The consequences of a Nuclear Attack on London

Operation Square Leg

In September 1980 various Government department conducted an exercise, code-named Operation Square Leg as part of the NATO 'Crusader' exercise, to evaluate the effects of a nuclear attack on Britain.[10] In this exercise 125 nuclear weapons with a total yield of about 200 megatons were assumed to have exploded over the UK (see Figure 7). It is of course unlikely that a real attack would follow pattern of this exercise in detail; nevertheless the exercise probably represents a reasonable estimate of likely targets in a limited-scale nuclear attack on this country. According to the Home Office publication *Domestic Nuclear Shelters Technical Guidance*, it is thought that in a nuclear war the UK might expect an attack of 200 megatons. [11] This may be an under-estimate. Mr. Geoffrey Pattie, Secretary of State for Defence (Air Force), in a written reply a question in the House of Commons concerning the Government assessment of the expected scale of a nuclear attack stated more than 1,000 megatons would be needed to destroy the ground-launched Cruise missiles once they were dispersed. [12]

We shall follow through the consequences of the Square Leg attack, concentrating on London. Unlike about 18 other cities for examples, Cardiff, Birmingham, Liverpool, Edinburgh, Glasgow, and Nottingham, which suffer direct hits -- Inner London is not hit directly, Five targets in or around the periphery of the London area are hit: Heathrow (two bombs, one a 1-megaton ground-burst and the other a 2-megaton air-burst), Brentford (a 2-megaton ground-burst), Croydon (a 3-megaton ground-burst), Potters Bar (a 3-megaton air-burst), and Ongar (a 2-megaton air-burst). These bombs are assumed to have exploded during the afternoon of Thursday 19 September. Southerly winds are prevailing. Within just a few hours, London is subjected to a release of explosive energy equivalent to about twice that released by all combatants during the five years of Second Word War.

How war might break out: the pre-attack period

January-August 1980

In the Square Leg simulation, Warsaw Pact forces start to mobilise in January 1980. By April the USSR demands Norwegian and Danish withdrawal from NATO. The tension grows until, during August, the NATO commanders proclaim a state of military vigilance in anticipation of war. Reserves and US reinforcements are mobilised. In addition to the military preparations, covert civil preparations for war are now made. Key personnel, such as specialists and senior administrators, are

disperse to various centres which are supposed to be relatively secure from attack. For higher level officials these centres are well-protected bunkers, but some borough centres are only hastily converted local authority buildings. The largely voluntary UK Warning and Monitoring Organisation (UKWMO), which exists to give warning of attack and subsequently to monitor fallout from 873 monitoring posts, is mobilised. The Wartime Broadcasting Service (WTBS) is set up and Police Support Units of about 40 men are allocated to guard key centres. [13]

Local authorities become increasingly involved in the preparations as staff are rapidly briefed about the role they have been allotted both before and after an attack. In general these people have not been previously informed about this. Problems may arise if these staff do not agree to their allocated role and prefer to stay at home to help their families and friends. Such problems are likely to become increasingly acute as the attack becomes imminent.

August—September 1980

Preparations for war now become publicly apparent, as some services and supplies are dispersed away from likely target areas. In London, equipment and selected staff of the London fire brigade are moved out of the city. Hospital staff within a 15-mile radius of Charing Cross are moved out, leaving only a skeleton service. Most patients are sent home. Some public buildings such as schools or libraries are provided with some protection against blast and fall-out and with communication facilities so that they can act as wartime control centres. Earth is piled up against walls. Power generation and cooking and waste disposal facilities are improvised, and a store of food and water made. Local authorities generally have small food reserves for emergencies, usually held within the school means service. These supplied are reserved primarily for the staff in wartime centres.

British Airways and nationalised shipping are taken over. On 27 August the Government puts into motion preparations to reserve art treasures from London.

On 12 September the Cabinet approves Queen's Order 2 (suspension of Parliament and the assumption of emergency powers). This effectively allows the Government to take any measures it deems necessary. This measure is followed by panic buying in the shops. Around the same time, the Prime Minister speaks to the nation on TV and Radio. A recorded instructions on how to prepare for a nuclear attack and with the distribution of pamphlets such as *Protect and Survive* and *Domestic Nuclear Shelters.*

Government advice before attack

It is Government policy to discourage the evacuation of urban areas. Their argument is that the fall-

out distribution will be unpredictable and will cover most of the country: "No part of the United Kingdom can be considered safe from both the direct effects of the weapons and the resultant fall-out." (*Protect and Survive*). [14] Clearly the Government would also wish to ensure a minimum of dislocation so that their preparations can be carried out efficiently. They have no desire to control and provide for refugees fleeing from the cities into the surrounding countryside. To quote an internal Home Office circular: ""There would be no question of implementing emergency feeding arrangements during the pre-attack period for those persons who chose to ignore the government's advice to stay in their own houses",[15] and *Protect and Survive*: "If you leave, your local authority may need to take your empty house for others to use."[14] It seems likely that in reality many people may attempt to leave obvious targets such as major centres of population and areas close to military bases despite Government advice to stay put. Indeed in the Square Leg simulation large numbers of people were assumed to have fled Birmingham, They were lucky to have done so because it suffered a direct hit. Only minor roads could be used by those leaving because major roads are designated Essential Services Routes (ESRs). The 14 major roads leaving London are designated ESRs and reserved solely for Government traffic (sec Figure 8).

Figure 8: Key map of London boroughs showing Essential Service Routes (ESRs)

Domestic Nuclear Shelters and *Protect and Survive* give advice on construction of simple shelters which are supposed to provide some protection against radioactive fall-out. If you have a garden, an earth shelter dug about 18 inches into the ground is recommended. Provided that all the materials are ready to hand the Home Office estimates that it would take two strong adults about 24 working hours each to make one. Many people would run into difficulties because there would not be enough

earth in this garden, or, since the water table is near the surface in some parts of London, their shelters might fill up with water. *Protect and Survive* also describes shelters which can be built inside the house. A basement is the best place but only 3 1/2 per cent of London's population has access to one. The alternative is to use a ground-floor room or the space under a table or under doors propped against an inner wall. Those shelters need covering with as much heavy material as possible and fastening to make them secure. These arduous preparations would be difficult for many people.

