



OPINION – Louis René Beres

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An Urgent Imperative: Clarifying “Firebreaks” of Nuclear Deterrence

There are plausible reasons to worry about a nuclear war stemming from the current Russian barbarisms in Ukraine. To clarify, any steady growth of President Putin’s tactical or theater nuclear forces could lower the threshold of actual nuclear weapons use, especially during unpredictable periods of expanding area warfare. Though nothing authentically scientific can ever be determined about such sui generis matters (i.e., matters without precedent), roughly-calculated probabilities could still be ascertainable. At their functional core, such calculations must always be about dialectical thinking processes. Accordingly, when examined from the overridingly critical standpoint of deterrent threat credibility, tactical or theatre nuclear forces would likely appear more persuasive than strategic nuclear weapons. This is because their retaliatory use would appear markedly less “unthinkable.”

Though this argument might at first sound oddly counter-intuitive or even foolish, it still remains consistent with almost four generations of continuously self-refining strategic theory. Such meticulous theory has generally been focused not only on enemy threat capabilities (e.g., conventional versus

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nuclear destructiveness), but also on decipherable enemy intentions. Looking ahead, adversarial capabilities and intentions will both need to be examined in their widest conceivable assortment of intersectional possibilities.

Some of the most worrisome possibilities here could be synergistic. Regarding Russia’s current war objectives in Ukraine,

which appear to have been determined by Putin decision-makers who never heard of Clausewitz’ “political object,” there is more to examine. While the Soviet Union still existed. Moscow incorporated elements of “first use” thinking into

its codified strategic doctrine. It would now appear that President Putin is actively re-committing to just such an earlier nuclear doctrine. Inter alia, it is a recommitment that could quickly prove to be profoundly destabilizing. There is more. In such time-urgent strategic calculations, it will be important to bear in mind that traditional Soviet nuclear doctrine had minimized the more conspicuous and stabilizing "firebreak" between conventional and nuclear weapons. More particularly, this adversarial military doctrine focused on subtler and potentially less decipherable differences between theater/tactical nuclear forces and strategic nuclear forces. For the United States and NATO allies, to meaningfully understand these differences will represent more of an intellectual problem than a political one.

A Problem of Synergies and "Escalation Dominance":

Going forward with their assessments of such bewildering issues, Russian, American and other nations' strategists could quickly find themselves overwhelmed by challenges of complexity. In the most plausible arenas of any prospective nuclear confrontation, latent and visible hazards could be exacerbated by variously unpredicted interactions of individual national doctrines. Whether foreseen or unforeseen, any or all such interactions could sometime become synergistic. By definition, such force-multiplying interactions would represent tangible fusions of doctrine wherein the presumptive "whole" of any deleterious conflict effect would be greater than the expected sum of its constituent "parts." Always, but especially now, nuclear war avoidance should be approached by national leaders as a daunting intellectual problem. For the United States in particular, such an imperative avoidance should

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represent a problem that will need to be confronted in tandem with other many-sided global challenges. During the relentlessly anti-intellectual Trump years, a corrosive American era of cascading decision-making incoherence on strategic matters, suggestions of scientific assessment were routinely brushed aside at the White House. All too frequently, these capricious dismissals were accompanied by distressingly witting gestures of complete indifference. During those years of dissembling policy-making, major US national security problems were framed by an American president in gratuitously rancorous terms. Regarding this country's present concerns about a nuclear war triggered by Russia's rabidly criminal behaviors in Ukraine, these frameworks were founded upon militarily senseless appeals to assorted ad hominem likes and dislikes. They were not founded upon what was most genuinely needed. Among other evident deficits, the haphazardly constructed frameworks were not fashioned with any concern for meeting increasingly complex requirements of "escalation dominance."

Routinely, as understood from the interrelated standpoints of disciplined doctrine and formal logic, President Trump's illogical appeals exhibited grave errors in strategic reasoning. Most obvious among these multiple and synergistic fallacies was the argument known as the argumentum ad baculum. Prima facie, from the start of his incoherent presidency, President Trump worked to compound this potentially irremediable misrepresentation. Today, armed with greater attention to applicable intellectual factors, American planners and policy-makers should look more systematically forward. What will happen next in President Putin's determinedly cruel war

against Ukraine, a war of aggression and genocide waged against hospitals, schools, nursing home and child-care centers? How can the United States best prepare for nuclear war avoidance or genocide in a European theater being rendered more and more unstable? Playing President Putin's "nuclear firebreak" game, shall Washington now seek to persuade Moscow of America's willingness to "go nuclear" if presumed necessary, or should the US accept less risky but simultaneously less advantageous operational moves? The core question is this: How can the United States best respond to the Russian war's ambiguously engineered terrors, a hard-to-decipher military chaos that harbors variously latent nuclear perils.

Probability and Disutility: For the United States, it is high time for fewer clichés and greater intellection. Regarding their indispensable responsibilities for world peace and global stabilization (these goals can never be achieved by ordinary politicians of any ideological stripe), capable thinkers will need to focus on two always-pertinent and closely interrelated criteria of military danger: probability and disutility. This first dimension concerns issues of presumed likelihood. The second deals with assorted matters of presumed physical suffering. "Cold War II" represents a comprehensive systemic context within which virtually all contemporary world politics could be meaningfully categorized and optimally assessed. Current "Great Power" dispositions to war, however ascertained, offer more-or-less auspicious analytic backgrounds for still-wider nuclear interactions. But how can this portentous context be suitably tempered or decently modified?

Quo Vadis?: Only the right questions can lead us to purposeful answers. Planning ahead, what explanatory theories and scenarios could best

guide the Biden administration in its multiple and foreseeable interactions with North Korea, China and Russia? Before answering this many-sided question with suitable conceptual clarity, a "correct" answer will depend upon a more closely considered awareness of relevant intersections and overlaps. Going forward with their understanding of Russian leadership orientations, President Biden's advisors will have to consider one potentially overarching assumption: The always-troubling expectation of adversarial rationality. Depending upon the

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outcome of any such consideration, the determined judgments will be different and more-or-less urgent. A primary "order of business" for America's strategic analysts and planners will be reaching informed conclusions about any specified adversary's ordering of preferences. By definition, only those adversaries who would value national survival more highly than any other preference or combination of preferences would be acting rationally. Will this category include Putin's Russia? And what about other prospective adversaries? This question ought never be minimized, disregarded or cast aside.

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Rationality, Irrationality and Madness: For scholars and policy-makers, additional basic questions should now be considered. First, what are the operational meanings of relevant terminologies and/or vocabularies? In the formal study of international relations and military strategy, decisional irrationality never means quite the same as madness. Nonetheless, certain residual warnings about madness ought still to warrant serious US policy consideration. This is because both "ordinary" irrationality and full-scale madness could exert comparable effects upon any examined state's national security decision-making

processes. There is nothing suitable here for the intellectually faint-hearted. This is not an issue about "attitude" (the term Trump had used to describe what he regarded as most important to any diplomatic negotiation), but about science-based "preparations." Sometimes, for the United States, understanding and anticipating these ascertainable effects could display existential importance.

In all such considerations, words could come to matter a great deal. In normal strategic parlance, "irrationality" identifies a decisional foundation wherein national self-preservation is not summa, not the very highest and ultimate preference. This preference ordering would have significant and palpable policy implications. An irrational decision-maker in Moscow need not be determinably "mad" to become troubling for policy planning analysts in Washington. Such an adversary would need "only" to be more conspicuously concerned about certain discernible preferences or values than about its own collective self-preservation. An example would be preferences expressed for feasible outcomes other than national survival. Normally, any such national behavior would be unexpected and counter-intuitive, but it would still not be unprecedented or inconceivable. Identifying the specific criteria or correlates of any such survival imperatives could prove irremediably subjective or simply indecipherable.

Whether President Putin were sometime deemed irrational or "mad," US military planners would still have to input a generally similar calculation. Here, the analytic premise would be advanced that a particular adversary "in play" might not be deterred from launching a military attack by American threats of retaliatory destruction, even

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where such threats would be fully credible and presumptively massive. Further, any such failure of US military deterrence could include both conventional and nuclear retaliatory threats. In fashioning America's nuclear strategy vis-à-vis nuclear and not-yet-nuclear adversaries, US military planners will have to include a mechanism to determine whether Russia will more

likely be rational or irrational. Operationally, this means ascertaining whether the identifiably relevant foe will value its collective survival (whether as a sovereign state or organized terror group) more highly than any other preference or combination of preferences. Always, this early judgment will need to be based upon defensibly sound analytic or intellectual principles. In principle, at least, this judgment should never be affected by what particular analysts might themselves "want to believe."

Inadvertent and Accidental Nuclear War: A

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further analytic distinction is needed between inadvertent nuclear war and accidental nuclear war. By definition, an accidental nuclear war would be inadvertent. Reciprocally, however, an inadvertent nuclear war need not always be accidental. False

warnings, for example, which could be spawned by mechanical, electrical or computer malfunction (or by hacking) would not signify the origins of an inadvertent nuclear war. Rather, they would fit under the more clarifying conceptual narratives of an accidental nuclear war. Most worrisome, in such concerns, would be avoiding a nuclear war caused by miscalculation. In striving for "escalation dominance," competitive nuclear powers caught up with multiple bewildering complexities in extremis atomicum could sometime find themselves embroiled in an inadvertent nuclear exchange. Ominously, any such unendurable outcome could arise suddenly

and irremediably, even though neither side had wanted such a war. Summing up such scenarios, in facing off against each other, even under optimal assumptions of mutual rationality, President Biden and President Putin would have to concern themselves with all possible miscalculations, errors in information, unauthorized uses of strategic weapons, mechanical or computer malfunctions and myriad nuances of cyber-defense/cyber-war.

In other words, even if Putin were suddenly judged humane and focused – a preposterous assumption, to be sure – Europe could still descend rapidly toward some form or other of uncontrollable nuclear conflagration. If this dire prospect were not sobering enough, it is also reasonable to expect that the corresponding erasure of a once-universal nuclear

taboo would heighten the likelihood of nuclear risk-taking and conflict in certain other parts of the globe, especially southwest Asia (e.g., Pakistan and India) and/or the Middle East (e.g., Israel and Iran). Regarding the Middle East, there is nothing about the Trump-brokered “Abraham Agreements” that should reduce any decipherable risks of a regional nuclear war. To the contrary, the intended effect of these agreements to weaken Shiite Iran is apt to backfire in several tangible ways. At the same time, Israel never did need to worry about suffering a major war with Bahrain, Morocco or the UAE. For Israel (it’s time for candor), the Abraham Agreements “put an end” only to nonexistent hazards.

Deterrence and Pretended Irrationality: There is more. A corollary US obligation, depending in large part upon this prior judgment concerning enemy rationality, will expect strategic planners to assess whether a properly nuanced posture of “pretended irrationality” could meaningfully enhance America’s nuclear deterrence posture. On several occasions, it should be recalled, former President Trump had openly praised at least the underlying premises of such an eccentric posture. Was such presidential praise intellectually

warranted and/or justified? Ever? It depends. US enemies continue to include both state and sub-state foes, whether considered singly or in variously assorted forms of collaboration. Such forms could be “hybridized” in different ways between state and sub-state adversaries.

Moreover, in dealing with Washington, each recognizable class of enemies could sometime choose to feign irrationality. In principle, this could

represent a potentially clever strategy to “get a jump” on the United States in any still-expected or already ongoing competition for “escalation dominance.” Naturally, any such calculated pretense could also fail, perhaps calamitously. Accordingly, cautionary strategic behavior based on serious conceptual thinking should always be the US presidential “order of the

day.” There is something else. On occasion, these same enemies could “decide,” whether consciously or unwittingly, to actually be irrational. In any such innately bewildering circumstances, it would become incumbent upon American strategic planners to capably assess which basic form of irrationality – pretended or authentic – is actually underway. Thereafter, these planners would need to respond with a dialectically orchestrated and optimally counterpoised set of all possible reactions.

Once again, especially in expressly intellectual terms, this would represent an uncommonly “tall order.” Once again, it would not represent a task for the intellectually faint-hearted. In this critical context, the term “dialectically” (drawn originally from ancient Greek thought, especially Plato’s dialogues) should be used with very precise meanings. This is suggested in order to signify a continuous or ongoing question-and-answer format of strategic reasoning. For President Biden and his counselors, nothing less disciplined could possibly suffice. By definition, any instance of enemy irrationality would value certain specific preferences (e.g., presumed religious obligations or personal and/or regime safety) more highly than

By definition, any instance of enemy irrationality would value certain specific preferences (e.g., presumed religious obligations or personal and/or regime safety) more highly than collective survival. For America, as we have just seen, the grievously threatening prospect of facing some genuinely irrational nuclear adversary is prospectively most worrisome with regard to war in Ukraine.

collective survival. For America, as we have just seen, the grievously threatening prospect of facing some genuinely irrational nuclear adversary is prospectively most worrisome with regard to war in Ukraine. Apropos of all such more-or-less credible apprehensions, it is unlikely that they could ever be meaningfully reduced solely by way of formal treaties or other traditional law-based agreements. Here, however, it would be well worth remembering seventeenth-century English philosopher Thomas Hobbes' classic warning in *Leviathan*: "Covenants, without the sword, are but words..." If this enduring problem of global anarchy were not daunting enough for American strategists and decision-makers, it is further complicated by the largely unforeseeable effects of worldwide pandemic and (perhaps correspondingly) the opaque effects of any consequent chaos.

