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PART I

THE URBAN ENVIRONMENT

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1. Contamination and reclamation in the urban environment

Since the majority of the population of Nordic countries, and indeed most of Western Europe, reside in towns and cities, decontamination and reclamation of urban areas must figure prominently in nuclear accident contingency planning.

If clean-up is to be both efficient and cost-effective a number of factors must be taken into account. They are:

- distribution of the deposited radionuclide(s) on the various urban surfaces (roofs, soil, walls, roads etc.)
- radiation levels on the various surfaces
- attenuation of radiation through shielding by urban structures (e.g. walls)
- radioactive characteristics of the contamination
- habits of the populace with respect to time spent indoors and outdoors and time spent on various floors within buildings typical of particular urban complexes
- decontamination by natural processes, described as weathering (which includes rain, traffic, routine cleaning)
- diminution in radiation levels through radioactive decay
- decontamination achievable by artificial means
- availability of equipment and machinery for cleaning surfaces
- methods of waste disposal
- potential for resuspension and deposition of contaminated particulate elsewhere.

2. Factors affecting distribution and levels of contamination in urban areas

2.1 Important radionuclides

Of all the radioactive materials which might be released in the event of a severe accident, ^{134}Cs and ^{137}Cs would present the greatest radiation hazard to the populace of a contaminated urban complex in both the medium and long-term.

2.2 Deposition, distribution and retention on urban surfaces

Airborne pollution, whether in the form of gases or particulates, arrives at the earth's surface either by dry deposition (i.e. in the absence of precipitation), wet deposition (in the presence of precipitation) or through occult deposition(in foggy conditions).

The distribution of radioactive fallout between the various components of an urban complex (e.g. walls, roofs, roads etc.) will depend largely on two factors, namely:

i) the deposition process (i.e. dry or wet)

Since about 1986, sufficient experimental observations have been made to make rather crude predictions regarding the behaviour of fallout under both dry and wet fallout conditions. Little is known about deposition in or on snow.

ii) the profile of the urban complex

Both the height and distribution of buildings will be important factors determining the deposition pattern.

2.2.1 Dry deposition

Since 1986, studies of the behaviour of fallout from nuclear weapons testing and from the Chernobyl accident in 1986 have provided an insight into where and for how long fallout will persist in the urban environment. In the Nordic countries, many of the studies have been conducted at the Risø National Laboratory in Denmark.

Soon after a radioactive cloud from Chernobyl passed over the city of Roskilde in Denmark in 1986, various radionuclides were identified and measured on a variety of urban surfaces in and around the city. The prevailing weather at the time of deposition was dry, stable and the windspeed about 3 m s^{-1}. The amount of each radionuclide on surfaces was measured (per unit area) and expressed relative to that found for paved areas (Table 1.1).

Table 1.1 *Deposition on various urban surfaces relative to deposition on paved areas*

Radionuclide	I	Cs	Ru	Ba	Ce	Zr
Paved areas	1	1	1	1	1	1
Walls	0.6	0.2	0.1	0.1	0.1	0.2
Windows	0.5	0.1	0.04	0.04		0.2
Grass (clipped)	5	6	1.1	1.2	1.0	1.0
Trees	17	10	7	6	6	13
Roofs	7	4	1	12	13	

Table 1.1 shows that the walls intercepted little fallout (per unit area), whereas trees and roofs intercepted about an order of magnitude more than horizontal paved areas.

2.2.2 Wet deposition

Precipitation scavenging, or washout of particles and gases, from the atmosphere can make a significant contribution to deposition. In the case of Chernobyl fallout, it led to areas of high deposition even at large distances (> 2000 km) from the reactor site and areas with wet deposition were generally much more contaminated than those receiving only dry deposition in the same vicinity.

Run-off is a term used to describe deposited rainwater which is not retained on the area receiving the rainfall. As run-off water can retain and carry away some of the radioactive material falling on impervious surfaces such as roads and roofs it needs to be evaluated in accident consequence assessments. The amount of radioactive material retained is clearly a factor to be considered in the assessment of dose. Equally, the fate of the contamination carried away in the run-off should also be considered.

Total run-off consists of surface run-off and infiltration, where infiltration is the flow of water through the surface. Infiltration of soils is often high, but construction materials in the urban environment are generally sufficiently impervious to prevent infiltration. For these impervious surfaces the following equation is valid:

$$Q = P - I_a$$

where Q is the direct run-off in mm,
P the total rainfall in mm, and
I_a the initial accumulated rainfall in mm prior to run-off.