People living in caravans, bungalows, or on the top few floors of blocks of flats where there is little protection against radiation could only move out and "make other arrangements", Since they would assume that their chances of survival depend on having a shelter, people without one would become desperate.

Protect and Survive advises each family to make a "fall-out room" innermost part of their house, and to build a primitive fall-out shelter (the "inner refuge") inside the fall-out room away from external walls. It says each person should stay inside refuge for 48 hours and within the fall-out for uo to 14 days. The fall-out room should therefore be equipped with stocks of food, water, warm clothing, medicines, candles, an improvised toilet, and other essentials to enable the occupants to survive unaided for this length of time,

Everyone needs to drink at least two pints of water a day, so family of four must store a minimum of 14 gallon:. We shall show in a later section (page 57) that in the conditions after nuclear attack far more than two pints would be necessary and that this store would be inadequate.

As for the problem of food, only foods which keep well and can be eaten cold should be stored, as there will be no power for cooking and refrigeration in the shelter. The food should be tinned or wrapped well to minimise contamination by radioactive dust. By considering the turnover times of food stocks in supermarkets and warehouses we estimate that there would be just enough food to go round provided that it was evenly distributed. But in the tense pre-attack period there would certainly be panic buying, hoarding, and sharply rising prices. The Ministry of Agriculture, Fisheries and Food has the legal power to intervene with control measures, but they are unlikely to be effective, particularly when most of their attention would necessarily be focused elsewhere. As Home Office internal circular ES1/79 [15] says; "Food would be scarce and no arrangements could ensure that every surviving household would have, say, 14 days' supply of food after attack." These comments apply equally well to other supplies required for the shelter, such as disinfectant, polythene bags, buckets, and batteries. As usual, the poor, the elderly, and the disabled would suffer more in such circumstances.

Many people will be in no position to construct a shelter or obtain sufficient supplies. There will be a

very strong temptation for them to steal supplies or to try to use other people's shelters. It is therefore no surprise that law and order is top priority for the Government. This is the task of the police, though the army will be used when necessary. Fines and imprisonment are unlikely to be effective deterrent in the face of impending nuclear war and stronger measures will have to be used. We cannot know whether the police and the army will attempt to stamp out all disturbances or just ensure that Government preparations and key sites are not interfered with. Even those areas where order is still maintained, there will be many people who without help can neither understand nor act upon the Government's advice. War Emergency Plans and Home Office circulars recognise this and suggest that local authorities' social services departments should help them. In view of the scale of the problem, the large of extra duties an already stretched service would have, and absenteeism, it is very unlikely that much help could be given.

In Government publications the image is given of a population quietly and efficiently preparing for war, In this picture plausible? There will be shortage of supplies, jammed roads as people try to flee the cities, and public alarm at the prospect of a nuclear attack. The may be considerable panic and civil unrest.

In contrast, official unpublished documents take this into account and outline special measures to be undertaken by the police, primarily "the detention or restriction of movement of potentially subversive people"[16] (our emphasis).. It is not at all clear who this means. Under conditions of extreme tension this may include many ordinary people.

Of course one should bear in mind that there may well be a far shorter time between public warning and an attack than was envisaged in Square Leg. This is partly because "warning of necessity for covert preparation for war [is] likely to be delayed as long as possible",[16] presumably in order not to precipitate an attack, An example of this policy occurred during 1962 Cuba Missile Crisis, when British civil defence was no mobilised for fear of provoking a Soviet pre-emptive attack.[17] There may even be no warning period of tension at all: for example, an attack may start by accident owing to a computer or system failure.

In any case, because of the extremely high speeds of ballistic missiles there may be as little as four or five minutes between the detection of a missile at take-off or in flight and its arrival, Even if people had proper shelters, in most cases they would not have enough time to reach them.

The Attack

In Operation Square Leg war was declared on 15 September. On Thursday 19 September there was an "Attack Warning Red" at 11:55 a.m. followed by a first strike on the UK between noon and 12:10, and a second between 1:00 and 3:00 p.m.

The period between declaration of war and nuclear attack could well have been rather shorter. Indeed Home Office circular ES1/81 states, "For planning purposes, it should be assumed that there may be as little as 7 days' warning of an attack and the basic essentials of plans should be capable of implementation in 48 hours." [18]

In the following detailed description of the effects of the Square Leg attack on London we will assume that most people are at home and in some sort of shelter. The consequences are appalling even given these very optimistic assumptions.

Detailed consequences in the London area

No detailed analysis of the civil defence aspects of Square Leg has yet been published by the Government, despite the declared intention of the Home Secretary to make the information public.[19]h We have therefore used the same conditions as in Square Leg to find out what would happens to London. We relate our finding to specific boroughs within the Grater London Council (GLC) area, an area some 25 miles across and with about 7 million inhabitants. Although London is used as the basis of this study the results are generally applicable to any city suffering a nuclear attack.

The maps (Figures 8 to 12) show the results of this nuclear attack. The same blast pressure rings are shown as in the one-megaton example but scaled where necessary for larger bombs and for different altitudes of detonation (see Appendix 1 for scaling laws).

Blast

Except for 3 a mere 2 per cent, the whole GLC areas is subjected to blast pressure greater than 1 p.s.i. Blast damage is therefore extensive. It is very doubtful that any windows would still be intact in the capital. Table 4 shows the area affected by various blast levels and resulting deaths and injuries. For a breakdown of casualties by borough see Table 5.

Sixteen per cent of London's population is killed and 36 per cent injured by the effects of blast alone. In blast damage Zone B, containing over a million people, a high proportion of survivors are trapped

under houses. The prospects of these people surviving the next few days are bleak because outside help will not be available. Many will die and add to the total blast casualties.

Table 4 Deaths and injuries resulting from blast

Blast zone	Blast pressure (p.s.i)	Percentage of GLC area	Dead	Injured	Uninured by blast
A	12 or more	8	401,000	8,000	–
B	5–12	21	567,000	453,000	113,000
C	2–5	46	167,000	1,506,000	1,674,000
D	1–2	23	–	512,000	1,313,000
outside D	less than 1	2	–	–	154,000
Total			1,135,000	2,481,000	3,354,000

Note: These figures are calculated using 1977 census figures where the total resident population of London was 6,970,000 people. Figures are rounded to the nearest thousand.