Chaos versus Anarchy:

Careful conceptual clarifications are once again in order. Chaos is not the same as anarchy. Chaos is "more than" anarchy. Indeed, we have lived with anarchy or the absence of central government in modern world politics since the Peace of Westphalia in 1648, but we have yet to descend into any worldwide chaos. There is more. Even in the midst of anarchy, there can be law. Since the 17th century, international law has functioned according to an often indecipherable "balance of power." For any American president conversant with the Constitution, international law is integrally a part of United States law. When former President Trump actively sought to undermine the International Criminal Court, he was acting contrary to both overlapping and intersecting systems of law, national and international.

Preemption, Asymmetry and Strategic Dialectic:

How should the American president proceed with managing nuclear risks in Ukraine? At some point, at least in principle, the best option could sometime seem to be some sort of preemption;

that is, a non-nuclear defensive first-strike directed against situationally appropriate hard targets. In actuality, it is already very late for launching any operationally cost-effective preemption against Russian forces. Any such action would come at much-too-substantial human and political costs. In more specific regard to crisis decision-making, the American side must consider how its nuclear weapons could best be leveraged in any plausible war scenario. A rational answer here could never likely include the actual operational use of such weapons. The only pertinent questions for President Biden's strategic planners should concern the calculable extent to which an asymmetrical US threat of nuclear

escalation could be rendered sufficiently credible.

All this should now imply a primary obligation for the United States to focus continuously on various incremental enhancements to its nuclear deterrence

posture; and to develop a wide and nuanced range of credible nuclear retaliatory options. The specific rationale of any such development is the counter-intuitive understanding that the credibility of nuclear threats could sometime vary inversely with perceived levels of destructiveness. In certain foreseeable circumstances, this means that successful nuclear deterrence of Russia over war in Ukraine could depend upon nuclear weapons that are deemed sufficiently low-yield or "small." Sometimes, in fashioning a national nuclear deterrence posture, counter-intuitive strategic insight is duly "on the mark," When Donald Trump liked to remind his North Korean counterpart that though both have a nuclear "button," his was "bigger," the former president displayed a thorough unawareness of nuanced nuclear deterrent strategy.

Prevention versus Punishment:

President Biden should continue to bear in mind that any US nuclear posture must remain focused on prevention rather than punishment. In all identifiable circumstances, using any portion of its available nuclear forces

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for vengeance rather than deterrence would miss the essential point; that is, to most fully optimize US national security obligations. Any American nuclear weapons use that would be based on narrowly corrosive notions of revenge, even if only as a residual or default option, would be glaringly irrational. These are all complex intellectual issues, of course, and not simply political ones. America's many-sided nuclear deterrent must be backed up by recognizably robust systems of active defense (BMD), especially if there should ever arise any determinable reason to fear an irrational nuclear adversary. Although it is already well-known that no system of active defense can be reassuringly "leak-proof," there is still good reason to suppose that certain BMD deployments could help safeguard US civilian populations (soft targets) and American nuclear retaliatory forces (hard targets). This means, inter alia, that technologically advanced anti-missile systems should remain indefinitely as a steadily-modernizing component of America's core nuclear deterrence posture. Significantly, too, there would be certain hard-to-foresee interactions or synergies taking place between US policy decisions and those of concerning American adversaries. In those more perplexing matters involving an expectedly irrational nuclear enemy, successful US deterrence would need to be based upon distinctly credible threats to enemy values other than national survival.

"Deliberate Ambiguity" and Adversarial Madness: America will have to rely on a broadly multi-faceted doctrine of nuclear deterrence. In turn, like its already-nuclear Israeli ally, specific

elements of this "simple but difficult" doctrine could sometime need to be rendered less "ambiguous." This complex and finely nuanced modification will require an even more determined focus on prospectively rational and irrational enemies, including both national and sub-national foes. This means eschewing any "seat-of-the-pants" attraction to each and every new strategic development or eruption, and (instead) to derive or extrapolate all specific policy reactions from a pre-fashioned and comprehensive strategic nuclear doctrine. There remains one penultimate but still critical observation. It is improbable, but not inconceivable, that certain of America's principal enemies would sometime be neither rational nor irrational, but mad. While irrational decision-makers would already pose very special problems for US nuclear deterrence – by definition, because these decision-makers would not value collective survival more highly than any other preference or combination of preferences – they might still be rendered susceptible to various alternate forms of deterrence.

Here, resembling rational decision-makers, they could still maintain a fixed, determinable and "transitive" hierarchy of preferences. This means, at least in principle, that "merely" irrational enemies could still sometimes be successfully deterred. This is an observation well worth further analytic study, especially at a time when sweeping Russian aggressions have become de rigeur. Mad or "crazy" adversaries, on the other hand, would have no such calculable hierarchy of preferences, and would not be subject to any strategy of American nuclear deterrence. Although it would likely be worse for the United States to have to face a mad nuclear enemy than a "merely"

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irrational one, Washington would have no foreseeable choice in this sort of emergency. This country, like it or not, will need to maintain, perhaps indefinitely, a “three track” system of nuclear deterrence and defense, one track for each of its still-identifiable adversaries that are presumptively (1) rational (2) irrational or (3) mad. This will not be task for narrowly political or intellectually averse US strategic decision-makers.

Among other things, it will require a capable assessment of pertinent synergies, some of them distressingly subjective. For the most notably unpredictable third track, special plans will also be needed for undertaking potentially indispensable preemptions and for certain corresponding/overlapping efforts at ballistic missile defense. There could be no reliable assurances that any one “track” would consistently present exclusively of the others. This means that American decision-makers could sometimes have to face deeply intersecting or interpenetrating tracks, and that these always-complicated simultaneities could be synergistic.

Overlapping Problems of Imperfect Information and Miscalculation: Even if America’s military planners could reassuringly assume that enemy leaderships were fully rational, this would say nothing about the accuracy of the information actually used by these foes in making their own calculations. Always, it should never be forgotten, rationality refers only to the intention of maximizing certain designated preference or values. It says nothing whatever about whether the information being used is correct or incorrect. From the standpoint of international law, it is always necessary to distinguish preemptive attacks from “preventive ones.” Preemption is a military strategy of striking first in the expectation that the only foreseeable alternative is to be

struck first oneself. A preemptive attack is launched by a state that believes enemy forces are about to attack. A preventive attack, on the other hand, is not launched out of any concern about “imminent” hostilities, but rather for fear of some longer-term deterioration in a prevailing military balance. In a preemptive attack, the length of time by which the enemy’s action is anticipated is presumptively very short; in a preventive strike, the anticipated interval is considerably longer.

A related problem here for the United States is not only the practical difficulty of accurately determining “imminence,” but also that delaying a defensive strike until imminence were appropriately ascertainable could prove existential. In principle, at least, a United States resort to “anticipatory self-defense” could be nuclear or non-nuclear and could be directed at either a nuclear or non-nuclear adversary. Any such resort involving nuclear weapons on one or several sides could quickly prove catastrophic.

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Final Observations: America is not automatically made safer by having only rational adversaries. Even fully rational enemy leaderships could sometimes commit serious errors in calculation that would lead them toward a nuclear confrontation and/or to a nuclear/biological war. There are also certain related command and control issues that could impel a perfectly rational adversary or combination of rational adversaries (both state and sub-state) to embark upon risky nuclear behaviors. It follows that even the most pleasingly “optimistic” assessments of enemy leadership decision-making could never reliably preclude authentically catastrophic outcomes.

For the United States, understanding that no scientifically accurate judgments of probability could ever be made about unique events (again, by definition, any nuclear exchange would be sui

generis, or precisely such a unique event), the very best lessons for America's president should favor a determined decisional prudence and a posture of conspicuously deliberate humility. Of special interest, in this connection, is the always erroneous presumption that having greater nuclear military power than an adversary is automatically an assurance of some future bargaining or diplomatic success. Why erroneous? Among other things, it is because the tangible amount of deliverable nuclear firepower required for deterrence is necessarily much less than what could ever be required for "victory."

For President Biden, this is a time for displaying nuanced and purposeful counter-intuitive wisdom in Washington, and not for clichéd political thinking. For the current US administration, operating in the largely-unpracticed nuclear age, ancient Greek tragedy warnings about excessive leadership pride are not only still relevant. They are more important than ever before. For the United States, classical Greek commentaries concerning hubris, left unheeded, could bring forth once unimaginable spasms of "retribution." The ancient tragedians, after all, were not yet called upon to reason about nuclear decision-making. None of this is meant to build ad hoc upon America's most manifestly reasonable fears or apprehensions, but only to remind those involved that competent national security planning must always remain a complex and detailed struggle of "mind over mind."

These issues remain fundamentally intellectual problems, challenges requiring meticulous analytic preparation rather than any particular presidential "attitude." Above all, such planning ought never to become just another calculable contest of "mind over matter;" that is, never just a vainly reassuring inventory of comparative weaponization or a presumptively superior "order of battle." Unless this rudimentary point is more completely understood by senior US strategic policymakers and

by the current president of the United States – and until these same policymakers can begin to see the utterly overriding wisdom of expanded global cooperation and human "oneness" – America could never render itself sufficiently secure from nuclear war.

In Ukraine, the historical conditions of nature bequeathed at the Peace of Westphalia (1648) could soon come to resemble the primordial barbarism of William Golding's *Lord of the Flies*. Long before Golding, Thomas Hobbes, the seventeenth-century English philosopher, warned insightfully in *Leviathan* (Chapter XIII) that in any such circumstances of human disorder there must

exist "continual fear, and danger of violent death...." In the still-clarifying imagery of ancient Greek drama, the American president should become more openly averse to any "monarchical-style" hubris than was his dissembling predecessor. To assume that the continuously failing system of belligerent

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nationalism first bestowed at Westphalia in 1648 can reliably prevent a nuclear war in the long-term represents human arrogance and self-delusion at its imaginable worst.

For the United States, reducing the still-growing threat of a catastrophic nuclear war should only be based upon continuously refined intellectual foundations. Escalating crises between Washington and Moscow will not really be about relative capabilities for strategic destruction. They will be about "perceptions of credibility," perceptions that could be erroneous and asymmetrical. These perceptions, moreover, could prove crucial in the inevitable search for "escalation dominance," a galvanizing search that might cause Russia and/or the United States to leapfrog the sequential rungs of any considered nuclear escalation "ladder." There could obtain no historically-based templates of purposeful action. All possible outcomes would remain highly unpredictable and sorely problematic. Accordingly,

for President Biden and the United States, this time should be recognized as an 11th hour moment of prudent policy-making, a time directed not by any seat-of-the pants strategic thinking, but by a rigorously dispassionate and well-reasoned strategic dialectic.

In the end, assorted differences between Russian and American views on nuclear “firebreak” theory may not prove conclusive or policy-determinative, but they nonetheless warrant Washington’s close analytic attention. As the Russians may already be recycling their Soviet-era doctrines on tactical nuclear weapons, these updated iterations will still need to be expertly vetted and continuously re-assessed. Among other things, such obligatory examinations by American strategists should focus on the plausible meanings of lower yields and shorter ranges in Russian military calculations. If Putin should sometime prove willing to cross the conventional-tactical nuclear firebreak (on the assumption that such a move would likely not invite a reciprocal cycle of nuclear escalation with the United States), the American president would face an incomparably tragic choice: capitulation or nuclear war.

Though it would be best for the United States to avoid ever having to reach such a fearful decisional cross-road, there could still be no guarantees of sustaining “mutual assured prudence” between Washington and Moscow. It follows that the growing existential hazards of Russia’s nuclear doctrine must be countered incrementally and intellectually. Though there are good “answers” for the United States and its allies in this unprecedented matter, they can be determined only by capable dialectical struggles of “mind over mind.” Looking ahead, American security and survival will hinge on fostering vital

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“perceptions of credibility,” Regarding Russia’s nuclear doctrine, only dedicated analytic minds can distance Planet Earth from World War III. In essence, Vladimir Putin’s nuclear doctrine is creating existential hazards for the United States.

The solely rational response from Washington should be to fully understand these unsustainable hazards, and then to plan appropriately for their most efficient minimization. The core problem here is intellectual, not political, and should be dealt with

accordingly.

Source: <https://moderndiplomacy.eu/2022/06/08/perceptions-of-credibility-existential-hazards-of-russian-nuclear-doctrine/>, 08 June 2022.

OPINION – Tom Nichols

We have No Nuclear Strategy

Americans have had a long respite from thinking about nuclear war. The Cold War ended more than 30 years ago, when the Soviet Union was dismantled and replaced by the Russian Federation and more than a dozen other countries. China at the time was not yet a significant nuclear power. A North Korean bomb was purely a notional threat. The fear of a large war in Europe escalating into a nuclear conflict faded from the public’s mind. Today, the Chinese nuclear arsenal could destroy most of the United States. The North Koreans have a stockpile of bombs. And the Russian Federation, which inherited the Soviet nuclear arsenal, has launched a major war against Ukraine. As the war began, Russian President Vladimir Putin ordered his nation’s nuclear forces to go on heightened alert and warned the West that any interference with the invasion would have “consequences that you have never

experienced in your history." Suddenly, the unthinkable seems possible again.

