Hazmat emergency preparedness in Hong Kong: what are the dangerous goods in Kowloon?

香港的危險物品緊急應變準備：在九龍有什麼危險品？

FG Walter 蘇達勳, JTS Chan 陳德勝, B Winegard 榮嘉博, FM Shirazi 施洛文, PB Chase, YY Chow 周育賢, M de Boer, K Denninghoff 戴學卓

Introduction: Hazmat emergency preparedness is critical, especially as Hong Kong prepares for major international events, such as the 2008 Olympic Equestrian Games. No published medical study has described the identities and quantities of dangerous goods (DG) in the Kowloon area and listed what antidotes are needed for these DG. This study describes what hazardous materials are most common in Kowloon to prioritise emergency preparedness and training. *Materials & methods: Design:* A descriptive, cross-sectional study. *Setting:* The Hong Kong Special Administrative Region, specifically Kowloon. *Sample:* The Hong Kong Fire Services Department (HKFSD) Dangerous Goods Database (DGD). *Interventions:* Descriptive statistical analyses with Stata 9.2. *Chief outcome:* Identifying and quantifying dangerous goods in the HKFSD DGD. *Results:* Most DG do not have antidotes. The most common DG with recognised antidotes are carbon monoxide, methylene chloride, fluorine, fluorides, fluoroboric acid, cyanides, nitriles, methanol, nitrobenzene, nitrites, and nitrates. The most common categories of DG are substances giving off inflammable vapours, compressed gases, and corrosive and poisonous substances. *Conclusions:* Hazmat emergency preparedness and training should emphasize these most common categories of DG. Disaster planning should ensure adequate antidotes for DG with recognised antidotes, i.e., oxygen for carbon monoxide and methylene chloride; calcium gluconate or calcium chloride for fluorine, fluorides, and fluoroboric acid; hydroxocobalamin for cyanides and nitriles; ethanol for methanol; and methylene blue for methaemoglobinaemia produced by nitrobenzene, nitrites, and nitrates. Supportive care is essential for patients exposed to hazardous materials because most dangerous goods do not have antidotes. (*Hong Kong j.emerg.med.* 2008;15:156-176)

導言：危險物品緊急應變準備是急需的，尤其是當香港籌備大型的國際活動，例如 2008 年的奧林匹克馬術比賽。並沒有發表過的醫療研究描述在九龍區的危險物品性質及份量，及列出這些危險物品所需要的解毒劑。這研究描述九龍最常見的危險物品以確定緊急應變準備及訓練的優先次序。**方法及物料：***設計：*描述性橫切面研究。*環境：*香港特別行政區，特定為九龍。*樣本：*香港消防處危險品數據庫。*介入：*描述性統計分析，使用 Stata 9.2。*首要結果：*鑒定及量化香港消防處危險品數據庫中的危險物

Correspondence to:
Frank G Walter, MD, FACMT, FAACT
University of Arizona College of Medicine, Department of Emergency Medicine, Arizona Emergency Medicine Research Center, Tucson, Arizona, USA
Email: frank@aemrc.arizona.edu

Billie Winegard, MPH
Farshad (Mazda) Shirazi, MD, PhD, FACEP
Peter B Chase, MD, PhD, FACEP
Melanie de Boer, PhD
Kurt Denninghoff, MD

Alice Ho Miu Ling Nethersole Hospital, Accident and Emergency Department, 11 Chuen On Road, Tai Po, N.T., Hong Kong
Chan Tak Shing, Jimmy, FHKAM(Surgery), FHKAM(Emergency Medicine), FCEM

Tuen Mun Hospital, Department of Orthopaedics and Traumatology, Tsing Chung Koon Road, Tuen Mun, N.T., Hong Kong
Chow Yuk Yin, FRACS(Orthopaedics), FHKCOS, FHKAM(Orthopaedic Surgery)

品。**結果：**大多數的危險物品沒有解毒劑。有認可解毒劑而最常見的危險物品是一氧化碳、二氯甲烷、氟、氟化物、氟硼酸、氰化物、腈、甲醇、硝基苯、亞硝酸鹽及硝酸鹽。最常見的危險物品類別為發放可燃氣體的物質，壓縮氣體、腐蝕性及有毒性的物質。**結論：**危險物品緊急應變準備及訓練應強調這些最常見的危險物品類別。災難應變計劃應確保對有認可解毒劑的危險物品有足夠的解毒劑，即是：氧氣（一氧化碳及二氯甲烷），葡萄糖酸鈣或氯化鈣（氟、氟化物及氟硼酸），羥鈷胺素（氰化物及腈）、乙醇（甲醇）、及亞甲藍（由硝基苯、亞硝酸鹽及硝酸鹽所產生的正鐵血紅蛋白血症）。由於大多數危險物品沒有解毒劑，對暴露於危險物品的病者必需使用支援性護理。

Keywords: Disaster planning, emergency medicine, epidemiology, hazardous substances, toxicology

關鍵詞：災難應變計劃、急症醫學、流行病學、危險物質、毒理學

Introduction

Medical direction of prehospital care and disaster planning are recognised responsibilities of emergency medicine. The Hong Kong College of Emergency Medicine states, "The goal of training in emergency medicine is to develop trainees into specialists who are competent to accept and exercise the highest responsibility in the field of emergency medicine. In particular, the doctor should demonstrate knowledge and skill in the ...management of emergency medical systems providing prehospital care..."[1] Dr. B. Cheng says, "Prehospital care has long been the realm of Emergency Medicine."[2] Dr. C.H. Chung states, "Disaster preparedness and response are part and parcel of the basic curriculum of modern Emergency Medicine training."[3]

Dr. C.C. Lau says, "In the United States, emergency physicians have sub-specialised in areas such as ... prehospital care."[4] The United States Model of the Clinical Practice of Emergency Medicine defines prehospital care as an emergency physician task and lists prehospital protocol development, multicasualty incidents, and disaster preparedness as other components of emergency medicine practice.[5] The United States Accreditation Council for Graduate Medical Education mandates emergency medicine patient care competencies, including, "...experience in out-of-hospital care... and disaster planning."[6]

Disaster medicine is a sub-specialty of emergency medicine. *Rosen's Emergency Medicine: Concepts and Clinical Practice* states, "The field of disaster medicine has become a major subspecialty within emergency medicine..."[7] Dr. C.H. Chung says, "'Mature' Emergency Medicine development includes...disaster medicine."[3]

Although some emergency physicians embrace their responsibilities in prehospital care, others do not. Dr. R.A. Cocks writes, "Although Accident and Emergency staff may feel that prehospital care is the province of the ambulance service alone, their interest in this area is important."[8] Dr. C.H. Chung states, "...present-day emergency physicians have four roles – clinician, trainer, researcher, and community service provider. ...Unlike their 'grandfathers', emergency physicians are no longer confined to the four walls of the A & E department."[9] Dr. C.H. Leong says, "...the College of Emergency Medicine could do this society much help by taking ownership and introduce schemes to better the prehospital service for all emergencies."[10] Dr. B.R. Holroyd emphasizes emergency physicians must be involved in prehospital care when he writes, "...experience demonstrates that the risk of not controlling the prehospital environment outweighs the risk of controlling it both medically and legally."[11] Dr. R.A. Cocks says, "The urgent need for research in prehospital care is becoming more widely recognised."[8] This current paper answers the urgent need for prehospital research published in peer-reviewed, indexed, medical journals, to reach emergency physicians who must supply medical leadership in prehospital care and disaster planning.

