From: "Stuart Slade" <shiva06804@yahoo.com>
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The Nuclear Game - The Attack And After

So far, when discussing nuclear weapons, we've always been working under the presumption that the historical situation applies and that we won't see a nuclear exchange. Lets look at the grim side of the equation now. The sirens are going and the National Emergency system is screaming its head off. What's the world going to be like in 25 minutes time? One thing we have to make clear before we start. We're talking about the biggest cataclysm in human history. When we say things like "doing well" or "doing badly", those terms are relative. Another thing is that most people's preconceptions about a nuclear war and its aftermath are wrong. Nevil Shute Norway did the world a great disservice when he wrote "On The Beach". The skewed viewpoint represented by that novel has been perpetuated ever since. A good modern example is the so-called "nuclear blast mapper" available on the internet that purportedly shows the effects of an initiation on an input home address. It doesn't, it doesn't even come close. A third preconception we have to get rid of is that there is such a thing as a limited nuclear exchange or a flexible response. There isn't now, never has been and never will be. The reasons why are primarily a C4I set of consideration but the inviolable rule is this "One Flies, They All Fly". Any exchange, no matter how limited, will escalate out of control until both participants have used all their devices.

Any country can be divided into two parts. The "A-country" is the big cities, the industrial and population centers and the resource concentration they represent. Big cities got to be that way because they are in desirable locations,near good ports, river crossings or mountain passes. When the city goes, so does the locations. The "B-country" is everything else. In effect the A-country represents big vulnerable collections of assets gathered into single spots. The B-country represents dispersed ranges of resources spread over large areas.This is a very important distinction. The relative value of the A-country and the B-country depends on the country and society involved. However one thing is constant, the support and supplies that the A-country needs to survive comes from the B-country. Given time, the B-country will rebuild the A-country. The survival of the B-country is, therefore, critical while the survival of the A-country might not be. Now, the primary asset of the B-country is its population; they are the ones who will generate resources from the B-country and turn them into product. So, the critical thing for a post nuclear environment is population. Save as much of that as we can and we're a jump ahead. That sounds eminently humanitarian. In reality it has awful consequences but we'll come to those later.

The extent to which the A-country can be rebuilt and the speed with which that can be achieved depends on the damage inflicted on the cities. One of the preconceptions that plague discussion of a nuclear war aftermath is the assumption that the cities will be totally destroyed write-offs but, in reality, the situation is by no means so simple. There's a few things that are important here. One is that big devices are a rarity. There are no 100 megaton devices, very few 25 and 10 megaton devices and not all that many 5 megaton weapons. The largest devices in widespread use are 1 megaton weapons and the majority of strategic weapons are in the 350 -150 kiloton bracket. 50 kiloton strategic weapons are quite common. The reason is quite simple. The destructive power of an explosion is distributed in three dimensions (actually four since the time component is very important) so the destructive power of a device is directly proportion to the cube root of its explosive power. Even worse, the destructive effects of a device are like many other distance related phenomena; they obey the inverse square law. Double the distance from the blast center and the effects are reduced by a factor of four. Therefore, a 1 megaton device is not 1,000 times as destructive as a 10 kiloton device, its ten times as such and those effects attenuate rapidly with distance. However, very big devices are MUCH heavier than small ones and consume disproportionate amounts of fissile material. Put all this together and its much more productive to have a large number of small devices than a small number of large ones.

Another is how the devices are used. The radius of destruction of nuclear devices is actually quite limited; this is a natural outgrowth of working on the inverse square law. Even with one of the "big" 1 megaton weapons, its fury is largely spent by the time the blast wave has reached ten miles from center. The smaller devices have lesser radii although the workings of the cube power rule mean that those radii are not as small as the difference in explosive power suggests. Nevertheless, the relatively limited effect of the devices shows that the general civilian presumption that ground zero for a nuclear strike on a city will be the city center is likely to be wrong. The devices will be targeted onto specific parts of the city that are judged to be of especial value. These may actually be in the suburbs or other peripheral areas.

