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Radiation Protection

PROTECTING AMERICA

A PROPOSAL FOR KI

STOCKPILING

A Program for KI Distribution in Schools

ProKIds

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ProKIds

BACKGROUND

Considerable evidence exists to support stockpiling of potassium iodide (KI) to protect the public from radiation released by a nuclear reactor or weapon. KI's well documented effect is to saturate the thyroid gland with non-radioactive, "cold" iodine, "filling it up" and thus preventing the absorption of radioactive iodine (RAI) which causes an aggressive form of thyroid cancer.[1]

Children and adults under age 40 are the most vulnerable to RAI and require special protection in a radiation emergency. Fortunately, the near 100% safety and effectiveness of KI, and the relative ease to store and distribute the tablets, means that the potential for a catastrophic radiological event can be greatly reduced. It is a step that should be taken.

THE DANGER

The nuclear fission process can produce numerous radioactive toxins, and RAI is among the most plentiful and dangerous. When released from a reactor or bomb, it can form into an aerosol and travel hundreds of miles downwind from its origin along an unpredictable path determined by wind, rain, and temperature. It can contaminate thousands of square miles and threaten millions of people. This has already happened; more than once.

The Japanese bombings and nuclear weapons testing in the 1950's demonstrated the danger posed by RAI. Today, nearly half of all exposed Japanese who were children in 1945 suffer from thyroid damage, and residents of South Pacific islands hundreds of miles from US nuclear test sites have developed thyroid damage at epidemic rates.[2, 3] In 1997, the US National Cancer Institute estimated that weapons testing in Nevada caused between 11,300 and 212,000 thyroid cancers among Americans.[4] But it was the massive release of RAI from the Chernobyl nuclear accident that most vividly demonstrated the danger. A study by the United Nations concluded that RAI formed a plume which blew across Europe, touching down erratically, leading to thousands of cases of thyroid cancer by 1999.[5] The US Nuclear Regulatory Commission (NRC) has estimated at least 6000 cancers due to Chernobyl, and the World Health Organization documented thyroid from the plume as far as 500 km downwind.[6] Nothing else released at Chernobyl had a similar impact, leading the NRC to report **"*except for thyroid cancer, there has been no confirmed increase in the rates of other cancers including leukemia*"** and that *"**the vast majority**"* of these thousands of cancers occurred *"**more than 50 km from the site**."*[7]

In fact, almost all cancer took place between 30 and 200 miles downwind of the reactor.

Only a small amount of KI was available at Chernobyl, but those lucky enough to get it were protected. As reported by the NRC "***thousands of measurements***" demonstrated that ***"the use of KI by the Pripyat population was credited with permissible iodine content (less than 30 rad) found in 97% of the 206 evacuees tested at one relocation center.***"[8] However outside of Pripyat, throughout Ukraine, Belarus, and Russia, where KI was not available, thyroid cancer spiked to epidemic levels.

But not in Poland, where 17 million doses of KI were distributed. As a result, Poland, alone among the countries in the region, has little or no cancer attributable to Chernobyl.[9] Remarkably, with the exception of gastric distress among recipients who received liquid KI, there were no other serious unwanted reactions (side effects) from the KI among the general population.

Certainly Americans deserve this same level of protection.

A PLAN TO PROTECT AMERICANS

Given the realistic possibility of a radiological emergency, authorities have the obligation to plan and prepare for KI's use. However, any plan for KI stockpiling must consider two factors.

First, given the randomness of a windblown radioactive plume, whether from a powerplant or weapon, it is impossible to determine where KI will be needed before an incident occurs. Worse, even during an incident, the ability to identify where contamination has occurred is limited because of a lack of adequate monitoring. Thus, anyone located within a potentially contaminated area cannot know their risk, and consequently should consider taking precautions.

And second, for maximum effectiveness, KI must be started as soon as possible and used daily in heavily contaminated areas (until the radiation decays). However, because of long production times, emergency supplies must be on hand prior to an incident, and a distribution method must be in place.