The horizons of emergency medicine are expanding. Dr. T.W. Wong states, "The traditional view that EM should only concern itself with the evaluation and

management of individuals with critical illnesses is probably too narrow."[12] He emphasizes emergency medicine and public health should collaborate on surveillance of health risks and develop policies to protect and improve the public's health.[12] Emergency medicine can use epidemiological studies, the main tool of public health, to identify health risks so they can be mitigated. Dr. Wong writes, "Emergency Medicine and Public Health may seem to be two poles of medicine at first glance. But, they have more in common if we look at them from a different perspective: both aim at improving the health of the population. We must prepare ourselves to take up this challenge."[12] The current paper answers this challenge by conducting an epidemiological study to identify and quantify the dangerous goods that can pose public health risks in the Kowloon area and listing the antidotes for these materials.

Drs. R.S.D. Yeung, J.T.S. Chan, and S.T. Ho write, "...both industrial chemical leakage and terrorist attack using chemical agents is a major concern to any cosmopolitan city. To best manage these incidents, we need a well written contingency response plan involving local government departments, the Police Department, the Fire Services Department and the receiving hospitals."[13] A critical portion of this disaster planning is hazard analysis. *Rosen's Emergency Medicine: Concepts and Clinical Practice* states, "An important consideration in disaster planning is an awareness of the types of events for which the hospital or community is vulnerable. ...After performing a hazard vulnerability analysis, emergency planners should consider the most probable events and prepare for them. ...The disaster planner must proactively identify all such hazards and prepare contingency plans for each. ...Hospitals in the vicinity of major chemical industries, transportation corridors, or probable terrorist targets (e.g., Disneyland) should be aware of potential hazards from incidents involving chemical and radioactive substances..."[7] This current study proactively identifies chemical hazards stored in Kowloon and lists the antidotes needed to treat them.

Hazmat emergency preparedness is critical, especially as Hong Kong prepares for major international events, such as the 2008 Olympic Equestrian Games.[14] To prioritise hazmat emergency preparedness and training, a literature search sought any published study that catalogued all hazardous materials (dangerous goods) used and stored in Hong Kong, including Kowloon. The literature search included the *Hong Kong Journal of Emergency Medicine* from 2000 through 2007, as well as the following electronic databases searched from their dates of inception through the first week of November 2007: MEDLINE, MEDLINE In-Progress & Other Non-Indexed Citations, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Cochrane Database of Systematic Reviews (DSR), Cochrane Central Register of Controlled Trials (CCTR), American College of Physicians (ACP) Journal Club, Database of Abstracts of Reviews of Effects (DARE), Toxicology Data Network (TOXNET), Toxicology Literature Online (TOXLINE), and Web of Science. The search terms for all these databases were Hong Kong combined with hazmat, hazardous materials, hazardous substances, and dangerous goods (DG). The literature search included all languages in each database. This literature search produced 67 publications; however, none of these catalogued all DG used and stored in Hong Kong, including Kowloon, or listed their antidotes. This study analyses DG used and stored in Kowloon to improve Hong Kong's disaster planning for hazmat incidents.

Materials & methods

The design of this study is a descriptive cross-sectional study of the Hong Kong Fire Services Department (HKFSD) Dangerous Goods Database (DGD) for the year 2000, the most recent year available for analysis. The HKFSD is required by law to maintain a database of Hong Kong's dangerous goods. This can be used to help guide emergency preparedness and training.

The HKFSD DGD originates from the HKFSD document, "Fire Protection Notice No. 4: Dangerous Goods General," (FPNN4).[15] This document categorises dangerous goods as detailed in Table 1 and states, "...these goods can only be used and/or stored

Table 1. Hong Kong Dangerous Goods categories, descriptions, classes, and divisions

Category	Description	Class	Description	Division	Description
1	Explosives	N/A	N/A	N/A	N/A
2	Compressed gases	1	Permanent gases	N/A	N/A
		2	Liquefied gases	N/A	N/A
		3	Dissolved gases	N/A	N/A
3	Corrosive substances	N/A	N/A	N/A	N/A
4	Poisonous substances	1	Substances giving off a poisonous gas or vapour	N/A	N/A
		2	Certain other poisonous substances		
5	Substances giving off inflammable vapours	1	Flash point <23°C	1	Immiscible with water
				2	Miscible with water
		2	Flash point ≥23°C, but <66°C	1	Immiscible with water
				2	Miscible with water
		3	Flash point ≥66°C (applicable to diesel oils, furnace oils, & other fuel oils only)	N/A	N/A
6	Substances which become dangerous by interaction with water	N/A	N/A	N/A	N/A
7	Strong supporters of combustion	N/A	N/A	N/A	N/A
8	Readily combustible substances	N/A	N/A	N/A	N/A
9	Substances liable to spontaneous combustion	N/A	N/A	N/A	N/A
9A	Combustible goods exempted from Section 6 to 11 of the Ordinance	N/A	N/A	N/A	N/A
10	Other dangerous substances	N/A	N/A	N/A	N/A

N/A = not applicable

in excess of the exempt quantity in accommodation approved and licensed by the Director of Fire Services."[15] The Director of Fire Services approves and licenses DG through the HKFSD Licensing and Certification Command's Dangerous Goods Division that maintains the HKFSD DGD.[16,17]

The HKFSD divides the Hong Kong Special Administrative Region (HKSAR) into three operational Fire Commands, Hong Kong (HK), Kowloon (K), and the New Territories (NT), based on their geographic locations.[16] Likewise, the HKFSD Dangerous Goods Division divides the DGD into three separate sub-databases based on these same geographic locations. The calendar year 2000 HKFSD DGD includes all three geographic locations and is of considerable size, with 1.294 megabytes of data distributed in a spreadsheet with 14 columns and 4,603 rows that create 64,442 data cells. This data distribution is detailed in Table 2. The column headings are detailed in Box 1.