So how does a nuclear device destroy things? The primary effects that result from the initiation of a device are

(in no particular order) a light flash, a heat flash a blast concussion wave and a sleet of direct radiation. In fact, of these the last is of relatively little significance. The range of the radiation is very short and is further attenuated by the inverse square law. Its only significant within the areas where blast and heat are already lethal. If thermal blast and concussion have already reduced you to the size, shape and color of a McDonalds hamburger, irradiating you as well is incredibly superfluous. Thus the direct effects we are interested in are light, heat and blast and they do arrive in that order. The further an observer is from the point of initiation, the greater the gap between them. This is very important. The flash of light that will blind a victim close in serves to warn a potential victim further out. Once a few miles out from ground zero, the light flash tells the population that a device has gone off and its shadows show them sheltered areas from the next effects to arrive. If an area is shadowed from light, its shadowed from radiant heat as well. The heat flash is the first really destructive effect to hit. This is direct radiated thermal energy; like light it travels in straight lines. It will set anything inflammable on fire to a considerable distance from ground zero. Interestingly, it won't set non-flammable things on fire and, for example, must enter a house via windows etc before setting that house on fire. If the windows are masked (for example painted white), the heat flash is unlikely to set a brick-built house on fire (US-style frame houses are a different matter which is why it makes me uneasy living in one).

Last to arrive is blast. Unlike light and heat, both of which travel in straight lines, blast can be funneled by structures, deflected and masked. The windows we carefully painted white are history; smashed by the blast wave and its associated wave front of debris but they've done their job. The heat flash has gone. Houses are actually quite well designed to resist pressure from outside - its pressure from inside that gives them problems. Again, if you can keep the blast out you've got a good chance. Impossible close in to ground zero but progressively easier as we get further from that point. Closing the shutters on windows inside the house is good; even taping the glass in a lattice pattern is astonishingly helpful. Compared with military targets, civilian structures have relatively low damage resistance. In the jargon we've been looking at, this is called protection factor (PF) - most civilians can, with a few minutes warning give themselves a PF of around 40 - meaning they are 40 times more likely to survive than an unprotected civilian. In other words, even though the structures surrounding them are soft and weak, there is a lot they can do that will greatly increase their chance of survival. Note that - even when the sirens are going off, there is still a lot you can do that greatly increases your chances of surviving - provided you have a chance of surviving in the first place.

Lets imagine somebody has taken a serious dislike to your home town and decided to remove it. For all intents and purposes, the effects of initiation are generated in the center of the device initiation and travel outwards evenly in all dimensions to produce a perfectly symmetrical sphere or fireball. Now think of the geometry of this. If the device is initiated at ground level, a so-called ground burst, half of all that energy will go into the ground, scouring out a crater but effectively being wasted. More goes skywards. Some will be reflected down towards the earth but very little; effectively that energy too is wasted. The only energy that is actually useful is that produced in a narrow segment around the equator of the spherical ball produced by the initiation. Thus, for this type of attack ground bursts seem very inefficient. They are.

So what do we do about it? Again, think of the geometry. If we lift the detonation point into the air, the segment of the sphere that will spend its energy destroying valuable things is increased and the amount that scours out a crater gets smaller. Keep thinking along these lines and we reach a point where the sphere of the fireball doesn't quite touch the ground at all. In this case almost all the energy from the lower half of the fireball destroys valuable things and none goes to digging a crater. This is called a low airburst and it remains a low airburst as long as the altitude of the point of initiation of the device is less than the diameter of the fireball (ie there is a fireball radius between the bottom of the fireball and the ground). If the point of initiation of the device is at an altitude greater than the diameter of the fireball it's a high airburst. If the intention is to knock down cities, low airbursts are the most effective way of doing it.

We haven't mentioned fall-out. The dreaded stuff that destroys humanity.Well, there's a reason for that; the device has only just been initiated, there isn't any fall-out yet. Fall out is caused (mostly) by debris from the ground being sucked into the fireball, irradiated and spewed out of the top. This radioactive plume coalesces in the atmosphere and falls back to earth. It's a mix of isotopes of varying half lives. The most vicious of these isotopes have short half lives and are gone in a few hours (usually before the fallout makes it back to the ground). The milder ones can hang around for millennia but their effects are tolerable (speaking relatively again). The really dangerous ones are those that have a half life of between 5 and 6 years - these are long-lived enough to be seriously contaminating and hot enough to be dangerous. The worst is cobalt). Now the blast and heat throw debris outwards, where does the debris sucked into the fireball come from? Answer is the crater scoured in the ground by the energy from the device that went into said ground. But hang on, we've just discovered the

best way to knock a city down is to use an airburst that doesn't crater the ground. Doesn't that mean no fallout? That's right, airbursts are relatively clean from a fallout point of view. They do generate some fallout from atmospheric dust and water vapor and a bit more (some very nasty) comes from the debris of the device but not as much as legend holds. This is especially the case since modern devices are very clean indeed and the debris from their initiation is far less than from the older designs.

