodborne pathogens, etc.). Evaluation, measurement and control of exposure to biological hazards.

6.6 Legislation

General understanding of occupational health, safety and hygiene legislation within at least one Canadian jurisdiction. Understanding of accepted industry health and safety standards including the American Conference of Governmental Industrial Hygienists threshold limit values, Canadian Standards Association's health and safety standards, and The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) guidelines respecting acceptable air quality.

6.7 Ergonomics

Understanding of biomechanical, anthropometric, physiological, anatomical, and engineering principles needed to design and organize the workplace for the purpose of preventing injuries and illnesses.

6.8 Biostatistics and Epidemiology

Techniques for study of occupationally induced diseases and physiological conditions in workplaces. Basic statistical and non-statistical interpretation of epidemiological data in evaluating hazards.

6.9 Safety

Understanding of basic safety principles as they apply to the practice of occupational hygiene (e.g., confined space).

6.10 Environmental Issues

Health and environmental effects of pollutants. Knowledge of current environmental issues and a general understanding of the requirements of environmental legislation. Knowledge of the potential impact of occupational hygiene controls (ventilation systems, air cleaning technologies) on public health.

6.11 Process–related Hazards

Hazards associated with processes within various occupational settings.

6.12 Labour Relations

Understanding of the roles and perspectives of the various occupational health, safety and hygiene perspectives of unions, workers, and management.

6.13 Ethics

Standards of ethical professional conduct, conflict of interest, CRBOH Code of Ethics.

6.14 Management

Development, implementation, and evaluation of occupational hygiene programs. Topics such as resource allocation, budgeting, delegation of authority, accountability, communication, policy making, etc.

7. Useful Equations for CRBOH Examinations

The following list of equations is intended to assist candidates in preparation for the CRBOH ROH examination. It will also be provided for use during completion of the examination. This list is not meant to be complete or exhaustive. Consequently, use of any or all of these equations will not necessarily result in successful completion of the ROH examination.

7.1 General Practice and Statistics

$ppm = \frac{V_{contam}}{V_{air}} x10^6$	$ppm = \frac{P_v}{P_{atm}} x10^6$	$ppm = \frac{mg/m^3 \times 24.45}{MW}$	$\frac{P_1V_1}{nRT_1} = \frac{P_2V_2}{nRT_2}$
$V_{TS} = \frac{gd_p^2(\rho_p - \rho_a)}{18\eta}$	$R_e = \frac{\rho dv}{\eta}$	$\frac{C}{C_0} = e^{-\frac{W}{V}}$	$\log\frac{I_o}{I} = abc$
$pH = -\log_{10}[H^+]$		$P_{total} = X_1P_1 + X_2P_2 + \cdots + X_iP_i$	
$TLV_{mix} = \frac{C_1}{TLV_1} + \frac{C_2}{TLV_2} + \cdots + \frac{C_n}{TLV_n}$		$TLV_{mix} = \frac{1}{\frac{F_1}{TLV_1} + \frac{F_2}{TLV_2} + \cdots + \frac{F_n}{TLV_n}}$	
$\overline{X} = \frac{X_1 + X_2 + \cdots + X_n}{n}$	$SD = \sqrt{\frac{\sum(\overline{x} - x_i)^2}{n-1}}$	$GM = 10^{\frac{\sum(\log x)}{n}}$	$GM = \sqrt[n]{(x_1)(x_2)\ldots(x_n)}$
$GSD = \frac{84.13\%tile\ value}{50\%tile\ value}$		$GSD = \frac{50\%tile\ value}{15.87\%tile\ value}$	
$SAE = 1.645\, CV_{total}$	$t = \frac{\overline{x_1} - \overline{x_2}}{SD_{pooled}\sqrt{1/n_1 + 1/n_2}}$	$SD_{pooled} = \sqrt{\frac{(n_1-1)SD_1^2 + (n_2-1)SD_2^2}{n_1 + n_2 - 2}}$	
$LCL = \frac{C_A}{STD} - \frac{SAE\sqrt{T_1^2C_1^2 + T_2^2C_2^2 + \cdots + T_n^2C_n^2}}{PEL\ (T_1 + T_2 + \cdots + T_n)}$		95% $Conf = \overline{X} \pm (1.645\, CV \cdot \overline{X})$	
95% $Conf = \overline{X} \pm (1.965\, CV \cdot \overline{X})$		$E_c = \sqrt{E_1^2 + E_2^2 + \cdots + E_n^2}$	$CV = \frac{SD}{\overline{X}}$