Regional hazard analysis is important for rational, hazard-based, regional response plans. These regional response plans are important because parts of Kowloon may be isolated and need to be self-sufficient during

Table 2. Hong Kong Fire Services Department Dangerous Goods Database details for the year 2000

Geographic area	Data quantity (megabytes)*	Rows of data (n)	Columns of data (n)	Data cells (n)
Hong Kong (HK)	0.253	929	14	13,006
Kowloon (K)	0.327	1,241	14	17,374
New Territories (NT)	0.714	2,433	14	34,062
Entire Hong Kong Special Administrative Region (total)	1.294	4,603	14	64,442

*Microsoft Office Excel 2003

Box 1. Details of the column headings in the Hong Kong Fire Services Department Dangerous Goods Database

License number for a business with Dangerous Goods
Business name on a license for Dangerous Goods
Locations of Dangerous Goods at a business (detailed in 4 columns):
    Building name
    Street address
    District
    Geographic location within the Hong Kong Special Administrative Region:
        Hong Kong (HK)
        Kowloon (K)
        New Territories (NT)
Name or description of Dangerous Goods
Category of Dangerous Goods
Class of Dangerous Goods, if applicable
Division of Dangerous Goods, if applicable
Maximum quantity of Dangerous Goods
    (detailed in 4 columns, based on units of measurement):
        Kilogram (kg)
        Metric tonne = 1,000 kg (t)
        Litre (L)
        Cylinder (cyl)

Note: Only bold entries above are reported and analysed in this study.

the initial portions of some disasters. In addition, the usual catchment areas of Hong Kong Hospital Authority hospitals may change during large-scale disasters that could disable a hospital or require patient transport elsewhere because the usual routes of transportation are impassable.

The DG license numbers, business names, business districts, addresses, and building names have been deleted to provide operational security and anonymity for businesses in the HKFSD DGD. The dangerous goods' classes and dangerous goods' divisions have been deleted because they relate mostly to physicochemical characteristics of the DG rather than to medically important toxicodynamics (the pathophysiology) of the DG. Occasionally, more than one dangerous good was recorded in a row of data from a single business in the HKFSD DGD. When this occurred, multiple DG in a single row were separated into unique rows to facilitate data analysis.

The setting for this study is the K geographic location. The sample for this study is the HKFSD DGD for the K geographic location. The HKFSD DGD

K geographic location raw data included 1,276 licensed business sites. These 1,276 licensed business sites had 2,162 DG on site because each licensed business sites could store more than one dangerous good. The dangerous goods' categories were known for 2,115 of the 2,162 DG (97.83%). The remaining 47 DG (2.17%) required manual categorisation by three medical toxicologists who independently assigned dangerous goods' categories to each of the DG that previously did not have an assigned category. These categories were based on each medical toxicologist's unique expert opinion, without consulting other medical toxicologists. Each medical toxicologist could consult the FPNN4, or, if the dangerous good was not found in the FPNN4, then they could consult POISINDEX, the Wireless Information System for Emergency Responders (WISER), TOXNET, or search the Internet.[18-20] The DG categories for DG that had no previously assigned category was determined for this study when two of the three medical toxicologists agreed on the category. Correlation of dangerous goods' categories independently assigned by each medical toxicologist to previously unassigned DG was assessed with a kappa coefficient and percent positive agreement.[21-23] Statistical analyses to describe the frequency of DG in the study area were conducted with Stata 9.2 (College Station, Texas, U.S.A.).

The kappa coefficient assessment showed substantial agreement with a kappa statistic of 0.77 ($p<0.0001$) among the three medical toxicologists.[21] The percent positive agreement was 76.47%.[22,23] In all cases where all three medical toxicologists were not in complete agreement, two concordant results determined the dangerous goods' categories. In no case did all three medical toxicologists assign three distinct dangerous goods' categories.

The HKFSD DGD does not include category 1 dangerous goods (explosives) because the Dangerous Goods Ordinance gives authority to regulate explosives to the Hong Kong Commissioner of Mines rather than the HKFSD.[15]

Up to a total of five DG for each dangerous goods' category and each metric are mentioned in the text to highlight the most common substances. Likewise, these same DG are bolded in the corresponding tables. If there are less than five DG for a given category or metric, then fewer are highlighted in the text and bolded in the tables.

This study was submitted to the Human Subjects Protection Program, i.e., the Institutional Review Board (IRB). This study received exempt status according to published regulations.

Results

The four most common categories of DG (based on the number of registered DG or based on the number of cylinders or litres) are substances giving off inflammable vapours, compressed gases, corrosive substances, and poisonous substances (Table 3). The five most common categories of DG measured in kilograms are corrosive substances, strong supporters of combustion, substances liable to spontaneous combustion, substances giving off inflammable vapours, and poisonous substances (Table 3). The five most common categories of DG measured in metric tonnes are corrosive substances, other dangerous substances, poisonous substances, readily combustible substances, and compressed gases (Table 3).

The five most common compressed gases, based on the number of registered DG, are oxygen, acetylene, nitrous oxide, unspecified compressed gases, and nitrogen (Table 4). The five most common compressed gases measured in cylinders are oxygen, acetylene, tetrafluoroethane (Freon 134A), unspecified compressed gases, and compressed air (Table 4). The five most common compressed gases measured in litres are liquid oxygen, compressed air, liquid nitrogen, nitrogen, and formaldehyde (Table 4). The five most common compressed gases measured in kilograms are carbon dioxide, bromotrifluoromethane (Halon 1301), bromochlorodifluoromethane (Halon 1211), heptafluoropropane, and nitrogen (Table 4). The only compressed gas measured in metric tonnes was anhydrous ammonia (Table 4).

The five most common corrosive substances, based on the number of registered DG, are unspecified corrosive

Table 3. Quantities of Dangerous Goods (DG) in Kowloon by category

Hong Kong DG category: number & description	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
1: Explosives	Not included in Dangerous Goods Database									
2: Compressed gases	462.00	21.73	9931.00	76.92	228233.00	1.24	36040.00	2.10	5.00	0.46
3: Corrosive substances	217.00	10.21	97.00	0.75	154921.00	0.84	891549.00	51.92	771.00	71.19
4: Poisonous substances	85.00	4.00	1.00	0.01	61757.50	0.34	56996.00	3.32	68.00	6.28
5: Substances giving off inflammable vapours	1131.00	53.20	2881.00	22.32	17935968.00	97.52	77510.00	4.51	0.00	0.00
6: Substances which become dangerous by interaction with water	35.00	1.65	0.00	0.00	50.00	0.00	11720.00	0.68	0.00	0.00
7: Strong supporters of combustion	78.00	3.67	0.00	0.00	9756.00	0.05	488522.00	28.45	0.00	0.00
8: Readily combustible substances	39.00	1.83	0.00	0.00	100.00	0.00	1204.00	0.07	20.00	1.85
9: Substances liable to spontaneous combustion	37.00	1.74	0.00	0.00	0.00	0.00	153677.00	8.95	0.00	0.00
10: Other dangerous substances	42.00	1.98	0.00	0.00	1054.00	0.01	0.00	0.00	219.00	20.22
Totals	2126.00	100.00	12910.00	100.00	18391839.50	100.00	1717218.00	100.00	1083.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

substances, sulphuric acid, sodium hydroxide solution, hydrochloric acid, and nitric acid (Table 5). The five most common corrosive substances measured in cylinders are hydrochloric acid, sulphuric acid, acetic acid, nitric acid, and phosphoric acid (Table 5). The five most common corrosive substances measured in litres are sodium hydroxide solution, hydrochloric acid, sulphuric acid, nitric acid, and cleaning mixtures with corrosive substances (Table 5). The five most common corrosive substances measured in kilograms are sodium hydroxide solid, unspecified corrosive substances, potassium hydroxide solid, sodium hydroxide solution, and sulphuric acid (Table 5). The two corrosive substances measured in metric tonnes are sodium hydroxide solid and unspecified corrosive substances (Table 5).