All this means that dropping a nuclear device on a city doesn't necessarily destroy it. In fact, an acquaintance of mine, Peter Laurie, used to start off his lecture on such things by suggesting that 1 megaton device dropped on London would do only trivial damage to the city. After the lynch mob had been brought under control, he'd put a pie cutter on a demographic map of London and prove the point. We touched on how limited the damage caused by a one megaton device initiated over the City of London would be in Part Two. To be fair,that includes people and property slightly damaged but repairable. The catch is that London wouldn't have been hit by one but by several (in fact four 350 kiloton and two 1 megaton weapons in one particular attack plan). This would still leave a substantial proportion of the population and a larger proportion of their assets intact.

The implication of all this is that despite being subject to concentrated attack, the A-country isn't totally destroyed (although its society is) and remains a storehouse of people and goods. As an institution a big city is not viable for a variety of reasons but that is a long way from saying its simply flat, black and glowing in the dark. Its quite possible (depending on the attack patterns) that the big cities may be relatively unscathed.

So what's been going on in the B-country. One attack pattern is to hit the nuclear weapons stationed out there. These are mostly silo-based missiles. The only way to destroy those is to explode a device directly on top of the silo and scour out of the ground. In other words, a ground burst. And they create huge amounts of fallout. This means that a counter-force strike is inherently much more dangerous to the survival of the population than a counter city strike. Weird isn't it? A counter-value strike attacking the population in their home cities gives them a reasonable chance of survival while a counter-force strike restricting the target plan to military targets and rejecting a deliberate attack on the cities radically decreases that chance of survival. It's a point we've seen happening over and over again - when dealing with nuclear weapons we often end up going places we never thought we would. Thats because the logic behind nuclear weapons use and the effects of that logic is often counter-intuitive. It also demands careful though and examination of reality, not preconceptions or postures. The B-country also gets hit by counter-city strikes but the dispersed nature of the population reduces their direct effects.

OK so its over. The devices have ceased to arrive and eventually, probably after some 36 to 48 hours the all clear sounds. Notice another thing here; most accounts (The Day After for example) of a nuclear attack have a spasm lasting a few minutes and thats it. Sorry, Ain't So. The exchanges go on for days.

What happens now? From now on we're looking specifically at the USA. We have to get the B-country working again. As we touched on earlier, the cities are not viable places to live. Without their support infrastructure, they will become plague pits and charnel houses - just like the cities in 1632 :) . They have to be evacuated and the people distributed in the B-country to make up for losses there. In the B-country people are ambling around with Geiger counters plotting what's hot and what isn't. At this point life gets grim. We triage the population. One triage is condition. Who cannot be saved and will be left to die, who can only be saved with massive (and probably impractical) effort, those who can be saved with the means available now (the ones who get priority) and who will recover without treatment. On top of this is another triage. The population is prioritized according to need for protection. Pregnant women and children are top, young women of childbearing age second. Young men third, older men fourth, old women bottom. This is ruthless and brutal but its essential for survival. Given a choice between saving a young woman who can bear children and an old woman who cannot, we save the potential mother. We do the same with food. Food and water are checked for radioactivity. The clean food goes to the children and young women, the more contaminated food to the lower priority groups. That old woman? She gets the self-frying steaks.

In this situation the US has a terrific advantage over the rest of the world. Its called the Second Amendment. The B-country population is largely armed, sometimes quite heavily. They do exactly what Founding Fathers envisaged - provide a body of armed people whom the local authority can assemble to maintain order. (The Supreme Court may argue that interpretation of the Second Amendment but by now they are doing so with the people who wrote it). In a more general sense, post-holocaust fiction usually has gangs of outlaws preying on the defenseless citizenry. Interestingly that doesn't seem to happen. In disasters people tend to work together rather than against eachother (for example in US urban disasters Hells Angels biker gangs have made sterling

contributions to relief efforts using their bikes and riding skills to get emergency supplies through to places others can't). While lawlessness and disorder do occur, the ease of forming a civilian militia (using the term properly here meaning something very much like the Sheriff?s Posse beloved of Westerns) brings that situation under control. Other countries are unlikely to be so fortunate.