Table 5 Casualties in Square Leg for each London borough

Total casualties from blast and radiation

	Blast casualties			Lower PF			Upper PF			Total
	Dead	Injured	Uninjured	Dead	Injured	Uninjured	Dead	Injured	Uninjured	Population
City of London		1,400	4,200	5,600			5,600			5,600
Barking	1,100	43,000	109,000	1,100	43,000	109,000	1,100	43,000	109,000	153,000
Barnet	72,000	125,000	95,000	269,000	8,200	15,000	227,000	28,000	38,000	292,000
Bexley		27,000	188,000		27,000	188,000		27,000	188,000	215,000
Brent	16,000	115,000	125,000	256,000			228,000	9,800	18,000	256,000
Bromley	33,000	102,000	158,000	119,000	47,000	126,000	80,000	69,000	144,000	293,000
Camden	7,000	74,000	109,000	189,000			183,000	2,000	4,000	189,000
Croydon	241,000	58,000	23,000	300,000	9,600	12,000	298,000	11,000	13,000	322,000
Ealing	146,000	95,000	51,000	292,000			286,000	1,900	3,600	292,000
Enfield	66,000	111,000	83,000	260,000			260,000			260,000
Greenwich		40,000	166,000	32,000	29,000	145,000	5,000	38,000	163,000	206,000
Hackney	3,800	64,000	127,000	194,000			194,000			194,000
Hammersmith	26,000	72,000	66,000	164,000			95,000	24,000	45,000	164,000
Haringey	11,000	103,000	114,000	228,000			228,000			228,000
Harrow	9,900	90,000	99,000	199,000			189,000	3,000	6,000	199,000
Harvering	15,000	101,000	125,000	15,000	101,000	125,000	15,000	101,000	125,000	240,000

Hillingdon	74,000	94,000	61,000	229,000			217,000	4,100	7,700	229,000
Hounslow	139,000	49,000	12,000	189,000	8,200	2,900	181,000	15,000	4,100	200,000
Islington	4,800	61,000	102,000	168,000			168,000			168,000
Kensington and Chelsea	6,600	66,000	87,000	159,000			95,000	20,000	44,000	159,000
Kingston upon Thames	5,300	55,000	76,000	9,000	58,000	70,000	5,300	55,000	76,000	136,000
Lambeth	37,000	111,000	135,000	283,000			283,000			283,000
Lewisham	8,000	93,000	143,000	223,000	3,900	17,000	167,000	21,000	55,000	244,000
Merton	28,000	71,000	67,000	135,000	12,000	19,000	80,000	35,000	50,000	168,000
Newham		57,000	172,000	94,000	24,000	111,000	13,000	52,000	165,000	230,000
Redbridge	2,400	67,000	160,000	54,000	40,000	135,000	3,700	66,000	159,000	229,000
Richmond upon Thames	87,000	54,000	24,000	127,000	22,000	16,000	124,000	24,000	17,000	165,000
Southwark	7,400	74,000	143,000	224,000			224,000			224,000
Sutton	59,000	61,000	46,000	107,000	26,000	34,000	92,000	35,000	39,000	167,000
Tower Hamlets		38,000	113,000	150,000			118,000	5,400	27,000	150,000
Waltham Forest	11,000	100,000	111,000	222,000			168,000	19,000	35,000	222,000
Wandsworth	15,000	117,000	146,000	278,000			201,000	24,000	53,000	278,000
Westminster	2,200	61,000	146,000	175,000	5,900	29,000	66,000	31,000	113,000	210,000
Total for Greater London	1,135,000	2,481,000	3,354,000	5,351,000	464,000	1,155,000	4,503,000	765,000	1,702,000	6,970,000

Note: Figures are quoted to the nearest thousand or 2 significant figures whichever is more accurate,

Apart from killing and injuring people the blast causes very extensive material damage. As far out as Zone C -- that is throughout 75 per cent of the GLC area -- roads are blocked by collapsed houses, fallen telegraph poles, overturned cars, and other debris. Houses throughout 29 per cent of the GLC area are reduced to rubble and those in a further 46 per cent too badly damaged to be repairable under wartime conditions. To give more specific examples of damage, Richmond, Kew, and Chriswick bridges are down and the elevated section of the M4 near Brentford is blown away. Kew Gardens is now a blackened charred landscape.

Burns and fire

The number of people receiving burns depends on how many are in the open or new windows when the bombs explode, type of clothing worn and even their skin type (darker skins absorb more heat). It is therefore difficult to predict burns casualties accurately. But even if only one per cent of the population were exposed there would be at least 50,000 second and third degree burns cases in the GLC area. This number alone would overwhelm the entire country's special burns units. As no outside help can be expected for as long as two weeks after the attack, the severely burned will suffer a very painful death. If large numbers of people are caught in the open while attempting to flee the capital, many more will die. Burns injuries are further complicated by other injuries such as cuts and broken limbs. People looking towards the flash are also blinded. Although this complete blindness may be only temporary, those affected do not know whether they are permanently blind or not. Permanent eye damage can be caused by retinal burns. In either case these people are much more vulnerable to further injury by fire or falling debris and will have difficulty finding shelter.

Fire damage is very severe. The fire-fighting services, however, are not to be used immediately after the attack. Much of the service has been withdrawn from London since the main concern is "the preservation of the fire service for its role in the longer survival period"[20]. Fires started all over the capital (see Figure 10) will continue until they burn themselves out. All of London may be destroyed in the conflagration and many deaths and injuries are likely to result. In our study, however, we have not included any flash-burn or fire casualties because of uncertainties in estimating the numbers, but certainly hundreds of thousands of deaths and injuries would be added to the final totals.

