I. Introduction

 There is only one way to prevent nuclear detonations, which the 1945 bombings of Hiroshima and Nagasaki have demonstrated to prove catastrophic, and that is by getting rid of our nuclear weapons altogether. Yet in recent years, progress towards this goal has stalled sometimes simply because of logistical squabbles, as when in 2012 negotiations to declare the Middle East free of nuclear weapons fell through. Through this paper, we hope to remind policymakers that the threats nuclear weapons pose are dire enough that we must bridge our differences and adopt a rigorous, comprehensive, multilateral solution that places disarmament as the highest goal and mitigates risks while we disarm.

 We focus on one particular risk that the continued retention of nuclear arsenal poses: global nuclear vulnerability (GNV), or the world’s vulnerability to nuclear weapons detonations. In particular, we highlight the potentiality for accidental nuclear incidents, or “close calls.” We first detail the potential consequences of any nuclear incident, accidental or deliberate. Then, we analyze prior close calls and, identifying the common causes behind these incidents, extrapolate methods to reduce safety risks while arsenals are still in place. Finally, we combine these recommendations with a reiteration of the necessity of hastening disarmament and enforcing nonproliferation.

II. Effects of Nuclear Detonation

The detonation of a nuclear device would have large and widespread effects on public health, domestic policy, and international geopolitical calculations. The detonation of a nuclear weapon would have public health impacts beyond just the initial blast. According to Benoit Pelopidas of the University of Bristol, there are three major sequential components to a nuclear detonation: the actual blast, the fires caused by the detonation of a bomb, and the radiation caused by the blast itself. Of the three, the radiation caused by the blast has the highest chance of causing a long-term public crisis. Some of the major effects of radiation are mutations/birth defects, cancers (esp. leukemia), sustained land infertility leading to famine, and contamination of water supply. Some of the environmental issues could be a "nuclear winter" which leads to land and water contamination. The failure of a nuclear reactor leads to protests against nuclear energy, pushing back the adoption of green sources of energy and leading to more fossil fuel use which leads to an increase in global warming. Also some of the general health issues are trauma, elevated stress, higher incidence of cardiovascular disease, various other mental health disorders, and suicides.

III. Prior Close Nuclear Weapons Use Mishaps

In order to understand the real risk of conducting nuclear experiments, we should identify key incidents involving nuclear materials. There are quite a few examples of experiments involving nuclear materials and devices that have malfunctioned in some way, along with human error and miscalculation that led to environmental fallout and extensive panic.

*Demon Core: 1945 and 1946*

During the creation and testing of the “demon core” subcritical mass of plutonium at the Los Alamos National Laboratory, two scientists were subjected to radiation poisoning when they stopped the core from going supercritical.

Category: Scientific

Incident Event Details:

* August 21, 1945
* May 21, 1946

Projected Event Yield: 23 kilotons (extrapolated from Operation Crossroads, which used the demon core)

Expected Damage:

* Two immediate deaths of Harry K. Daghlian Jr. and Louis Slotin; linked to health problems that developed in spectators
* Citywide nuclear detonation, potentially hundreds of immediate deaths and radioactive contamination

*Human Radioactive Experiments: 1945*

Category: Scientific

Incident Event Details:

Projected Event Yield:

Expected Damage:

* Civilians who might be experimented on could potentially have gotten radiation poisoning without their knowledge or consent.

*Castle Bravo: 1954*

Category: Scientific

Incident Event Details:

Actual Event Yield: 15 megatons (2.5 times greater than expected, over 1000 times the Hiroshima bomb)

Actual Damage:

* Radioactive fallout over 11,000 km2
* Long-term health damages to inhabitants of the islands

*Goldsboro: 1961*

Category: Military

Incident Event Details:

Projected Event Yield: 2-2.5 megatons per device, 4-5 megatons in total
Expected Damage:

* According to a story published by ibiblio, a project of the University of North Carolina–Chapel Hill’s School of Journalism and Mass Communication and the School of Information and Library Science, “[T]he blast from a ground-level detonation of four megatons would have left a crater in the ground a third of a mile wide and leveled homes five miles away, while the heat would have set fires and inflicted third-degree burns to a distance of nine miles from the point of detonation.”
* In short, a detonation would have inflicted home destruction and severe burns to neighboring residents. Radioactive fallout and subsequent poisoning and contamination would result largely from the fission sequence that fueled the fusion sequence.