The most common poisonous substances, based on the number of registered DG, are unspecified poisonous substances, sodium hypochlorite solutions, ammonia solutions, chloroform, methylene diphenyl diisocyanate, perchloroethylene, and phenol (Table 6).

Table 4. Names and quantities of compressed gases in Kowloon

Category 2: Compressed gases	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Acetylene	45.00	9.74	1904.00	19.17	0.00	0.00	0.00	0.00	0.00	0.00
Air (compressed)	31.00	6.71	502.00	5.05	90000.00	39.43	0.00	0.00	0.00	0.00
Ammonia, anhydrous	6.00	1.30	112.00	1.13	0.00	0.00	0.00	0.00	5.00	100.00
Argon	13.00	2.81	161.00	1.62	0.00	0.00	0.00	0.00	0.00	0.00
Boron trichloride	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Bromochloro-difluoromethane (Halon 1211)	2.00	0.43	0.00	0.00	0.00	0.00	4000.00	11.10	0.00	0.00
Bromotri-fluoromethane (Halon 1301)	3.00	0.65	2.00	0.02	0.00	0.00	8000.00	22.20	0.00	0.00
Carbon dioxide	21.00	4.55	153.00	1.54	0.00	0.00	20000.00	55.49	0.00	0.00
Carbon monoxide	1.00	0.22	4.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Chlorine	2.00	0.43	4.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Dichloro-difluoromethane (Arcton 12, Freon 12)	3.00	0.65	27.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
Dichloro-fluoromethane (Arcton 21, Freon 21)	1.00	0.22	3.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Dichlorosilane	2.00	0.43	2.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Ethyl chloride	1.00	0.22	30.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Fluorine	2.00	0.43	4.00	0.04	20.00	0.01	0.00	0.00	0.00	0.00
Formaldehyde	4.00	0.87	50.00	0.50	200.00	0.09	200.00	0.55	0.00	0.00
Germane	2.00	0.43	2.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Helium	4.00	0.87	105.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00
Heptafluoropropane	3.00	0.65	10.00	0.10	0.00	0.00	3300.00	9.16	0.00	0.00
Hexafluoroethane	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen	12.00	2.60	212.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00
Krypton	2.00	0.43	70.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00
Methane	2.00	0.43	22.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Methyl chloride	1.00	0.22	8.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Arsine & Hydrogen	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Carbon dioxide & Air	1.00	0.22	2.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Carbon dioxide & Nitrogen	4.00	0.87	4.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Carbon dioxide & unspecified other gases	1.00	0.22	2.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

(continued on page 164)

Table 4. Names and quantities of compressed gases in Kowloon

Category 2: Compressed gases	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Mixed Gases: Carbon dioxide, Oxygen & Nitrogen	4.00	0.87	7.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Fluorine & Helium	1.00	0.22	20.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Halon 1301 & Nitrogen	1.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Hydrogen & Nitrogen	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Hydrogen, Carbon dioxide & Nitrogen	3.00	0.65	6.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Methane & Argon	1.00	0.22	20.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Nitrogen, Carbon dioxide & Hydrogen	1.00	0.22	5.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Nitrous oxide & Oxygen	1.00	0.22	14.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Oxygen & Nitrogen	4.00	0.87	28.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Oxygen & Nitrous oxide	8.00	1.73	89.00	0.90	0.00	0.00	0.00	0.00	0.00	0.00
Mixed Gases: Phosphine & Silane	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Monochloro-difluoromethane (Arcton 22, Freon 22)	3.00	0.65	46.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00
Neon	2.00	0.43	70.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	**32.00**	**6.93**	**340.00**	**3.42**	**4500.00**	**1.97**	**540.00**	**1.50**	0.00	0.00
Nitrogen (liquid)	**14.00**	**3.03**	**43.00**	**0.43**	**20173.00**	**8.84**	0.00	0.00	0.00	0.00
Nitrogen tetroxide (nitrogen peroxide)	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nitrous oxide	**34.00**	**7.36**	**303.00**	**3.05**	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen	**99.00**	**21.43**	**2860.00**	**28.80**	0.00	0.00	0.00	0.00	0.00	0.00
Oxygen, liquid	**26.00**	**5.63**	**380.00**	**3.83**	**113340.00**	**49.66**	0.00	0.00	0.00	0.00
Phosphorus hydride (Phosphine)	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Silane	2.00	0.43	2.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

(continued on page 165)

Table 4. Names and quantities of compressed gases in Kowloon (cont'd)

Category 2: Compressed gases	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Sulphur dioxide	1.00	0.22	30.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Sulphur hexafluoride	4.00	0.87	37.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00
Tetrafluoroethane (Freon 134A)	6.00	1.30	1109.00	11.17	0.00	0.00	0.00	0.00	0.00	0.00
Trichloromono-fluoromethane (Arcton 11, Freon 11)	2.00	0.43	55.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Trifluoromethane (Carbon trifluoride, Freon 23)	1.00	0.22	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified compressed gases	34.00	7.36	994.00	10.01	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified Freon	2.00	0.43	70.00	0.70	0.00	0.00	0.00	0.00	0.00	0.00
Totals	462.00	100.00	9931.00	100.00	228233.00	100.00	36040.00	100.00	5.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

The only poisonous substance measured in cylinders is carbon tetrachloride (Table 6). The five most common poisonous substances measured in litres are sodium hypochlorite solutions, phenol, unspecified poisonous substances, perchloroethylene, and methylene diphenyl diisocyanate (Table 6). The five most common poisonous substances measured in kilograms are unspecified poisonous substances, trichloroethane, trichloroethylene, calcium hypochlorite, and cyanides (Table 6). The only poisonous substances measured in metric tonnes were unspecified poisonous substances (Table 6).

The five most common substances giving off inflammable vapours, based on the number of registered DG, are diesel oils; petrol; paints, lacquers, and varnishes; paint thinners; and kerosene (Table 7). The most common substances giving off inflammable vapours measured in cylinders are ethyl alcohol; kerosene; methyl alcohol; paints, lacquers, and varnishes; isopropyl alcohol; and acetone (Table 7). The five most common substances giving off inflammable vapours measured in litres are diesel oils, naphtha, petrol, potable spirits, and unspecified substances giving off inflammable vapours (Table 7). The four substances giving off inflammable vapours measured in kilograms are diesel oils, petrol, leaded petrol, and xylene (Table 7). No substance giving off inflammable vapours was measured in metric tonnes (Table 7).

The two most common substances which become dangerous by interaction with water, based on the number of registered DG, are unspecified substances which become dangerous by interaction with water and zinc powder (Table 8). No substance which becomes dangerous by interaction with water is measured in cylinders (Table 8). The only substances which become dangerous by interaction with water measured in litres are unspecified substances which become dangerous by interaction with water (Table 8). The five substances which become dangerous by interaction with water, measured in kilograms are thermites, zinc powder, unspecified substances which become dangerous by interaction with water, aluminum metal in unpolished powder form, and magnesium metal. No substance which becomes dangerous by interaction with water was measured in metric tonnes (Table 8).