These factors suggest that any plan to protect the public must be:

1. Local. Short-term emergency supplies should be stored around nuclear power plants and high-potential terrorist targets in neighborhood locations which are convenient and well known to the public. Without local storage, the ability to deliver KI quickly to potentially affected populations will be severely impaired.
2. Long-Term. Provision must be made to provide supplemental long-term supplies in areas known to be contaminated in a release. Here the danger will go beyond the short term and could extend for weeks.
3. Inclusive. The area involved could be very large and threaten millions with real or perceived danger. Almost everyone will want KI, and it is difficult to formulate an argument why everyone who wants it should not get it.
4. Feasible. A method to quickly distribute KI to those who are most vulnerable must be in place. Further, the distribution procedure must be simple and uncomplicated and avoid using resources (such as police or emergency personnel) that will be required elsewhere.
5. Flexible. The plan must be capable of adapting to unanticipated circumstances.
6. The stockpiled KI product must be:
   - A) Completely effective, completely safe.
   - B) inexpensive, long-lasting,
   - C) maintenance free, light-weight, small and easy to store locally,
   - D) easy to distribute and administer, and easy to ship to where it is needed.

To meet these requirements, this plan recommends storing an emergency supply of KI tablets in every school located 50 miles from a nuclear power plant. These tablets would be available for distribution in the event of an emergency, and would provide short-term (six days) protection for children and their families. This will allow time to ship additional KI from a central national stockpile into areas where protection beyond six days will be needed.

HOW MUCH KI MIGHT BE NEEDED?

The number of people who might be affected by a radiation emergency varies greatly by reactor. However, all schools located up to 50 miles from a nuclear power plant can be determined, and at least 1500 packages (each containing 6 KI tablets) should be stored in each.

In addition to the short-term (six days) supply held in every school, a national stockpile of 10 million boxes of KI should be stored in a centralized location for shipment into possibly contaminated areas once an accident has occurred. These tablets will provide the long-term protection needed in places that are, or may be, contaminated by RAI.

For anyone who might be exposed to RAI, FDA guidelines call for the administration of one KI tablet per day until the radiation decays. But the extent of the threat to any individual is dependent upon the amount of RAI released, the proximity to the release point, and the location of random "hotspots" along the plume's path. The release point, of course, could be a terrorist target, or any educational or commercial nuclear reactor throughout the country. Given that more than half of the US population lives within 50 miles of a nuclear power plant, and about two-thirds are under age 40, about a third of the US population could require a short-term supply.

But the danger posed by RAI is limited and highly defined by its 8.1 day half-life. RAI decays rapidly, and after 7 half-life cycles (about 60 days), 99% of the RAI will have disappeared. Consequently, in heavily irradiated areas closest to the release point, dangerous levels might remain in the environment for as long as two months. However, as the distance from the release point increases, the RAI is diluted, and the length of time KI needs to be taken is reduced.

Given the decrease in danger as a factor of distance, and in light of RAI's half-life, the short-term emergency supply of six tablets will be enough for most people. However, near the release, individuals will probably require supplemental tablets for longer-term protection. The amount that might be required is as follows:

Distance From Release Point	Number of Tablets Required (per person- one tablet per day)
1 to 25 miles	40 or more tablets
25 to 50 miles	20 to 40 tablets
50 to 100 miles	6 to 20 tablets
Beyond 100 miles	2 to 6 tablets (if exposure indicated)

WHEN SHOULD KI BE TAKEN?

There is disagreement when individuals exposed to RAI should take steps to assure thyroid protection. The International Commission on Radiological Protection (ICRP) has recommended an intervention threshold level of 1-2 rem, while the NRC's guidelines do not call for action until a 5 rem threshold dose is reached. There is also disagreement if the tablet distribution area should extend to 10, 20, 50, or 100 miles from the reactor.

However, two technical studies on the expected consequences of serious nuclear accidents done for the NRC make these modest disagreements somewhat meaningless. **Both predict over 1000 rem** at 25 miles, between **300 to 380 rem** at 50 miles, and **70 to 100 rem** at 100 miles.[10, 11] Accordingly, there can be little doubt that the threshold exposure to warrant KI administration could be reached well beyond 10 miles, and possibly as far as 100 miles downwind of any RAI release.