Roed (1987) showed that the amount of run-off from roofs was highly influenced by the type of surface material. For rainfall (P) of 9.2 mm shortly after the Chernobyl accident he found that for roofs with a pitch of 45°, the I_a values were 1.8 mm for cement tile, 4.2 mm for red clay tile, 1.4 mm for eternite (an asbestos type of material) and 0 mm on silicone treated surfaces. At the same time, Roed measured the concentration of several radionuclides in run-off water and rain water and comparisons of rainfall and run-off water are given in Table 1.2.

***Table 1.2** Concentration of radionuclides in run-off water relative to that in rainwater for a precipitation event of 9.2 mm.*

Surface type	Radionuclide		
	Cs	**Ru**	**Ba**
Cement tile	0.49	0.56	0.40
Red tile	0.55	0.65	0.58
Eternite	0.14	0.30	0.37
Silicone treated eternite	0.74	0.52	0.67

In some recent experiments at Risø, a similar situation was observed for run-off of radiocaesium falling on road surfaces. For a rainfall of 6 mm, an I_a of 3.8 mm was observed for asphalt and 3.4 mm for concrete. The ratio of the activity concentration of ^{137}Cs in run-off water to that in rainwater was 0.16 for red tile and 0.21 for concrete tile.

The retained wet deposition is defined as the amount of radioactive material retained on a given surface after precipitation has stopped.

The distribution of material deposited on walls by wet deposition is dependent not only on run-off but also on windspeed and wind direction since the amount of rainwater striking the wall is dependent on the angle of incidence.

2.3 Seasonality

Deposition and retention of radioactive fallout on various urban surfaces will vary according to the time of year. This dependence on time of year is known as 'seasonality'. For example, the pattern of contamination on the ground resulting from deposition in snow will be different from that formed by rain. Similarly, deciduous bushes and trees will intercept fallout most effectively when in leaf. Other meteorological conditions, such as wind speed and intensity of rain, which generally follow a seasonal pattern, will also influence the deposition pattern.

3. Dose reduction by natural processes

3.1 Weathering

Following the initial interception of fallout by an urban surface, the surface will continue to be exposed to the weather. Weathering (the action of rain, snow, frost) will tend to displace the adsorbed radioactive material. Sometimes, pedestrian and road traffic and routine street cleaning are also included under the heading of weathering.

Two years after wet deposition of fallout from Chernobyl on the town of Gävle in Sweden, Roed and Sandalls (1989) redetermined the distribution of radiocaesium on walls, roads, paved areas and grassed areas. The measurements were made in the town centre and in a nearby industrial area. The relative amounts on the different urban surfaces immediately after deposition and 2 years later, are shown for radiocaesium in Table 1.3. Table 1.4 shows the relative amounts of radioiodine, wet deposited on different surfaces immediately after deposition.

Table 1.3 *Distribution of wet deposited radiocaesium relative to grassed areas for a precipitation event of 5-10 mm.*

Surface	Immediately after deposition	2 years after deposition
Grassed areas	1	1
Road pavings with		
a) heavy traffic	0.4-0.8	0.01 - 0.05
b) light traffic	0.4-0.8	0.05-0.2
Roofs	0.3-0.9	0.1-0.7
Walls	0.001-0.03	0.01-0.03

Table 1.4 *Distribution of wet deposited radioiodine relative to grassed areas immediately after a precipitation event of 5-10 mm.*

Surface	Radioiodine levels immediately after deposition
Grassed area	1
Paved area	0-0.03
Roofs	0-0.04
Walls	0.01-0.03

4. Forced decontamination of urban surfaces

Various methods have been tested for physically removing radioactive contamination from urban surfaces and some of the more successful will be described here.

4.1 Street cleaning with brushes and vacuum cleaners

The efficiency of street cleaning methods is strongly dependent on the dust loading and the nature of the surface. Urban surfaces generally carry a burden ofparticulates ranging from sub-micron up to 1000 μm in diameter. The dust loading and the nature of the surface are important factors affecting the decontamination efficiency of the different methods.