The five most common strong supporters of combustion, based on the number of registered DG,

Table 5. Names and quantities of corrosive substances in Kowloon

Category 3: Corrosive substances	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Acetic acid	14.00	6.36	18.00	18.56	1532.50	0.96	250.00	0.03	0.00	0.00
Ammonium bifluoride	3.00	1.36	0.00	0.00	3185.00	2.00	25.00	0.00	0.00	0.00
Arp 302	1.00	0.45	0.00	0.00	60.00	0.04	0.00	0.00	0.00	0.00
Boron trifluoride Acetic acid complex	1.00	0.45	0.00	0.00	0.00	0.00	200.00	0.02	0.00	0.00
Chloroacetic acid (monochloroacetic acid)	1.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloroacetyl chloride	1.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chromic acid (solution)	3.00	1.36	0.00	0.00	565.00	0.35	0.00	0.00	0.00	0.00
Cleaning mixtures with corrosive substances	4.00	1.82	0.00	0.00	7680.00	4.81	0.00	0.00	0.00	0.00
Fluoroboric acid (hydrofluoboric acid)	1.00	0.45	0.00	0.00	0.00	0.00	75.00	0.01	0.00	0.00
Formic acid	6.00	2.73	0.00	0.00	120.00	0.08	244.00	0.03	0.00	0.00
Hydrochloric acid (muriatic acid or spirits of salt)	22.00	10.00	40.00	41.24	39985.00	25.05	810.00	0.09	0.00	0.00
Hydrofluoric acid solution (hydrogen fluoride solution)	2.00	0.91	0.00	0.00	122.00	0.08	0.00	0.00	0.00	0.00
Nitric acid	16.00	7.27	7.00	7.22	18780.00	11.77	0.00	0.00	0.00	0.00
Perchloric acid not exceeding 72% W/W in solution	1.00	0.45	0.00	0.00	50.00	0.03	0.00	0.00	0.00	0.00
Phosphoric acid (orthophosphoric acid)	11.00	5.00	7.00	7.22	7440.00	4.66	30.00	0.00	0.00	0.00
Phosphorus trichloride (phosphorus chloride)	1.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium hydroxide, solid	7.00	3.18	0.00	0.00	0.00	0.00	2945.00	0.33	0.00	0.00
Potassium hydroxide solution	1.00	0.45	0.00	0.00	100.00	0.06	0.00	0.00	0.00	0.00
Sodium hydroxide, solid	14.00	6.36	0.00	0.00	0.00	0.00	690077.00	77.40	700.00	90.79
Sodium hydroxide solution	22.00	10.00	0.00	0.00	54352.00	34.05	1370.00	0.15	0.00	0.00
Stannic chloride, anhydrous (tin tetrachloride)	1.00	0.45	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00
Sulphuric acid	34.00	15.45	25.00	25.77	19252.50	12.06	1204.00	0.14	0.00	0.00
Thionyl chloride	1.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unspecified acids	2.00	0.91	0.00	0.00	227.00	0.14	136.00	0.02	0.00	0.00
Unspecified corrosive substances	50.00	22.73	0.00	0.00	6150.00	3.85	194163.00	21.78	71.00	9.21
Totals	220.00	100.00	97.00	100.00	159601.00	100.00	891549.00	100.00	771.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

Table 6. Names and quantities of poisonous substances in Kowloon

Category 4: Poisonous substances	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Ammonia solutions, containing not less than 10% ammonia by weight	4.00	4.94	0.00	0.00	1112.50	1.83	50.00	0.09	0.00	0.00
Barium salts (except barium sulphate, barium cyanide and such salts of barium as are included in Category 7)	2.00	2.47	0.00	0.00	0.00	0.00	83.00	0.15	0.00	0.00
Bleaching powder (calcium hypochlorite)	2.00	2.47	0.00	0.00	0.00	0.00	570.00	1.00	0.00	0.00
Carbon tetrachloride	2.00	2.47	1.00	100.00	200.00	0.33	0.00	0.00	0.00	0.00
Chloroform	4.00	4.94	0.00	0.00	700.00	1.15	0.00	0.00	0.00	0.00
Cyanides, metallic (except ferri-cyanides & ferro-cyanides)	3.00	3.70	0.00	0.00	0.00	0.00	465.00	0.82	0.00	0.00
Dichloromethane (methylene chloride)	2.00	2.47	0.00	0.00	100.00	0.16	120.00	0.21	0.00	0.00
Diphenylmethane diisocyanate	1.00	1.23	0.00	0.00	200.00	0.33	0.00	0.00	0.00	0.00
Methylene chloride	1.00	1.23	0.00	0.00	500.00	0.82	0.00	0.00	0.00	0.00
Methylene diphenyl diisocyanate	4.00	4.94	0.00	0.00	2800.00	4.62	0.00	0.00	0.00	0.00
Nitrobenzene	1.00	1.23	0.00	0.00	112.00	0.18	0.00	0.00	0.00	0.00
Perchloroethylene	4.00	4.94	0.00	0.00	5949.00	9.81	405.00	0.71	0.00	0.00
Phenol (carbolic acid) & its homologues	4.00	4.94	0.00	0.00	13300.00	21.93	1.00	0.00	0.00	0.00
Sodium hypochlorite solutions	12.00	14.81	0.00	0.00	26190.00	43.19	180.00	0.32	0.00	0.00
Trichloroethane (1,1,1- & 1,1,2-)	3.00	3.70	0.00	0.00	290.00	0.48	2870.00	5.04	0.00	0.00
Trichloroethylene	3.00	3.70	0.00	0.00	200.00	0.33	832.00	1.46	0.00	0.00
Unspecified poisonous substances	31.00	38.27	0.00	0.00	10104.00	16.66	51420.00	90.30	68.00	100.00
Unspecified resins	2.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	81.00	100.00	1.00	100.00	60645.00	100.00	56946.00	100.00	68.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

Table 7. Names and quantities of substances giving off inflammable vapours in Kowloon