WHICH FORM OF KI SHOULD BE STOCKPILED?

KI is available in two forms, liquid and tablets. While liquid KI is appropriate for use by infants or others too young to take solid food, its weight, bulk, short shelf life, and environmental sensitivity limit its suitability for localized (school) stockpiling. Further, in its liquid form, KI can be a severe gastric irritant which can cause unwanted side-effects, however these side effects are absent if KI tablets are used. In addition, because liquid KI requires careful measuring by eye-dropper, we recommend it be kept only in hospitals where it can be administered by trained personnel.

KI tablets, on the other hand, are small, lightweight, and easy to store with no special maintenance. They are available in two strengths; 130 mg (full strength) and 65 mg (half strength). This plan recommends the storage of both sizes for short-term emergency and long-term needs.

Emergency (Short-term School) Storage: The 130 mg tablet is ideal for school storage and emergency distribution to all adults and children. It is very safe for use by children (who can take either a whole or half tablet), and its small physical size (about 9000 tablets per cubic foot) means a school would have no difficulty finding storage room. The tablet has a ten-year shelf life. Further, the ability to split a 130 mg tablet into two 65 mg doses adds an extra margin of public safety in the event of unanticipated developments (or greater than expected demand) in a national emergency. Most important though is that because both children and adults can safely take a 130 mg dose, the use of a single size for both age groups will simplify storage and distribution logistics.

[The advantage of having just a single size was noted by the National Council on Radiation Protection (NCRP) who concluded "***For accuracy of administration, ease of distribution, and precise dosage, the use of a single dose form is a most desirable goal.***" They further stated that "***toxic effects are not noted with doses of 130 mg of KI per day given to children over a course of years***" and that in a radiation emergency, for simplicity, "**it seems reasonable to supply adult doses to children.**"[12]

The FDA cites KI's safety at either dose. They have written that 130 mg of KI would be "**extremely safe**" for school children and that "*the **overall benefits** of taking up to 130 mg of KI instead of the lower doses recommended for certain age groups **far exceed** the small risks of overdosing.*"[13] In fact, regarding the 130 mg strength for **ALL** age groups, FDA has written that the possibility of side effects is insufficient ***"to conclude, or even to suggest"*** a significant number of serious reactions.][14]

Central Storage: As noted above, areas that are heavily contaminated will require more than a six day supply of KI. For this need, additional KI should be warehoused at a central location where it could be shipped as needed. Since storage space is not a major consideration, the physically larger 65 mg tablets should be used. Children would take one tablet daily for protection, while adults would take two. These tablets are packaged in boxes of 20 tablets.

DISTRIBUTION

In the event of a threatened or actual radiation emergency, authorities would have the flexibility to order schools in threatened areas to close, and to send each child home with one to three unopened packages of KI, each containing six tablets. (The decision to take the tablets would be left to the parents.) Thus, in one step, virtually all school-age children and their parents would receive enough KI to protect them for at least 6 days. If necessary, schools beyond the initial distribution area could also distribute their tablets if authorities saw value in this step.

For areas where authorities conclude that the danger may continue beyond 6 days, additional KI would be shipped to schools within the affected area where it could be easily distributed within the six days available. Distribution might consist of 3 boxes of 65 mg tablets (60 tablets) to anyone staying within 25 miles of the release point, 2 boxes (40 tablets) for anyone located within 25 to 50 miles of the release, and 1 box (20 tablets) for everyone 50 to 100 miles downwind. It is likely that no additional tablets will be required for anyone beyond 100 miles.

The essential feature of this plan is its flexibility. Because the six packs are available for immediate distribution to the most vulnerable groups, and because officials will have at least 6 days to prepare for and evaluate the need for additional KI, there will be time for events to dictate thoughtful action that would be most appropriate for the circumstances.