Sartor et al (1957) found that the efficiency of sweeping with a brush in removing dust from streets was 15% for particles of less than 43 μm diameter, the overall efficiency for all particles was about 50%. The following equation relating particle size to efficiency of removal was derived:

$$M = M_2 + (M_0 + M_2) \cdot e^{-kE}$$

M is the amount of contamination on the surface of the street after sweeping, M_0 the amount of contaminant before sweeping, E the effort in using the equipment (relating to time per unit area) and M_2 and k are dimensionless constants depending on sweeper characteristics, particle size and street surface.

The studies of Clark and Cobbin (1964) indicated that the efficiency of sweeping is sensitive to particle size and initial mass loading in such a way that the methods would be inefficient for particle sizes smaller than 20 μm and for loadings below about 11 g m^{-2}.

Using a rotating broom sweeper Menzel (1962) removed about 70% of the contamination from moist soil carrying a thin cover of a grass species called Fescue. A second sweeping removed about 90% of the contamination.

The use of a stiff street broom on an asphalt and a concrete road with a dust loading of 50 g m^{-2} by Roed & Sandalls (1990) failed to remove very small dry deposited particulates contaminated with radiocaesium. This was consistent with the findings of Clark and Cobbin (1964). With a dust loading of 200 g m^{-2}, 40% was removed from the asphalt road and 57% from the concrete road.

Calvert et al., (1984) attempted to remove road particles by sweeping with an "improved" vacuum sweeper: the overall efficiency for the pick-up head was about 90% for particles smaller than 2 μm.

By fire-hosing roof material, Owen et al (1960) found decontamination factors of more than ten on flat tar and gravel roofs, and Miller (1960) obtained a decontamination factor of three on a concrete roof and a shingle roof treated two days after contamination.

Gjorup et al (1982) used brushes and vacuum cleaners to remove aged ^{137}Cs fallout but the treatment had no effect on red clay tiles. On corrugated asbestos a DF (decontamination factor, defined as the contamination level before relative to that after decontamination) of about two was achieved.

An overall conclusion is that mechanical removal of contaminated street dust may significantly reduce the contribution to dose rate from road surfaces which have a high dust loading, but little or no effect can be expected at dust loadings of less than 50 g m^{-2}.

4.2 High pressure water-hosing

A high-pressure washer (28-48 Bar) has been used to remove plutonium particles (0.8 mm) from asphalt and concrete surfaces (Dick and Baker, 1961). The decontamination factor on asphalt was 10-12 and on concrete 4-40, by practically immediate application.

Using a KEW Powerforce 1002 K high pressure water jet with a maximum nozzle pressure of 100 Bar, a decontamination factor of 2.2 on Chernobyl radiocaesium contamination was found by Roed & Sandalls (1990). In further tests, Roed and Andersson (1993) used the KEW high pressure cleaner to remove radiocaesium from roofs in the CIS countries (former Soviet Union) and recorded decontamination factors of 1.3-2 depending on the amount of moss and algae present. The more moss and algae per unit area the greater the efficiency of decontamination.

As a conclusive remark relating to these references it can be said that high pressure water hosing can lead to a large reduction in contamination level, if applied very rapidly, but as 'natural' weathering will relatively quickly reduce the level of contamination on a road paving, the method is significantly less effective when applied in inhabited areas after a few years.

4.3 Cutting and removing grass

When fallout is deposited onto grass, as in the case of dry deposition, most of it will eventually be transferred to the surface of the soil, unless the grass is cut and the contaminated grass removed. Krieger and Burmann (1969) found that the transport process from grass to soil had a half-life in the order of 7-18 days. However, if the grass is cut and removed immediately following dry deposition, decontamination factors of 2-10 can be achieved (CEC 1991).

4.4 Pruning trees and bushes

This can be a highly effective means of reducing radiation levels in the environment but the reduction per unit mass of biomass will depend on how effectively the plant has intercepted and retained the contamination.

4.5 Digging small gardens

Digging gardens to a depth of one spade can reduce gamma radiation levels at the soil surface by a factor of about six (Gjorup et al. 1982). This is an attractive countermeasure since it can be performed easily and does not require special tools.

4.6 Ploughing large gardens

A dose reduction factor of about 15 can be achieved by ploughing to a depth of 30 cm (Roed 1982). However, subsequent ploughing may return much of the radioactive contamination to the surface. Deep-ploughing to a depth of 45 cm can reduce the dose rate at the soil surface by a factor of 20 (Roed 1982).