7.2 Noise

$Lp = 20(\log\frac{P}{P_o})$		$Lp_2 = Lp_1 + 20\log(\frac{d_1}{d_2})$	
$Lp_{diff} = 10\log(10^{\frac{Lp_T - Lp_B}{10}})$		$L_{p_T} = 10\log(\sum_{i=1}^{N} 10^{\frac{L_{p_i}}{10}})$	
$L_{eq} = 10\ \log[\frac{1}{T}\sum_{i=1}^{N}(10^{\frac{L_i}{10}} t_i)]$		$\%D = 100[\frac{C_1}{T_1} + \frac{C_2}{T_2} + \cdots + \frac{C_i}{T_i}]$	
$L_p = L_w + 10\log(\frac{DF}{4\pi r^2} + \frac{4}{R})$	$L_{OSHA} = 16.61\ \log(\frac{\%D}{100}) + 90\ dBA$ $L_{eq} = 10\ \log(\frac{\%D}{100}) + 85\ dBA$		
$DI = 10\log_{10} DF$	$f_2 = \sqrt{2} f_1$	$f = \frac{(N)(RPM)}{60}$	
$f = \frac{c}{\lambda}$	$f_2 = 2f_1$	$f_2 = \sqrt[3]{2} f_1$	$f_c = \sqrt{f_1 f_2}$

7.3 Ventilation

$Q = VA$	$V = 1.29\sqrt{VP}$ m/s $V = 4005\sqrt{VP}$ ft/min	$TP = VP + SP$
$\lvert SP_h \rvert = VP + h_e$	$Q' = \frac{Q}{K}$	$Q = 1.29\, C_e A\sqrt{SP}$ m^3/sec $Q = 4005\, C_e A\sqrt{SP}$ ft^3/sec
$h_e = \frac{1 - C_e^2}{C_e^2} VP$	$C_e = \sqrt{\frac{VP}{\lvert SP_h \rvert}}$	$VP_{ave} = (\frac{\sqrt{VP_1} + \sqrt{VP_2} + \ldots + \sqrt{VP_n}}{n})^2$

$VP_r=[\frac{Q_1}{Q_3}]VP_1+[\frac{Q_2}{Q_3}]VP_2$	$Q_2=Q_1(\frac{Size_2}{Size_1})^3(\frac{RPM_2}{RPM_1})$	$P_2=P_1(\frac{Size_2}{Size_1})^2(\frac{RPM_2}{RPM_1})^2(\frac{\rho_2}{\rho_1})$	
$PWR_2=PWR_1(\frac{Size_2}{Size_1})^5(\frac{RPM_2}{RPM_1})^3(\frac{\rho_2}{\rho_1})$		$AHP = \frac{Q(TP)}{6356}$	$Power=\frac{(Q)(TP)}{(ME)}$ Watts
$FSP = SP_{out} - SP_{in} - VP_{in}$	$Q_{cor} = Q_{design}\sqrt{\frac{SP_{chosen}}{SP_{calc}}}$	$Q_2 = Q_1\sqrt{\frac{\rho_1}{\rho_2}}$	$C=\frac{G}{Q'}(1-e^{-Q't/V})$
$\ln\frac{(G-Q'C_2)}{(G-Q'C_1)}=-\frac{Q'(t_2-t_1)}{V_{room}}$	$C=(\frac{G}{Q'}x10^6)+C_{supply}$		$C=\frac{ER\times24.45\times10^6}{MW\times Q'}$
$Q=\frac{(24.45)(SG)(ER)(K)(10^6)}{(MW)(TLV)}$		$C_t=C_o e^{-Q't/V}$	$N=\frac{60Q}{V_{room}}$ per hr
$t_2-t_1=-\frac{V}{Q'}\ln(\frac{C_2}{C_1})$	$V = 1096\sqrt{\frac{VP}{\rho}}$ ft/min	$V = 1.414\sqrt{\frac{VP}{\rho}}$ m/sec	$F_h=\frac{h_e}{VP_h}$

$$H_f = \frac{0.0155\ V^{0.533}}{Q^{0.612}} \quad \text{for galvanized sheet duct}$$