There was a time when citizens of the United States cared about nuclear weapons. The reality of nuclear war was constantly present in their lives; nuclear conflict took on apocalyptic meaning and entered the American consciousness not only through the news and politics, but through popular culture as well. Movie audiences in 1964 laughed while watching Peter Sellers play a president and his sinister adviser in *Dr. Strangelove*, bumbling their way to nuclear war; a few months later, they were horrified as Henry Fonda's fictional president ordered the sacrificial immolation of New York City in *Fail-Safe*. Nuclear war and its terminology—overkill, first strike, fallout—were soon constant themes in every form of entertainment. We not only knew about nuclear war; we expected one.

But during the Cold War there was also thoughtful engagement with the nuclear threat. Academics, politicians, and activists argued on television and in op-ed pages about whether we were safer with more or fewer nuclear weapons. The media presented analyses of complicated issues relating to nuclear weapons. CBS, for example, broadcast an unprecedented five-part documentary series on national defense in 1981. When ABC, in 1983, aired the movie *The Day After*—about the consequences of a global nuclear war for a small town in Kansas—it did so as much to perform a public service as to achieve a ratings bonanza. Even President Ronald Reagan watched the movie. (In his diary, he noted that *The Day After* was "very effective" and had left him "greatly depressed.")

I was among those who cared a lot about nuclear weapons. In the early days of my career, I was a Russian-speaking "Sovietologist" working in think tanks and with government agencies to pry open the black box of the Kremlin's strategy and intentions. The work could be unsettling. Once, during a discussion of various nuclear scenarios,

a colleague observed matter-of-factly, "Yes, in that one, we only lose 40 million." He meant 40 million people. The end of the Cold War, however, led to an era of national inattentiveness toward nuclear issues. We forgot about nuclear war and concentrated mostly on keeping nuclear weapons out of the "wrong hands," which reflected the American preoccupation with rogue states and terrorists after 9/11. This change in emphasis had worrisome side effects. In 2008, a blue-ribbon commission headed by a former secretary of defense, Schlesinger, sounded the alarm: A new generation of nuclear-weapons personnel in the Air Force and Navy did not understand its own mission. In 2010, the chairman of the Joint Chiefs of Staff, Admiral Mullen, warned that American defense institutions were no longer minting

nuclear strategists. "We don't have anybody in our military that does that anymore"....

...Voters no longer cared either. During the Cold War, regardless of what other issues might be raised, every presidential election

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was shadowed by worry over whose finger would be on "the button." In 1983, Reagan—hardly a detail-oriented president or master policy wonk—asked for an uninterrupted half hour of television during prime time to discuss his defense budget and his plans for a national missile-defense system, replete with charts and graphs. Millions of Americans watched. But in 2015, when President Trump was asked during the Republican Party primary debates about U.S. nuclear forces, he could only say, "With nuclear, the power, the devastation is very important to me." Such an answer would once have been disqualifying for any candidate. This time, millions of Americans shrugged. It was perhaps inevitable after the Cold War that serious thinking about nuclear weapons would be stashed away, in the words of a NATO nuclear planner some years ago, like "the crazy aunt in the attic." But the end of the Cold War did not resolve the most crucial question that has plagued nuclear strategists since 1945: What do nuclear weapons actually do for those who have

them? The American security analyst Bernard Brodie declared in the mid-1950s that nuclear weapons represented the “end of strategy,” because no political goal could justify unleashing their apocalyptically destructive power. In the 1980s, the political scientist and nuclear-deterrence scholar Robert Jervis amplified the point, noting that “a rational strategy for the employment of nuclear weapons is a contradiction in terms.”

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American leaders, however, didn’t have the luxury of declaring nuclear war to be insanity and then ignoring the subject. The dawn of the Cold War and the birth of the Bomb occurred almost exactly at the same time. The Soviet Union, once our ally, was now our foe, and soon its nuclear arsenal was pointed at us, just as ours was pointed right back. Someone had to think about what might come next. When contemplating the outbreak of nuclear war, the British strategist Michael Howard always asked: What would such a war be about? Why would it happen at all? History supplies an answer, and reminds us that the perils of the past remain with us today. The American nuclear arsenal was constructed as the United States dealt with a series of postwar crises. From the Berlin blockade to a hot war in Korea, Communist dangers seemed to be spreading unchecked across the planet.

By 1950, the Communist bloc extended from the Gulf of Finland to the South China Sea. With America and its allies outnumbered and outgunned, nuclear weapons and the threat of their use seemed to be the only Western recourse. Nuclear planning in this period was shaped by the inescapable dictates of geography. The Soviet

American strategists tried to think through the possibility of “limited” nuclear wars in various regions, but as Schlesinger later admitted to Congress, none of the scenarios stayed limited for long. Everything came back to escalation in Europe. This was not an idle fear.

Union straddled two continents and spanned 11 time zones. The United States was relatively safe in its North American fortress from anything but an outright Soviet nuclear attack. But how could Washington protect NATO in Europe and its other allies scattered around the world? With Germany a divided nation and Berlin a divided city, any future

conflict in Europe would always favor the Soviets and their tanks, which could roll across the plains almost at will.

This set up the basic structure of some future World War III in a way that every American of that period could understand: No matter how or where East and West might come into significant military conflict, the Soviets were certain to move the confrontation to Europe. A crisis might begin somewhere else—maybe the Caribbean, maybe the Middle East—but war itself would move to Germany and then spiral into a global catastrophe. American strategists tried to think through the possibility of “limited” nuclear wars in various regions, but as Schlesinger later admitted to Congress, none of the scenarios stayed limited for long. Everything came back to escalation in Europe. This was not an idle fear.

In 1965, for example, when the United States began bombing North Vietnam, the Soviet General Staff proposed a “military demonstration” of an unspecified nature aimed at Berlin and West Germany. “We do not fear approaching the risk of war,” the Soviet defense minister told Leonid Brezhnev and other Soviet leaders. The leadership declined the defense minister’s advice, and the episode was kept secret for decades. But the Kremlin and its high command continued to plan for defeating NATO quickly and

decisively in Germany, no matter where a crisis might begin. They knew it was their best option, and so did we. Once war moved to Central Europe, events would cascade with a brutal inevitability. The only way the United States could stop such an attack would be to resort to the immediate use of small, short-range nuclear arms on the battlefield. As Soviet forces advanced, we would strike them—on NATO’s own territory—with these “tactical” weapons. The Soviets would respond in kind. We would then hit more targets throughout Eastern Europe with larger and longer-range weapons, hoping to bring the Soviets to a halt.

Again, the Soviets would respond. With so many nuclear weapons in play, and with chaos and panic enveloping national leaders, one side or the other might fear a larger attack and give in to the temptation to launch a preemptive strike against strategic nuclear weapons in the American or Soviet heartland. All-out nuclear war would follow. Millions would die immediately. Millions more would perish later. The U.S. and NATO not only expected this nuclear escalation but threatened to be the ones to initiate it. There was a terrifying but elegant logic to this policy. In effect, the West told the Kremlin that the use of nuclear weapons would occur not because some unhinged U.S. president might wish it, but because Soviet successes on the battlefield would make it an inescapable choice.

By the 1960s, the march of technology had allowed both East and West to develop a “triad” of bombers, submarine-launched missiles, and

land-based intercontinental missiles. Arsenals on both sides soon numbered in the tens of thousands. At these levels, even the most aggressive Cold War hawks knew that, in a full exchange, mutual obliteration was inevitable. Detailed and exacting war plans would collapse in days—or even hours—into what the nuclear strategist Herman Kahn called “spasm” or “insensate” war, with much of the Northern Hemisphere reduced to a sea of glass and ash. The reality that nuclear war meant complete devastation for both sides led to the concept of mutual assured destruction, or MAD, a term coined by American war planners. MAD was at first not so much a policy as a simple fact.

In the early 1970s, the United States proposed that both sides turn the fact into a defined policy: The superpowers would recognize that they had enough weapons and it was time to set limits. The Soviets, with some reservations, agreed. The race to oblivion was put on pause. Today, MAD remains at the core of strategic deterrence. The United States and Russia have taken some weapons off their quick triggers, but many remain ready to launch in a matter of minutes. By treaty, Washington and Moscow have limited themselves to 1,550 warheads apiece. The basic idea is that these numbers deny either side the ability to take out the other’s arsenal in a first strike, while still preserving the ability to destroy at least 150 urban centers in each country. This, in the world of nuclear weapons, is progress.

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The fall of the Soviet Union changed many things, but in nuclear matters it changed almost nothing. The missiles and their warheads remained where they were. They continue to wait in silent service. The crews in silos, submarines, and bombers now consist of the grandchildren and great-grandchildren of the people who built the first nuclear weapons and created the plans for their use.

The missiles and their warheads remained where they were. They continue to wait in silent service. The crews in silos, submarines, and bombers now consist of the grandchildren and great-grandchildren of the people who built the first nuclear weapons and created the plans for their use. And yet for years we have conducted international politics as if we have somehow solved the problem of nuclear war. Nuclear weapons are a crutch we have leaned on to avoid thinking about the true needs and costs of defense. With hardly any debate, over a period of 30 years we doubled the number of nations under NATO's nuclear guarantee. We have talked about drawing down forces in places such as South Korea and shied away from expensive decisions about increasing our naval power in the Pacific—all because we think that nuclear weapons will remedy imbalances in conventional weapons and that the mere existence of nuclear weapons will somehow stabilize these unstable situations. Worrying about whether this broad reliance on nuclear deterrence risks escalation and nuclear war seems outdated to many. Memories of the Cold War, a young scholar once said to me, are a form of "baggage" that inhibits the making of bold policy.

This brings us, of course, to Ukraine. The war there could put four nuclear-armed powers—Russia, the United States, the United Kingdom, and France—onto the same battlefield, and yet arguments over the U.S. and NATO response to the Russian invasion have sometimes taken place in a nuclear void. President Joe Biden has rallied a global coalition against Moscow while

remaining determined to avoid a direct military conflict with Russia. He wisely declined to raise U.S. nuclear readiness to match Putin's nuclear alert. But he has had to steer this careful path while

President Joe Biden has rallied a global coalition against Moscow while remaining determined to avoid a direct military conflict with Russia. He wisely declined to raise U.S. nuclear readiness to match Putin's nuclear alert. But he has had to steer this careful path while buffeted by demands from people who seem unmoved (or untouched) by memories of the Cold War.

American political leaders have a responsibility to educate the public about how, and how much, the United States relies on nuclear weapons for its security. If we mean to reduce U.S. conventional forces and go back to relying on nuclear weapons as a battlefield equalizer, then the public should know it and think about it. If the U.S. nuclear arsenal exists solely to deter the use of enemy nuclear weapons, then it is time to say so and spell out the consequences.

buffeted by demands from people who seem unmoved (or untouched) by memories of the Cold War. Calls for a more aggressive confrontation with Russia, including demands for a no-fly zone over Ukraine, backed by American power, have been advanced by a range of prominent figures. Republican Representative Adam Kinzinger even introduced a congressional resolution authorizing Biden to use American military force against Russia. These demands ignore the reality, as the Harvard professor Graham Allison wrote earlier this year, that in the event of a hot war between nuclear superpowers, "the escalation ladder from there to the ultimate global catastrophe of nuclear war can be surprisingly short." Allison's warning is especially relevant today, when Russia and NATO have effectively switched places: Russia is now the inferior conventional power, and is threatening a first use of nuclear weapons if faced with a regime-threatening defeat on the battlefield.

Our collective amnesia—our nuclear Great Forgetting—undermines American national security. American political leaders have a responsibility to educate the public about how, and how much, the United States relies on nuclear weapons for its security. If we mean to reduce U.S. conventional forces and go back to relying on nuclear weapons as a battlefield equalizer, then the public should know it and think about it. If the U.S. nuclear arsenal exists solely to deter the use of enemy nuclear weapons, then it is time to say so and spell out the consequences. Every presidential administration since 1994 has

released a “nuclear posture review” that supposedly answers the question of why, exactly, America has a nuclear arsenal. Is it to fight nuclear wars or to deter a nuclear attack? And every administration has fudged the response by saying, essentially, it’s a little of both.

This is not a serious answer. And it avoids the deeper question: If we do not in fact wish to use nuclear weapons, then what must we do to ensure that our conventional capabilities match our international commitments? We have accepted evasions from our leaders because we take strategic nuclear deterrence for granted—as something that exists around us almost independently, like gravity or the weather. But deterrence relies on human psychology and on the agency and decisions of actual people, who must continually manage it. Decades of denial have left Americans ill-prepared to think about the many choices that keep the nuclear peace. Effective deterrence, even in a post-Cold War world, requires the capacity to face the reality of nuclear war squarely. And it means understanding once again what it would feel like to hear the sirens—and to wonder whether they are only a drill.

Source: <https://www.theatlantic.com/magazine/archive/2022/07/us-nuclear-strategy-cold-war-russia/638441/>, 01 June 2022.

OPINION – Eric Gomez

The Bad ‘Ol Days: Where Russia’s Nuclear Strategy Goes after Ukraine

The war in Ukraine could produce a more aggressive Russian nuclear strategy than the one it had prior to the conflict. The poor performance of Russia’s conventional forces are creating a mix

of structural conditions that is similar to the collapse of the Soviet Union. Based on Russia’s approach in the post-Soviet period, it will likely place greater emphasis on limited nuclear options and have a lower threshold for nuclear first use. A more aggressive Russian nuclear doctrine would have serious implications for U.S. extended deterrence in Europe, especially as Sweden and Finland call for NATO membership.