4.7 Removal of layer of soil

Various ordinary types of earth-moving equipment have been used to remove contaminated soil. These include graders, bulldozers and pan-type scrapers (Menzel et al. 1961; Menzel 1962; Owen, 1965). The reported dose reductions were typically 80-90% by removal of roughly the top 5 cm. The results are in reasonable agreement with those obtained by Melin et al. (1991) near the Chernobyl power plant. In these experiments, a dose rate reduction of about 85% was achieved by scraping to a depth of 20-50 cm in a radius of 10 m around the point of measurement. A disadvantage of surface soil removal as a means of decontamination is the generation of large amounts of radioactive waste (cf. part 6).

4.8 Washing hard surfaces with ammonium nitrate solution

Under ideal conditions, washing hard surfaces with NH_4NO_3 solution (0.1 M) gave decontamination factors of 1.5-4 (Sandalls, 1987). The treatment, however, must be carried out shortly after the deposition. Roed & Sandalls (1989) showed that 5 years after contamination, only about 15% could be removed from brick and tiles using a solution of NH_4NO_3 (0.1 M).

4.9 Steam-cleaning

Steam-cleaning of radiocaesium contaminated Fletton bricks, concrete paving slabs, concrete tiles and clay tiles has not been found to be effective (Sandalls, 1987). Only hard blue engineering bricks showed a significant loss (40%).

4.10 Sand-blasting

Sandalls (1987) used dry sand-blasting on various urban surfaces and obtained decontamination factors of 1.5 - 100 on brick and stone. Roed (1985) used wet sandblasting on clay roof tiles contaminated with radiocaesium from the Chernobyl fallout and removed two-thirds of the contamination.

Roed (1992) removed about 80% of Chernobyl contamination on asbestos roofs in the former Soviet Union by wet sand blasting 6 years after deposition occurred.

4.11 Road planing

By removing a thin layer of asphalt from a road surface using a road planer, Barbier et al. (1980) obtained a decontamination factor of more than 100.

Road planing is generally a very effective method for removal of contamination, since it removes the surface to which the contaminants are attached. However, the method is rather expensive and not a very fast way to decontaminate.

5. An outline strategy for dose reduction in the contaminated urban environment

The ultimate goal of a reclamation/decontamination study is the provision of a contingency plan for reducing radiation doses to man through reclamation and decontamination. In developing such a strategy, many factors need to be considered in order to provide the most cost-effective strategy for any given scenario.

Some of the important factors to be considered in formulating strategic countermeasures are:

1) Distribution of the deposited material with respect to the different outdoor surfaces.
2) The contribution of the different surfaces to dose rate.
3) The decontamination or dose reduction achievable on the individual surfaces using appropriate methods.
4) The practicability of the various reclamation/decontamination procedures.

The central part of a town normally consists of tall buildings, extensive paved areas and a limited amount of green areas. In contrast, residential suburbs have smaller buildings, gardens with trees and bushes and a limited amount of paved areas.

Within an urban area, various discrete components occur (e.g. walls, paved areas, roofs, grassed areas, etc.) and the individual contributions to overall dose of each of these components will depend on their surface area, the amount of radioactive material retained, the energy of the radionuclides present and the degree of shielding. As part of the procedure for reducing radiation dose to the populace of a given urban area the physical characteristics of the area need to be determined initially in some detail. This should include determination of the size of buildings, thickness of the walls, type of roofs, extent of grassed and paved areas, amount of trees, etc.

From a knowledge of the prevailing weather during deposition, and of the content of the radioactive plume, the relative distribution of radioactive contamination on the different surfaces can be estimated. An effective source strength can then be defined. Wet deposition and dry deposition will, for example, give different effective source strengths for the various surfaces in an urban area.

Having defined the source strength, the next step is to calculate the relative dose rate at different locations (indoors and outdoors) due to deposition on the different urban surfaces (roofs, walls, paved areas, trees, bushes, etc.). The mean relative dose rate to a member of the local populace can then be estimated taking into consideration the time that they will spend in the different locations.

The next step is to estimate the decontamination factors achievable for the various surfaces and, from this, to estimate what the relative source strengths will be after decontamination. The new dose rates at the various locations can then be calculated to show the reduction in dose rate achievable through decontamination.