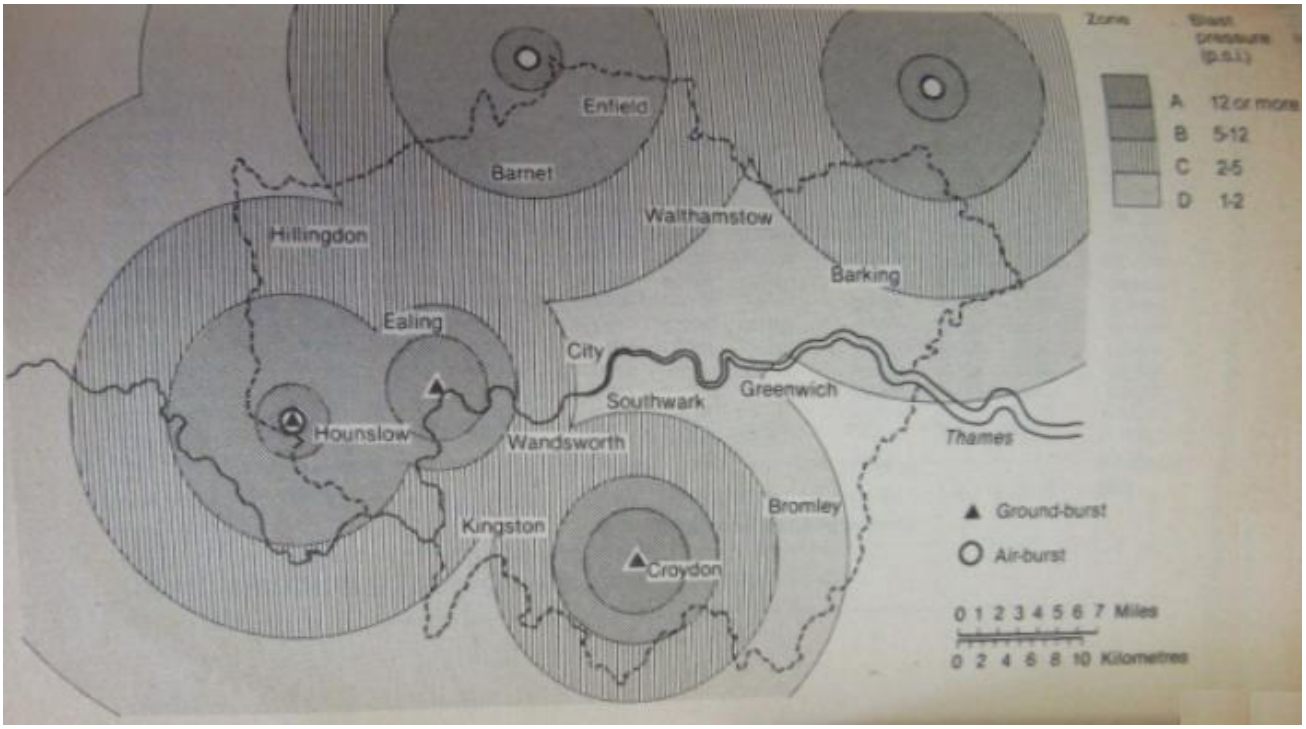

Figure 9: Blast

Figure 10; Fire and burns

Fall-out

In Square Leg the ground-burst explosions at Croydon, Brentford, and Heathrow create mushroom-shaped clouds 10 to 20 miles across (see Figure 11). These clouds are blown northwards by the wind, depositing fall-out as they go. In most parts of London survivors have less than half an hour before fall-out arrives, to put out fires, crawl out from under debris, and reconstruct their shelters. In the east of London, survivors have rather longer (about four hours) before fall-out arrives from the bomb on Eastbourne. These first few hours or minutes are crucial. In over 50 per cent of the GLC area an unprotected person receives a lethal dose of radiation within six hours of the attack (within one hour in boroughs such as Hillingdon,, Ealing, and Southwark). The total radiation dose an unprotected person receives over the next two weeks is shown in Figure 12. The fall-out is spread over very large areas of the capital. Here we have drawn idealised cigar-shaped distributions of fall-out with none of "hot spots" of radiation which are found in reality (see Pages 17-19). The actual radiation dose received by various districts may well turn to be different. Nevertheless the idealised contours shown give on average a reasonably accurate indication of the overall situation (see Appendix 2).

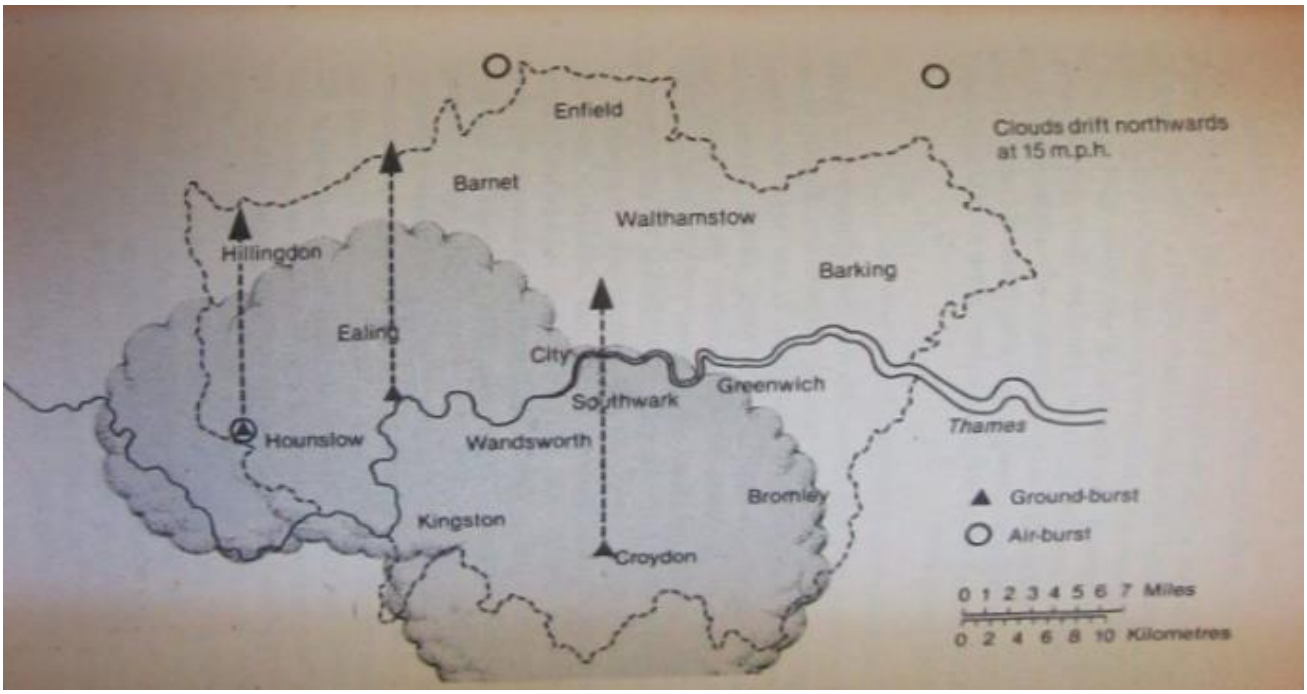

Figure 11: Mushroom clouds

Although most people receive most of their total radiation dose within the first few days, the resulting deaths from radiation sickness do not occur until days or weeks later. Details of the development of symptoms and of the times involved were shown previously in Table 3, page 20. Clearly almost all Londoners are radiation victims, unless they can protect themselves in effective shelters, Even

outside the potentially lethal radiation zones, almost everybody is affected by early symptoms of radiation sickness (anorexia, nausea, vomiting, and diarrhea).Between 10 and 50 per cent of those receiving a dose of up to 200 rads suffer these symptoms.