*Cuban Missile Crisis: 1962*

Category: Civilian

Incident Event Details:

Projected Event Yield: Unknown—The worst-case scenario would have been nuclear war, in which an untold number of missiles would have been fired.

Expected Damage:

* The consequences of a nuclear war would have been disastrous, ranging from immediate civilian death to long-term radioactive contamination, radiation illness, and the political and economic instability these events would trigger, not to mention irreparably damaged U.S.-Soviet political relations.

*Palomares Accident: 1966*

Category: Military

Incident Event Details:

Projected Event Yield: 70 kilotons-1.45 megatons per device, 2.8-5.8 megatons in total

Expected Damage:

* Similar consequences of a detonation in the Goldsboro incident: property destruction and burns to the nearby population. The fission sequence triggering the fusion sequence would also cause some radioactive contamination.

*Baneberry Incident: 1970*

Category: Military

Incident Event Details:

Actual Event Yield: 10 kilotons

Actual Damage:

* Radioactive fallout affected eighty-six workers at the test site, two of whom later died from leukemia. In addition, winds carried radioactive dust into California, Oregon, and Washington State, potentially spreading it into rain clouds and causing radiation to rain on the population or farmland.

*Damascus Incident: 1980*

A rocket fuel explosion in 1980 in Damascus, Ark., that forced the evacuation of people living near a Titan II missile complex.

Someone dropped a socket in the silo. And the socket fell about 70 feet, pierced the missile, caused a fuel leak and then there was a huge explosion.

They put safety mechanisms in the warheads to make sure they only detonate over the target where they're supposed to. And that's a testament to the engineering skill of the warhead designers and to good luck.

*Chernobyl: 1986*

Category: Civilian

Incident Event Details:

Actual Event Yield:

Actual Damage:

* Massive environmental contamination, numerous deaths

*Tomsk-7: 1992*

Category: Scientific

Incident Event Details:

Projected Event Yield: No nuclear detonation

Expected Damage:

* Radioactivity would contaminate local agricultural fields, leeching into food and poisoning inhabitants. In addition, contamination in the air and water would damage civilian life expectancy and increase the rates of radiation-caused illnesses like cancers.

*Black Brant Scare: 1995*

Category: Military

Incident Event Details:

Projected Event Yield: 13-23 kilotons if a fission bomb was fired; 200 kilotons-56 megatons if a hydrogen bomb was fired. These numbers are extrapolated from the CTBTO Preparatory Commission’s data on prior nuclear weapons tests.

Expected Damage:

* Physical damages would include property damage from the shockwaves the explosions would release, severe burns to civilian populations, and radiation poisoning and radioactive contamination. In addition, the blunder would potentially irreparably damage U.S.-Soviet relations.

IV. The Current Nuclear State

* Global Nuclear Inventory

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* Obama advocates “nuclear free world”
* Modernization of nuclear weapons
	+ US planning $1 trillion dollars on upgrading nuclear weapons over next 30 years or $355B over the next decade
	+ Reduction offset by upgrades
* Only China of five nuclear weapon states has committed to an unconditional no-first-use policy
* Global Nuclear Vulnerability
	+ US and Russia nuclear weapons on “hair-trigger alert” or “launch on warning” increase the risk of accidental, unauthorized, or mistaken launch of nuclear weapons. Britain and France SLBMs are on low levels of alert. China’s nuclear forces are completely off-alert alongwith off-alert nuclear weapons of other nuclear armed nations - India, Israel, North Korea, and Pakistan.