Category 5: Substances giving off inflammable vapours	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
1,2-Dichloroethane	1.00	0.09	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
1-2 Epoxy propene (including diethyl ether & propylene oxide)	1.00	0.09	0.00	0.00	60.00	0.00	0.00	0.00	0.00	0.00
Acetaldehyde	1.00	0.09	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Acetone	**23.00**	**2.04**	**120.00**	**4.17**	8009.00	0.04	0.00	0.00	0.00	0.00
Acetonitrile	1.00	0.09	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Alcohol butyl (tertiary)	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aluminium paste	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amyl alcohol (tertiary)	6.00	0.53	0.00	0.00	337.50	0.00	0.00	0.00	0.00	0.00
Amyl alcohol, unspecified	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	5.00	0.44	0.00	0.00	571.00	0.00	0.00	0.00	0.00	0.00
Benzyl chloride	2.00	0.18	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
Black Wash 61A	1.00	0.09	0.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00
BTY #1	1.00	0.09	0.00	0.00	150.00	0.00	0.00	0.00	0.00	0.00
BTY #2	1.00	0.09	0.00	0.00	150.00	0.00	0.00	0.00	0.00	0.00
Butyl acetate	3.00	0.27	0.00	0.00	200.00	0.00	0.00	0.00	0.00	0.00
Butyl alcohols (other than tertiary butyl alcohol)	4.00	0.35	0.00	0.00	125.00	0.00	0.00	0.00	0.00	0.00
Carbon disulphide (carbon bisulphide)	6.00	0.53	0.00	0.00	126.00	0.00	0.00	0.00	0.00	0.00
Cement, liquid (adhesive)	2.00	0.18	0.00	0.00	300.00	0.00	0.00	0.00	0.00	0.00
Chlorobenzene	1.00	0.09	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
Cleaning mixtures giving off inflammable vapours	3.00	0.27	0.00	0.00	2150.00	0.01	0.00	0.00	0.00	0.00
Collodion	1.00	0.09	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
Diesel oils	**299.00**	**26.51**	0.00	0.00	**6214153.00**	**34.66**	**32450.00**	**41.87**	0.00	0.00
Diethyl ether	23.00	2.04	0.00	0.00	3065.00	0.02	0.00	0.00	0.00	0.00
Dimethylformamide	1.00	0.09	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Ethyl acetate	6.00	0.53	0.00	0.00	400.00	0.00	0.00	0.00	0.00	0.00
Ethyl alcohol	**37.00**	**3.28**	**1030.00**	**35.75**	40411.00	0.23	0.00	0.00	0.00	0.00
Ethylene glycol Monobutyl ether	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas oil (distillates)	60.00	5.32	0.00	0.00	856286.00	4.78	0.00	0.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

(continued on page 169)

Table 7. Names and quantities of substances giving off inflammable vapours in Kowloon (cont'd)

Category 5: Substances giving off inflammable vapours	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Gel coal	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inflammable printer inks	4.00	0.35	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Isopropyl alcohol	16.00	1.42	120.00	4.17	2300.00	0.01	0.00	0.00	0.00	0.00
Kerosene (aviation turbine fuel, paraffin)	80.00	7.09	800.00	27.77	284181.40	1.58	0.00	0.00	0.00	0.00
Limonene	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methyl alcohol	17.00	1.51	361.00	12.53	11495.00	0.06	0.00	0.00	0.00	0.00
Methyl ethyl ketone	10.00	0.89	0.00	0.00	2782.00	0.02	0.00	0.00	0.00	0.00
Methyl isobutyl ketone	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methylated spirit (mixture of ethyl & methyl alcohols)	2.00	0.18	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Naphtha (petroleum or coal-tar naphtha)	5.00	0.44	0.00	0.00	3559100.00	19.85	0.00	0.00	0.00	0.00
Nitrocellulose (collodion cotton)	1.00	0.09	0.00	0.00	28365.00	0.16	0.00	0.00	0.00	0.00
Nitrofen	1.00	0.09	0.00	0.00	900.00	0.01	0.00	0.00	0.00	0.00
Paint thinners	83.00	7.36	100.00	3.47	181893.50	1.01	0.00	0.00	0.00	0.00
Paints, lacquers & varnishes (including cellulose & enamels)	89.00	7.89	350.00	12.15	448240.50	2.50	0.00	0.00	0.00	0.00
Papanicolaou EA50	1.00	0.09	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
Papanicolaou OG6	2.00	0.18	0.00	0.00	250.00	0.00	0.00	0.00	0.00	0.00
Pentane	1.00	0.09	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00
Petrol (aviation gasoline, motor spirit, lighter fuel)	158.00	14.01	0.00	0.00	2615216.00	14.58	22500.00	29.03	0.00	0.00
Petrol, leaded	7.00	0.62	0.00	0.00	79867.00	0.45	22500.00	29.03	0.00	0.00
Petroleum (crude)	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum spirit (petroleum ether, ligroin)	7.00	0.62	0.00	0.00	6237.50	0.03	0.00	0.00	0.00	0.00
Polyester resin	3.00	0.27	0.00	0.00	529.00	0.00	0.00	0.00	0.00	0.00
Potable spirits	3.00	0.27	0.00	0.00	1816000.00	10.13	0.00	0.00	0.00	0.00
Propyl alcohol (propanol)	6.00	0.53	0.00	0.00	970.00	0.01	0.00	0.00	0.00	0.00
Pyridine	1.00	0.09	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00
Rubber solutions	3.00	0.27	0.00	0.00	708.50	0.00	0.00	0.00	0.00	0.00
Styrene	2.00	0.18	0.00	0.00	40.00	0.00	0.00	0.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

(continued on page 170)

Table 7. Names and quantities of substances giving off inflammable vapours in Kowloon (cont'd)

Category 5: Substances giving off inflammable vapours	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Synolite resin	1.00	0.09	0.00	0.00	150.00	0.00	0.00	0.00	0.00	0.00
Tetrahydrothiophene	1.00	0.09	0.00	0.00	6000.00	0.03	0.00	0.00	0.00	0.00
Toluene	11.00	0.98	0.00	0.00	7340.00	0.04	0.00	0.00	0.00	0.00
Toluene ethers	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turpentine and turpentine substitutes	29.00	2.57	0.00	0.00	24885.00	0.14	0.00	0.00	0.00	0.00
Unspecified solvents	5.00	0.44	0.00	0.00	151183.00	0.84	0.00	0.00	0.00	0.00
Unspecified substances giving off inflammable vapours	67.00	5.94	0.00	0.00	1565510.00	8.73	0.00	0.00	0.00	0.00
Vinyl ether	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waycoat 'WNRD' developer	1.00	0.09	0.00	0.00	150.00	0.00	0.00	0.00	0.00	0.00
Xylene	12.00	1.06	0.00	0.00	9511.00	0.05	60.00	0.08	0.00	0.00
Totals	1128.00	100.00	2881.00	100.00	17931288.15	100.00	77510.00	100.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

Table 8. Names and quantities of substances which become dangerous by interaction with water in Kowloon

Category 6: Substances which become dangerous by interaction with water	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Aluminium metal or alloy in unpolished powder form	1.00	2.86	0.00	0.00	0.00	0.00	250.00	2.13	0.00	0.00
Calcium carbide	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Calcium metal & alloys (non-pyrophoric)	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Lithium	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Lithium hydride	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Magnesium metal or alloys containing 50% or more magnesium (excluding ingots, bars or sticks)	1.00	2.86	0.00	0.00	0.00	0.00	20.00	0.17	0.00	0.00
Potassium metal	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Sodium metal	1.00	2.86	0.00	0.00	0.00	0.00	5.00	0.04	0.00	0.00
Thermites (commerical, consisting of finely divided aluminium & iron oxide only)	1.00	2.86	0.00	0.00	0.00	0.00	10000.00	85.32	0.00	0.00
Unspecified substances which become dangerous by interaction with water	24.00	68.57	0.00	0.00	50.00	100.00	500.00	4.27	0.00	0.00
Zinc powder or dust	2.00	5.71	0.00	0.00	0.00	0.00	920.00	7.85	0.00	0.00
Totals	35.00	100.00	0.00	0.00	50.00	100.00	11720.00	100.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

are unspecified strong supporters of combustion, hydrogen peroxide, gold mixtures for electroplating, ammonium nitrate, and dynomix emulsion (Table 9). No strong supporters of combustion are measured in cylinders (Table 9). The four most common strong supporters of combustion, measured in litres are sodium nitrite, unspecified strong supporters of combustion, hydrogen peroxide, and sodium peroxide (Table 9). The five most common strong supporters of combustion measured in kilograms are unspecified strong supporters of combustion, ammonium nitrate, dynomix emulsion, gold mixtures for electroplating, and chromium trioxide (Table 9). No strong supporter of combustion is measured in metric tonnes (Table 9).