Protection against fall-out

The radiation levels drawn on the map (Figure 12), while fatal for an unprotected person, do not necessarily prove fatal for someone in a shelter of some sort. For those without a purpose-built shelter Home Office advice is to stay indoors at home in a makeshift shelter with two weeks' supply of food and water. The Home Office pamphlet *Protect and Survive* gives advice on constructing a shelter from books, doors, tables, etc. According to *Domestic Nuclear Shelters: Technical Guidance*, however, neither a shelter like this, nor the makeshift garden shelter on page 32, could withstand a blast pressure of more than 1 1/2 p.s.i., [11] and consequently would collapse in 85 per cent of the GLC area (see Figure 9). *Domestic Nuclear Shelters: Technical Guidance* gives details of stronger shelters which cost more and take longer to construct. These are called the 'Indoor Kit Shelter', the 'Outdoor Kit Shelter', and the Purpose-Built Shelter'. The Indoor Kit Shelter is basically a steel box which has to be constructed by a specialist, at a cost of £500 - £800 (1980 prices). To quote: "it could be used for other purposes, e.g. as a workbench", (which gives an idea of its size). It is to be placed in the fall-out room and surrounded and covered brick, concrete blocks, or sandbags. About 3,300 bricks are needed for this: "it takes four people approximately 10 hours to carry 2,500 bricks from a stockpile and stack them around a shelter". There would, however, be no stockpile. Concrete blocks and sandbags would be equally difficult to obtain - but the instructions are "install in crisis period".

The next grade up, the Outdoor Kit Shelter, would cost £900- £1,800 plus installation costs. You dig a large hole in your garden (if you have one), place the shelter in it and cover it over. The leaflet says "install in peacetime or, crisis period", but later on: 'the time required to excavate will depend on your ability but with two fit people it should be possible to carry out all the necessary work within a week."

Lastly, the Purpose-Build Shelters is to be installed in the garden by professionals in peacetime. The price is given as £6,000 - £10,000 (current price are rather higher). It must be installed in an area with good drainage – otherwise it may fill up with water. The kit shelters will collapse inside blast Zone B. The purpose-built shelter will withstand this but must be sited well clear (at least one and a half times the height) of nearby buildings to avoid the occupants being trapped by falling debris. In densely populated urban areas such as London, suitable sites are very rare. As explained above, the makeshift shelters described in *Protect and Survive* collapse throughout 85 per cent of the GLC area in the Square Leg attack. In addition only 3 1/2 per cent of Londoners have access to a basement best suited for the simpler shelters. [21] In view of these difficulties most people would have to rely solely on their houses for protection.

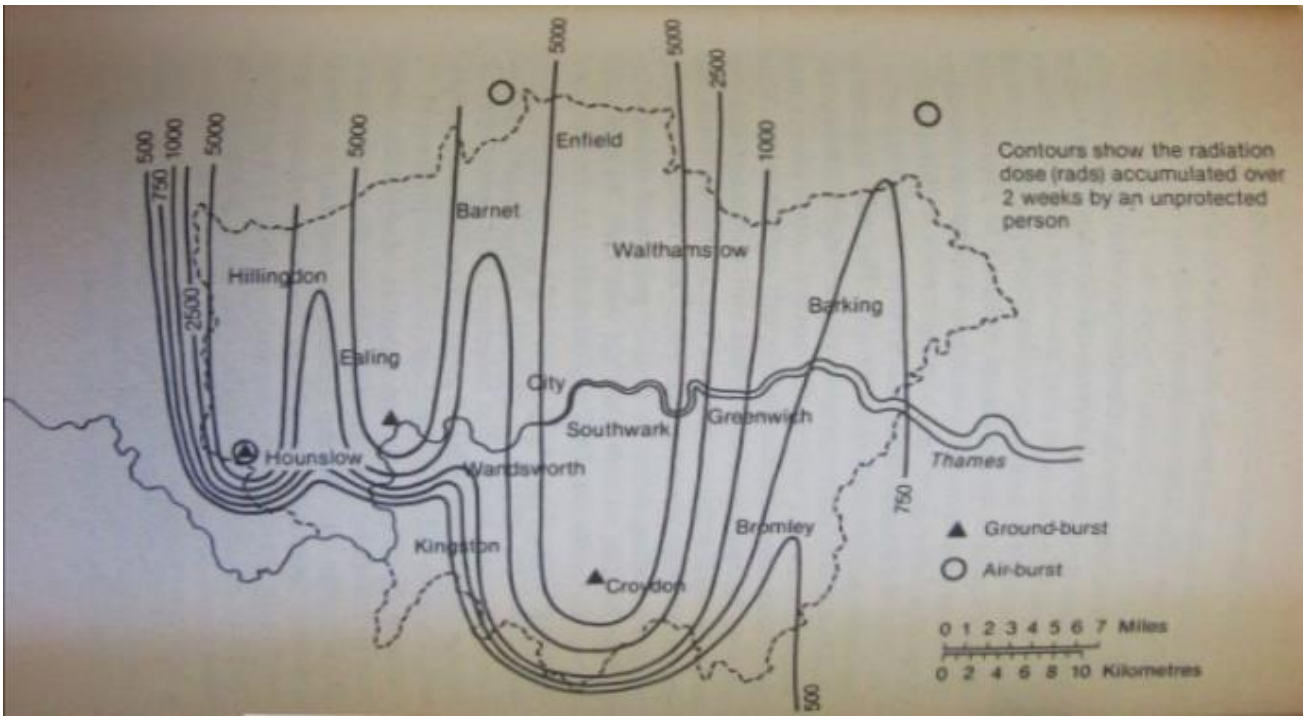

Figure 12: Radiation

One of the most important qualities of a shelter, apart from its resistance to blast, is its fall-out protection factor (PF, see page 22). Having examined the Home Office protection factors for houses and makeshift shelters, we compare the details of our own analysis with Home Office figures in Appendix 3, but the two main points are as follows:

● The Home Office calculations for the PF of a house assume that the roof and all windows are intact and that no fall-out could enter by these routes. This assumption is invalid for London where throughout the entire city virtually no window or roof would be intact after Square Leg attack. Fall-out particles will enter houses and increase the dose of radiation received. Home Office PF values for an undamaged house therefore cannot be used.

