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PROVISION OF A TECHNO-ECONOMIC STUDY ON DIFFERENT OPTIONS OF HOSPITAL WASTE MANAGEMENT IN THE *SZENT IMRE* HOSPITAL, BUDAPEST, HUNGARY

Waste Management Master Plan — Technical Report No. 1

Prepared For Government of Hungary
by the United Nations Industrial Development Organization

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ABSTRACT

PROVISION OF A TECHNO-ECONOMIC STUDY ON DIFFERENT OPTIONS OF HOSPITAL WASTE MANAGEMENT IN THE *SZENT IMRE* HOSPITAL, BUDAPEST, HUNGARY

WASTE MANAGEMENT MASTER PLAN

Objective

To provide a waste management plan for the Szent Imre hospital, Budapest with a view to reducing the cost of waste disposal (discarding).

Action

Note was taken of the earlier work, in particular the analysis of various effluent samples undertaken by: Spectromass Analytical Laboratory Limited (Dr. Éva Czajlik), Fehérvári ut. 144/211, 1116-Budapest.

The Consultants undertook a detailed inspection of the various hospital departments. The findings are outlined in Waste Audit — Technical Report No. 2.

This waste management master plan outlines the actions proposed which assist in reduction in waste costs, and generally improved environmental sustainability.

- Urgent action is required for mercury spills (broken thermometers) and to include atmospheric air and blood mercury measurements.
- Solvents — recommendations for cost-effective alternatives are provided.
- Segregation of wastes, i.e. into blue and yellow bags is of paramount importance.
- A Hospital Waste Manager should be appointed, quickly followed by a Hospital Waste Management Committee.
- Unit cost allocations (budgets) should be implemented.

CONTENTS

ABBREVIATIONS

ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
BOD	Biological oxygen demand
BPEO	Best practical environmental option
BSO	Backstopping Officer (For this project — Dr. Zoltán Czisér, UNIDO, Vienna)
CEC	Commission of the European Communities
CD-ROM	Compact disc — read-only-memory
CEE	Central and Eastern European (Region)
CHP	Combined heat and power
CMO	Chief Medical Officer
COD	Chemical oxygen demand
COSHH	Control of Substances Hazardous to Health
CPL	Classification packaging and labeling
DC	Development cooperation
DFID	Department for International Development
DOSE	Dictionary of Substances and their Effects
DSA	Daily Subsistence Allowance
EBRD	European Bank of Reconstruction and Development
EC	European Commission; or European Community
EMAS	Environmental management and audit scheme
EMS	Environmental management system
EINECS	European Inventory of Existing Chemical Substances
EU	European Union
FIFO	First-in-first-out
GBq	*Giga Becquerel*
GLP	Good laboratory practice
GMP	Good manufacturing practice
GOST	State Standard of USSR (Gosudarstvennyi Standard USSR), Izdatelstvo Standartov Novopresnenski Per.3 D-557, Moscow
HMSO	Her Majesty's Stationery Office
IAEA	International Atomic Energy Agency, Vienna
IBC	International Business Communities Limited
IDSP	Industrial Development Support Programme
IFCS	International Forum on Chemical Safety
ILO	International Labour Office
IMS	Integrated management system
IOMC	Inter-organizational Programme for the Sound Management of Chemicals
IPC	Integrated pollution control
IPCS	International Programme on Chemical Safety

IPPC	Integrated pollution prevention and control
IRPTC	International Register of Potentially Toxic Chemicals
ISG-3	Internet Forum on Chemical Safety
ISO	International Standards Organization
JIT	Just in time
MAK	Maximale arbeitsplatz konzentration
MEL	Maximum exposure limit
MBI	Market based instruments
MSDS	Material safety data sheet
NGO	Non-government organization
OECD	Organization for Economic Cooperation and Development
PCB	Polychlorinated biphenyl
PCCDs	Polychlorinated dibenzo dioxins
PCDFs	Polychlorinated dibenzo furans
PEC	Predicted environmental concentration
PET	Polyethylene terephthalate
PHARE	Polish-Hungarian Assistance for Reconstruction and Economy
PNEC	Predicted no effect concentration
POP	Persistent organic pollutant
PRTR	Pollutant Release and Transfer Register
PVC	Polyvinyl chloride
SI	Statutory Instrument
STW	Sewage treatment works
TC	Technical cooperation
TCDDs	Tetrachlorodibenzodioxins
TQM	Total quality management
UK	United Kingdom of Great Britain and Northern Ireland
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
WHO	World Health Organization

I. RECOMMENDATIONS

As a result of the waste audit (q.v. Technical Report No. 2), it was possible to propose the following options for the Hospital Waste Master Plan:

A. *Yellow Bags — Clinical and Infectious Waste*

i. As these are closed by simply knotting, and are liable to unauthorized opening, it is **recommended** that ideally they are sealed with a numbered unopenable plastic closure tag. These are available in Hungary and used for sealing other bags and for disposal of cytotoxic drums. As an interim measure string or a simple plastic tag should be used.

ii. The internal transport requires upgrading to prevent possibility of rupture of the bags. Such transport as a minimum, should incorporate either wheeled yellow containers suitable for loading directly onto external transport; as a minimum, metal mesh cages should be used.

iii. Considerable care is required to ensure that yellow bags, needles/sharps boxes, etc., should be stored, whilst awaiting transport either internal or external in secured areas, and hence avoid access by the public or other unauthorized personnel.

iv. External transport. Greater operator care is required, e.g. compulsory wearing of gloves, goggles, face mask and other protective clothing. Smoking, eating or drinking during loading must be strictly forbidden. The hospital van should carry the international ADR biohazard sign whilst transporting hazardous waste. (This is a requirement of the Hungarian Ministry of Environment and Regional Planning).

B. *Blue (green/black) Bags.*

General garbage and non-clinical waste.

i. Again these need to be sealed with plastic tags or at the very least string.

ii. Consideration should be given to segregation, i.e. into paper, glass, plastic, metal (aluminum), general garbage — similar to the scheme operated at Vienna International Airport. However, it is recognized that a national infrastructure for recycling for such waste is required.

C. Radioactive Waste (Nuclear Medicine department)

i. It is noted that only technetium-99m is used routinely and hence the problems with radioactive waste is minimal. (There was also an occasional use of iodine-125 but this, too, was well controlled).

ii. However, the practice of using standard biohazard (No. 6) yellow bags for radioactive waste should be discontinued, in favor of properly labeled bags, ideally **not yellow** (or yellow with red stripes) and carrying the International radioactive sign (No. 7), prominently.

D. Mercury

i. Guidelines (to be drafted later in contract) are required on the best possible means for treating mercury from broken thermometers, blood pressure manometers, etc.

ii. Consideration is also required for mercury losses from the three dental chairs.

iii. Mercurochrome. The consultants were surprised to find this in use in 1998, as its use in the United Kingdom was discontinued >20 years ago. However, they lack the clinical expertise to recommend alternatives. Possibilities include povidone iodine and Chlorhexidine. This might be a discussion topic for the three Hungarian experts in August 1998 (see Technical Report No. 6 — Appendix L), or at the International Workshop, w/c 2 November 1998 (see Technical Report No. 5) to be organized later in the program).

iv. Taking the maximum level of 34.7 μg/l (north corner building 'A') and 27.8 μg/l (southern corner building 'A') on 10 July 1997, this would result in a predicted environmental concentration of ~0.1 μg/l at the sewage treatment facility. This would be further diluted by 10^5 on reaching the Danube river — mercury levels 0.1 — 0.3 μg/l in 1988.

v. The mercury problem is considerable, and further monitoring of effluents, atmospheric air and blood mercury levels of both chronic patients and nursing staff are **strongly advised.**

vi. The immediate **recommendation** is that flowers of sulfur be made available for treating all metallic mercury spillages. Other clean up procedures include: vacuum suction; sponge boxes (see also Technical Report No. 6 — Appendix M).

E. Recycling Plastic Waste

i. Currently, polythene empty saline bottles used in the (private) dialysis unit are taking up considerable space in blue bags.

It is **recommended**, especially in from this kidney dialysis unit, that these have the closures removed and the body of the bottles shredded and sold as clean polythene waste for recycling. That is unless recycling or reuse is feasible.

F. Cost Control

i. It appears that the considerable cost of waste especially for incineration, landfill, etc., is accounted for centrally.

It is **recommended** costs be apportioned to individual department budgets. (See Section XII.)

It is essential that all private healthcare units on the site have financial responsibility for their waste disposal.

G. Formaldehyde

There is no logical reason why the formaldehyde from the Pathology department cannot be discarded to drain (see Section V.B), as the PEC/PNEC ratio is 0.05.

This action will require approval by the Ministry of Environment and Regional Planning.

H. Potable Water Quality

As the potable water supply to the 11th Budapest District and the Szent Imre hospital is derived from the Danube river, it was noted that the total trihalomethane content (6 samples) was 8.3 μg/l and is hence of negligible concern.

I. Hospital Action Requirements

i. Appoint a Waste Manager;

ii. Set up Task Force/Hospital Waste Management Committee;

iii. Install an EMS.

II. EXPLANATORY NOTE

UNIDO has sponsored a number of Technical Projects for the Szent Imre hospital in Budapest, Hungary.