During the collapse of the Soviet Union Russia’s conventional military was large but of generally poor quality, and a weakened economy meant that rapid improvements in military technology were going to take time. Moscow opted to make up for its conventional weakness by increasing the prominence of nuclear weapons for national security and adopting more aggressive doctrines of nuclear use. Without viable, conventional means to protect against NATO’s more advanced military forces, Russia would reach for limited nuclear options early in a conflict to demonstrate resolve and the risks of continued aggression. As Russia modernized its conventional military forces during the 2000s

and 2010s it improved its ability to deter conflict and control escalation without crossing the nuclear threshold. These improvements were correlated with changes in nuclear doctrine that set a comparatively higher bar for nuclear weapons use. To be clear, Russian strategy still allows for nuclear use in a wide variety of circumstances, including if a conventional war threatens “the very existence of the state.” However, compared to the nuclear strategy it adopted in the immediate aftermath of the Soviet Union’s collapse, Russia’s current nuclear

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Moscow opted to make up for its conventional weakness by increasing the prominence of nuclear weapons for national security and adopting more aggressive doctrines of nuclear use. Without viable, conventional means to protect against NATO’s more advanced military forces, Russia would reach for limited nuclear options early in a conflict to demonstrate resolve and the risks of continued aggression.

strategy is relatively less aggressive. Russia's invasion of Ukraine is creating three consequences and conditions that will likely lead Moscow to rely more on its nuclear forces going forward.

First, the war in Ukraine demonstrates the limitations of Russia's conventional military modernization. Russia's military has significantly underperformed in Ukraine, despite employing many of its most potent capabilities. Western military aid keeps flowing into Ukraine despite Russian warnings of consequences and the weapons being sent to Ukraine do not represent the most advanced capabilities that NATO could bring to bear in a direct conflict with Russia. Russian military power, while capable of inflicting a great deal of damage, still lags behind NATO. Second, Russia will face significant hurdles in correcting this conventional imbalance because its economy is reeling from economic sanctions imposed because of its decision to attack Ukraine. The exposed weaknesses of the Russian military are therefore likely to persist for an extended period. Adjusting nuclear strategy is an attractive option for Russia because it can be done quickly and on the cheap. Third, the likely addition of Finland and Sweden to the NATO alliance will push on Russia's high threat perceptions. In early April, Russian officials warned that admitting the two countries to the alliance would lead to Russian countermoves, including greater deployments of nuclear forces in the Baltic region. Adding Finland to the alliance would greatly improve NATO's ability to target Russia's Zapadnaya Litsa naval base, which hosts ballistic missile submarines, and nearby strategic nuclear weapons storage facilities.

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Russia's nuclear strategy is likely heading to a bad place. Its invasion of Ukraine is laying bare the shortcomings of conventional force modernization while also encouraging NATO expansion and worsening Russia's general security environment.

Putin brought this situation upon himself by invading Ukraine. Still, it is within the United States' interest to reduce the likelihood of Russia adopting a more aggressive nuclear strategy. Failing that, the United States should reduce nuclear danger stemming from a potential shift in Russian strategy. The United States should tread

very carefully on the issue of NATO expansion. Sweden and Finland's rush to join the alliance is understandable but because of Russian threat perceptions, U.S. extended nuclear deterrence becomes more complicated. If Sweden and Finland's admission to NATO is a foregone conclusion, the next best way to reduce nuclear risk would be for the alliance to refrain from deploying missile defense and long-range conventional strike systems on the new members' territory. Moscow has repeatedly cited both types of capabilities as especially threatening to the survivability of its nuclear deterrent. A NATO deployment of long-range conventional strike weapons to Finland would be especially threatening given the proximity of the nuclear submarine base at Zapadnaya Litsa.

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Russia's nuclear strategy is likely heading to a bad place. Its invasion of Ukraine is laying bare the shortcomings of conventional force modernization while also encouraging NATO expansion and worsening Russia's general security environment. The United States should be aware of the long-term risks and consequences of a more aggressive Russian nuclear strategy. Restraint could help lessen the blow.

Source: https://www.realcleardefense.com/articles/2022/06/09/the_bad_of_days_where_russias_nuclear_strategy_goes_after_ukraine_836520.html, 09 June 2022.

NUCLEAR STRATEGY

CHINA

China's Defense Minister Says Country's Nuclear Arsenal 'for Self Defense'

China has made "impressive progress" in developing new nuclear weapons, but will only use them for self-defense, and never use them first, Chinese Defense Minister Fenghe...at the Shangri-La Dialogue on June 12. In response to a question about reports from 2021 on construction of more than 100 new nuclear missile silos in China's east, he said China "has always pursued an appropriate path to developing nuclear capabilities for protection of our country."

...Nuclear weapons displayed in a 2019 military parade in Beijing — which included upgraded launchers for China's DF-41 intercontinental ballistic missiles – were operational and deployed. "China has developed its capabilities for over five decades. It's fair to say there has been impressive progress" "China's ... policy is consistent. We use it for self defense. We will not be the first to use nuclear (weapons)." ...The ultimate goal of China's nuclear arsenal was to prevent nuclear war.... The U.S. State Department in 2021 called China's nuclear buildup concerning and said it appeared Beijing was deviating from decades of nuclear strategy based around minimal deterrence. It called on China to engage with it "on practical measures to reduce the risks of destabilizing arms races."

Source: <https://www.reuters.com/world/china/chinese-defence-minister-says-countrys-nuclear-arsenal-for-self-defence-2022-06-12/>, 12 June 2022.

JAPAN-USA-SOUTH KOREA

Japan, US and South Korea Poised to Enhance Nuclear Umbrella Strategy

Japan, the U.S. and South Korea are working to strengthen their shared nuclear deterrence strategy, which could involve South Korea restarting joint military exercises featuring American strategic bombers. When U.S. President Biden visited South Korea and Japan on a five-day tour...he and the two Asian leaders confirmed a willingness to reactivate talks on "extended deterrence" — a term used to describe the nuclear umbrella. South

Korea agreed to resume the Extended Deterrence Strategy and Consultation Group with the U.S. The high-level talks between diplomatic and defense officials have not been held since January 2018. Japan agreed on close cabinet-level communications. The U.S. nuclear arsenal can be used at any time, meaning that the threat of mutually assured destruction prevents another nuclear power from freely attacking American targets. With extended deterrence, U.S. nuclear capabilities are provided to nonnuclear allies.

Washington's desire to strengthen the nuclear umbrella comes out of a sense of crisis over East Asian security. The Pentagon says China likely intends to have at least 1,000 deliverable nuclear warheads by 2030 — roughly quintuple the estimated stockpile from 2020. Evidence suggests that North Korea may soon carry out its seventh nuclear test. With the invasion of Ukraine, Russian President Putin has hinted at the possibility of using nuclear weapons, raising concerns of a lower threshold to their use. For Japan, the U.S. and South Korea, revisiting the

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nuclear deterrence strategy has taken on renewed urgency from the threats posed by nuclear states China, North Korea and Russia. Washington is especially focused on restoring the nuclear umbrella in South Korea. Recently departed South Korean President Jae-in deemphasized U.S. military involvement in his country in favor of advancing dialogue with the North. Moon's progressive administration distanced itself from large joint military exercises with the U.S., which would provoke North Korea.

Moon's conservative successor, Suk-yeol, took office in May pushing a harder line on national security. Yoon placed priority on the American nuclear umbrella and expressed a desire to strengthen the deterrence capabilities of the U.S.-South Korea alliance.... If the new South Korean administration moves to join the U.S. in boosting deterrence capabilities, "Japan could concentrate resources on Taiwan" Expanding joint exercises would improve the operational capabilities of Japan, the U.S. and South Korea. The trio would be able to respond more effectively to a conflict on the Korean Peninsula, freeing up capacity for deterring China in Taiwan's neighborhood. "Japan, the U.S. and South Korea need to be on the same page on strategy so that they can carry out combat missions during emergencies"

Source: <https://asia.nikkei.com/Politics/International-relations/Japan-U.S.-and-South-Korea-poised-to-enhance-nuclear-umbrella-strategy>, 01 June 2022.

USA

U.S. Defense Officials Balk at Biden's Nuclear Budget

Top U.S. defense officials disagreed publicly with some Biden administration decisions to strip funding for nuclear capabilities from its \$813

billion fiscal year 2023 request for national defense, while Republicans in Congress attacked the budget proposal as dangerously insufficient to keep pace with China, Russia, and inflation. This budget funds modernization of all three legs of the nuclear triad to ensure...a safe, secure, and effective nuclear deterrent"

Sen. Inhofe (R-Okla.) criticized the request for making "cuts to key capabilities" in the U.S. nuclear arsenal, meaning that "we will lose ground against China's and Russia's rapidly expanding arsenals." He wrote a letter signed by 40 Republicans...demanding that the Biden administration focus investment on nuclear modernization and boost the budget by 5 percent over inflation...

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The White House eliminated funding in 2023 for the new nuclear-armed SLCM, which the Trump administration proposed in its 2018 Nuclear Posture Review (NPR). According to news reports, the Biden administration's version of the NPR reflects this decision. The White House sent a classified version of its NPR to Congress on the same day as it released its budget, but an unclassified version has not been made

public. ..

Source: <https://www.armscontrol.org/act/2022-06/news/us-defense-officials-balk-bidens-nuclear-budget>, June 2022

EMERGING TECHNOLOGIES AND DETERRENCE

CHINA

China's 'Particle Beam Cannon' is a Nuclear-Power Breakthrough

The prototype "particle beam cannon" recently completed by Chinese Academy of Sciences' Institute of Modern Physics may sound like science fiction, but it is a novel new technology that promises to recycle dangerous waste produced by a nuclear reactor. A product of China's

huge investment in advanced nuclear-energy systems, the breakthrough could move the country toward energy independence and further cement its global leadership in climate-friendly technology.

In a typical fission reactor, atoms of heavy isotopes such as uranium-235 are broken apart, releasing energy. The process also releases extra neutrons, which collide with other atoms and break them apart in a chain reaction. The broken atoms are spent fuel that is cooled for a few years and then carefully stored for a few centuries. But a proposed new type of reactor built with this "cannon"—formally, a proton accelerator—could recycle this spent fuel, making it cheaper and safer to generate electricity.

As envisioned, an accelerator-driven system, or ADS, consists of three parts: the proton accelerator launches protons, the spallation target contains the heavy element to be split, and the sub-critical reactor contains the fuel which causes fission. The accelerator fires protons at a heavy element (most likely bismuth) surrounded by a blanket of spent fuel and fresh fissile material (most likely thorium-232 or uranium-238). The target splits apart, releasing neutrons that are absorbed by the spent fuel, turning it back into fissile heavy isotopes—that is, fresh nuclear fuel. Importantly, this process is self-terminating, and does not run the risk of a chain reaction or a meltdown.

The Institute of Modern Physics' completion of a prototype accelerator is a big step toward a working ADS, and a prime example of China's huge investment in advanced nuclear energy systems paying dividends in new innovations. Unlike numerous governments that have abandoned nuclear energy entirely, China sees fission as key to a more secure future. ...

Source: Thomas Corbett and Peter W. Singer, <https://www.defenseone.com/ideas/2022/06/chinas-particle-beam-cannon-nuclear-power-breakthrough/368082/>, 13 June 2022.

BALLISTIC MISSILE DEFENCE

CHINA

World's 1st Anti-Hypersonic System? China Says it is Ready with an AI-Powered Defense Against Mach 5+ Missiles

While Beijing has repeatedly demonstrated its hypersonic offensive capabilities, it is now time for a 'Chinese defense system' against hypersonic missiles. Chinese military researchers claim to have developed AI technology that can predict the trajectory of a hypersonic glide missile as it approaches a target at speeds exceeding five times that of sound.... A rocket is used to launch a hypersonic glide vehicle to hit a target. The glide vehicle subsequently separates from the rocket and moves toward its target at a speed of at least Mach 5, or five times the speed of sound. It is extremely difficult to track a hypersonic glide missile due to its unpredictable trajectory and the ability to enter space and re-enter the atmosphere in a very short period. Countries like the US are also relentlessly working on developing air missile defense against hypersonic missiles.

The Chinese researchers, however, seem to be several steps ahead of their American counterparts. According to them, a Chinese AI-powered air defense system can predict the potential kill trajectory of an incoming weapon and launch a swift counterattack with a three-minute advance time. The typical missile stays within an 8-kilometer (5-mile) target zone, which is quite small for a weapon that can travel that distance in under two seconds.... These

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Chinese claims come at the heel of a dedicated effort in the United States to build and test a hypersonic weapon system to match the capabilities of its adversaries, China and Russia.

...The US recently carried out a successful test of an Air-launched Rapid Response Weapon (ARRW) hypersonic missile, a few days after it had successfully tested its Hypersonic Air-Breathing Weapon Concept (HAWC). Though efforts in the US are ongoing, there could be some time before a weapon is fielded. However, that has not deterred China's quest to develop a defense against it in advance.

How Does AI Defend Against Hypersonic Missile?

A hypersonic glide weapon, unlike a normal ballistic missile, may move through the atmosphere like a stone skipping across water and bank to the left or right, making it more difficult to detect and intercept, according to SCMP. At Mach 5 or higher speed, there is little time for an air defense system to respond to the threat, and it is widely assumed that current technology will be unable to intercept a hypersonic glide missile....