From the costs of the various decontamination methods, and the corresponding achievable reduction in dose rate, the cost of a fractional reduction in dose rate for the various types of surfaces can be calculated. A comparison of these data will then indicate the most cost-effective means of dose reduction.

Case studies
The following are examples of how to develop a strategy plan for dose reduction in four typical urban complexes. Examples are given for:

1) detached houses in a suburban area
2) two-storey semi-detached houses
3) rows of two-storey terrace houses
4) multi-storey blocks of flats.

The cost and effectiveness of different decontamination procedures are given in Table 1.5. The procedures are suitable for most urban environments.

***Table 1.5** Cost and Effectiveness of Procedures for Removal of Radiocaesium*

Surface	Procedure	DF or DRF	Cost (ECU per m^2)
Windows	Cleaning	10	2
Asphalt, concrete	Sweeping	1-5	0.1
Asphalt, concrete	Vacuum sweeping	1-5	0.04
Grass	Cutting	2-10	0.016
Asphalt, concrete	Water jets	1-10	0.1
Roofs	--- " ---	1-5	3
Walls	--- " ---	1	1
Roads (asphalt)	Planing	>100	3
Walls	Sandblasting	>100	10
Roofs	-	3-100	20
Grass and soil	Removal of surface	4-10	0.2
Trees	Cutting/defoliating	10-100	7
Garden	Digging	6	1
Fields and parks	Ploughing	15-50	0.1

It can be seen that the decontamination factors (DF) or the dose reduction factors (DRF) vary considerably between methods. The wide ranges quoted for DFs for many of the methods arises because the decontamination achievable is often dependent on the circumstances in which the contaminated occurred, i.e. wet or dry deposition, the amount and intensity of rainfall at the time of wet deposition, how much rain has fallen since deposition occurred, etc. It is necessary therefore to be able to estimate what can be achieved in terms of dose reduction for the individual surfaces after taking these different factors into account. This has been done for both wet and dry deposition and the results are included in Table 1.5. The Table also shows the cost of treating each of the surfaces.

Table 1.6 shows estimates of typical source strengths before and after decontamination. The relative source strengths given in the table are relative to deposition on very short grass where it is assumed that all the deposited material is retained on the grass and none on the soil.

Table 1.6 *Relative source strengths before and after decontamination.*

Surface type	Dry deposition: before/after decontamination	Wet deposition: before/after decontamination
Walls	0.100/0.050	0.010/0.010
Roofs	1.000/0.500	0.400/0.300
Garden	1.000/0.100	0.800/0.100
Street	0.400/0.200	0.500/0.300
Trees	3.000/0.100	0.100/0.010
Indoors	0.020/0.010	-