One of the objectives of these studies will be to lay the foundation for an overall waste management plan for all the hospitals in Budapest and subsequently for hospitals in the whole of Hungary.

This study furthers the Recommendations outlined in two previous UNIDO reports, viz.:

TF/HUN/94/F90/11-51 — by T. Hall; and
TF/HUN/94/F90/11-52 — by M.J. Skinner

One of their Recommendations was the provision of a detailed set of chemical and bacteriological analyses of the effluent streams from the Szent Imre hospital in Budapest.

These results are given in UNIDO Report TF/HUN/94/F90 — by Spectromass Analytical Laboratory Limited (Dr. Éva Czajlik).

The Szent Imre hospital is situated in the XIth District of Budapest and serves a population of 250,000 people, ~10% of the total Budapest population. In May 1998 the hospital had ~900 beds with an 80% bed occupancy rate. The average length of stay is 13 days.

The staff level was 1814 in 1995, of which 362 were physicians, and middle health personnel including nurses, 988.

The average cost per hospital day was HUF 3930. This means that the total budget for the Szent Imre hospital is in the order of HUF 1.2×10^9.

The hospital was commissioned in 1950.

Note: May 1998 US $ 1.00 = HUF 210.

The other Technical Reports in this series include:

No. 2. Szent Imre Hospital — Waste Audit
No. 3. Techno-economic Options
No. 4 Training In-House Hospital Management — St. Imre Hospital, 7—11 September 1998
No. 5. International Workshop — Handout
No. 6. Appendices
No. 7. Inspections of Other Hungarian Hospitals and Incinerators
No. 8. Final Report

III. INTRODUCTION

The core objective of this study is to lay the foundations for an overall waste management plan for the Szent Imre hospital in Budapest, other hospitals in Budapest and subsequently for hospitals for the whole of Hungary, and ultimately in the whole Central and Eastern European (CEE) Region.

One of the most important aspects in the compliance for hospital waste of all types with United Kingdom and European Community Guidelines and Recommendations (See Technical Report No. 6 — Appendix B). Due note was taken of the Hungarian *Guidelines to the Management of Wastes Generated in the Health Care Institutions, National Institute of Health, Budapest, 1994 (Draft in Hungarian); The Hungarian Decree No. 102/1996 (VII.12.) Korm, on Hazardous Wastes*, and relevant sections of the Basle Convention. Recommendations (See Technical Report No. 6 — Appendix C).

The waste audit at the Szent Imre hospital included the provision for minimizing such wastes, and indicating costs for provision of the most effective means for treating the wastes. A short study tour of three Hungarian experts arranged for 3—14 August 1998 to inspect relevant facilities within the United Kingdom. A training course is also to be arranged for senior hospital technical staff at the Szent Imre hospital, 7—11 September 1998.

The study concludes with a handout for an International Workshop to be held later in the program, at which general principles in waste management, minimization, risk reduction and compliance with internationally recognized standards might be discussed.

Currently, there are no definitive waste management plans for the disposal of liquid and solid wastes generated by Hungarian hospitals.

This is leading to possible contamination of both receiving waters and to soil pollution; additionally there is the possibility of unreasonable occupational hazards to hospital staff (and in general possible public health hazards and to the public at large) who may come into contact with especially biological, clinical, and hazardous chemical waste.

- Consideration was given to atmospheric emissions from boiler facilities, any incinerator which might be recommended, and other hospital effluvia including anesthetic gases.

- Hungary is one of the Countries seeking early accession to the European Union and hence there is a clear requirement for the Government of Hungary to demonstrate clearly that that are working towards the rapid introduction of the Environmental and other Directives which have been or are scheduled in the near future to be approximated by the current EU Member States.

Whilst there are no current EU Regulations that apply directly to the disposal of hospital wastes, there are in existence a number of Directives, Recommendations, Guidelines, etc. which apply to waste disposal in general (see also Technical Report No. 6, Appendix B). Additionally, a number of EU Member States, including the United Kingdom have in place a number of Guidelines applicable to the safe disposal of clinical and other wastes generated by hospitals.

The team had a series of meetings with the hospital officials and relevant professional staff who have direct responsibilities for waste of every kind.

Having obtained these general views and gained their confidence, the team:

- Investigated the operations within the Szent Imre Hospital;
- Examined the staff structure within the Szent Imre Hospital, especially those staff (Engineering Manager) having responsibility for the safe disposal of all types of hospital waste, including kitchens, wards, theaters, laboratories (including photographic), engineering services (boiler blow down, air conditioning), etc.;
- Took note of the hospital drainage system;
- Attempted to advise the hospital management on the appointment of a local Waste Manager;
- Initiated a procedure for preparing an inventory of all wastes generated — see Waste Audit — Technical Report No. 2.

These activities required:

- An understanding by the experts of the overall health current and immediate future health care structure and plans in Hungary and especially in the Budapest area;
- Routes for the disposal of solid waste in Hungary;
- Routes for the disposal of hazardous waste in Hungary and in particular the Budapest area;
- Routes for the recovery/disposal of organic solvent waste (and POPs in general) in Hungary;
- The system for the disposal of liquid wastes including the status of sewage treatment in Budapest (the Buda side in particular);
- The current status of landfills facilities especially in the Budapest area;
- The current availability of incinerators and furnaces, especially those capable of handling halogenated wastes — alternatives to conventional incinerators, e.g. cement kilns were considered, but not viewed to be a viable option;
- Definitions of waste and associated terms were based on those contained in the WHO-IPCS Training Module No. 1, *Chemical Safety - The Fundamentals of Applied Toxicology - The Nature of Chemical Hazards*, 1997, pp. 258 (WHO/PCS/97.14), see also Technical Report No. 6 — Appendix D; but supplemented with further definitions from other sources.

Cooperation was received from officers of:

- The National Public Health Center;
- The Ministry of Welfare;
- Ministry of the Environment;
- Ministry of Trade and Industry, especially the UNIDO representative (and the UNIDO/UK Industrial Development Support Programme (IDSP));
- Waste disposal organizations and consultants;
- British Embassy.

IV. PRELIMINARY SECTION

A. Background and Justification

The modernization of both economy and society has been the strategic development target of the Hungarian Government since 1990 when the change in the political system created the possibility of transition from a centrally planned to a market economy. The new coalition government took office in Hungary on 15 July 1994 and soon published the broad outlines of its economic program. In this program the development objectives for health and environment protection are among the items of top priority. It is noted that a further reorganization will occur following the May 1998 elections.

The Government can foresee the future of the Hungarian economy only through increasing its integration into the world economy and joining the European Union (EU). These are the principal development goals of this program. An important short-term objective is to accelerate legal, institutional and infrastructure changes to harmonize regulations and standards with those of the EU.

The Europe Agreement was signed between the Republic of Hungary and the European Community (EC) on 16 December 1991 to facilitate the free movement of goods, services and capital, and effective integration of the Hungarian economy into the EC. The Agreement was ratified by the then 12 Member States of the EU, the European Parliament and the Hungarian Parliament. It came into force on 1 February 1994.

The Government of the United Kingdom of Great Britain and Northern Ireland (UK) and UNIDO signed an agreement in March 1991 about the establishment of a UNIDO/UK Industrial Development Support Programme (IDSP) for Hungary to facilitate the country's transition from a centrally planned to a market economy through the provision of British advice, skills and training. UNIDO/UK IDSP projects aim principally at the development of economic infrastructure in Hungary, including the legal and institutional links. This project document is in line both with the political and economic objectives of the UNIDO/UK IDSP. The UK Government has approved in principle the project for financing.

In Hungary, as in many countries, the management of hospital waste is a relatively new concern. A large variety of hazardous materials are generated in hospitals although the overall waste quantities are relatively low. Due to the lack of a record-keeping system on waste generation, it is often difficult to identify hazardous wastes in hospitals and data, if available, are not reliable. In order to address the different options for hospital waste management, the inventory of the generated wastes should, as a prerequisite, be established. The awareness has, however, been increasing as hospital waste management is advancing at the top of environmental agenda for municipalities and government. There is an emerging consensus among all interested parties that the safe disposal of hospital waste is an urgent matter.

The counterpart cooperating organization is the Szent Imre Teaching Hospital located in the 11th district of Budapest, Hungary. This hospital is one of the main hospitals in Budapest of ~900 beds (May 1998) and is particularly important to be part of this project because, in addition to the hospital waste management, it would partly address some industrial and municipal waste management issues of the district.

The project, is the first of this kind by UNIDO and is one of the first international initiatives (q.v. WHO, Nancy office, *Healthcare Waste Management within Hospitals*) related to hospital waste in Hungary, will develop the methodology and the framework for hospital waste identification and remedial action guidelines.

The project is anticipated to generate several positive external advantages. In addition to other benefits to the Hungarian Government and communities, the project will serve as a pilot case for hospital waste management/minimization schemes/programs in other transition economy countries in Central and Eastern Europe. In order to maximize the regional and inter-regional relevance of the project, a pilot program on hospital waste management with technological and managerial guidelines (methodology) will be presented at an International Workshop to assist developing similar programs in other countries. Hospital managers, waste management experts and other healthcare officials at decision making level from the region and other interested regions, and observers from potential international funding agencies will be invited to participate in the workshop.