Artificial Intelligence is capable of handling such unpredictable tasks and develops a defense against an unpredictable trajectory and incredibly high speed. The defending side normally has no idea about the mass, size, shape, aerodynamic control system, or purpose of hostile weapons, but by analyzing observed flight data, the AI may make a fairly accurate assumption...every move a missile makes will give off some modest but useful signals about its design, capabilities, and mission, regardless of how advanced or fast it is. As a result, a machine learning system may learn from data collected during the early phases of a hypersonic flight and utilize that information to forecast the most likely trajectory during the flight's later stages....

Source: [https://eurasianimes.com/worlds-1st-](https://eurasianimes.com/worlds-1st-anti-hypersonic-system-china-says-its-is-ready/)

[anti-hypersonic-system-china-says-its-is-ready/](https://eurasianimes.com/worlds-1st-anti-hypersonic-system-china-says-its-is-ready/), 02 June 2022.

NUCLEAR ENERGY

GERMANY

Germany Remains Firmly Anti-Nuclear Despite Energy Crisis

Germany's government has no intention of changing its policies on nuclear energy even as worry about a halt to Russian gas supplies intensifies among politicians. Following calls from opposition parties to discuss the extension of the lives of Germany's three remaining nuclear power plants, Chancellor Scholz said the decision on these power plants had already been made. "We also know that building new nuclear power plants makes little sense".... "If someone decides to do so now they would have to spend 12-18 billion euros on each nuclear power plants and it wouldn't open until 2037 or 2038.

And besides, the fuel rods are generally imported from Russia. As such one should think about what one does." Instead of prolonging the lives of its nuclear power plants, Germany will extend the life of coal plants and use them in case it needs to.... The plants will be kept on standby for almost two years in case a gas supply outage occurs. The country already has several coal and oil-powered power plants on such standby in case of supply disruption....

Source: <https://oilprice.com/Latest-Energy-News/World-News/Germany-Remains-Firmly-Anti-Nuclear-Despite-Energy-Crisis.html>, 09 June 2022.

UKRAINE

IAEA-led Visit to Zaporizhzya Nuclear Power Plant is a Must, Grossi Tells IAEA Board

IAEA Director General Mariano...reiterated the need for an expert mission to Ukraine's Zaporizhzya Nuclear Power Plant, the site of

The defending side normally has no idea about the mass, size, shape, aerodynamic control system, or purpose of hostile weapons, but by analyzing observed flight data, the AI may make a fairly accurate assumption.

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which is under the control of Russian forces. "The current situation is untenable. Every day it continues; every day that vital maintenance work is delayed; every day that supply chain interruptions cause a break in the delivery of vital equipment; every day the decision-making ability of Ukrainian staff is compromised; every day the independent work and assessments of Ukraine's regulator are undermined; the risk of an accident or a security breach increases"

He said he is actively working to agree and organize an IAEA-led international mission to the Zaporizhzhya plant to carry out essential nuclear safety, security and safeguards work at the site. He expressed his grave concern at the extremely stressful and challenging working conditions under which Ukrainian management and staff are operating the plant. The number of indispensable nuclear safety and security pillars that have been compromised at the plant is at least five out of the seven: "This is why IAEA safety and security experts must go" to the site....

"This mission is not a matter of wanting or wishing, it is an obligation on the side of Ukraine and on the side of the IAEA. The IAEA will go to Zaporizhzhya NPP under the legally binding safeguards agreement that Ukraine has with the IAEA." Similar missions have led to tangible results. At Chernobyl, the IAEA experts re-established the flow of safeguards information to the IAEA, took crucial measurements of radiation in the environment, assessed Ukraine's needs and delivered a preliminary batch of equipment. Dozens of radiation detectors are once again transmitting data from the area around the Chernobyl site after Ukraine succeeded in reviving a vital information link that was cut at the start of the conflict.

Working with Ukraine: The IAEA is working closely with Ukraine to address what needs to be done to uphold the highest possible level of safety and security at the country's nuclear facilities and continue to implement nuclear safeguards.... "The best action to ensure the safety and security of Ukraine's nuclear facilities and its people would be for this armed conflict to end now"

Source: <https://www.iaea.org/newscenter/news/iaea-led-visit-to-zaporizhzhya-nuclear-power-plant-is-a-must-grossi-tells-iaea-board>, 09 June 2022.

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USA

Pentagon Aims to Demo a Nuclear Spacecraft within 5 Years Ultra Safe Nuclear's Radioisotope Battery would Power Orbiting Satellites

In the latest push for nuclear power in space, the Pentagon's Defense Innovation Unit (DIU) awarded a contract in May to Seattle-based Ultra Safe Nuclear to advance its nuclear power and propulsion concepts. The company is making a soccer ball-size radioisotope battery it calls EmberCore. The DIU's goal is to launch the technology into space for demonstration in 2027. Ultra Safe Nuclear's system is intended to be lightweight, scalable, and usable as both a propulsion source and a power source. It will be specifically designed to give small-to-medium-size military spacecraft the ability to maneuver nimbly in the space between Earth orbit and the moon.

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The DIU effort is part of the U.S. military's recently announced plans to develop a surveillance network in cislunar space. Besides speedy space maneuvers, the DIU wants to power sensors and communication systems without having to worry about solar panels pointing in the right direction or batteries having enough charge to work at night....

Radioisotope power sources are well suited for small, uncrewed spacecraft.... Such sources rely on the radioactive decay of an element that produces energy, as opposed to nuclear fission, which involves splitting atomic nuclei in a controlled chain reaction to release energy. Heat produced by radioactive decay is converted into electricity using thermoelectric devices. Radioisotopes have provided heat and electricity for spacecraft since 1961. The Curiosity and Perseverance rovers on Mars, and deep-space missions including Cassini, New Horizons, and Voyager all use radioisotope batteries that rely on the decay of plutonium-238, which is nonfissile—unlike plutonium-239, which is used in weapons and power reactors.

For EmberCore, Ultra Safe Nuclear has instead turned to medical isotopes such as cobalt-60 that are easier and cheaper to produce. The materials start out inert, and have to be charged with neutrons to become radioactive. The company encapsulates the material in a proprietary ceramic for safety.... Ultra Safe Nuclear's contract is one of two awarded by the DIU—which aims to speed up the deployment of commercial technology through military use—to develop nuclear power and propulsion for spacecraft. The other contract was awarded to Avalanche Energy, which is making a lunchbox-size fusion device it calls an Orbitron. The device will use electrostatic fields to trap high-speed ions in slowly changing orbits around a negatively charged cathode. Collisions between the ions can result in fusion reactions that produce energetic particles.

Both companies will use nuclear energy to power high-efficiency electric propulsion systems. Electric propulsion technologies such as ion thrusters, which use electromagnetic fields to accelerate ions and generate thrust, are more

efficient than chemical rockets, which burn fuel. Solar panels typically power the ion thrusters that satellites use today to change their position and orientation...higher power from EmberCore should give a greater velocity change of 10 kilometers per second in orbit than today's electric propulsion systems. Ultra Safe Nuclear is also one of three companies developing nuclear fission thermal propulsion systems for NASA and the Department of Energy. Meanwhile, DARPA is seeking companies to develop a fission-based nuclear thermal rocket engine, with demonstrations expected in 2026.

Source: <https://spectrum.ieee.org/nuclear-spacecraft>, 09 June 2022.

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NUCLEAR COOPERATION

INDIA–FRANCE

Supply of Six Nuclear Reactors: Question Mark on Russia Inputs, India Evaluates French Push at Jaitapur

Amid mounting uncertainties over the civil nuclear partnership with Russia in the wake of the Ukraine war, there are indications of fresh progress on the much-delayed deal with French power utility EDF for the supply of six EPR nuclear reactors. The DAE is actively examining a binding techno-commercial offer submitted by the French state-owned power company to help build six third-generation EPR reactors at Jaitapur in Maharashtra.

New Delhi had accorded an “in-principle” approval of the site at Jaitapur in Maharashtra for setting up of six reactors of 1650 MWe each as part of an umbrella nuclear deal signed with France in September 2008. However, that proposal has been hanging fire on account of multiple factors,

including the slowdown in nuclear projects globally post the Fukushima incident and internal reorganisation at French nuclear utility Areva (which was subsequently taken over by EDF).

If the Jaitapur deal takes off, it would be the largest nuclear power generating site in the country with a total capacity of 9,900 MWe and one of the biggest-ever export deals for the French side. Sources said the issue of the techno-commercial offer came up during delegation level talks between Prime Minister Narendra Modi and French President Emmanuel Macron in May. ...

Source: <https://indianexpress.com/article/india/supply-of-six-nuclear-reactors-question-mark-on-russia-inputs-india-evaluates-french-push-at-jaitapur-7966435/>, 13 June 2022.

INDIA-RUSSIA

Russia has put to rest all speculations regarding "slowing down" assistance for nuclear power plant in India following sanctions on Moscow and has recently supplied the first batches of reliable and cost-efficient nuclear fuel for the Units 1 & 2 of the KNPP. The new fuel supplied by Russian nuclear major ROSATOM has increased uranium capacity and the special feature of the new fuel is the new generation type, officials said. Rosatom does not face any Western sanctions.

"The TVEL Fuel Company of Rosatom has supplied the first batches of TVS-2M nuclear fuel to India for the two functioning units of KNPP, powered by VVER-1000 reactors. After the nearest refuelling, the power unit 1 will start operations in 18-month fuel cycle," a Rosatom statement said. "Thus, TVEL has fulfilled the agreement with NPCIL on

implementation of a comprehensive engineering project, including introduction of TVS-2M nuclear fuel and elongation of the fuel cycle from 12 to 18 months for both VVER-1000 reactors," it stated.

The TVS-2M fuel assemblies have a number of advantages as it is reliable and cost-efficient, claimed Rosatom. "Due to the rigidity of a fuel bundle makes it more efficient and more vibration-resistant.

The new fuel has increased uranium capacity - one TVS-2M assembly contains 7.6% more fuel material as compared to the earlier fuel bundles. In addition, the special feature of the Kudankulam fuel in particular is the new generation anti-debris

filter protecting bundles from debris damage, which may be caused by small-sized objects in the reactor core" according to the statement.

"Operation in longer fuel cycles also enhances economic efficiency of a plant, as reactors have to undergo stoppage and refuelling less frequently, so the power units produce more electricity," Rosatom.

KNPP needs to purchase less fresh fuel. "We offer to our foreign clients the solutions which have proved successful performance at the Russian nuclear power plants. TVS-2M fuel is efficiently operated in 18-months fuel cycle at Rostov NPP and Balakovo NPP in Russia, as well as Tianwan NPP in China. Fuel bundles with ADF-2 anti-debris filter have also showed good results at Rostov NPP. Besides, all VVER-1000 reactors in Russia operate at higher capacity, 104% of the nominal,

and this experience is also a matter of interest of nuclear power plants operators abroad," Alexander Ugryumov, Senior Vice President for Research and Development at TVEL said in a

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statement. Russia is building the KNPP and power units No. 1 and No. 2, was commissioned in 2013 and 2017. Power units 3-5 and 5-6 are the second and third stages of KNPP which are currently under construction.

Earlier ROSATOM, notwithstanding challenges associated with logistics and geo-political upheaval, following the Ukraine conflict, was able to assist in major construction work at the third reactor (Unit 3) in the Kudankulam Nuclear Power Plant (NPPP). The reactor vessel was installed in design position at Kudankulam NPP Unit 3. The technology used for installation made it possible to significantly reduce the time period of the project implementation due to optimization and reduction of the duration and number of assembly operations.

Source: Dipanjan Roy Chaudhury, <https://economictimes.indiatimes.com/news/india/russia-supplies-reliable-and-cost-efficient-nuclear-fuel-for-kudankulam-plant/articleshow/92193918.cms>, 14 June 2022.

NUCLEAR PROLIFERATION

AUSTRALIA

The Illegal Transfer of Nuclear Weapons Materials Involved in AUKUS cannot be Denied: Chinese Envoy

The AUKUS trilateral nuclear submarine cooperation violated the Treaty on the NPT, the comprehensive safeguards agreement of the IAEA and additional protocol signed between Australia and the IAEA, China's Permanent Representative to the UN in Vienna Wang Qun said on June 10, noting the US, the UK and Australia must give an account to the international community....

The Chinese envoy said the AUKUS has a far-reaching negative impact on global strategic stability, security order and regional peace and

stability, which should be politically responded to by relevant international and regional security mechanisms. The three countries cannot repeatedly stick heads in the sand and must earnestly fulfill their legal obligations on non-proliferation. As a nonnuclear weapon state under the NPT, Australia must promptly and comprehensively declare its nuclear weapons materials and related facilities at all stages....The US and the UK have applied double standards on nuclear proliferation issues, as they imposed unilateral sanctions on civilian nuclear programs of some nonnuclear weapon states, while at the same time blatantly transferred nuclear weapon material to Australia....

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Such double standards have a disastrous impact on the international non-proliferation regime and the resolution of hotspot issues, including the Iran nuclear issue and the Korean Peninsula's nuclear issue....

Source: <https://www.globaltimes.cn/page/202206/1267784.shtml>, 10 June 2022.

GENERAL

Global Nuclear Arsenal to Grow for First Time Since Cold War: Think-Tank

The global nuclear arsenal is expected to grow in the coming years for the first time since the Cold War while the risk of such weapons being used is the greatest in decades, a leading conflict and armaments think-tank said. Russia's invasion of Ukraine and Western support for Kyiv has heightened tensions among the world's nine nuclear-armed states, the SIPRI think-tank said in a new set of research.