The most common readily combustible substances, based on the number of registered DG, are unspecified readily combustible substances (Table 10). No readily combustible substance is measured in cylinders (Table 10). The only readily combustible substance measured in litres is tetrahydrofuran (Table 10). The four most common readily combustible substances, measured in kilograms, are copper thermite, nitrocellulose-based film, red phosphorus, and celluloid scrap (Table 10). The only readily combustible substance measured in metric tonnes is naphthalene (Table 10).

The most common substances liable to spontaneous combustion, based on the number of registered DG, are unspecified substances liable to spontaneous combustion and sodium hydrosulphite (Table 11). No substance liable to spontaneous combustion is measured in cylinders or litres (Table 11). The most common substances liable to spontaneous combustion, measured in kilograms, are unspecified substances liable to spontaneous combustion and sodium hydrosulphite (Table 11). No substance liable to spontaneous combustion is measured in metric tonnes (Table 11).

The three most common other dangerous substances, based on the number of registered DG, are unspecified other dangerous substances, methyl ethyl ketone peroxide, and unspecified plasticizers (Table 12). No other dangerous substance is measured in cylinders (Table 12). The three most common other dangerous substances measured in litres are exylena, methyl ethyl ketone peroxide, and cyclohexanone (Table 12). No other dangerous substance is measured in kilograms (Table 12). The two most common other dangerous substances, measured in metric tonnes, are unspecified other dangerous substances and blowing agents for rubber manufacture (Table 12).

The 2,162 DG in the K geographic location of the HKFSD DGD comprise 205 unique DG (Tables 4-12). Of these 205 unique DG, 16 (7.80%) have recognised antidotes (Table 13). The most common dangerous goods with recognised antidotes are carbon monoxide, methylene chloride, fluorine, fluorides, fluoroboric acid, cyanides, nitriles, methanol, nitrobenzene, nitrites, and nitrates (Table 13). The antidotes for these most common dangerous goods are oxygen for carbon monoxide and methylene chloride; calcium gluconate or calcium chloride for fluorine, fluorides, and fluoroboric acid; hydroxocobalamin for cyanides and nitriles; ethanol for methanol; and methylene blue for methaemoglobinaemia produced by nitrobenzene, nitrites, and nitrates (Table 13).

Discussion

This is the first study describing the DG stored in Kowloon. The most common categories of DG are substances giving off inflammable vapours, compressed gases, corrosive substances, and poisonous substances. These are the same categories of DG that were found to be most common on Hong Kong, Lantau, and Lamma Islands.[24] Hazmat emergency preparedness and training should focus on these most common DG. Preparing and training for hazmat incidents caused by the most common DG stored in a geographic location is a logical approach; however, this logical approach has not been validated in a prospective study. Previous retrospective studies suggest preparing and training for hazmat incidents caused by exposures to the most common DG in a geographic location, i.e., airborne toxicants.[25,26] Multiple prospective studies support this logical approach and found airborne toxicants (gases) were the majority of the ten most common chemicals causing hazmat incidents.[27-30]

Table 9. Names and quantities of strong supporters of combustion in Kowloon

Category 7: Strong supporters of combustion	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Ammonium dichromate	2.00	2.56	0.00	0.00	0.00	0.00	320.00	0.07	0.00	0.00
Ammonium nitrate, free from added organic matter & not being included in Category 1	5.00	6.41	0.00	0.00	0.00	0.00	150885.00	30.89	0.00	0.00
Chromium trioxide	3.00	3.84	0.00	0.00	0.00	0.00	4072.00	0.84	0.00	0.00
Dynomix emulsion	5.00	6.41	0.00	0.00	0.00	0.00	110000.00	22.52	0.00	0.00
Gold mixtures for electroplating	6.00	7.69	0.00	0.00	0.00	0.00	15000.00	3.07	0.00	0.00
Hydrogen peroxide	13.00	16.67	0.00	0.00	1851.00	18.97	1758.00	0.36	0.00	0.00
Potassium chlorate	1.00	1.28	0.00	0.00	0.00	0.00	130.00	0.03	0.00	0.00
Potassium nitrate	2.00	2.56	0.00	0.00	0.00	0.00	460.00	0.09	0.00	0.00
Potassium permanganate	2.00	2.56	0.00	0.00	0.00	0.00	2150.00	0.44	0.00	0.00
Sodium	2.00	2.56	0.00	0.00	0.00	0.00	820.00	0.17	0.00	0.00
Sodium nitrite	1.00	1.28	0.00	0.00	4000.00	41.00	0.00	0.00	0.00	0.00
Sodium peroxide	2.00	2.56	0.00	0.00	1600.00	16.40	0.00	0.00	0.00	0.00
Unspecified strong supporters of combustion	34.00	43.59	0.00	0.00	2305.00	23.63	202927.00	41.54	0.00	0.00
Totals	78.00	100.00	0.00	0.00	9756.00	100.00	488522.00	100.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

Table 10. Names and quantities of readily combustible substances in Kowloon

Category 8: Readily combustible substances	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Celluloid scrap (including film scrap)	1.00	2.56	0.00	0.00	0.00	0.00	1.00	0.08	0.00	0.00
Copper thermite	1.00	2.56	0.00	0.00	0.00	0.00	1000.00	83.06	0.00	0.00
Film (nitrocellulose base)	1.00	2.56	0.00	0.00	0.00	0.00	200.00	16.61	0.00	0.00
Naphthalene (crude or refined)	1.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	20.00	100.00
Red phosphorus	1.00	2.56	0.00	0.00	0.00	0.00	3.00	0.25	0.00	0.00
Tetrahydrofuran	1.00	2.56	0.00	0.00	100.00	100.00	0.00	0.00	0.00	0.00
Unspecified readily combustible substances	33.00	84.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	39.00	100.00	0.00	0.00	100.00	100.00	1204.00	100.00	20.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

Table 11. Names and quantities of substances liable to spontaneous combustion in Kowloon

Category 9: Substances liable to spontaneous combustion	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Sodium hydrosulphite (sodium dithionite)	2.00	5.41	0.00	0.00	0.00	0.00	950.00	0.62	0.00	0.00
Unspecified substances liable to spontaneous combustion	35.00	94.59	0.00	0.00	0.00	0.00	152727.00	99.38	0.00	0.00
Totals	37.00	100.00	0.00	0.00	0.00	0.00	153677.00	100.00	0.00	0.00

The most common dangerous goods (DG) in each metric are bolded.