B. Project Methodology

The following brief description of hospital waste management is in line with the current Guidelines to the Management of Wastes Generated in the HealthCare Institutions, National Institute of Hygiene, Budapest, 1994 (draft in Hungarian).

i. Inventory of Generated Wastes

The accuracy of an inventory of generated waste depends on the survey methods used. Historically, most generators of hospital waste have not kept good records of the amount generated. The development of an inventory of generated wastes could be based upon calculated amounts that are 'typically' generated in various healthcare facilities. Generation factors could be taken from literature and other published reports and applied to facilities in a specific country.

A more accurate approach would involve relevant field research and surveys of facilities that generate hospital waste. This approach may involve self-reporting by the generator through a questionnaire, on-site field surveillance and interviews, and reviews of records kept by disposal locations and hauliers if they exist.

It should be born in mind that, typically, hospital waste may not comprise more than one or two percent of total solid waste. Also, hospitals (as data in the US indicate), generate approximately 50% of the total medical waste. Since half of the medical waste come from other than hospital sources, it is very important to consider those sources. Other generators may include households, diabetics, farming operations, agricultural businesses, etc. Generators that may be under some type of regulation (not necessarily for waste, but for other purposes) include private practice physicians, dentists, pediatricians, veterinarians, mortuaries, hospitals, nursing homes, police stations and other emergency services, ships, cosmetic piercers, tattooists, acupuncturists, beauticians, osteopaths, opticians, chiropodists, clinical and industrial laboratories; other generators may also include laboratories at universities and military units.

At the beginning of an inventory it would be important in agreeing to a definition. A variety of different terms are used concerning hospital waste. Often, such terms as medical waste, hazardous medical wastes, infectious waste, pathological waste, etc., are all used. Additionally, scalpel blades, disposable needles (many times referred to as 'sharps') can pose a major safety hazard, particularly for those handling and transporting the waste.

For a selection of definitions (WHO, and other sources) See Technical Report No. 6, Appendix D.

ii. Waste Management

The management of generated waste depends on the awareness, policies and strategies followed by the hospital administration, as well as the waste management opportunities available directly to the hospital and the municipality to which the hospital belongs. In general, waste management should aim at minimizing the generated waste. The methodology in developing and implementing a waste minimization approach consists of source reduction, and recycling and control of residual waste. It begins with a waste minimization audit which is a systematic procedure for identifying generated waste, and ways to reduce, control or eliminate the waste.

The following phases are **recommended** when establishing a waste management and waste minimization program in hospitals:

1. Incorporating waste management (with focus on hazardous waste and special wastes) in planning and organization;

2. Identification/assessment of waste and hazardous (biological and chemicals) waste;

3. Feasibility of waste management options and techno-economic analysis/ prioritization:

4. Implementation of measures following the priority list.

Details on the activities that are involved at the respective phases listed above are described as follows:

- **Planning and Organization.** It is important to obtain the commitment of management for an effective waste management/waste minimization program. Once this commitment is available, overall identification and assessment programs must be elaborated. For this purpose, an assessment program task force should be organized.

- **Identification and Assessment of Waste and Hazardous (Biological and Chemical) Waste.** As soon as a management commitment is appointed, the various sections generating and/or handling waste materials should be informed of the development of this waste management program and that their cooperation should be secured. The authoritative recognition to the waste management program is necessary for the project data collecting team and the assessment task force to enable them to start their assignment on data collection and processing.

  It is also important to develop a basic understanding of the activities that generate waste at a hospital facility. Flow charts might assist to identify the quantity, types and rates of waste generating activities. The preparation of material balances for various processes can also be useful to trace the various process components and to identify losses that may not have been accounted for so far. This is useful especially when attempts are made to differentiate between infectious and hazardous waste. During the process of identifying the waste generating activities, a priority list should be prepared for follow-up action.

  The main objectives of this step is to identify a comprehensive range of waste management/ waste minimization opportunities. These opportunities will be prioritized for further evaluations. The range of opportunities will include waste control methods, source reduction approaches and recycling schemes.

  The identification of the present methods of handling, collecting and disposing of medical waste should also include an identification, if any, of existing in-country rules, regulations or other management requirements. Such requirements could conceivably be in-place, but not be enforced. Similarly, some clinics, hospitals and research institutes may voluntarily have mechanisms or handling procedures for their medical waste.

  Health risks from hazardous biological waste need not be great, where there is satisfactory hospital waste management. As a part of this task, it is suggested to examine the health risks associated with general exposure by the public; risks of occupational exposure by workers in the handling, transport and disposal of waste; and the risks that may accompany different hospital waste treatment methods. Records or reported cases of disease transmission from public or worker contact with hospital waste, where such records exists should be reviewed.

- **Alternatives and Techno-Economic Analysis.** Opportunities for waste management and minimization that are identified will be assessed through techno-economic evaluations. The result of these evaluations will contribute to setting up a list of recommendations for implementations (see Technical Report No. 3 — Techno-Economic Options).

  Costs of different technological and management options should be estimated using experience in the United Kingdom, with modifications to account for options in Central-East European countries. Internal costs at hospitals, clinics, etc., can be estimated through discussions with the facility managers. To the contrary, costs for hospital waste transportation, treatment (if needed), incineration or other disposal techniques will be dependent upon the location and availability of services. This would have to be estimated by conducting a search and a review of such services that may be available, or of services that may be established as a new business opportunity.

  The need for hospital waste management services will provide business opportunities for existing or new entrepreneurs. Experience in the United Kingdom shows that hospital waste management can be a lucrative business.

- **Implementation and Priorities.** The prioritization of problems and the identification of remedial measures are the prerequisites for the successful implementation.

  The prioritization of problems should include issues that relate to:

  a. Handling and collection;
  b. Transport of waste;
  c. Efficacy of treatment methods;
  d. Public or community problems versus an occupational or worker problem;
  e. Regulatory and enforcement mechanisms;
  f. Needs for rules, regulations, guidelines;
  g. Need for treatment and disposal facilities; and
  h. Financial cost and business opportunities for medical waste management.

  Remedial measures for hospital waste management may cover a broad spectrum including waste management at the point of generation, through transportation, processing and finally to the point of final disposal. The required remedial measures can range from the very simple to the complex. Simple housekeeping measures, such as safety procedures for handling and bagging, can result in immediate safety improvements for the workers handling hospital waste. Additionally, properly bagged and identified waste makes hauling and further handling by others easier.

  Technological options for processing may include autoclaving, microwave treatment, chemical decontamination, electrothermal inactivation and others. Additionally, the performance requirements for incineration should also be reviewed. The use of mobile incinerators and heavy duty shredders should be given due consideration. The requirements for land disposal, where that may be an option, should be identified. Discharge to drain may be an option but this will depend on water quality requirements.

It is suggested that the prioritization and the subsequent optimization take into account a system that provides for hospital waste management measures sufficient to protect the workers and public from hospital waste hazards, including its transport, while minimizing the cost for such a system. It is a common experience that one may actually over design a hospital waste system that can go beyond what is needed. For example, there is no need to autoclave the waste, if it is going to an incinerator that can properly burn it. Clearly, care needs to be taken in bagging and transporting the waste, but requiring autoclaving before taking the waste to an incinerator is likely an unnecessary expense. This type of optimization should be examined.

Prioritization hospital waste management techniques is important, since a full implementation of an optimal system would likely not be achieved immediately. The prioritization should also reflect existing capabilities, opportunities, and activities that could be implemented at minimal or no added costs.

The implementation of the recommendations on optimal waste management and minimization depends on various factors ranging from the top management of the hospital, to financial constraints and external pressures such as surrounding communities, legislative/regulatory constraints, etc.

Good housekeeping recommendations can be implemented without or at very low cost if there is a commitment of the top management.

V. ACTIONS FOR HANDLING, TREATMENT AND SPECIFIC WASTES

The earlier UNIDO reports series TF/HUN/94/F90 in 1996 by Hall and Skinner identified a number of specific wastes. Some of these were the subject of laboratory examination reported by Spectromass Analytical Laboratory Limited in 1997. These are discussed below, with recommendations where applicable.

A. Ampoules, Syringes, Needles, Infusion Bottles, etc., Chemotherapeutic And Antineoplastic Chemicals

i. Glass and Plastic Ampoules, Syringes and Needles

These need to be deposited in yellow boxes, ideally segregated. This is current practice at the Szent Imre hospital (q.v. Waste Management Audit — Technical Report No. 2. These yellow boxes are then disposed of by incineration.

ii. Infusion Bottles

These need to be considered in two classes:

- Those likely to be contaminated with human body fluids (if any) — these require to be placed in yellow bags and incinerated.

- Those with no direct contact with human body fluids, e.g. saline solutions used by the dialysis unit. Ideally, these should be returned to the supplier for recycling. If this is not possible, their tops (container metal closure, etc.) should be removed for recycling of the metal and the body of the bottle shredded and sold as good quality polythene scrap for re-use.

iii. Chemotherapeutic and Antineoplastic Chemicals

In general, these are particularly hazardous chemicals and any residues should be subject to incineration. At the Szent Imre hospital, the pharmacy operates a 'just-in-time' purchasing policy which means that there should be no out-of-date stocks of these expensive drugs. Residues in ampoules or other usage forms should be deposited in 'yellow' containers for incineration.