Table: Total High-Alert Nuclear Forces in 2008

|  |  |  |  |
| --- | --- | --- | --- |
|  | Missilenumbers | Warheadnumbers | Total yield (MT) |
| USA | 560 | 1302 | 315 |
| Russia | 340 | 1279 | 870 |
| ***Total*** | ***900*** | ***2581*** | ***1185\**** |

*\* Total yield of US and Russian operational nuclear arsenals is approximately 2657 MT, thus about 45% of the yield is on high alert*

Some of the dangers of keeping missiles on high-alert are:

* + False alarm due to warning sensors being fooled
	+ False alarm due to accurate but ambiguous warning data
	+ False alarm due to human error
	+ False alarm due to technical problems with the warning system
	+ Technical problems with command and control systems
	+ Environmental and Ecological consequences of war involving high-alert nuclear weapons
* New small, stealthy, and precise weapons – B16 and Cruise missile
	+ Smaller, more precise weapons could make them more usable
* Threat of hydrogen bomb
* Terrorism
	+ Cyber terrorism
		- Deliberate acts of individual or state-sponsored terrorism must now be factored into false military warning signals
	+ Nuclear Terrorism
		- Nuclear facilities
		- Buying materials online
* Potential Hotspots
	+ India and Pakistan
		- Tense relations
	+ Middle East
		- Iran
		- Israel Palestine
	+ US and Russia
		- Russia redrawing map of Europe: Ukraine crisis, annexation of Crimea, and threats against other Eastern European States
		- Increasing tension between US and Russia
		- Russia’s large-scale buildup of nuclear forces
		- Russia’s revised nuclear doctrine and recent threats to use nuclear weapons
		- China is considering putting nuclear weapons on high alert for the first time and to build an early warning system to detect an incoming attack
	+ N. Korea
		- Emergence of rogue state
* New START treaty

V. Proposed Future Response Plans

Analysis of the cases where nuclear weapons were close to being used helps identify factors that increased the risk of inadvertent use. It can be said with certainty that there was a higher than expected probability of nuclear use owing to accident, error or misjudgment. The risks associated with nuclear weapons remain, the consequences being catastrophic. While on some occasions prudent judgment saved the day, in others errors of judgment nearly led to an extremely costly miscalculation. It highlights the importance of adequate decision-making time in avoiding nuclear use, the importance of outside mediation, effectiveness in government communications, involvement of key decision-makers, the limits of learning, the decisive role of individuals in following intuition and prudent decision-making, often in violation of protocol. After cold war, both US and Russia have made significant progress in reducing their nuclear arsenals. But despite the progress, more work is needed towards the goal of “global zero” and nuclear disarmament. Additional steps to further reduce the risks posed by nuclear weapons and work towards the path of abolition of nuclear weapons may include:

* Reducing US reliance upon nuclear weapons in US national security
* Reducing the number of deployed long range weapons in US and Russia
* Cutting the number of stored weapons and dismantling them. Currently there are no treaty limits on nuclear weapons in storage
* Speeding up the dismantlement of retired warheads, to make reductions less easily reversible
* Encouraging US and Russia to take a “No First Use’ pledge for their nuclear weapons
	+ Builds confidence and trust
* Eliminating the remaining short-range battlefield weapons
* Taking ballistic missiles off hair-trigger alert buys time for prudent judgment, avoid miscalculation, resolve miscongception, and reduce the chance of an accidental or erroneous launch
	+ Re-alerting race cannot occur if there is no realerting
	+ High alert status is not needed for deterrence
	+ High alert status is not relevant to extended deterrence
	+ High alert status is not needed for “nuclear warfighting”
	+ Beneficial to reduce high time pressured presidential option
	+ US decision to take missiles off high alert could affect the internal Chinese debate and help influence China to refrain from putting its own nuclear weapons on high alert since US nuclear policy is the largest external influence on Chinese nuclear policy
* Putting together new global nuclear environmental treaty