● The Home Office calculations average out the thickness of the side of a house. In reality radiation more easily penetrates the thinner parts such as windows and doors. The larger amounts of radiation passing through these thinner sections must be taken into account. Because of this fact alone, Home Office PFs for undamaged houses are overestimates.

For many survivors the protection factor of a shelter is a rather academic point. Survivors inside damage Zone B have no home left nor any reasonable chance of reconstructing their shelter. They have little hope of avoiding a fatal radiation dose. They could try to leave the fall-out area if they were

capable of moving, except that they would not know where to go, nor would they know if they were in a high fall-out zone. Only purpose-built shelters would be of any use. Inside Zones C and D, houses have damaged roofs, cracked walls, and smashed windows, Fall-ut particles easily enter such shelter. Even in the area of lightest damage in London (outside Zone D) fall-out enters through broken windows.

Protection factors:
In our calculations an upper and a lower value of protection factor have been used in each blast zone as follows:

Zone	Blast Protection factors pressure (p.s.i.)	Protection factors	
		Lower value	Upper value
A	12	1	1
B	5-12	1	2
C	2-5	2	5
D	1-2	5	10

The lower values of protection factors represent a reasonable estimate once blast damage is taken into account (see Appendix 3). The upper value is optimistic and discounts the majority of blast damage. In Zone D the value of 10 corresponds to a Home office calculated value for an undamaged house (*Domestic nuclear Shelters: Technical Guidance*).

Casualties due to fall-out in the GLC area

Calculating casualties from fall-out is a complex task because of the different protection factors which must be applied in each blast-damage zone. Also, people already injured by blast or burns are much more susceptible to radiation. Full details of our calculations are given in Appendix 4.

The effects of radiation add many more casualties because large areas of London are exposed to extremely high cumulative doses of radiation. For example, about one-fifth of the GLC area is exposed to over 6,000 rads within two weeks of the attack. Even if the effects of blast in reducing protection factors are neglected and a Home Office calculated PF of 10 is used, over one million people still receive a fatal dose of 600 rads or more. Once the effects of blast and injury are taken into account this figure is much higher. Within two weeks of the attack about 4 million people have received a fatal dose of radiation and are either dead or will e m the weeks ahead. Out of these 4 million casualties about half a million people receive very high but not Immediately fatal doses of radiation and will take a long, as the time to die. These unfortunate people can only be described "living dead", but until

they die they will be indistinguishable from less severe cases of radiation illness.

Total casualties

The total casualties about two months after the attack, taking into account only blast and radiation, are given Table 6. Figures in (a) have been calculated using the lower PF values, and in (b) the optimistic upper values

Table 6 Total casualties in the GLC area

	Dead	Injured	Uninjured by blast or radiation
(a)	5,351,000	464,000	1,155,000
(b)	4,503,000	765,000	1,702,000

These casualty figures are difficult to grasp because of their sheer magnitude, but it is a little easier if you take a example of 14 people you know. On average, immediately after the attack, two of your friends will be dead and five injured, of which one may be alive but trapped under rubble. One more may be so severely burned that he or she will soon die. A further six will be unhurt by blast but will be in danger from fires started by intense heat. Within a few days or so of the attack all your surviving friends will probably be suffering from nausea and vomiting caused by the symptoms of early radiation sickness. Within two, weeks eight of your surviving friends will have received fatal dose of radiation and will die over the next few weeks. Those injured or trapped under a house will die earlier. So after two months, neglecting the effects of fire, four ot you friends may be alive. More probably only two or three will survive once the effects of fire are taken into account. Even this gloomy picture ignores all the other problems that would be experienced over the month following the attack and which are described in the next chapter, so these figures must be regarded as conservative estimates.

A fairly clear picture of casualties also emerges by looking at some London boroughs as examples (see Table 5, page 38). As one would expect, it is in boroughs nearer to the ground zeros that blast casualties are highest. Boroughs such as Hounslow and Croydon suffer badly in this respect.

Other boroughs with relatively light blast damage suffer huge casualties due to radiation. Lambeth and Islington, for example, are subjected to a cumulative dose of over 10,000 rads (20 times the lethal dose). Only those in a purpose-build underground shelter could survive such radiation levels. The most disturbing and insidious aspect of radiation sickness is that people do not know whether or not

they have received a fatal dose. Millions of people could live for weeks in extreme suffering waiting to see if they would die. It should also be realised that many casualties would occur outside the GLC area, which we have not taken into account in this study,

Life in the shelter

Let us consider the case of a family of four which has improvised a shelter, managed to obtain supplies for 14 days, generally followed the Home Office advice given in *Protect and Survive* and survived the immediate effects of the attack with shelter intact although the chances of a family managing to get his far are remote. Insurmountable problems may arise before the attack with food shortages, during the attack from blast and fire, and afterwards from radiation. However, it is important to find out what conditions would be like for any survivors outside blast and fire damage zones.

Our family of four are advised to remain inside their inner refuge for at least two days. Conditions are very cramped. They will have water, boxes of food, an improvised toilet, a first-aid kit, radio, blankets, and warm clothing. If they have taken the advice seriously they will also have taken in toys and games to pass the time. Somehow on top of all this they must fit themselves in (see Figure 13).