Hence, there should be no direct discharges of these hazardous substances to drain.

However, Szent Imre hospital, in common with normal hospital practice, does not take any special precaution regarding the disposal (discarding) of patients' excreta. This is of little consequence to the receiving waters in view of both the dilution factor $>10^7$ and, as in the vast majority of cases, these drugs are either highly reactive or will be subject to biodegradation even in sewerage systems. Further degradation would occur if the Szent Imre hospital effluent was subject to aerobic treatment.

It should be noted that, for example, bleomycin and cis-platin do not so biodegrade, and if there was a very substantial (>10 fold) increase in the use of these drugs, then methods for the treatment of patients' excreta may warrant serious consideration.

B. Formaldehyde (10% Aqueous Solution)

Estimated quantity discarded 500 liters/annum, i.e. ~50 kg H.CHO/annum.

Whilst formaldehyde is a known carcinogen, it is the professional view of the consultants that this small quantity of formaldehyde can be discharged to drain.

The United Kingdom Statutory Instrument 1980, No. 1709 *The Control of Pollution (Special Waste) Regulation 1980*, Schedule 1, Part II (See Section VI, Special Waste), attempts to quantify the meaning of substances which are 'dangerous to life'.

Furthermore, the former London Waste Regulation Authority (now the Environment Agency) recommends that special waste *shall not contain known or probable human carcinogens at a concentration of 1% w/w or more.*

As it would appear that the Hungarian Environmental Regulations are more stringent than the British and EU, consideration should be given to the relaxation of these regulations, at least for such modest discharges from hospitals.

It should be borne in mind that dilution within the Pathology department, and with the further dilution within the overall hospital waste water, that the predicted environment concentration (PEC) in both cases would be <1.

For the record the calculated concentration based on 50 kg H.CHO in the Danube river flow, 650 m^3/sec is ~0.03 μg/l, which is less than the 0.1 μg/l used by Thames Water Authority's Catchment Quality Control studies undertaken by one of the consultants (MLR) 1976—1989.

A predicted environmental concentration of 0.03 μg/l is well below the predicted no effect concentration (PNEC) of most freshwater aquatic organisms, see Part 6 — Appendix K, viz. LC_{50} (96 hr) bullhead 62 μg/l, and bluegill sunfish 100 μg/l, allowing a safety factor of 100 means that the PEC/PNEC ratio is 0.03/0.62 = 0.05, and hence, very significantly less than one. Thus the risk potential to the Danube river from the potential discharges from the Szent Imre hospital is negligible. Furthermore, formaldehyde is readily biodegradable.

If the Hungarian regulatory authorities wish, in the light of the foregoing, to maintain their position, then the laboratory may wish to consider oxidizing the formaldehyde with hydrogen peroxide and sodium hydroxide to yield sodium formate.

A further alternative would be to convert the formaldehyde to paraformaldehyde which has in the United Kingdom a waste re-use potential. However, 50 kg per annum would be too small to make this option viable.

Hence, it is **recommended** that the Hungarian Ministry of Environment and Regional Planning revise their regulations to permit the discharge of 500 liters of 10% formaldehyde solution per annum (i.e. 1—2 liters/day) to drain.

This matter should be included in the International Workshop w/c 2 November 1998 as an example of the value of PEC/PNEC ratios.

It should be remembered that the larger safety consideration is the risk of nasal cancer from an occupational health viewpoint.

It should be noted that according to the analysis undertaken by Spectromass Analytical Laboratory Limited (Budapest) that the formaldehyde in the drinking water at the Szent Imre hospital can be 3.2 — 11 μg/l which is a matter of very considerable concern.

C. *Radio Nuclides*

As detailed in Technical Report No. 2 — Waste Management Audit, the Szent Imre hospital only used technetium-99 m, and small quantities of iodine-125 for radioimmunoassay. These are well controlled and hence there is minimal risk.

The only **recommendation** is that the yellow bags carrying the biological sign (Category No. 6) should be replaced with bags carrying a further and distinctive marking (e.g. red stripes) and the international radioactivity sign (Category No. 7).

D. *Organic Solvents*

The Pathology department uses and discards acetone, ethanol, chloroform and xylene.

The first three are mixed together prior to discarding for incineration. The xylene, too, is incinerated.

i. Acetone

Estimated quantity discarded is 500 l/annum.

The Ministry of Environment and Regional Planning imposes a ban on the discharge of acetone based on its flammability. Flash point -18 °C.

This is assumed to be based on a similar argument as to the restriction imposed by the Environment Agency in the United Kingdom, viz. *Special waste to include waste having a flash point of 21 °C or less.*

Simple dilution, as would occur within normal usage would effect a dilution to ensure that the flash point is >21 °C.

Alternatively, the acetone can be used as a fuel source within the Pathology or the neighboring Bacteriological Laboratory for spirit lamps — see also ethanol below.

It should be noted that acetone is readily biodegradable.

ii. Ethanol

Estimated quantity discarded 300 l/annum.

Ethanol has a flash point of 13 °C and a similar argument applies as in the case of acetone above. It may be remembered that one can ignite brandy (~40% ethanol) to pour on one's pudding, one cannot ignite wine (~12% ethanol)!

Again, ethanol is readily biodegradable.

It is hence **recommended** that the acetone and ethanol are used to fuel spirit lamps or otherwise be discarded to drain.

iii. Chloroform

Estimated quantity discarded 500 l/annum.

There is no option but to incinerate chloroform.

However, because of its chlorine content and the possible formation of TCDDs during incineration, a substitute might be sought. This should be discussed when the Hungarian experts visit the United Kingdom in August 1998.

iv. Xylene

Estimated quantity discarded 500 l/annum.

The waste xylene in principle can only be incinerated; however, in view of its high calorific value a low price should be negotiated. Alternative means could include its use in motor mowers and other engines used in the hospital extensive grounds; or if regulations permitted, by addition it to the hospital's diesel fuel emergency stock.

E. Disinfectants

Formaldehyde is used for the disinfection of instruments, e.g. endoscopes — for discarding processes see above.

Chlorine-based disinfectants: these are essential for disinfection and sterilization procedures. Quantities used on floors, toilets, etc., and hence when washed to drain are no different to normal domestic usage and therefore of no concern.

The same argument applies to phenol-based disinfectants.

Quaternary ammonium-based disinfectants are used widely within the hospital, but as they cationic surfactants, react with anionic detergents, their effect on receiving waters is negligible and are of no concern.

F. Mercury

The earlier UNIDO report (Dr. Éva Czajlik) indicated that there were (unacceptably) high levels of mercury in the wastewater from the hospital, i.e. up to 35 µg/l (detection limit 0.7 µg/l).

Reasons for this included:
- Breakage of thermometers, blood pressure manometers, etc.; and,
- Dentistry.

During the waste audit the following sources were identified:

- **Breakage of thermometers.** 200 per month (300 purchased — some external losses); (see below for health hazards);

- **Breakage of blood pressure manometers.** About 4 per month, some mercury recovered;

- **Dentistry**. Only three dental chairs in operation — but no provision for the recovery of mercury in aqueous emissions: the excess amalgam was sent for reprocessing; and,

- **Mercurochrome.** The pharmacy reported use of 2 kg of 2% for use in the main ward areas especially for chronic bed ridden patients, some also used for out patients. Mercurochrome has not been used in the United Kingdom for over 20 years, suggested alternatives include povidone iodide and chlorhexidine. This matter could be raised during the visit of the three Hungarian experts to the United Kingdom in August 1998.

  The consultants noted that mercurochrome had not been used in the United Kingdom for >20 years.

i. Recommendations

- Alternatives to be sought for the mercurochrome,

- Dentist's chairs to be equipped with mercury (amalgam) recovery devices (interceptors);

- Much greater care is needs to be exercised regarding spillages from thermometers. The hospital is old with many crevices in the flooring.

Whatever the proportion of such spilled mercury which might be discharged to drain, and with the attendant downstream consequences, the risk is small but nevertheless significant, taking note of a dilution factor of >100,000 between the hospital and the receiving water (the Danube river), as reported by Benedek, P. 'River Danube Pollution and Its Risk Assessment', in: *Risk Assessment.* Richardson, M.L. (Ed.), The Royal Society of Chemistry, London, 1988, pp. 315—362.

The greatest adverse effect is to human health, both patients and more so medical (nursing) staff from inhalation of mercury vapor.

Currently, there is no provision for treating split mercury, e.g. vacuum suction, mercury sponges, sawdust or preferably flowers of sulfur, neither does the laboratory possess any means for simple atmospheric air monitoring, nor for measurement of blood (or other body fluid) mercury content.

It is **recommended** a written procedure with spill kit, including flowers of sulfur, are made available immediately for treatment of mercury metal spills, and that urgent consideration be given to the purchase of a low cost atmospheric air monitoring device; serious consideration should also be given to a means for blood mercury measurements.