7.4 Radiation

$I_2 = I_1(\frac{d_1}{d_2})^2$	$Rem = (RAD)(QF)$	$A = A_i(0.5)^{\frac{t}{T_{1/2}}}$	$A_i = \frac{0.693}{T_{1/2}} N_i$
$A = A_i e^{\frac{-0.693t}{T_{1/2}}}$	$\frac{1}{T_{1/2_{eff}}} = \frac{1}{T_{1/2_{rad}}} + \frac{1}{T_{1/2_{bio}}}$	$T_{1/2_{eff}} = \frac{T_{1/2_{rad}} x\ T_{1/2_{bio}}}{T_{1/2_{rad}} + T_{1/2_{bio}}}$	
$X = 3.32\ \log[\frac{I_1}{I_2}][HVL]$		$I_2 = \frac{I_1}{2^{\frac{X}{HVL}}}$	$X = \frac{\log[\frac{I_1}{I_2}]HVL}{\log 2}$
$PD = \frac{E^2}{3770}$	$I = I_o B e^{-ux}$	$W = \frac{4P}{A}$	$PD = 37.7H^2$
$r = (\frac{PG}{4\pi EL})^{1/2}$	$spatial\ ave = (\frac{\sum_{i=1}^{N} FS_i^2}{N})^{1/2}$	$B_r = \sqrt{B_x^2 + B_y^2 + B_z^2}$	$t = \frac{0.003 J/cm^2}{E_{eff}}$
$t = \frac{EL}{ML}\ x\ 0.1h$	$O.D. = \log[\frac{I_o}{I}]$	$D_L = \sqrt{a^2 + \Phi^2 r^2}$	$I_2\ =\ I_1\ x\ magnif^2$

7.5 Heat/Cold Stress

$WBGT = 0.7t_{nwb} + 0.2t_g + 0.1t_{db}$		$WBGT = 0.7t_{nwb} + 0.3t_g$	$C = 0.65v^{0.6}(t_\alpha - 95)$
$\Delta S = (M - W) \pm C \pm R - E$	$R = 15(t_w - 95)$	$HSI = \frac{E_{req}}{E_{max}} x 100$	$E_{max} = 2.4v^{0.6}(42 - vp_w)$
$cfm\ =\ \frac{Total\ Sensible\ Heat\ (BTU/hr)}{1.08(\Delta T)}$			

7.6 Constants

gas constant, $R = 8.314\,J/mole°K$	Avogadro's number $= 6.024 \times 10^{23}$
speed of sound in air at $0°C = 331\,m/sec$ $(+0.6\,m/sec/°C)$	
Planck's constant $= 6.626 \times 10^{-27}\,erg\,sec$	speed of light $= 3 \times 10^{8}\,m/sec$
molar vol at $25°C$, $1\,atm = 24.45\,l$	density of air $= 1.2\,kg/m^3$ @ 760 mmHg, $21°C$

7.7 Conversions

$°F = 9/5\,(°C) + 32$	$°R = °F + 460$	$°K = °C + 273$	$1\,ft^3 = 28.32\,l$
$1\,atm = 14.7\,psi = 760\,mm\,Hg = 29.92\,in\,Hg = 33.93\,ft\,water = 1013.25\,mbar = 101{,}325\,pascals$			
$1\,ft^3 = 7.481\,U.S.\ gal$	$1\,l = 1.06\,qt$	$1\,m/sec = 196.9\,ft/min$ $1\,m^3/sec = 2119\ ft^3/min$	$1\,lb = 453.6\,gm$ $1\,inch = 2.54\,cm$
$1\,gram = 15.43\,grains$	$1\,BTU = 1054.8\,joules = 0.293\,watt\,hr$		$1\,Gray = 100\,Rad$
$1\,Curie = 3.7 \times 10^{10}\,disint/sec$ (Becquerel)		$1\,Sievert = 100\,Rem$	
$1\,Tesla = 10{,}000\,Gauss$		$g = 981\,cm/sec^2 = 32\,ft/sec^2$	