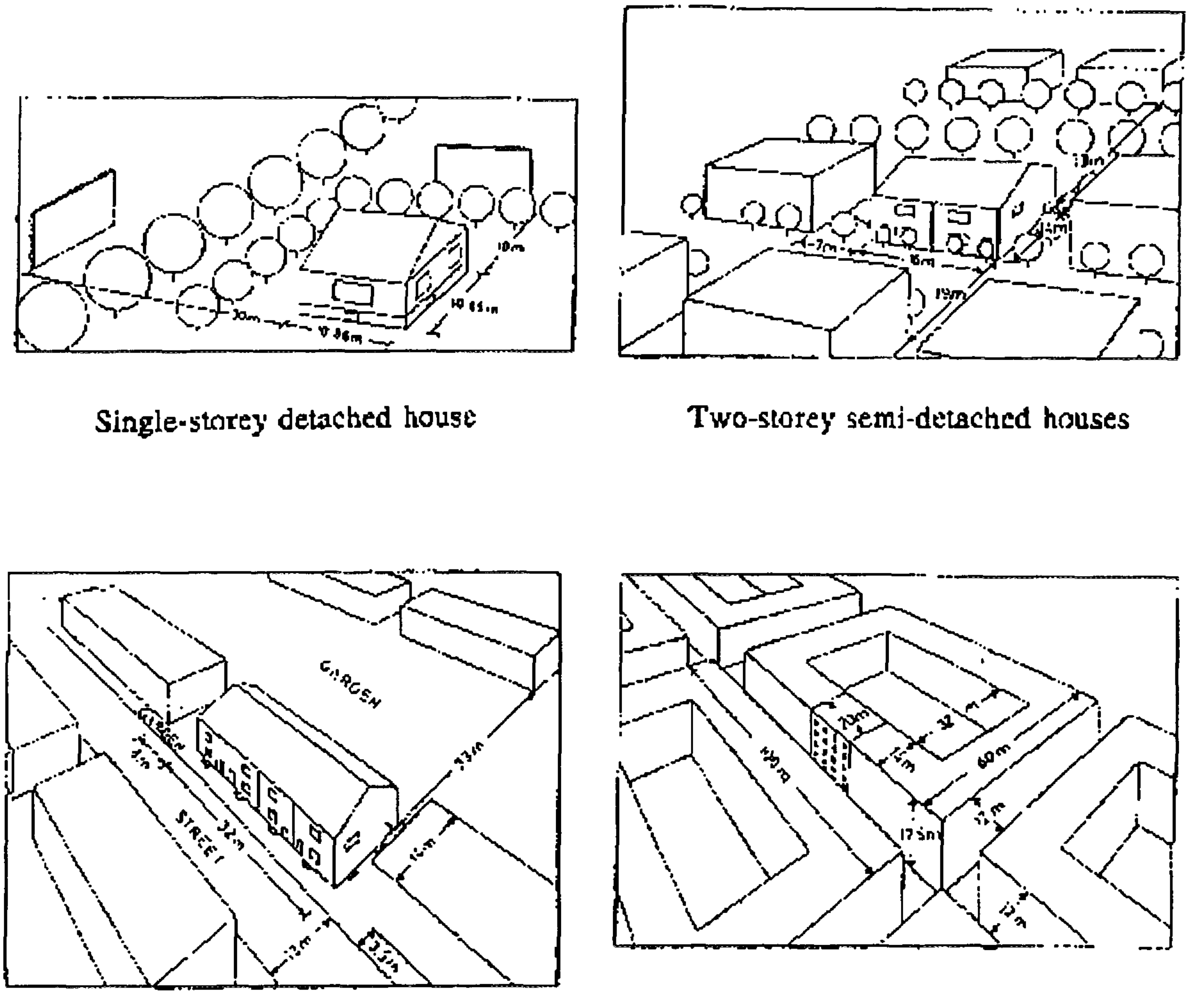
Assuming these relative source strengths before and after decontamination the relative contribution to dose rate in four different urban areas of varying population density has been calculated (Jacob and Meckback, 1987). An example of the type of results obtained by this method is given in Table 1.7. The Table shows the contribution to dose rate at different locations from the different sources such as walls, gardens, trees, etc.

The location factor is defined as the dose rate at the specific location relative to that on an infinite grass surface where all the deposited matter is retained on the grass. The pre-decontamination, location factor is given, in the last row of Table 1.7.

Table 1.7 *Fractional contribution (%) to dose rate at different locations in and around terrace houses. Dry deposition, before decontamination. Source energy: 300 keV.*

Deposition surface	**Relative source strength**	**Ground floor**	**First floor**	**Attic**	**Street**	**Garden**
Windows	0.05	1.2%	2.4%	0.0%	0.1%	0.1%
Walls	0.10	1.6%	2.0%	0.1%	1.5%	1.7%
Roof	1.00	0.3%	6.8%	74.2%	1.3%	0.4%
Basement windows	0.05	0.0%	0.0%	0.0%	0.0%	0.0%
Light Shafts	0.40	0.1%	0.0%	0.0%	0.0%	0.1%
Neighbouring walls	0.10	0.9%	1.3%	0.3%	1.2%	1.2%
Neighbouring roofs	1.00	1.2%	4.0%	4.6%	1.6%	0.9%
Garden	1.00	36.3%	24.1%	3.5%	31.5%	60.1%
Street	0.40	4.0%	2.7%	0.4%	26.8%	0.6%
Ground beyond building	1.00	5.8%	12.9%	11.0%	9.0%	5.6%
Trees	3.00	48.7%	43.8%	5.9%	26.8%	29.3%
Location Factor		0.07	0.04	0.32	0.63	0.94

The four simulated environments are shown in Fig 1.1.



Single-storey detached house

Two-storey semi-detached houses

Rows of terrace houses (2 stories)

Multi-storey blocks of flats

Figure 1.1 *The four urban environments as simulated by Jacob and Meckback*

Table 1.8 shows estimated achievable decontamination factors based on Risø's experimental data, together with estimated costs per unit area, if, for instance, walls and roofs are fire-hosed, streets are vacuum-swept, trees are cut down, gardens are dug and internal surfaces cleaned by normal domestic cleaning methods.