Mercury discharges to the receiving water and in particular to the ambient atmosphere are a matter of concern. Facilities for monitoring of water, plus that of ambient air should be obtained. Blood mercury levels from chronic patients and nursing staff should be undertaken.

ii. Adverse Health Effects

- Toxic vapor, poisonous to kidney and nervous system.
- Mercury vapor harms plants.
- Toxic to animals
- Accumulates and concentrates in food chains
- Mercury waste can be co-disposed in landfills. (See also Technical Report No. 6 — Appendix K).[1]

G. Waste Anesthetic Gases (15 kg/week)

In common with normal medical practice, nitrous oxide only is used. The amounts discharged to the atmosphere are negligible. The hospital pharmacy's policy of holding minimum stocks, ensures that there is no out-of-date stock for discarding. No action required.

H. Plastic Materials (Petri Dishes, Infusion Sets, Surgical Gloves), etc.

Estimated quality 12,000 kg per annum.

Note: no bacteriology is undertaken on the Szent Imre main site, and hence disposal of Petri dishes does not occur. It should be noted that the normal method of disposal of Petri dishes is incinerating, ideally with prior autoclaving on infection safety grounds.

The other plastic items can be disposed of in yellow bags (clinical waste) if contaminated with possible infectious materials, e.g. blood; or to blue bags (non-hazardous waste) if not so contaminated. The latter are then dispatched to controlled landfill sites.

From a cost viewpoint, it is essential that the hospital exerts maximum management control over the segregation of this type of waste in view of the cost differential between the total disposal cost for non-hazardous waste US $ 26,930; and for clinical waste US $ 25,368. These are 1997 figures. (It was not possible to derive a cost per container or per kg.)

I. Other Toxic and Corrosive Chemicals

Only cyanide is used in the clinical laboratory. This is oxidized with sodium hypochlorite solution and then discarded to drain — this is acceptable and normal practice.

Additional care should be exercised over discharges of acids in view of the low pHs (2.8) observed in 1997.

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[1] Richardson, M.L. and Gangolli, S. *Dictionary of Substances and their Effects (DOSE).* The Royal Society of Chemistry, Cambridge, United Kingdom, 1992—1995, Vol. 5, pp. 379—383.

J. Photographic Chemicals

Estimated quantity 3,640 liters/annum

i. **Waste Silver**

As described in detail in Waste Management Audit — Technical Report No. 2, it is essential that all silver waste is recovered. This should provide a means of income for the hospital (possibly as much as HUF 2 M/annum).

ii. **Other Chemicals, Developers, Sensitizers, etc.**

Photographic films during developing result in expensive chemicals, e.g. phenylene diamine derivatives being washed off. Within the United Kingdom (and elsewhere within Western countries), these are recovered for purification and re-use by very large scale users of photographic film, etc., processors of movies (and now to a lesser extent, TV), film. Whilst it would not be economically viable for any hospital to consider this, it would be of value for the hospital management, via the Ministry of Welfare, to investigate the sale of such solution to any large industrial photographic developing facilities within Budapest. The UNIDO representative at the Ministry of Industry, Trade and Tourism should be able to identify such facilities.

K. Biological Hazardous Waste Materials to be Handled with Specific Care, Infectious Waste Materials (Fecal, Blood Contained Materials)

Estimated quantity 30,000 — 50,000 kg per annum. See also Waste Management Audit — Technical Report No. 2.

As mentioned in Section H above, management needs to exert maximum effect in ensuring that the strict rules regarding segregation are adhered to.

Advice on the different types of hazardous waste are provided in Training In-house Hospital Management, Szent Imre Hospital 7—11 September 1998 — Technical Report No. 4 (under preparation).

The following is **recommended** for the appropriate disposal of equipment:

- When using auto-destruct and disposable syringes and needles, place each syringe and needle in a specially designed puncture-resistant container (sharps box).
- Do not recap the needle
- Do not transfer contaminated sharps from container to container.

VI. SPECIAL WASTE

Table 1: United Kingdom Statutory Instrument 1990, No. 1709. The Control of Pollution (Special Waste) Regulations 1980

SCHEDULE 1 **Regulation 2**

Part I
LISTED SUBSTANCES

Acids and alkalis
Antimony and antimony compounds
Arsenic compounds
Asbestos (all chemical forms)
Barium compounds
Beryllium and beryllium compounds
Biocides and phytopharmaceutical substances
Boron compounds
Cadmium and cadmium compounds
Copper compounds
Heterocyclic organic compounds containing oxygen, nitrogen or sulfur
Hexavalent chromium compounds
Hydrocarbons and their oxygen, nitrogen and sulfur compounds
Inorganic cyanides
Inorganic halogen-containing compounds
Inorganic sulfur-containing compounds
Laboratory chemicals
Lead compounds
Mercury compounds
Nickel and nickel compounds
Organic halogen compounds, excluding inert polymeric materials
Peroxides, chlorates, perchlorates and azides
Pharmaceutical and veterinary compounds
Phosphorus and its compounds
Selenium and selenium compounds
Silver compounds
Tarry materials from refining and tar residues from distilling
Tellurium and tellurium compounds
Thallium and thallium compounds
Vanadium compounds
Zinc compounds

Part II
MEANING OF 'DANGEROUS TO LIFE'

1. *Waste is to be regarded as dangerous to life for the purposes of these regulations if—*

(a) *a single dose of not more than five cubic centimeters would be likely to cause death or serious damage to tissue if ingested by a child of 20 kilograms' body weight or*

(b) *exposure to it for fifteen minutes or less would be likely to cause serious damage to human tissue by inhalation, skin contact or eye contact.*

Assessing effects of ingestion

2. *(1) The likely effect of ingestion is to be assessed by the use of reliable toxicity data in the following order of preference:*

Class 1: Information about the effect of oral ingestion by children;
Class 2: Data derived by extrapolation from information about the effects of oral ingestion by adults;
Class 3: Other information about human toxicity;
Class 4: Information about animal toxicity;
Class 5: Information about the toxicity of analogous chemicals.

(2) Where conclusive information falling within one of the classes set out in sub-paragraph (1) is available no regard shall be paid to information falling within a class baring a higher number, and the reference to using data in an order of preference is to be understood accordingly.

3. *Where the waste is in such a form that —*

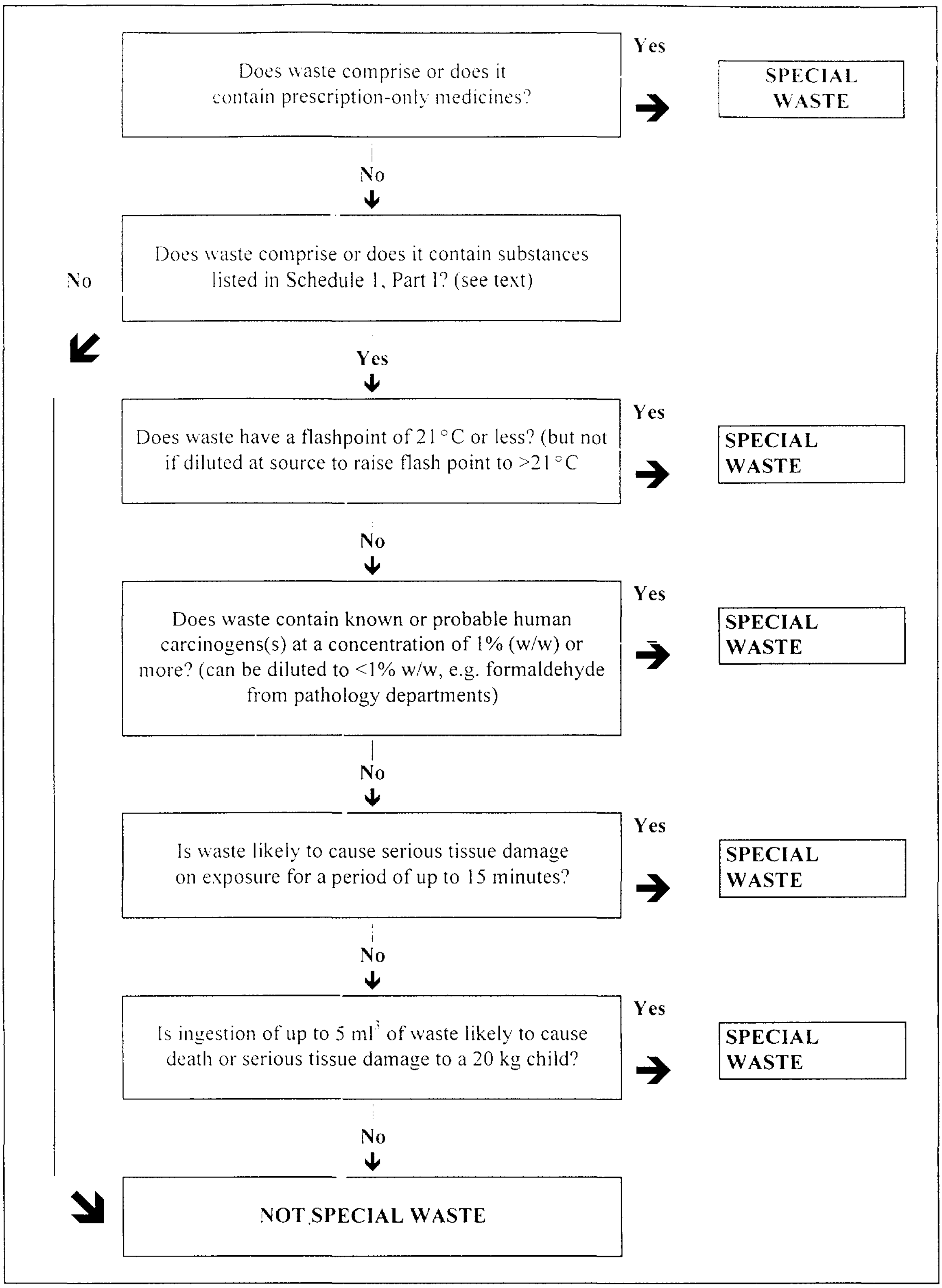
(a) *the ingestion of less than five cubic centimeters is not possible, or*

(b) *there is no risk that a toxic constituent could be assimilated if the waste were to be ingested,*

then it is not to be regarded as dangerous to life by reason of a sub-paragraph 1(a) of this schedule.