While the number of nuclear weapons fell slightly between January 2021 and January 2022, SIPRI said that unless immediate action was taken by the nuclear powers, global inventories of warheads could soon begin rising for the first time

in decades. "All of the nuclear-armed states are increasing or upgrading their arsenals and most are sharpening nuclear rhetoric and the role nuclear weapons play in their military strategies," Wilfred Wan, Director of SIPRI's Weapons of Mass Destruction Programme, said in the think-tank's 2022 yearbook.

"This is a very worrying trend." Three days after Moscow's invasion of Ukraine, which the Kremlin calls a "special military operation", President Vladimir Putin put Russia's nuclear deterrent on high alert. He has also warned of consequences that would be "such as you have never seen in your entire history" for countries that stood in Russia's way.

Russia has the world's biggest nuclear arsenal with a total of 5,977 warheads, some 550 more than the United States. The two countries possess more than 90% of the world's warheads, though SIPRI said China was in the middle of an expansion with an estimated more than 300 new missile silos. SIPRI said the global number of nuclear warheads fell to 12,705 in January 2022 from 13,080 in January 2021. An estimated 3,732 warheads were deployed with missiles and aircraft, and around 2,000 - nearly all belonging to Russia or the United States - were kept in a state of high readiness.

Source: <https://www.ndtv.com/world-news/global-nuclear-arsenal-to-grow-for-first-time-since-cold-war-think-tank-3061504>, 13 June 2022.

Nuclear-Armed Nations Spent \$82.4bn on Weapons in 2021

The world's nine nuclear-armed countries spent \$82.4bn upgrading their atomic weaponry in 2021, eight percent more than the year before, a campaign group has said. The biggest spender

was the United States, which accounted for more than half the total spending, followed by China, Russia, the United Kingdom and France, the ICAN said in its annual report on nuclear spending.

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spending failed to deter a war in Europe and squandered valuable resources that could be better used to address current security challenges, or cope with the outcome of a still raging global pandemic. This corrupt cycle of wasteful spending must be put to an end."

ICAN noted that nuclear weapons producers also spent millions lobbying on defence, with every \$1 spent lobbying leading to an average of \$256 in new contracts involving nuclear weapons. "The exchange of money and influence, from countries to companies to lobbyists and think tanks, sustains and maintains a global arsenal of catastrophically destructive weapons," the report said.

The SIPRI warned that all nine nuclear-armed countries were increasing or upgrading their arsenals, and that the risk of such weapons being deployed appeared higher now than at any time since the height of the Cold War.

ICAN estimates North Korea spent \$642m on nuclear weaponry in 2021 even as its economy struggled under United Nations sanctions and the pandemic-linked closure of borders. Pyongyang walked away from denuclearisation talks after the collapse of a summit with then-US President Donald Trump in 2019, and has carried out a record number of missile launches this year. There are concerns it is preparing for its first nuclear

"Nuclear-armed states spent an obscene amount of money on illegal weapons of mass destruction in 2021, while the majority of the world's countries support a global nuclear weapons ban," the group said in its report. "This

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weapons tests since 2017. There is no official confirmation on the amount North Korea spends on nuclear weapons or its arsenal. SIPRI estimates it has as many as 20 warheads.

Nuclear Weapons Spending, 2021

1. United States \$44.2bn
2. China \$11.7bn
3. Russia \$8.6bn
4. UK \$6.8bn
5. France \$5.9bn
6. India \$2.3bn
7. Israel \$1.2bn
8. Pakistan \$1.1bn
9. North Korea \$642m

Source: <https://www.aljazeera.com/news/2022/6/15/nuclear-armed-nations-spent-82bn-on-weapons-in-2021>, 15 June 2022.

IRAN

Iran Increased Efforts to Obtain Illicit Nuclear Missile Technology - German Intel

The cumulative efforts of German intelligence gathering led to the release on June 7 of another damning indictment of the Iranian regime's efforts to secure illicit technology for its nuclear program in the federal republic. "The German domestic intelligence agencies were able to identify a significant increase in the indications of proliferation-related procurement attempts by Iran for its nuclear program"

German Accusations: Iran's clerical regime is cited 59 times in the 368-page document that addresses security threats faced by Germany in 2021. Western powers and Israel believe Iran's regime is determined to build an atomic weapons

device.... The German intelligence report said proliferation "activities of foreign powers also include the procurement of know-how and products for the development and production of weapons of mass destruction and delivery technologies." The delivery systems cited cover the launching of missiles....

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A second intelligence report from the southwest state of Rhineland-Palatinate said there are nations that are "often unable to develop and manufacture their own products" for proliferation and seek "to obtain the necessary knowledge, products and goods illegally using secret service

methods...procurement attempts have been observed for years, especially on the part of the Islamic Republic of Iran." Germany's sixteen states each produce an intelligence report on security threats. The intelligence services in the German states are similar to the Shin Bet.

The revelation of the Iranian's alleged increase in illegal procurement activities in Germany was rapidly reported by news outlets in Saudi Arabia, Bahrain and the UAE. Germany along with the US, France, Britain, China and Russia are seeking to bring Iran's regime back into compliance with the JCPOA. The world powers offered Tehran sanctions relief in exchange for a short-term freeze on the development of its nuclear program.

The 'Largest Nuclear Missile Program in the Middle East': The federal intelligence report noted that Iran's clerical state is pursuing "one of the largest missile programs in the Middle East," the intelligence document highlights.... The revelation of the Iranian's alleged increase in illegal procurement activities in

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Source: <https://www.jpost.com/middle-east/iran-news/article-709120>, 10 June 2022.

IAEA Warns of 'Fatal Blow' to Nuclear Deal as Iran Removes its Cameras

Indirect talks between Iran and the United States on reviving the 2015 deal have been stalled since March. Iran on June 9 dealt a near-fatal blow to chances of reviving the 2015 Iran nuclear deal as it began removing essentially all the IAEA monitoring equipment installed under the deal.... Iran had warned of retaliation if the IAEA's 35-nation Board of Governors passed a resolution drafted by the United States, France, Britain and Germany criticising Tehran for its continued failure to explain uranium traces found at undeclared sites. The resolution was passed by a crushing majority late on June 8. Iran told the agency overnight it planned to remove equipment including 27 IAEA cameras as of June 9, which is "basically all" the extra monitoring equipment installed under the 2015 deal going beyond Iran's core obligations to the agency.... That leaves a window of opportunity of three to four weeks to restore at least some of the monitoring that is being scrapped, or the IAEA will lose the ability to piece together Iran's most important nuclear activities....

Source: <https://www.thehindu.com/news/international/iaea-warns-of-fatal-blow-to-nuclear-deal-as-iran-removes-its-cameras/article65516806.ece>, 11 June 2022.

Biden's 'Lack of Political Will' Stopping Return to Iran Nuclear Deal, Experts Say

Fourteen months after the US joined talks in Vienna aimed at reviving the Iran nuclear deal, experts say the Biden administration is unwilling to take the final steps over the finish line because of a lack of "political will". Returning to the accord was a key part of Biden's foreign policy platform during his presidential campaign, during which he

pledged to use "hard-nosed diplomacy and support from our allies to strengthen and extend [the Iran deal]". Now, with most of the agreement having been drafted, talks have stalled as Iran demands the White House reverse Donald Trump's April 2019 decision to designate the IRGC as a foreign terror organisation (FTO). At the time of the listing, the move was condemned as a "poison pill" that would only work to derail a potential return to the nuclear deal, from which the Trump administration unilaterally walked away in 2018.

Now, the IRGC listing is understood to be the final remaining impediment for a negotiated return to the deal - which many say is the only path towards keeping Iran away from obtaining an atomic bomb.... Biden is reluctant to remove sanctions on the IRGC due to political pressure on the White

House. "This is all about political will. If there was such a thing as a point of no return - and we were to believe the rhetoric of the Biden administration - we passed it months ago".... "And it's been clear from the very beginning that to get it they will have to undo a very significant amount of the deliberate poison pills and traps that the Trump administration had laid out. And those were deliberately designed to be politically costly, such

as the delisting of the IRGC."...with Biden making it clear where the US stood on the IRGC designation, Iran has to now choose whether it will agree to a return to the deal. "President Biden isn't going to reverse his position.

What we don't know is if Iran will reverse its position. And so we're in this limbo moment waiting to see if indeed the Iranians want the deal more than they want the lifting of the IRGC designation".... "The decision currently rests with Iran on whether they want to come back and sign on to this agreement that they've negotiated for well over a year or not. And

Iran had warned of retaliation if the IAEA's 35-nation Board of Governors passed a resolution drafted by the United States, France, Britain and Germany criticising Tehran for its continued failure to explain uranium traces found at undeclared sites.

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the ball I believe, rests squarely on Tehran's side of the court."....

Source: <https://www.middleeasteye.net/news/iran-nuclear-deal-lack-political-will-stopping-return-to-accord-say-experts>, 10 June 2022.

Iran should Withdraw from Nuclear Non-proliferation Treaty, Says Khamenei Rep.

Iran should withdraw from the Treaty on the NPT, an article on the front page of the Iranian Kayhan newspaper, affiliated with Iranian Supreme Leader Ali Khamenei, urged on June 7. The article cited the stalling of talks on a return to the JCPOA nuclear talks, a wave of pressure on Iran, the continued reluctance of the US to lift sanctions, and recent reports by the IAEA against Iran as a reason for Iran to withdraw from the NPT, calling such a move the "minimum solution for [Iran's] diplomatic apparatus." "Withdrawal from the NPT as high-pressure leverage could be a strong response to the US and European approach to the Islamic Republic of Iran's nuclear activities,"... "The West is concerned that the NPT - a treaty whose general spirit is to contain non-nuclear-weapon states - will fail and a domino effect will begin as countries withdraw from the treaty."

The article added that withdrawal from the non-proliferation treaty "has more benefits than membership," and that Iran could withdraw from the NPT by activating Article 10 of the treaty, which allows a party to leave if it determines that "extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country." If it decides to withdraw, Iran would have to give notice to the other parties to the NPT, as well as to the United Nations Security Council, three months in advance. The Kayhan article complained that the IAEA had become "a political tool for the United States and Europe with false reports and coordination with the criminal Zionist regime".... "The IAEA is silent about all the countries that have officially and openly violated the provisions of the NPT, and has focused all its efforts on Iran, which it knows does

not seek to develop nuclear weapons, and under the pretext of inspections, it obtains the latest military information and details of our country's scientists and provides it to the enemies of Iran with pictures for sabotage in nuclear and military facilities and assassination of our country's scientists.... All the evidence suggests that the nuclear challenge is just an excuse, and the only way forward for us to get that excuse out of the hands of the enemy is to use Article 10 of the NPT and withdraw from the treaty"....

Support Growing in Iran for Anti-nuke Fatwa to be Revoked:

A fatwa (Islamic religious decree) listed on Khamenei's official English-language website states that "the Islamic Republic of Iran considers the use of nuclear, chemical and similar weapons as a great and unforgivable sin. We proposed the idea of 'Middle East free of nuclear weapons' and we are committed to it. This does not mean forgoing our right to peaceful use of nuclear power and production of nuclear fuel." Former Iranian diplomat Amir Mousavi...there is a growing call in Iran for Khamenei to reconsider his fatwa against the use of nuclear weapons, warning that the fatwa may be seen as a "weakness" and may be a "basis" for assassinations and other attacks against Iran..."A fatwa is not permanent, according to the Ja'afari Shi'ite jurisprudence. A fatwa is issued in accordance with developing circumstances. Therefore, I believe that if the Americans and Zionists act in a dangerous manner, the fatwa might be changed"....

Source: <https://www.jpost.com/middle-east/iran-news/article-708823>, 07 June 2022.

NATO-RUSSIA

NATO Denies Providing Guarantees to Russia about Non-proliferation of Nuclear Weapons

Camille Grande, Assistant Secretary-General of the NATO, confirmed that the alliance does not plan to provide guarantees to Russia about the non-proliferation of nuclear weapons on the

The article added that withdrawal from the non-proliferation treaty "has more benefits than membership," and that Iran could withdraw from the NPT by activating Article 10 of the treaty, which allows a party to leave if it determines that "extraordinary events, related to the subject matter of this Treaty, have jeopardized the supreme interests of its country.

territory of Sweden and Finland, if they join the alliance.... The Assistant Secretary-General of NATO, in response to a question about providing security guarantees to Russia against the deployment of nuclear weapons in Sweden and Finland if it joins the alliance: "I am not sure that it is worth providing any guarantees to Russia about our military strategy in this region." Grande noted that there are no talks so far regarding the deployment of this type of weapon. Earlier, Ukrainian President Vladimir Zelensky said that Western sanctions against Russia had no effect on the Russian position.

Source: <https://see.news/nato-denies-providing-guarantees-to-russia-about-non-proliferation-of-nuclear-weapons/>, 08 June 2022.

NORTH KOREA

North Korea Ramps Up its Nuclear Threats

The war in Ukraine has geopolitical implications for the Far East that go beyond Russia's imperial presence in that part of the world. Moscow's invasion in Eastern Europe is geopolitically the most far-reaching event since the end of the Cold War.... Much is at stake in how Beijing and Pyongyang will react to Moscow's "special military operation" in Eastern Europe – not only for their neighbors involved but also for the rest of the world.