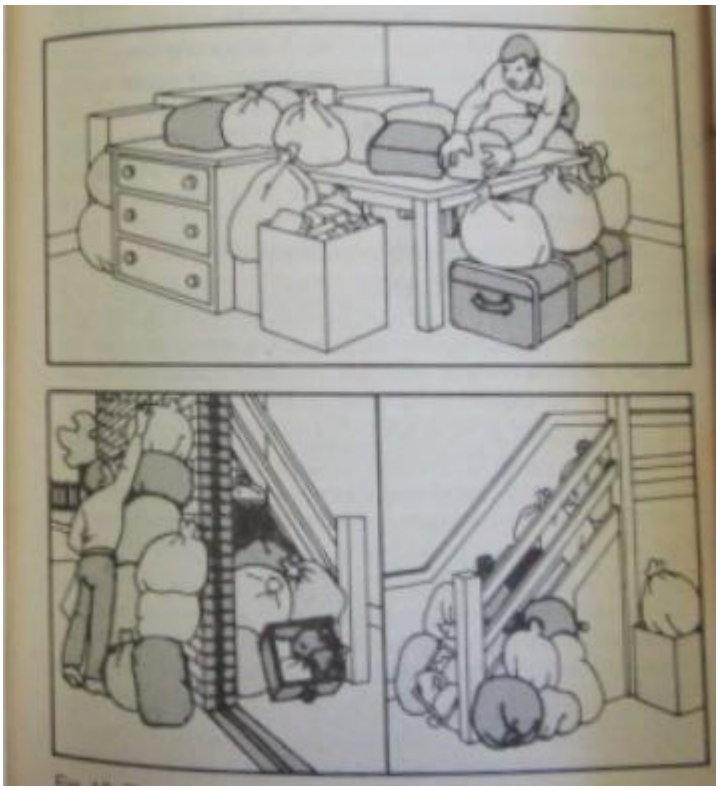

Figure 13: The Protect and Survive shelter

There is likely to be at least one injured person in each shelter. Many will die from complications arising from a combination of relatively minor injuries even though each individual injury would not normally be fatal.

As time progresses the shelter inhabitants receive and increasing dose of radiation. The earliest stages of radiation sickness begin with nausea, vomiting and diarrhea (see Table 3, page 20). Even at comparatively low doses below 200 rads, a significant number of people show these symptoms. In these conditions, because of the resulting dehydration, the recommended drinking water allocation is inadequate. Sanitation becomes of critical importance. In such cramped conditions it is impossible to avoid contact with excrement and vomit. The smell alone probably causes those not suffering from radiation sickness, especially children, to feel nauseated or to vomit. In these unhygienic condition it is virtually impossible to keep anything clean: contamination of utensils, and, even more importantly, of wounds, is unavoidable. Large quantities of uncontaminated water, far in excess at that recommended, would be required,

Radiation drastically reduces the body's resistance to infection. Bacteria and viruses are, however, extremely resistant to radiation. As a result, the people in the shelter are likely to develop ailments such as gastro-enteritis or measles, and respiratory infections such as acute colds bronchitis, or pneumonia. These ailments alone could prove fatal. Isolated in their shelter, they cannot judge whether their sickness or diarrhea is caused by gastro-enteritis, acute psychological shock, or a potentially fatal radiation dose,

Survivors in the shelter are likely to suffer extreme psychological stress following a nuclear attack. The concern over any missing family members and friends, the lack of outside information during the communications black-out, and the feeling of nausea and claustrophobia will all combine to produce fear or uncontrolled terror, and a complete loss of any sense of reality. A death inside the shelter will cause enormous emotional stress especially as radiation levels outside may be too high to allow the survivors to bury the corpse. Because of the greater vulnerability of children to radiation many adults will watch their children die before they themselves are affected. *Protect and Survive* merely advises that the body be placed in another room, covered securely, and identification attached. [14] Another factor contributing to psychological stress is the very real threat of violence from groups outside desperately seeking food, water, or shelter. Maintenance of security has to remain the responsibility of the individuals in the shelter. They certainly cannot just ring for the police.

Despite the dangers from radiation and from other survivors, trips outside the shelter to look for food and fresh water and to remove waste may soon become unavoidable, however hazardous. It is also possible that conditions inside the shelter will become so intolerable that some may find the outside preferable, even knowing full well that they will receive an increased dose of radiation. Inevitably

fall-out will be brought into the shelter and contaminate remaining food and water. Fall-out will also drift in on air currents. Because of this, the level of radiation inside the shelter will rise, as will the risk of breathing in and eating or drinking radioactive particles.

The map of London after the attack (Figure 12) show that, because of fall-out, there are few areas where our family in an improvised shelter could survive the two-wee shelter period. Also, in many areas a two-week shelter period would not be long enough. Over a large area of London, radiation would be so high that it would take much longer than two weeks for the dose rate to fall to 1/2 rad per hour (the wartime "all-clear" dose rate). For 15 per cent of London – over a million people – the wait for the "all-clear" would be over five weeks (see Figure 14). In these areas survivors after two weeks are still supposed to restrict visits outside severely. In practice, where the wait would be very long the radiation levels would be high enough to kill anyway the "all-clear", if it sounded at all, would be an ironic message delivered to corpses or hose already dying from radiation sickness.