Mixed waste: samples

4. *Waste is to be regarded as dangerous to life if a sample of five cubic centimeters taken from any part of a consignment falls within either of the descriptions in paragraph 1 of this schedule.*



Note that the above represents a logical approach to the assessment of a waste's status according to the defined criteria. The order in which the questions appear does not imply any grading of importance, but will usually provide the quickest reasoned decision.

Figure 1: Special Waste Assessment Procedure Diagram

Table 2: Release to Air — Identified Substances

Oxides of sulfur and other sulfur compounds
Oxides of nitrogen and other nitrogen compounds
Oxides of carbon
Organic compounds and partial oxidation products
Metals, metalloids and their compounds
Asbestos (suspended particulate matters and fibers), glass fibers and mineral fibers
Halogens and their compounds
Phosphorus and its compounds
Particulate matter

Table 3: Release to Water — Identified Substances

Mercury and its compounds
Cadmium and its compounds
All isomers of hexachlorocyclohexane
All isomers of DDT
Pentachlorophenol and its compounds
Hexachlorobenzene
Hexachlorobutadiene
Aldrin
Dieldrin
Endrin
Polychlorinated biphenyls
Dichlorvos
1,2-Dichloroethane
All isomers of trichlorobenzene
Atrazine
Simazine
Tributyltin compounds
Triphenyltin compounds
Trifluralin
Fenitrothion
Azinphos-methyl
Malathion
Endosulfan

Table 4: Release to Land — Identified Substances

Organic solvents
Azides
Halogens and their covalent compounds
Metal carbonyls
Organo-metallic compounds
Oxidizing agents
Polychlorinated dibenzofuran and any congener thereof
Polychlorinated dibenzo-*p*-dioxin and any other congener thereof
Polyhalogenated biphenyls, terphenyls and naphthalenes
Phosphorus
Pesticides — including biocides and plant protection substances, comprise any chemical substance or preparation prepared or used for destroying any pest, including those used for protecting plants or wood or other plant products from harmful organisms; regulating the growth of plants; giving protection against harmful creatures; rendering such creatures harmless; controlling organisms with harmful or unwanted effects on water systems, buildings or other structures, or on manufactured products; or protecting animals against ectoparasites.
Alkali metals and other oxides and alkaline earth metals and their oxides.

VII. EFFLUENT MONITORING

The earlier (1997) data generated by Spectromass Analytical Laboratory Limited, indicated that the effluent from the Szent Imre hospital was in general terms similar to that of domestic sewage.

As it would appear that the Szent Imre hospital's sewage charges are based solely on their potable water (metered) consumption and not on effluent strength, there is no cost benefit in undertaking further analysis.

The only exception, as indicated in Section V.F, is mercury.

However, should the Mayor's Office or other wastewater authority instigate charging on strength, e.g. COD, suspended solids or other parameters, then it would be in the hospital's interest to have undertaken by an accredited laboratory the parameters indicated in Table 5 on a monthly basis.

Table 6 indicates the limit values for drinking water (EU and WHO). It should be noted (see Technical Report No. 3 — Techno-economic Options) that the average of six results (1997–1998 for potable water samples taken from the hemodialysis unit at the Szent Imre hospital by the National Public Health Centre averaged 8.3 μg/l total trihalomethanes.

It is suggested that analyses should be undertaken as indicated in Table 5.

Table 5: Analytical Parameters — Monthly

A	Sewage pump (kitchen, pathology, boiler house, offices)
B	Hemodialysis center (dialysis unit — *note private*!)
C	Southern corner of building 'A' (isotope laboratory, clinical chemistry, otolaryngology, gynecology/obstetrics)
D	Northern corner of building 'A' (surgery, gynecology/obstetrics, intensive care unit, inpatients)
E	Building 'B' (inpatients, psychiatry, neurology)
TW	Tap water (input)

Points	**Parameter**
A-E, TW	pH*
A-E, TW	BOD
A-E, TW	COD
A-E, TW	Suspended solids
A-E, TW	Ammonia*
A-E, TW	Phenol index*
A-E, TW	Organic solvent extract*
C, D	Mercury (weekly initially)
A-E, TW	Chloroform — too high in TW
A-E, TW	Carbon tetrachloride — try to eliminate use in laboratories
B	Benzene
B, C	Toluene
A-E	Xylenes
A-E	Quaternary ammonia compounds
A-E	Free chlorine
A-E, TW	Zinc*
A-E, TW	'Benzol'*
A-E, TW	Organic solvent

*Hungarian limit values apply

Table 7 indicates the Hungarian limit values for sewage water. It should be noted that a discharge of ~30 µg/l mercury from a hospital ward is unlikely to exceed the 0.005—0.5 mg/l standard after dilution within the hospital. The hospital would appear to be within the limit in the main part.

Table 6. Limit Values for Drinking Water

Compounds	µg/l EU 95/C131/03	µg/l WHO 1993
cis 1,2-Dichloroethene		30
Chloroform	40	200
1,1,1-Trichloroethane		2000
1,2-Dichloroethane	3	50
Benzene		10
Carbon tetrachloride		2
Trichloroethene	70	70
Bromodichloromethane	15	60
Toluene		700
Dibromochloromethane		100
Tetrachloroethene	40	40
Chlorobenzene		300
Ethyl benzene		300
m-,p-xylene		500
Bromoform		100
1,4-Dichlorobenzene		300
1,2-Dichlorobenzene		1000

Table 7. Hungarian Limit Values for Sewage Water

	Limit mg/l
Organic solvent extract	40—60
Phenols	5.0—1.0
pH	6.5—10
Ammonia	100—150
Zn	2.0—10
Hg	0.005—0.05
Benzol	50—100
Organic solvents	50—100

Exceptions include pH from sample B — Hemodialysis center, Clinical laboratory (Building 'R'), for which further examination, source of the acid materials, and rectification is required. At pH 2.80, this is still likely to be counterbalanced by the higher pH from the other discharge points. See also Section V, I.)

Table 8 indicates typical water authority consent conditions in the United Kingdom.

Table 8. Typical Water Authority Consent Conditions for the United Kingdom

Parameter	**mg/l (except pH and temperature)**
Sulfides (as S)	2
Cyanide (as CN)	2
Sulfur dioxide	10
Formaldehyde	20
Chlorine (free)	2
Free ammonia (NH_3)	100
Sulfate (as SO_4)	1200
Copper	5
Nickel	5
Zinc	5
Cadmium	1
Lead	10
Chromium	10
Suspended solids*	400
Total fatty matter (oil/grease)	100
pH	6—11
Temperature	43 °C (max)

* The figure for suspended solids is important as it would inevitably be exceeded if maceration of disposables followed by discharge to sewers was practiced to any extent.

VIII. TRANSPORT

A. Loading and Unloading Waste

Manual handling operations should be kept to a minimum.

Persons handling waste must be provided with suitable protective clothing including Wellington boots or leg protectors, overalls and industrial gloves. Industrial apron may provide added protection and eye protection must be worn when cleaning up spillages. Ideally, aprons and gloves should be needle prick proof. Detailed training is essential.

Respiratory protective equipment is not normally required.

Waste bags should be handled by the neck and should not be thrown or dropped. This is a further reason to ensure that they are securely closed by a tag. Pushing bags should be avoided.

Eating, drinking, chewing and smoking are prohibited while handling clinical waste.

Hand-washing facilities must be available and should be used after removal of protective clothing, and prior to eating, drinking, smoking, etc.

Hepatitis A and B, and tetanus immunization is recommended for staff who handle clinical waste.

B. Internal Transport

Trolleys, carts, etc., used for waste transportation should have smooth and impermeable surfaces and should not offer harborage to insects. Carts should be easy to clean and drain, be designed so that waste particles do not become lodged in their fabric and enable waste to be easily loaded, secured and unloaded. In general, personnel movement should be segregated from waste flow. Furthermore, if it is possible, special service accesses; hallways or parts of hallways should be established, especially in any reconstruction. (See also Technical Report No. 2, Szent Imre Hospital — Waste Audit, Section IV, F.)