So we're in a race. Can we rebuild the B-country so that its firstly self-sustaining without the services provided by the A-country while the stockpile of pre-attack assets survive. Can we reconstruct a working society fast enough so that we can feed enough people to keep going? Can the surviving women bear enough children (and survive doing so) to replace the death toll. For the loss won't stop with the attack. Diseases we consider trivial today, measles, chickenpox, influenza, will be mass killers. No medical treatment. Unless your lucky enough to be where some medical facilities have survived, a broken leg that gets infected is likely to be a death sentence. Its possible to look on this world as a 17th century US colonial environment and there's a lot of truth in that. The downside is that the colonial pioneers didn't have the decaying charnel houses of the cities to worry about. This is another key thing to bear in mind; many more people will die after a nuclear exchange and will die in it. Eric was quite correct in making his Doctor fear disease more than any other factor - its a thing that worried everybody looking at post holocaust (and now you know why the US has such well-equipped clinics tucked away in remote places).

Winning that race is vital. Lose and we're extinct. The population drops like a stone as disease, radiation and injury take their toll. Then, it should bottom out and start to recover. Teams of older men and infertile women go to the cities to recover what they can. The radiation levels continue to drop. Fortunately we don't have to worry about nuclear winter, that's been largely discredited (the atmospheric models that were used were far too simplistic and the reality seems to be we may actually get a more temperate and less changeable climate out of things - somebody once described it as a Nuclear Autumn). The ozone layer also won't be a problem - it'll regenerate fast enough and the effects of the bombs may actually be beneficial.

The ugly side of life continues. Abortion and contraception are likely to be highly illegal. We MUST have those babies. There will be more than enough parents who have lost their own (or have received too high a radiation dose to chance the FLK problem) to look after any that are unwanted. Women are enslaved by their reproductive systems again. Don't like that but there is nothing we can do about it. The social pressure on women to have children will be immense in both material and moral senses. Women who can have children get the best of everything, the cleanest and best food, the most comfortable housing, the most careful protection. Women who can have children but refuse to do so will be social outcasts (and in this sort of society to be an outcast is virtually a death sentence). We're likely to see a situation where women of childbearing age are "protected" by severe restrictions ("don't go outside the house, the radiation may harm your babies" gets abbreviated to "don't go outside") . This is a grim and disturbing picture; we take an old woman out of her house and throw her in the snow to provide shelter for a pregnant mother and her children - then lock her in. Newborn babies obviously damaged by radiation are likely to be killed on the spot. That may or may not be justifiable but I think its inevitable.

No electricity, limited medicine, almost no dentistry, no travel - we really are back to the middle ages. The fallout patterns and other things shift so its likely we'll see communities having citadels they can retreat to if necessary. Gasoline runs out cars will go; we're back to horses for transport. Fortunately we don't need factories to make more horses. Justice by the way is run by Judge Lynch. Don't expect to attack a woman and survive. Guns are also a declining asset. As the ammunition runs out we'll be making weapons in blacksmiths shops. Its interesting to see what the designers will come up with, using modern know-how with 17th century assets. We'll probably see bows and arrows come back into fashion - and that means metal body armor.

Eventually when conditions permit, our new society moves back to rebuild the A-country. It'll be a long, long time before there is another Federal Government(such things need technology to survive - a calculated guess is that it would take two centuries before a powerful central government evolved again - if it evolves again).

- End of lecture series -

Its interesting to note how much of the post-nuclear attack projections have carried through into 1632. In fact, I originally bought 1632 precisely because I was interested in how Eric's thoughts would fit with the studies that I knew had been done. The parallelism was very close indeed. 1632 quickly identified the crucial problem - the need to get population levels up so that there is enough of a workforce to do everything that needs to be done. Replace refugees from the war zone with refugees from the A-country and the situations are very close. In many

ways, the situation described in 1632 is a lot closer to a post-nuclear attack scenario than the novels that purport to describe such situations directly.

The gearing down of technology is another issue where there are substantial parallels - although a lot of dispersal has been done and small towns have more strategic assets than they might think. There is a reason why the Pentagon places so many contracts with small, out-of-the-way companies. The basic logic is correct though; a post nuclear environment can support limited industrialization using steam and water power and can restore limited electricity.

1632 has another lesson for the post-nuclear environment; the critical importance of getting a working society up and running and getting trade links established. The normal run of post-holocaust novels forget that yet it was the thing most people studying the situation spent most time looking at. Mike Stearns got the point straight away - if he presented himself at a think-tank we'd hire him on the spot. I suspect he'd fit in quite well.