Table 12. Names and quantities of other dangerous substances in Kowloon

Category 10: Other dangerous substances	Registered DG at licensed business sites		Quantitative analysis							
			Cylinders		Litres		Kilograms		Metric tonnes	
	n	%	n	%	n	%	n	%	n	%
Blowing agents for rubber manufacture	1.00	2.38	0.00	0.00	0.00	0.00	0.00	0.00	19.00	8.68
Cyclohexanone	1.00	2.38	0.00	0.00	100.00	9.49	0.00	0.00	0.00	0.00
Exylena	1.00	2.38	0.00	0.00	500.00	47.44	0.00	0.00	0.00	0.00
Methyl ethyl ketone peroxide	3.00	7.14	0.00	0.00	454.00	43.07	0.00	0.00	0.00	0.00
Unspecified other dangerous substances	34.00	80.95	0.00	0.00	0.00	0.00	0.00	0.00	200.00	91.32
Unspecified plasticizers	2.00	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals	42.00	100.00	0.00	0.00	1054.00	100.00	0.00	0.00	219.00	100.00

The most common dangerous goods (DG) in each metric are bolded.

Hazmat disaster planning in Kowloon will require more resources than Lantau, Lamma, and Hong Kong Islands. This is because Kowloon has more licensed business locations, more total registered DG, and more unique, registered DG than Lantau, Lamma, and Hong Kong Islands. Kowloon has 1,276 licensed business sites; this is 37% more than the 929 licensed business sites on Lantau, Lamma, and Hong Kong Islands.[24] These 1,276 licensed business sites in Kowloon have 2,162 registered DG; this is 52% more registered DG than the 1,420 registered DG on Lantau, Lamma, and Hong Kong Islands.[24] The 2,162 registered DG in Kowloon comprise 205 unique, registered DG; this is 36% more than the 151 unique, registered DG comprising all 1,420 registered DG on Lantau, Lamma, and Hong Kong Islands.[24]

Most DG (92.20%) in Kowloon do not have antidotes. This is similar to the finding that most DG (91.39%) on Hong Kong, Lantau, and Lamma Islands do not have antidotes.[24] Therefore, supportive care is essential for patients exposed to hazardous materials in both these geographic locations of the HKSAR. This common finding supports similar hazmat emergency preparedness and response training for both these geographic locations of the HKSAR.

Kowloon has similar, but not the same DG with recognised antidotes as Lantau, Lamma, and Hong Kong Islands (Table 13).[24] Lantau, Lamma, and Hong Kong Islands have fluorides, but lack fluorine or fluoroboric acid as registered DG.[24] Kowloon has fluorine and fluoroboric acid, both of which react with

Table 13. Dangerous goods in Kowloon with their corresponding recognised antidotes

Dangerous goods	Recognised antidotes
Category 2: Compressed gases	
Carbon monoxide	Oxygen
Fluorine Mixed Gases: Fluorine & Helium	Calcium gluconate or calcium chloride
Category 3: Corrosive substances	
Ammonium bifluoride Fluoroboric acid Hydrofluoric acid solution (hydrogen fluoride solution)	Calcium gluconate or calcium chloride
Category 4: Poisonous substances	
Cyanides	Hydroxocobalamin
Category 5: Substances giving off inflammable vapours	
Acetonitrile	Hydroxocobalamin treats cyanide produced by metabolism of acetonitrile to cyanide
Dichloromethane (methylene chloride)	Oxygen treats carbon monoxide produced by metabolism of dichloromethane to carbon monoxide
Methyl alcohol (methanol)	Ethanol
Methylated spirit (mixture of ethyl alcohol & methyl alcohol)	
Nitrobenzene	Methylene blue treats methaemoglobinaemia formed from oxidation of haemoglobin by nitrobenzene
Category 7: Strong supporters of combustion	
Ammonium nitrate	Methylene blue treats methaemoglobinaemia formed from oxidation of haemoglobin by ammonium nitrate, potassium nitrate, sodium nitrate, and sodium nitrite
Potassium nitrate	
Sodium nitrate	
Sodium nitrite	

water, including water in the human body, to produce fluoride that can cause hypocalcaemia; this can be treated with the antidotes calcium gluconate or calcium chloride. Lantau, Lamma, and Hong Kong Islands have hydrazine that can cause seizures that can be treated with the antidote pyridoxine.[24] Kowloon lacks hydrazine as a registered DG. Lantau, Lamma, and Hong Kong Islands have nitrates, but lack nitrobenzene and nitrites as registered DG.[24] Kowloon has nitrates, nitrobenzene and nitrites, all of which can cause methaemoglobinaemia when absorbed into the body in sufficient doses.

One aspect of hazmat emergency preparedness is training for the medical evaluation and care of people exposed to DG. One preparedness approach for the medical management of people exposed to DG in Hong Kong is training healthcare professionals with the Advanced Hazmat Life Support (AHLS) Provider Course. The AHLS Provider Course focuses on the most common categories of DG found in this study, i.e., substances giving off inflammable vapours, compressed gases, corrosive substances, and poisonous substances. The AHLS Provider Course also emphasizes supportive care for patients exposed to hazardous materials and teaches the indications, contraindications, complications, dosages, routes, and mechanisms of action for antidotes identified in this study, i.e., oxygen, calcium gluconate and calcium chloride, hydroxocobalamin, and methylene blue (Table 13). The AHLS Provider Course has trained 548 Hong Kong healthcare professionals preparing for routine

hazmat incidents as well as medical support at the 2008 Olympic Equestrian Games.[31,32]

Limitations of this study include the fact that it is a retrospective review of prospectively collected data initially intended for regulatory use, not research. However, these are the best data available for analyses at this time. This study suffers from the weaknesses of all retrospective studies, including reporting bias, selection bias, missing data, and possible confounders that are difficult to control in retrospect. Another limitation is that the year 2000 is the most recent year of the HKFSD DGD available for analysis. Timelier data would better guide preparedness for the 2008 Olympic Equestrian Games, other major events, and routine hazmat incidents. Another limitation is that many DG are measured in cylinders, as is allowed in and described in FPNN4; however, this is a non-Système International (SI) unit of measurement and there is no standard cylinder size specified in FPNN4.[15] Therefore, there is no standard conversion from cylinders to kilograms or litres.

Conclusion

Hazmat emergency preparedness and training should emphasize supportive care and focus on the most common categories of dangerous goods in Kowloon, i.e., substances giving off inflammable vapours, compressed gases, and corrosive and poisonous substances. Disaster planning and training should emphasize antidotes needed to treat the most common dangerous goods with recognised antidotes in Kowloon, i.e., oxygen for carbon monoxide and methylene chloride; calcium gluconate or calcium chloride for fluorine, fluorides, and fluoroboric acid; hydroxocobalamin for cyanides and nitriles; ethanol for methanol; and methylene blue for methaemoglobinaemia produced by nitrobenzene, nitrites, and nitrates.

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