C. Road Transport

Clinical waste should normally be transported in a purpose built vehicle which should incorporate:

i. Adequate size with a minimum body height of 2.1 m;

ii. A bulkhead between the load and the driver's cabin designed to retain the load during a 30 kph collision;

iii. A system to secure the load;

iv. A secure compartment to carry plastic bags, protective clothing, cleaning equipment, disinfectants, etc.;

v. A supply of hand cleaning materials in the driver's cab;

vi. If loosely stacked, bagged waste is carried, the internal body surfaces should be lined so as to be smooth, with all corners covered for easy cleaning. The surfaces should be suitable for steam and chemical cleaning processes;

vii. Suitable identification on the outside, including contact telephone number (freephone, if possible) in the event of an accident. Ideally, the driver should have a mobile telephone.

The hospital's clinical waste policy should specify frequent steam cleaning or disinfection of vehicles (at least weekly) and whenever spillage or leakage has occurred.

IX. BEST PRACTICE GUIDANCE

It is not uncommon for clinical waste to be discovered in public places. Clinical waste not always in yellow bags which themselves might contain clinical waste, sharps containers, used needles, and dental care waste have been found on unlicensed sites, riverbanks, highways and household waste sites.

In the United Kingdom these incidents are serious breeches of the Duty of Care imposed by Section 34 of the Environmental Protection Act 1990 and the Environmental Protection (Duty of Care) Regulation 1991, and as a result in the UK hospitals, and others, have been prosecuted and fined.

A. Identification of Best Practice

The key to best practice in the management of clinical waste disposal is correct **identification** and **segregation**. (See also Training In-house Hospital Management, Szent Imre Hospital, 7—11 September — Technical Report No. 4, under preparation)

By correctly identifying and segregating the waste at its source, the waste enters the most suitable waste stream and follows the appropriate disposal (discarding) route. Incorrect identification and segregation can incur unnecessary injury and infection and lead to the waste producer incurring additional costs.

B. Waste Transfer and Disposal

Until recently, a number of establishments had their own on-site incinerator plant for waste disposal. Within the UK, the removal of Crown immunity and the attendant requirement to meet emission regulations has meant the closure of hospital-based incinerators. These days, waste is invariably taken off site for disposal elsewhere, often via transfer stations, which can increase the opportunity for waste going astray, or being delayed prior to final treatment.

In which cases, it is recommended that the hospital management, as part of a Duty of Care, undertakes performance checks to ensure that their approved contractor takes the waste to the designated disposal (discarding) site.

C. *Waste Segregation and Collection*

Arrangements to separate household type waste at general ward level are usually rudimentary. Patients should be supplied with small locker waste bags for their own use. The contents of these bags can be regarded as normal domestic waste; but, waste material from medical activities may be placed inadvertently in these receptacles and therefore enter the incorrect waste stream.

Clinical waste generated from general ward procedures is usually placed in yellow plastic bags, held in secure storage areas and taken for incineration supplied by the contractor.

Wheeled bins are currently the preferred means, whilst this method may not be suitable or every hospital site, this system minimizes the number of times that waste bags are handled and as a consequence minimizes the occurrences of injury and spillage. Other alternatives include designated rooms or areas 'yellow', or deployed large notices to encourage correct handling.

In order to achieve improvements in the segregation of clinical and non-clinical wastes the following needs consideration:

i. Improving knowledge on the sources of waste and how much volume is generated, by each source;

ii. Introducing procedures and improving staff training to allow identification of clinical and non-clinical wastes;

iii. Developing quality control methods with the associated risk assessments to attain the required degree of waste separation;

iv. In the preparation, implementation and review of waste management policy, hospitals should involve **all** waste-producing areas in the process and, where necessary, appoint dedicated waste managers;

v. Quality control procedures and associated risk assessments should be considered to assist top hospital management with waste segregation arrangements;

vi. All clinical waste producers must ensure that waste enters its legitimate waste stream and cannot escape from the waste stream, thus ensuring that the waste is safely managed and disposed of (discarded) at a suitably licensed or authorized facility;

vii. Waste flow should be segregated from personnel movement, wherever possible;

viii. Waste storage areas within each hospital premises, including temporary storage areas, should be physically separated from areas to which the public has access;

ix. Every effort should be made to reduce risks and hence increase safety.

X. UNIT COST CONTROL

The purpose of departmental costing is to establish and correctly allocate 'costs' of an enterprise and having done so use the results for management control as indicated in Section C below, also to provide data for the preparation of cash flows and preparation of targets for future performance.

A. Prepare Departmental Budgets

It would be necessary to prepare annual total and departmental budgets to be projected on a four weekly basis. The budgets would cover:

i. Direct cost of materials;

ii. Direct cost of wages and salaries;

iii. Overheads including an appropriate share of central administrative costs, preferably with a percentage loading to help cover future capital requirements

iv. Depreciation of major plant and equipment calculated on the estimated useful life of the asset;

v. Obsolescence — the writing off of minor equipment with a short life, e.g. computers;

vi. Interest, actual or notional arising from the financing of capital investment;

vii. Actual or notional charge for rent of space occupied.

B. Coding System

A system of 'coding' would be needed in the central accounts records whereby expenditure incurred could be readily allocated to the individual department.

C. Monthly Cost Reports

The four weekly cost reports and comparisons against budget would require to be monitored (and reasons for variances ascertained) by a member of management staff. This officer would be required to report to a finance committee with recommendations where applicable for action or where relevant for a revision of a department's budget when, for example, experience showed that initial budgets were incorrect, or circumstances had changed.

D. *Periodic Revisions*

It is usual whilst maintaining the original annual budget to prepare periodic revised forecasts based on experience of actual costs as the year proceeds. These would give early warning of variances between performance and the pre-prepared budgets and supply data for implementation of future years' budgets.

The advantages of departmental costing is that it is a tool for management control and for establishing the accountability of each departmental manager who would be responsible for variations between the four weekly performance and the four weekly budget. Furthermore, performance better than budget by certain departments may point to areas where other departments can be encouraged to improve performance.

(This section was drafted by John R. Antoine, FCA, Sub-contractor).

XI. QUESTIONS WHICH CAN BE ASKED

A. *Waste Collection*

i. Waste collectors should provide waste producers with clear and simple information about what is expected from them and how waste will be removed from their premises;

ii. Use only waste carriers registered with the relevant ministry (environment).

B. *Waste Disposal*

i. Make sure your waste is taken in the correct containers to a licensed or authorized facility;

ii. Make sure that a written description of the waste is given to the waste collector;

iii. Only employ reputable and registered contractors;

iv. Ensure that the waste is transferred only to a facility which is licensed by the relevant competent authority.

Under no circumstances take clinical waste to the local authority or other unlicensed waste reception sites for disposal.

C. *Waste Management Policy*

i. Ensure that there are adequate health and safety procedures;

ii. Establish a waste management policy;

iii. Implement the policy throughout all working procedures;

iv. Review the policy periodically to make improvements;

v. Keep records of the types and quantities of waste generated and the date of its removal;

vi. Train **all** staff so that they are aware of waste management procedures;

vii. Designate a person to have overall responsibility for managing waste and ensure that they are fully aware of the regulatory requirements;

viii. Develop a *Duty of Care* program.

D. *Waste Generation and Storage*

i. Attempt to reduce the quantity of waste generated;

ii. Segregate waste according to type;

iii. Use only the correct storage containers and ensure that they are correctly labeled;

iv. Dispose of drugs in a safe and proper manner;

v. Under no circumstances allow needles or syringes to be placed or left in public places;

vi. Ensure that any vehicles comply with ADR requirements.

E. *General Environmental Policy*

i. Is the hospital **registered** under ISO 9000 series?

ii. Is the hospital seeking registration?

iii. Are there quality procedures in place?

iv. Is the hospital **accredited** under ISO 14000 Series/EMAS, etc., and if so name of verifying body?

v. Does the hospital have an Environmental Management System in place?

vi. When was the waste management policy written?

vii. Approved by whom?

viii. When was it last reviewed?

ix. Is there a separate clinical waste policy?

x. Where are copies of the waste management and clinical waste policies held?

xi. Is there a separate defined policy for special waste?

xii. Does the hospital have a specific policy to deal with spillages and possible contamination from spillages?

F. Waste Management Policy Implementation

i. Is there a person with specific operational responsibilities for waste management?

ii. What is the status of this person within the hospital?

iii. Provide an outline of the qualifications and training that this person has received.

iv. Are responsibilities allocated to named individuals, and how are these responsibilities implemented?

v. Can the hospital demonstrate how this is achieved, e.g. minutes of meetings, etc.

vi. Provide details of waste management contractors employed.

vii. Are they registered carriers?

viii. What is the extent of these contractors' responsibilities?

ix. Are the contractors involved in waste management policy decisions?

x. Do the contractors operate a quality management system?

xi. What is currently being considered with respect to waste regulations?

xii. What are the costs of waste treatment and disposal, e.g.
- Blue bags;
- Black bags;
- Yellow bags;
- Sharps containers;
- Recyclable materials, e.g. scrap metal, paper, plastics, glass.

xiii. Is the hospital aware of internal segregation/man power/pre-treatment costs?