The Long Shadow of the Korean War: When the West won the Cold War in 1991, some thought that history had ended. Liberal democracy and the market economy prevailed, and there was no ideological dispute left. However, it is precisely the war in Ukraine that reminds...how much history, particularly real or imagined injustice, counts. What makes several Asian hotspots so dangerously volatile is that they are perceived to come from historical injustice. The Korean War (1950-1953) was among the bloodiest conflicts after World War II. There has been no peace agreement signed between North and South Korea, and the Korean Peninsula is divided along the lines of the precarious cease-fire.

While South Korea has evolved from a militarized dictatorship to a stable democracy, North Korea remains stuck in a dynastic dictatorship. This fact makes relationships with the regime in Pyongyang highly complex affairs. On the other hand, there is great clarity about what North Korea wants from the world, mainly from the United States. Everything is about the survival of the regime and the deterrence of any force in the outside world that could threaten North Korea's integrity.

Long before the war in Ukraine, Pyongyang had studied conflicts and the lessons from Washington's attempts at regime change. One thing was clear: none of the countries that the U.S. invaded possessed nuclear weapons. For the Kim clan and its inner circle, there can be no doubt that without the possession of nuclear arms, they would have shared the sorry fate of Muammar Qaddafi and Saddam Hussein. Nuclear weapons serve as life insurance.

Reliance on Nuclear Weapons:

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nuclear arms, they would have shared the sorry fate of Muammar Qaddafi and Saddam Hussein. Nuclear weapons serve as life insurance. Beijing shares this view as it accepts Pyongyang's nuclear ambitions, despite China's advocacy of a nuclear-free Korean Peninsula....

Scenarios: In its rhetoric, the North Korean regime relies on bellicose attacks against its foreign enemies, namely the U.S., South Korea and Japan, to rally the nation. But the full-fledged survival strategy of the regime is also based on domestic terror and nearly total control over the population....

Expect a Nuclear Test: Since the beginning of 2022, Pyongyang has conducted several highly provocative rocket tests. It aimed to demonstrate that it does not respect United Nations resolutions, that it violates the Japanese economic exclusion zone at will, and that it willingly provokes Washington with ballistic missile tests that have the potential to reach the American mainland. Expectations are that North Korea may launch another nuclear test in 2022, an action that will ratchet up tension in the Far East....

Warrior Nation: It is necessary to understand the nature of North Korea's political system to fully grasp the strategic relevance of its missile and nuclear programs. It is indeed a unique regime: no other country can be compared with it, not only because of the extreme seclusion practiced by Pyongyang. It is the very specific combination of dynastic rule, militarism and Stalinism that distinguishes North Korea. How does this system survive despite its repeated failures that cause massive human suffering? The brainwashing through an almighty propaganda apparatus does not explain it all. The regime also has built a strategy of national cohesion on the idea of a warrior nation. The North Korean population is constantly on high alert against enemies; it overshadows all other concerns. The strategy has another major advantage too. If there is no invasion, no violation of the borders, the regime can legitimately claim to have fulfilled its foremost task – protecting the nation's integrity and independence....

South Korea's Firming Stance:

The behavior of the North Korean regime is highly unpredictable. To a certain degree, this unpredictability is by design. One thing seems certain: Suk-yeol, elected South Korea's president on March 9...is known as a hawk when it comes to relations with the North...promised to steer a markedly more rigorous course than his predecessor Jae-in. It is unclear how the relations between the two Koreas will evolve in the months to come. Recently, Pyongyang made friendly comments about outgoing President Moon. His successor, who promised more support for the military and security sectors, will probably find himself the target of unkindness from the North....

Source: <https://www.gisreportsonline.com/r/nuclear-weapons/>, 09 June 2022.

SOUTH KOREA

Why Some South Koreans Want their Own Nuclear Bomb

Hours after US President Biden left Tokyo following a five-day tour to Japan and South Korea, officials in Seoul sounded the alarm over the launch of a suspected ICBM test from North Korea. If confirmed, the launch of an ICBM – a weapon that is capable of reaching the continental United States – will mark Pyongyang's second such missile test this year. With denuclearisation talks stalled, the governments of South Korea and the US are also warning that the impoverished nation may be preparing for a nuclear test – its first in five years and seventh overall....

While resigned to the North's growing nuclear and missiles arsenal, most people said they wanted President Suk-yeol, who took office on May 10, to respond firmly. ... A poll by the US-based think-tank in February found that as many as 71 percent of South Koreans favour acquiring their own nuclear weapon – mainly because North Korea has continued to develop its weapons programme in defiance of global sanctions and censure. From larger weapons meant for strategic use, North Korea has now developed tactical weapons that can be used on the battlefield, "with low yields and less nuclear fallout and with which they can attack South Korea, and also Japan".... "This is all the more problematic, because the North has developed all sorts of vehicles, long range as well as short-range missiles, with which they can deliver these nukes to South Korea".... While South Korea "remains very vulnerable, it is "unfortunately, largely reliant on the US extended deterrence"

Suk-yeol, elected South Korea's president on March 9...is known as a hawk when it comes to relations with the North...promised to steer a markedly more rigorous course than his predecessor Jae-in. It is unclear how the relations between the two Koreas will evolve in the months to come.

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Will the US Risk LA for Seoul? The US has maintained a formal deterrence commitment to South Korea since it intervened in the Korean War of 1950-53 to push back invading troops from the North. It also deployed tactical nuclear weapons to South Korean territory in 1958 to deter any renewed attacks, but pulled them out in 1991 as part of a bid to persuade Pyongyang to allow international inspection of its nuclear facilities. At the time, Washington pledged to protect the South – which had abandoned its own nuclear ambitions and had signed on to the treaty on the NPT – using nuclear bombers and submarines based in the Pacific Ocean and the continental US. But now, with the North's ever-increasing nuclear and missile capabilities, analysts say there is "lingering doubt" in South Korea about whether the US's deterrence strategy is good enough to defend the country – especially as North Korea now claims to have a "second-strike" retaliatory capability against the US.... Yoon, the South Korean president, on the campaign trail had said he would ask the US to redeploy tactical nuclear weapons to the country. He has since backtracked, affirming in a joint statement following Biden's visit, a commitment to the "complete denuclearisation" of the Korean peninsula....

Source: <https://www.aljazeera.com/news/2022/6/3/why-south-koreans-want-their-own-nuclear-bomb>, 03 June 2022.

URANIUM PRODUCTION

USA

US Seeks \$4.3bn in Funding to Accelerate Domestic Uranium Production

The US is looking to raise funds of \$4.3bn to buy enriched uranium directly from domestic producers and cut imports from Russia in the wake

of its invasion of Ukraine,...Considering prospects that Russia could cease uranium supply to the US, the US Energy Department (DOE) officials held a

North's ever-increasing nuclear and missile capabilities, analysts say there is "lingering doubt" in South Korea about whether the US's deterrence strategy is good enough to defend the country – especially as North Korea now claims to have a "second-strike" retaliatory capability against the US.

meeting with key congressional staff and emphasised the urgent need for funding for the nuclear-reactor fuel...potential supply interruption for enriched uranium from Russia could disrupt operations at commercial nuclear reactors, the person

noted....The plan aims to speed up the development of enriched uranium domestically, as well as produce reactor fuel from uranium.... A government buyer is also planned to enable direct purchase of domestically produced enriched uranium.

Currently, the US operates only one commercial enrichment facility, a New Mexico plant. It is owned by the British-German-Dutch consortium Urenco. The plan to expand enrichment capabilities in the US, if materialised, could benefit firms such as Centrus Energy and ConverDyn, a joint venture between General Atomics and Honeywell International. US Energy Secretary Granholm was

US Energy Secretary Granholm was cited by the news agency as saying that the dependence on imports from Russia is a "vulnerability" for the US national and economic security. In 2020, the US imported 16.5% of its uranium from Russia.

cited by the news agency as saying that the dependence on imports from Russia is a "vulnerability" for the US national and economic security. In 2020, the US imported 16.5% of its uranium from Russia. In a separate announcement, Orea Mining reported that Nord Gold, its joint-venture partner in the Montagne d'Or gold mine project in French Guiana, France, has been hit with sanctions by the US Department of Treasury, Office of Foreign Assets Control. Nord Gold is owned or controlled by oligarch Alexey Mordashov.

Source: <https://www.mining-technology.com/news/us-funding-domestic-uranium/>, 08 June 2022.

NUCLEAR SAFETY

GEORGIA

Georgia Shares Experience in Combating Illegal Nuclear, Radioactive Trafficking with Partners

Professionals from 10 partner countries of Georgia have been introduced to Georgia's experience in combating illegal trafficking of nuclear and radioactive threads in a working group of the Interpol's Geiger project... Practical simulations held in meetings of the group and involved dozens of participants,...with the working sessions hosted at the Sarpi border crossing point in south-west Georgia, the Black Sea port of the seaside city of Batumi, and the city's International Airport. Sharing Georgia's "advanced capability" in detecting and responding to attempts of trafficking radioactive materials was included in the sessions...The working sessions were organised by the General Secretariat and the National Central Bureau of the Interpol.

Source: <https://agenda.ge/en/news/2022/2193>, 09 June 2022.

NORWAY-RUSSIA

Norway and Russia Suspend Cooperation on Nuclear Safety

During a recent meeting of the Norwegian-Russian Commission on Nuclear Safety it was decided that Norway will put funding for cooperation with Russia on hold. Norway has frozen all payments to projects about nuclear safety cooperation in Northwestern Russia following Russia's military action in Ukraine as a result of which Russia has suspended co-operation with Norway. Per Strand, Director of the Norwegian Radiation and Nuclear Safety Authority (DSA), said: "We will continue our dialogue with Russian authorities about the issue

of nuclear safety where it is important for our own nuclear preparedness, and to reduce the risk of incidents and nuclear pollution." Rosatom Director and Russian delegation member Oleg Kryukov expressed regret over the halt to cooperation. "It is sad that Norway stops funding the handling of nuclear waste.

Sharing Georgia's "advanced capability" in detecting and responding to attempts of trafficking radioactive materials was included in the sessions.

However, we will continue working with ongoing projects, it will just take us longer" He spoke about the long-term work on securing and removing

used nuclear fuel from the disused submarine base in the Andreeva Bay, located some 40 kilometres from the Norwegian-Russian border. The first shipment of used fuel was made in 2017, and some 50% has since been removed. Norway has long contributed to this work, and the DSA says it is in Norway's interest that it is conducted in a secure manner.

Per Strand described dialogue between the parties as good and frank despite the demanding situation. "As long as there are sources of dangerous waste affecting health and environment in Northwestern Russia, we must continue cooperation about raising alarms in the

We will continue our dialogue with Russian authorities about the issue of nuclear safety where it is important for our own nuclear preparedness, and to reduce the risk of incidents and nuclear pollution." Rosatom Director and Russian delegation member Oleg Kryukov expressed regret over the halt to cooperation. "It is sad that Norway stops funding the handling of nuclear waste.

case of nuclear incidents, environmental monitoring and government work" ...it was the Ministry of Foreign Affairs that had decided to put cooperation on hold. During the meeting, the Russian delegation also described the current status of the work on managing sunk and dumped submarines and other objects in the Barents and

Kara Seas with reactor cores and radioactive waste onboard. Norwegian and Russian co-operation on this work will also be frozen.

Following the commission meeting, Norway's Foreign Ministry stated: "Nuclear safety cooperation between Norway and Russia is a key

aspect of our bilateral relationship. It is in our common interest to reduce the risk of accidents and radioactive contamination."

Source: <https://www.neimagazine.com/news/newsnorway-and-russia-suspend-co-operation-on-nuclear-safety-9759051>, 08 June 2022.

UKRAINE

Video Shows Russian Cruise Missile Flying Past Ukrainian Nuclear Power Plant towards Kyiv, Ukraine Says

Ukraine's nuclear officials published video that it says shows a Russian cruise missile traveling "critically low" over one of its plants on June 5. The video...was taken from surveillance cameras at the nuclear plant in Yuzhnoukrainsk at 5.30 a.m...it shows a "cruise missile similar to a Caliber type rocket." In the footage...a faint horizontal mark can be seen traveling at speed across the sky. Insider was unable to authenticate the footage. The video was published as Russia launched new air strikes on Kyiv — the first in around a month— striking a train repair shop,...the missile in its footage was "probably one of the rockets that hit Kyiv this morning." However,...the missile shown was on its way to the strategic port city of Mykolaiv, which has also been under sustained attack from ground troops and shelling...a facility there was struck and three people killed.

Two cruise missiles over the region were shot down on June 6 before hitting anything... Fredrik Dahl, the spokesperson for the IAEA...the agency was looking into the matter. "Any such incident would be extremely serious,"..."If a missile goes astray near a nuclear power plant, it could have a severe impact on its

physical integrity, potentially leading to a nuclear accident." ... "act of nuclear terrorism" by Russia, adding: "Russia continues to threaten the nuclear safety of Ukrainian nuclear power plants and threatens the world with a new nuclear catastrophe."

Source: <https://www.businessinsider.in/international/news/video-shows-russian-cruise-missile-flying-past-ukrainian-nuclear-power-plant-towards-kyiv-ukraine-says/articleshow/92038021.cms>, 06 June 2022.