The plan's flexibility is enhanced by its simplicity. Problems with liquid storage are absent, and the six-packs are so small and compact that they can be kept virtually anywhere. Schools are the obvious place to keep KI tablets because that's where the children are, and schools are frequently designated as public shelters in emergencies. In addition to schools, KI six-packs could be kept at police and fire stations for protection of emergency response personnel, and at post offices for distribution to the general public if required.

FEASIBILITY

It is likely that the NRC reactor-design philosophy of "leak before break" would provide up to two days for KI distribution before a release occurs, and that the six days provided by the six-pack will be enough to obtain and distribute any additional tablets for long-term protection. Storing KI in schools and daycare facilities would be an effective and efficient way to get the tablets to those who need them most in the least amount of time. Under this approach, and under the circumstances where a release occurs during a school day, the vulnerable population is protected almost immediately. Yet even in a worst case (where a release occurs on a weekend and distribution is delayed until the following Monday), this would still be early enough (in most cases) to block 85% to 90% of the radiation that an individual in an exposed area might receive.

There is substantial value to starting KI even after receiving an initial radiation exposure because radiation effects are cumulative. Taking KI after an initial dose is extremely valuable since this prevents the build-up of additional RAI during the 60-day period it takes for the radioactivity to decay. Therefore, even in the event of a two or three day delay, it is important for children and young adults to begin KI use as soon as possible in order to minimize total exposure.

Of course, storing KI in schools could leave childless adults without tablets. For this reason, small amounts of KI should also be kept at police, fire stations, or post offices, and liquid KI could be obtained at hospitals.

COST

KI is inexpensive. For 500 students and their parents (1500 packages), the cost per school would be $2700 for 10 years of protection (at 30 cents per tablet). **The annual cost is just $270 per school**—or just 3 cents per adult dose, and half this amount for children. By virtually any measure, this is a modest cost for protection of the most vulnerable.

Boxes of 20 tablets of the 65 mg strength are also inexpensive. The cost per box is just $5.80 each, meaning that the annual cost for a child's dose is under 3 cents.

Consider the financial impact of a radiation emergency. A nuclear attack or a nuclear accident on the scope of Chernobyl could potentially cause 15,000 to 50,000 cases of thyroid cancer. In addition, probably 3 to 10 times this number of people would suffer other thyroid problems, such as thyroid nodules or hypothyroidism. Medical costs to treat these injuries would be staggering, and the cost in human suffering (especially among children) would be incalculable.

(Some idea of the cost of a nuclear accident was presented in an April 2006 study by the International Atomic Energy Agency (IAEA)[15], which found that, in Belarus, "*government spending on Chernobyl amounted to 22.3 percent of the national budget in 1991.*" The Report also found that "*In Ukraine, 5-7 percent of government spending each year was still devoted to Chernobyl-related benefits and programmes* [though the accident took place 20 years earlier]." The cost of a terrorist incident could be similar.)

Worse would be the psychological toll. Because cancer can take 25 years to develop, and because no one would know if they had received a cancerous dose, anyone who was unprotected will worry about their health for years. This has been observed among Chernobyl survivors who blame radiation for virtually every ailment they suffer. But it's a self-fulfilling prophecy. Widespread anxiety has led to significant stress among the entire population, which the IAEA report calls "*a paralyzing fatalism*". This has led to a consequent general deterioration of the health of the entire society at an enormous cost which cannot even be estimated. Clearly, if people understood that the small pills issued by the government would protect them, much of the future psychological "cost" of a radiation emergency would be avoided.

CONCLUSION

While the chances of a nuclear emergency are unclear, it is impossible to deny the realistic potential for one to occur. One estimate, by a former NRC Commissioner, suggested a 50% chance of a powerplant accident in any twenty-year period.[16] And while no one can judge the likelihood of a terrorist attack or hostile nuclear action by a state (Pakistan, Iran, or North Korea, for example), this threat can certainly not be dismissed. Indeed, the cliché—"not if, but when"—is all-too frequently heard.