G. Auditing Against Waste Management Policy

i. Does the hospital audit its waste management policy and implementation procedures?

ii. Are audits 'internal' or 'external'?

iii. How often are these audits carried out and by whom?

iv. If internal, what training have the auditors received?

v. What aspects does the audit cover?

vi. What is the form of the audit report?

vii. Who is consulted in the draft audit report?

viii. Who approves the final draft?

ix. How widely is the report distributed?

x. Who has the responsibility for correcting deficiencies?

xi. Are there any follow-up procedures to ensure implementation?

xii. How often are the contractors handling clinical waste audited?

xiii. Who undertakes the audit, and with what training?

xiv. Consider instigating 'Duty of Care'

H. Training in Waste Management Procedures

i. What categories of staff are trained with respect to waste management procedures —

- Clinical directors
- Senior managers
- Departmental managers
- Portering staff
- Domestic staff
- Nursing staff
- Medical staff
- Administrative staff
- Other

ii. What aspects of waste management does the training cover?

iii. Are the courses tailored to the needs of differing groups?

iv. Who undertakes the training?

v. What are the qualifications and experience of the trainers?

vi. Are records kept, where, by whom and in what form?

vii. What arrangements are made for temporary staff?

viii. Who is responsible for identifying training deficiencies?

ix. Are training needs reviewed on a regular basis? How often?

x. What actions are undertaken where there is a failure to comply?

I. Disposal (Discarding)

i. How is waste categorized and what quantities are produced?

ii. What types of containers are used?

iii. Are the following notes kept —

- Duty of Care transfer notes
- Special waste consignment notes

iv. Is there a designated person with responsibility for record-keeping?

v. Is there a licensed incinerator on site?

vi. What are the emission monitoring facilities?

vii. Who undertakes the monitoring and at what frequency?

viii. Does the emission from the incinerator comply with regulations, and if not, what is the frequency of non-compliance?

ix. Does the incinerator cause groundwater pollution? If so, what remediation plans are in hand?

x. Where does the waste identified in Section I (i) go for treatment and disposal (discarding)?

xi. What are the alternatives?

xii. List the procedures for segregation during handling, e.g. the contractor, until final disposal.

J. *Waste Handling*

i. What are the handling routes for the different categories of the wastes identified in Section I (i)? Waste and personnel movement should be segregated wherever possible.

ii. What internal vehicles are used?

iii. Can the waste be separated on the vehicles?

iv. Are the vehicles hosed down/cleaned, and how often?

v. Where is the waste stored on site?

vi. Are storage facilities adequate/secure?

vii. Are different waste streams segregated, and how is this achieved?

viii. What provisions have been made to segregate 'special waste'?

ix. Are storage facilities vermin proof?

x. How are spillages/breakages dealt with?

xi. Are there procedures for autoclaving or otherwise treating laboratory wastes to render them safe?

xii. What are the procedures for disposal of human tissue?

xiii. What is the extent of waste arising from outpatient activity, and what advice does the hospital provide?

xiv. Is there a different segregation policy for the outpatient department?

xv. Where is such information displayed?

xvi. How is segregation achieved.?

xvii. Are adequate containers/bags available? (i.e. yellow bags, sharp boxes, blue/black bags and appropriate colored bags for other materials).

xviii. Are these suitable for internal purposes/comply with policy?

xix. Are there any instructions displayed?

xx. Is there a tagging/bag marking system at the point of origin?

xxi. How is this implemented?

xxii. How are drugs, particularly cytotoxics, disposed of from the department?
(a) used

(b) partially used
A description should be made of the container used, container labeling and transport means).

xxiii. How/where are the wastes stored whilst in the department, prior to their removal?

xxiv. Are storage facilities for clinical wastes:
secure ?
segregated?

xxv. Who often is waste removed from the department?

xxvi. Who removes it?

xxvii. How is segregation maintained during transport/transfer?

xxviii. How are spillages dealt with?

XII. CONCLUSIONS

In formulating a master plan for hospital waste management, the following needs to be stressed:

A. Reduction in Waste Produced

This incorporates a 'ladder principle':

i. Prevention
ii. Reuse
iii. Recycling
iv. Combustion with energy generation
v. Incineration
vi. Landfill.

This will achieve a reduction in consumption of resources, energy saving and reduced impact on the environment.

B. Waste Management Strategy Within Hospitals

i. Designation of a Waste Manager

He/she should be a member of the senior hospital management committee, e.g. the hospital engineer, laboratory manager. It is vital that this person has direct access to the General Manager/Medical Director.

ii. Provision of a Waste Management Committee

This should consist mainly of departmental heads with representations from nursing and other support staff. It is essential that the costs of waste disposal and hence its ultimate fate should have its own budget line so that departmental heads know the disposal costs they are incurring. and able to discuss this with their colleagues in order to ensure greater savings.

iii. Waste Management Responsibilities

This is a key responsibility for each and every employee in the hospital from the General Manager to janitorial staff. Visitors should be encouraged to be litter-conscious — the Hospital Waste Committee may wish to consider 'litter fines'.

C. *Waste Disposal Routes*

i. Atmosphere

a. Boiler

The boiler is likely to be the major source of atmospheric emissions. In the case of the Szent Imre hospital, this is normally fueled with natural gas and hence emissions will be carbon dioxide and water with low emissions of carbon monoxide, nitrogen oxides and sulfur oxides.

b. Air conditioning units/refrigeration plants

It is vital to ensure that these do not emit chlorofluorocarbon gases.

c. Anesthetic gases

These are likely to be limited to nitrous oxide in quantities that are unlikely to cause adverse effects.

d. Incinerators

If based at hospitals, these will require sophisticated monitoring and control to ensure that atmospheric emissions of TCDDs and other hazardous substances are maintained at the required low levels.

Considerable care should also be taken regarding the possibility of groundwater pollution.

This aspect will be discussed further in Technical Report No. 3 — Techno-economic Options.

ii. Water Pollution

There should be few problems with water pollution as hospital effluents are broadly similar to normal domestic sewage. However, note should be taken of the following:

- Non-water miscible solvents should **NOT** be discharged to drain.

- Chemicals used in the chemical laboratories should not be discharged to drain, unless a PEC/PNEC ratio is <1.

- In general terms, water miscible solvents can be discharged to drain providing that their flammability is reduced by dilution with water and that the PEC/PNEC ratio in the receiving water is less than one.

- In special circumstances, the use of garbage grinders may be considered (see Technical Report No. 3 — Techno-economic aspects.

iii. Solid Wastes

Non-infectious and non-hazardous waste can be disposed of in landfills.

- Infections and hazardous (see Section V) must be incinerated, ideally using a combined heat and power incinerator. (See Technical Report No. 3 — Techno-economic aspects.)

D. Aspects Learnt

Some of the aspects learnt from the Szent Imre hospital which can be applied to other hospitals within Hungary (and regionally) are:

i. Segregation of waste between blue and yellow bags is essential to minimize costs.

ii. Pharmacies should adopt a 'just-in-time' procedure to ensure that there is no accumulation of out-of-date or other unwanted drugs.

iii. Disposal of formaldehyde from the Pathology Department.

This is currently being incinerated, as the Hungarian Waste Regulations prohibit discharge to drain.

A simple PEC/PNEC ratio calculation indicated that if it were to be discharged to drain, the ratio would be ≅ 0.05 in the Danube river (the ultimate receiving water).

This also assumes that the formaldehyde would not be eliminated by either xenobiotic metabolism or biodegradation. Similar calculations would be required to be undertaken for other hospitals discharging via sewage treatment facilities to smaller rivers.

An increase in sewage treatment facilities from primary settlement to at least secondary, i.e. aeration (activated sludge, or rotating filters, etc.) would further obviate such problems.

iv. Mercury

Residues of mercury in the Szent Imre hospital effluent was of concern to the consultants. These residues require urgent action for their reduction. See section V, F.

The volatility of mercury from broken thermometers is likely to lead to occupational health problems for both chronic patients and nursing staff. Atmospheric air monitoring and blood mercury levels need to be monitored urgently.

Similarly, treatment of mercury spills with flowers of sulfur is a simple, cheap and effective treatment for mercury spillages.

For the future, electronic thermometers, whilst more expensive, may be the preferred option.

v. Photographic Wastes

a. *Silver*
It is essential that silver should be recovered and the income so gained recovered by the relevant hospital departments;

b. *Phenylene diamine derivative*
The possibility of recovery/recycling should be investigated via the Department of Industry, Trade and Tourism.

vi. Solvents

a. *Water miscible solvents*
e.g. acetone and ethanol, after suitable dilution to reduce their flammability to >21 °C, can be discarded to drain. Alternatively, they can be used in departmental spirit lamps;

b. *Chloroform*
An alternative should be sought. Must be incinerated;

c. *Xylenes*
Must be burnt, either in an incinerator, but at a low cost in view of its calorific value or use in hospital garden management motor facilities, or added to boiler fuel oil stock.

E. Master Plan

This Master Plan includes a series of self assessment questions — See Section XII.

F. Unit Cost Control

A system for introducing unit cost control should be implemented to ensure that each department manager is fully aware of the costs of the disposal of the waste his/her department generates.