Table 1.8 *Estimated achievable decontamination factors and costs*

Surface type	Roofs	Walls	Streets	Trees	Garden	Internal
Efficiency (DRF):						
Dry deposition	2	2	2	50	10	2
Wet deposition	1.3	1	1.7	10	8	-
Costs ECU m^{-2}	3	1	0.04	7	1	1

If it is considered that the average person living in one of the four urban areas spends 85 % of their time indoors (distributed equally in time between the different floors), 10 % in the garden and 5 % on the street, the location-averaged dose rates from the different contaminated surfaces can be calculated. This has been done in Table 1.9, which shows the contribution to dose rate in the four environments, from wet and a dry deposition of 1 MBq m^{-2} on grass, using the relative source strengths given in Table 1.6. The costs and efficiency of the chosen decontamination/reclamation procedure have been calculated from the data in Table 1.8.

From Table 1.8. it is seen that generally, prior to decontamination, the garden and the trees are the main contributors to the dose from a dry deposition. Roofs also seem important, especially in environments of smaller houses, whereas the streets become more important in areas of high population density. It is seen that the employment of the proposed inexpensive and practicable countermeasures for gardens and trees can reduce the dose rate by about a factor of 4. In the wet deposition case, the dose contributions from ground deposition on gardens and streets are the most important. Reclamation of the garden areas alone generally gives a dose reduction by a factor of about 4.

Table 1.9 Dose rates and countermeasures example. Location averaged dose rates from a deposition corresponding to 1 MBq m^{-2} dry deposition on grass. Source energy 662 keV.

	Roofs	Walls	Streets	Trees	Garden	Internal
1) Single-storey detached houses						
Dose rate contribution from different surfaces [µGy d^{-1}]:						
DRY:	6.13	4.95	-	17.91	26.47	0.96
WET:	2.45	0.12	-	0.60	21.18	0
% dose reduction by decontamination/reclamation of the surfaces:						
DRY:	5.43%	4.40%	-	30.83%	42.33%	0.85%
WET:	2.52%	0	-	2.21%	76.11%	0
Costs per person per % dose reduction [ECU]						
DRY:	16.30	7.43	-	12.05	3.73	76.05
WET:	35.17	-	-	168.13	2.07	-
2) Two-storey semi-detached houses						
Dose rate contribution from different surfaces [µGy d^{-1}]:						
DRY:	3.32	0.37	-	4.65	9.45	0.96
WET:	1.33	0.04	-	0.16	7.56	0
% dose reduction by decontamination/reclamation of the surfaces:						
DRY:	8.94%	0.96%	-	24.30%	45.50%	2.59%
WET:	3.66%	0	-	1.54%	72.85%	0
Costs per person per % dose reduction [ECU]						
DRY:	10.74	45.38	-	8.14	2.09	34.67
WET:	26.25	-	-	128.69	1.30	-
3) Rows of terrace-houses (2 stories)						
Dose rate contribution from different surfaces [µGy d^{-1}]						
DRY:	1.21	0.29	1.31	2.94	5.66	0.96
WET:	0.35	0.03	1.25	0.13	4.53	0
% dose reduction by decontamination/reclamation of the surfaces:						
DRY:	5.05%	1.19%	5.47%	23.93%	42.76%	4.06%
WET:	1.40%	0	7.96%	1.90%	62.94%	0
Costs per person per % dose reduction [ECU]:						
DRY:	18.82	32.79	0.24	4.24	2.35	27.85
WET:	68.48	-	0.15	52.00	1.56	-
4) Multi-storey blocks of flats (5 stories)						
Dose rate contribution from different surfaces [µGy d^{-1}]:						
DRY:	0.05	0.27	1.77	1.95	4.00	0.96
WET:	0.02	0.03	2.22	0.07	3.21	0
% dose reduction by decontamination/reclamation of the surfaces:						
DRY:	0.23%	1.60%	10.32%	22.31%	43.06%	5.69%
WET:	0.09%	0	16.02%	1.06%	50.71%	0
Costs per person per % dose reduction [ECU]						
DRY:	172.31	48.44	0.07	0.27	0.47	20.79
WET:	552.06	-	0.05	5.60	0.39	-

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