Despite this, current planning pays scant attention to the impact of a release on most people. Although the NRC's key emergency accident response plan acknowledges that in a serious accident "*much of any particulate material in a radioactive plume will be deposited within about 50 miles"* of the release"[17], distributing KI to prevent cancer is limited to just 10 miles. The NRC explains this by noting that "*life-threatening doses* [of radiation] *would generally not occur*" beyond ten miles.

But "*life-threatening*" radiation doses (measured in thousands of REM) do not cause cancer. They kill first. Cancer-causing doses are as low as 3 to 5 REM, and research and experience indicate that these dose levels—and the cancer they would cause—would be expected for many tens of miles downwind. For reasons which are difficult to understand, the decision not to stockpile KI in order to alleviate the cancer threat is inexplicable.

It means that millions of children could be at risk in an accident, and assures that there will be no KI to protect them. Although the FDA, the National Academy of Sciences, the American Thyroid Association, the American Academy of Pediatrics, and numerous others support KI's availability, current policy is to leave most people unprotected and to hope that evacuation and avoidance of contaminated food will be sufficient to prevent cancer. It is a policy that is highly questionable.

What is most disturbing about limiting response planning to evacuation and food control is that experience indicates it won't work. Evidence suggests that the ability to conduct a mass evacuation is highly questionable. Most troubling is that limiting KI distribution to ten miles may lead some to believe that if they are 11 miles away, they are safe and need not take any protective actions. The consequences of this could be catastrophic. Further, the focus on intercepting contaminated food and water ignores NRC findings that the major initial short-term threat in a release is inhaled RAI in the air, not ingested in food and water. And how authorities would find, destroy, and replace contaminated food and water has not been made clear.

No one disputes that potassium iodide is an inexpensive, highly effective method to add a significant level of safety in a dangerous world. Therefore, to continue to ignore known facts and instead to depend on plans that are inadequate, is irresponsible. One can only wonder what explanation officials would give if tens of thousands of Americans developed avoidable cancers because no one had acted.

U.S. NUCLEAR REGULATORY COMMISSION

Examination of the Use of Potassium Iodide (KI) as an Emergency Protective Measure for Nuclear Reactor Accidents.

NUREG/CR-1433
Sandia National Laboratories, October, 1980

EFFECTS OF CORE-MELT ATMOSPHERIC ACCIDENTS BY DISTANCE

Distance From Reactor In Miles	Mean Thyroid Dose (REM) for Exposed Adult Outdoors	Probability of Thyroid Damage to Exposed Adult Located Outdoors
1	13,800	60%
5	6,800	70%
10	3,200	70%
25	1,100	40%
50	380	13%
100	100	3%
150	36	1%
200	16	.5%

Data taken from Tables 3 and 4 with following clarifying notes:
--For children, increase dose and probability of damage by an approximate factor of two
--Includes inhalation dose only. Does not include effects of ingestion of contaminated food or water
--Thyroid damage includes benign pre-cancerous and cancerous thyroid nodules and ablated thyroids.
--Table constructed assuming typical weather conditions

NOTE: NRC Guidelines call for Protective Action (KI) when thyroid dose reaches 3 to 5 REM

U.S. NUCLEAR REGULATORY COMMISSION

*An Analysis of Potassium Iodide (KI) Prophylaxis for the General Public in the Event of a Nuclear Accident**

Plume Center-Line Thyroid Doses (rem) for RSUR-1 Accident
S. Cohen & Associates, April, 1992. NUREG/CR-6310

Distance Range (MI)	**Infant**	**Child**	**Teenager**	**Adult**	**Average Person**
1-5	20,000	38,000	24,000	9,550	20,000
5-10	7,400	14,500	8,950	3,600	7,300
10-25	1,800	3,450	2,150	865	1,800
25-50	300	575	365	145	300
50-100	69	135	85	34	70
100-150	31	62	39	16	32
150-200	19	38	24	9	19
200-350	8	17	11	4	9

Thyroid dose includes all radionuclides and pathways. Doses assume typical weather conditions.
Data excerpted from Table 4-8

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