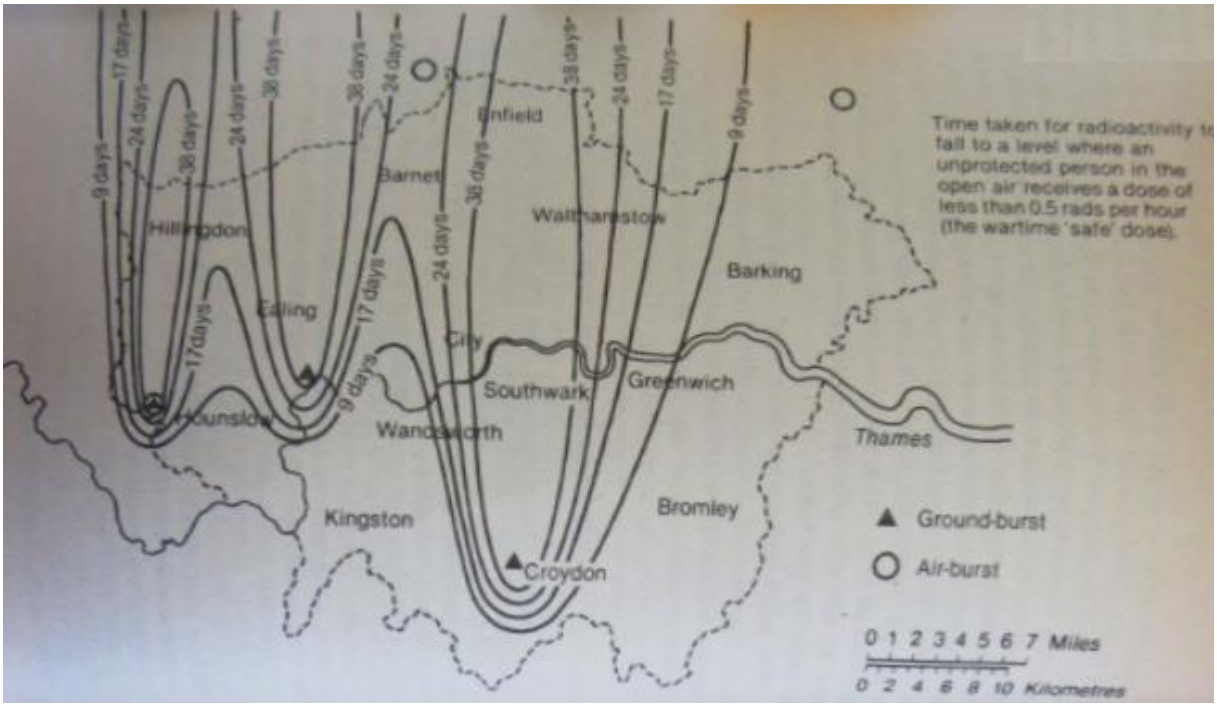

Figure 14: When is it safe to come out?

Millions of Londoners, who sheltered and followed Government advice in boroughs such as Lambeth, Southwark, Islington, Haringey, Ealing, Harrow, Hillingdon, or Hackney would receive a lethal dose more slowly than those who took no precautions at all. In this case taking Government advice would be worse than taking none at all because one would simply be delaying the inevitable for few miserable weeks.

When is it safe to come out?

● It is Home Office policy to give the "all-clear" message in locality when the radiation level has fallen to a dose rate of 1/2 rad per hour. This figure is calculated on the assumption that people would still spend 6 to 8 hours inside every day so that the daily dose would not exceed 10 rads, which is assumed to be the body's recuperation rate. Although this dose is considered to be "safe" and the all-clear would be given at this point, this daily dose of radiation is higher than the permitted yearly dose for radiation workers in peacetime, and the accumulated dose of several days working in the open air is certainty large enough to cause sterility and damage to the bone-marrow. [7]

Figure 14 shows how long it takes for the level of radioactivity fall to this "safe" level in the Greater London area after the Square Leg attack. One should bear in mind that few of the people sheltering inside the 17-day contour lines will survive, because their overall accumulated dose during the shelter period and after will be enough to kill them, The map also implies that it will not be safe for rescue workers to enter or pass through large areas of London until well over a month after the attack - a factor which would seriously hamper any attempts at recovery.

Summary

- In the context of the Square Leg attack on London the advice in *Protect and Survive* is worthless, unless you are lucky enough to be outside the main fall-out area or have access to really effective shelter — which means going underground for several weeks.
- The advice given by the Home Office is based on faulty assumptions which lead to overestimates of the protection given by buildings.
- Even in the Square Leg attack, in which no bomb fall on Inner London, over one million die in seconds from blast injuries and more than 4 million from radiation over a period of up to two months after the attack. At least half million people are injured by blast. About one million Londoners survive uninjured by blast. Many of these surfer bums or non-fatal radiation sickness.

[10] D. Campbell: "World War III – an exclusive preview". *New Statesman,* 3 October 1980 (see also "Scotland's nuclear targets", *New Statesman,* 6 May 1981)

[11] *Domestic Nuclear Shelters: Technical Guidance,* HMSO, 1981, 262, 44/18, 83, 85, 46/18, 195, 108/41, 110/18.

[12] Hansard, written answers to questions, 203, defence, 7 March 1981.

[13] London Borough of Islington War Emergency Plan

[14] *Protect and Survive,* HMSO, 1980, 30/3, 32/7, 52/24, 56/24.91/3, 7

[15] Home Office, Circular ES1/1979, "Food and Agriculture Controls in War", section 12.

[16] Watford District War Emergency Plan; 34/Pt2. VII, Pt1, X.

[17] D. Smith, *The Defence of the Realm in the 80's,* Croom Helm, 1980, 95/89-102

[18] Home Office, Circular #S1/1981, "Civil Defence Review"; 35/2, 85/3

[19] Hansard, Home Secretary's announcement in Parliament, 7 August 1980

[20] Home Office, Circular ESS/1974, "War Emergency Planning for the Fire Service", 4.

[21] *Greater London Housing Condition Survey,* 1981, p162

[22] Home Office, Circular ES6/1976, "Water Service's in War", 57/5,, 59/5, 60/5

Table 3 Medical effects of radiation

Dose (rads)	Symptoms	Deaths (average)
0-100	Men become temporarily sterile in 20-50 rads range	0
100-200	Nausea and vomiting within 3-6 hours of receiving dose and lasting less than 1 day, followed by no symptoms for 2 weeks. Recurrence of symptoms for another 4 weeks Number of white blood cell reduced.	0
200-600	Nausea and vomiting lasting 1-2 days. No symptoms for 1-4 weeks followed by a recurrence of symptoms for up to 8 weeks. Diarrhea, severe reduction of white blood cells blood bolsters on skin, bleeding, infection. Loss of hair above 300 rads	9-98% in 3-12 weeks from internal bleeding or infection
600-1,000	Nausea and vomiting starting within 1/2 hour of receiving dose of radiation and lasting 2 days. No symptoms for 5-10 days	98-100% from internal bleeding or infection
1,000-5,000	Nausea and vomiting starting within 1/2 hour of receiving dose and lasting less than a day. No symptoms for about 1.7 days, then diarrhea, level, distributed salt balance in blood for 2-14 days.	100% within 14 days from collapse of circulation
More than 5000	Nausea and vomiting immediately followed by convulsions, loss of control of movement and lethargy	100% in 48 hours from failure of breathing or brain damage