If a missile goes astray near a nuclear power plant, it could have a severe impact on its physical integrity, potentially leading to a nuclear accident." ... "act of nuclear terrorism" by Russia, adding: "Russia continues to threaten the nuclear safety of Ukrainian nuclear power plants and threatens the world with a new nuclear catastrophe.

Ukraine, which also has four operating nuclear power plants with a total of 15 reactors, has requested the IAEA's technical assistance for this purpose. During their three-day stay at the Chernobyl plant and the Exclusion Zone, a team of seven IAEA experts provided support to their Ukrainian counterparts on radiation protection, safety of waste management and nuclear security.

IAEA Completes Follow-up Mission to Chernobyl

The technical follow-up mission - the IAEA's second to the Chernobyl site in the past six weeks - was part of efforts to help ensure nuclear safety and security

in Ukraine during the current military conflict. Ukraine, which also has four operating nuclear power plants with a total of 15 reactors, has requested the IAEA's technical assistance for this purpose. During their three-day stay at the Chernobyl plant and the Exclusion Zone, a team of seven IAEA experts provided support to their Ukrainian counterparts on radiation protection, safety of waste management and nuclear security.

In addition, IAEA safeguards staff conducted verification activities that had been planned as part of the annual implementation plan established by the IAEA.

During the mission, the team visited the main facilities for the management of radioactive waste and used fuel to

discuss and assess their status with staff there and to identify areas for future support; provided training on the radiation monitoring equipment delivered by the IAEA in April, verified the radiation protection programme in all facilities at

the Chernobyl plant and the Exclusion Zone and identified actions for further enhancements; observed the physical protection arrangements at nuclear, used fuel, waste and radioactive material facilities located in the same area and identified potential areas of cooperation; provided support on emergency preparedness and response and discussed the additional assistance that could be provided through the IAEA Response and Assistance Network mechanism; and discussed the re-establishment of the automated radiation monitoring system and received information on the forthcoming connection of this system with the IAEA International Radiation Monitoring Information System.

The team also verified declared nuclear material and activities at facilities selected by the IAEA; checked the functioning of the remote safeguards data transmission from Chernobyl to IAEA headquarters which was re-established at the end of April after two months of interruption; and upgraded the installed remote safeguards data transmission systems. "The IAEA has from the beginning of the conflict been focused on providing technical support to Ukraine and its nuclear facilities during these extremely difficult and challenging times for the country".... "This week's combined IAEA safety, security and safeguards mission succeeded in achieving all its objectives, despite the significant logistical challenges in travelling and working in Ukraine. It was the third such mission to Ukraine since the conflict began and it will be followed by others in the coming weeks and months."...

Source: <https://world-nuclear-news.org/Articles/>

IAEA-completes-follow-up-mission-to-Chernobyl#:~:text=The%20International%20Atomic%20Energy%20Agency,security%20and%20safeguards%20activities%20there,06%20June%202022.

NUCLEAR WASTE MANAGEMENT

CANADA

Rock, Steel, Copper and Clay will Encase Nuclear Waste for 'Many Thousands of Years'

The organization looking for a new underground home for Canada's nuclear waste ran through a trial run recently on the equipment and method needed to safely store this material. The Nuclear Waste Management Organization (NWMO) said it has

"successfully" completed a full-scale demonstration of the "engineered barriers" to containerize and store spent nuclear fuel inside a proposed deep geological repository, which could be built in the Dryden-area of northwestern Ontario. The two finalists to host this storage

facility are Wabigoon Lake Ojibway Nation and Ignace area, and Saugeen Ojibway Nation-South Bruce in southwestern Ontario. The site selection process began more than a decade ago with 22 interested communities initially in the running. The NWMO expects to select a site in 2023. Plans call for the repository to be built more

than 500 metres below ground encased in "natural shield of solid rock." The design would involve a series of engineered and natural barriers to ensure the facility's safety "for many thousands of years."

The recent demonstration at the NWMO's Oakville test facility involved the construction of a life-size

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The recent demonstration at the NWMO's Oakville test facility involved the construction of a life-size model of the one of the proposed underground storage rooms. Heavy machinery moved containers, designed to hold spent fuel, into the room and filled the remaining space with "protective material" that will ensure the containers strength and durability.

model of the one of the proposed underground storage rooms. Heavy machinery moved containers, designed to hold spent fuel, into the room and filled the remaining space with “protective material” that will ensure the containers strength and durability. The fuel containers, made of thick carbon steel and coated with corrosion-resistant copper, were encased in protective layers called buffer boxes. These boxes are made of heavy bentonite clay to provide additional protection against corrosion or degradation.

Bentonite is considered an effective barrier against water flow and microbial growth. Each fuel container in its buffer box weighs 8,000 kilograms – “heavier than a large elephant,” according to NWMO – which then were lifted and placed into the room. The remaining space from floor to ceiling was filled with loose granular bentonite. NWMO said once the demonstration was complete, the room was emptied to evaluate the installation of this system. The analysis of this process will go into the ongoing design and planning of the repository.

“All elements of the demonstration performed as expected and according to plan,”...“The demonstration shows not only the NWMO’s ability to install the engineered-barrier system, but also the calibre of our technical teams, who are invested in the project’s success and committed to doing what’s right for Canadians and Indigenous peoples.” Once the site is named, the NWMO said the project will undergo “rigorous licensing and regulatory decision-making process” before construction begins.

Source: <https://www.timminstoday.com/local-news/rock-steel-copper-and-clay-will-encase-nuclear-waste-for-many-thousands-of-years-5456359>, 12 June 2022.

GENERAL

Nuclear Waste Management Market Estimated to Hit USD 6,878.9 Million by 2027, at a CAGR of 2.8%

According to a comprehensive research report by Market Research Future (MRFR), “Nuclear Waste Management Market Analysis by Waste Type, By Reactor Type (PWR, BWR, Gas-Cooled Reactors, PHWR), by Application (Industrial and Utility) by Region - Global Forecast to 2027” valuation is poised to reach USD 6,878.9 Million by 2027, registering an 2.8% CAGR throughout the forecast period (2021–2027).

Nuclear Waste Management Market Overview:

The global nuclear waste management market is expected to garner significant traction. The growing awareness about the importance of

The global nuclear waste management market is expected to garner significant traction. The growing awareness about the importance of nuclear waste management is a key driving force. Stringent norms and regulations introduced to control toxic nuclear emissions impact the market value positively, mandating more investments in nuclear power projects.

nuclear waste management is a key driving force. Stringent norms and regulations introduced to control toxic nuclear emissions impact the market value positively, mandating more investments in nuclear power projects. Increasing funding support by the public & private sectors in an organized, consistent, and timely manner to set up waste

management facilities contribute to the market growth, multiplying the total number of nuclear waste management plants.

In the process of electricity generation using nuclear reactors results in a small amount of waste, which must be managed as directed by regulations. Several management strategies are practiced for the direct disposal or reuse in reactors to generate more low-carbon electricity. Besides, increasing technological advances boost the market size, improving waste management solutions and techniques.

Nuclear Waste Management Market Segments:

The nuclear waste management market report is segmented into waste types, reactor types, applications, and regions. The waste type

segment comprises low-level waste, intermediate-level waste, and high-level waste. The reactor type segment comprises PWRs, BWRs, gas-cooled reactors, and PHWRs. The application segment comprises industrial and utility. The region segment comprises North America, Europe, Asia Pacific, the Middle East & Africa, and others.

Nuclear Waste Management Market Regional Analysis:

North America dominates the global nuclear waste management market. The strong presence of key technology providers, waste management companies, and well-established infrastructure, offers ample opportunities for significant growth. With over 104 operating commercial nuclear reactors at 56 nuclear power plants in 28 states, the US accounts for the leading share in the regional market.

Besides, industrial safety standard-setting associations and energy regulatory commissions, such as the US DOE, the US NRC, and the US Environmental Protection Agency (EPA), impact the region's market shares positively. Moreover, the early uptake and widespread awareness of the benefits of advanced waste management solutions boost the regional market growth.

Europe is another lucrative market for nuclear waste management. The rise in the electricity produced by nuclear power plant capacity due to increased energy demand is a key growth driver. The region witnesses increased nuclear electricity production, which has increased the amount of spent fuel, resulting in the passing of legislation on nuclear waste management in the EU.

The legislation guiding the management of spent

fuel and nuclear waste responsibly and safely is built on internationally recognized principles without imposing undue obligations on future electricity generations.

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Industry Trends: Most countries today use nuclear technology to generate electricity and radioactive material for many other purposes. This, as a result, increases the need for an effective process for managing radioactive waste and spent nuclear fuel generated from these activities safely and

efficiently.

However, nuclear waste must be processed properly to make it safe for disposal. Waste processing comprises collection & sorting, reducing the volume of waste and, changing its chemical & physical composition, and conditioning it to make it immobilized and packaged before storage & disposal. There are

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several researches ongoing to develop new waste management solutions & techniques and improve existing ones.

For instance, on June 10, 2022, Delkia, a UK-based systems integrator, announced that it is working with Kawasaki, a robotics company, to develop and test software

to control a robotic arm that can protect staff during nuclear waste categorization. Currently, processes, such as equipment dismantling and sorting of contaminated materials, are done manually by wearing PPE suits.

This means operators are working and in contact with potentially dangerous nuclear substances for about 8-9 hours daily. Therefore, Delkia and Kawasaki decided to develop this innovative robot arm to protect workers and enhance safety at the facility, ensuring maximum protection from

radioactive materials.

Also, manual nuclear waste management is costly and time-consuming, especially when many industries face labor-shortage issues. The nuclear industry is increasingly looking for machinery & tools to perform the tedious, repetitive, and often dangerous tasks associated with a waste categorization.

The model can sort and manage different categories of nuclear waste, making it safer & more cost-effective than current processes. The software will control the movements and safety-critical functions of the robot. Therefore, a robot-led waste categorization process is certainly highly desirable in the nuclear industry.

The nuclear waste management market witnesses several strategic partnerships, alongside other strategies such as expansion, mergers & acquisitions, collaboration, and service & technology launches. Major industry players make vast investments in research and development activities and foster their expansion plans. For instance, on March 04, 2022, June 07, 2022, Skanska Talonrakennus Oy, a Finnish contractor responsible for the construction of the used fuel encapsulation plant at Olkiluoto, announced that it has entered the installation phase and handed over the building to a Finnish waste management company – Posiva, for the installation of the nuclear systems and commissioning of the process systems of the encapsulation plant.

Source: <https://www.globenewswire.com/news-release/2022/06/15/2462765/0/en/Nuclear->

Waste-Management-Market-Estimated-to-Hit-USD-6-878-9-Million-by-2027-at-a-CAGR-of-2-8-Report-by-Market-Research-Future-MRFR.html, 15 June 2022.

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For a long time, the US nuclear industry has been stagnating, in large part because of the tremendous costs of building massive new plants. SMRs, by contrast, are small enough to be built in a factory and then hauled elsewhere to produce power. Advocates hope this will make them more cost-effective than the big reactors of today, offering an affordable, always-on complement to less-predictable renewables like wind and solar.

USA

Smaller Reactors may Still have a Big Nuclear Waste Problem

...Figuring how to bury radioactive atoms isn't exactly simple—it takes a blend of particle physics, careful geology and engineering, and a high tolerance for reams of regulations. But the

trickiest ingredient of all is time. Nuclear waste from today's reactors will take thousands of years to become something safer to handle. So any solution can't require too much stewardship. It's gotta just work, and keep working for generations.

By then, the utility that split those atoms won't exist, nor will the company that designed the reactor. Who knows? Maybe the United States won't exist either. Right now, the US doesn't have such a plan. That's been the case since 2011, when regulators facing stiff local opposition pulled the plug on a decades-long effort to store waste underneath Yucca Mountain in Nevada,

stranding \$44 billion in federal funds meant for the job. Since then, the nuclear industry has done a good job of storing its waste on a temporary basis, which is part of the reason Congress has shown little interest in working out a solution for future generations. Long-term thinking isn't their strong suit. "It's been a complete institutional failure in the US"....

But there's a new type of nuclear on the block: the SMR. For a long time, the US nuclear industry has been stagnating, in large part because of the

tremendous costs of building massive new plants. SMRs, by contrast, are small enough to be built in a factory and then hauled elsewhere to produce power. Advocates hope this will make them more cost-effective than the big reactors of today, offering an affordable, always-on complement to less-predictable renewables like wind and solar. According to some, they should also produce less radioactive waste than their predecessors. A Department of Energy-sponsored report estimated in 2014 that the US nuclear industry would produce 94 percent less fuel waste if big, old

reactors were replaced with new smaller ones...By many measures, the SMR designs produce not less, but potentially much more waste: more than five times the spent fuel per unit of power, and as much as 35 times for other forms of waste. Startups seeking licenses to build SMR designs have disputed the findings and say they're prepared for whatever waste is generated while the US sorts out permanent disposal....

Source: <https://www.wired.com/story/smaller-reactors-may-still-have-a-big-nuclear-waste-problem/>, 02 June 2022.



Centre for Air Power Studies

The Centre for Air Power Studies (CAPS) is an independent, non-profit think tank that undertakes and promotes policy-related research, study and discussion on defence and military issues, trends and developments in air power and space for civil and military purposes, as also related issues of national security. The Centre is headed by Air Marshal Anil Chopra, PVSM AVSM VM VSM (Retd).

Centre for Air Power Studies

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