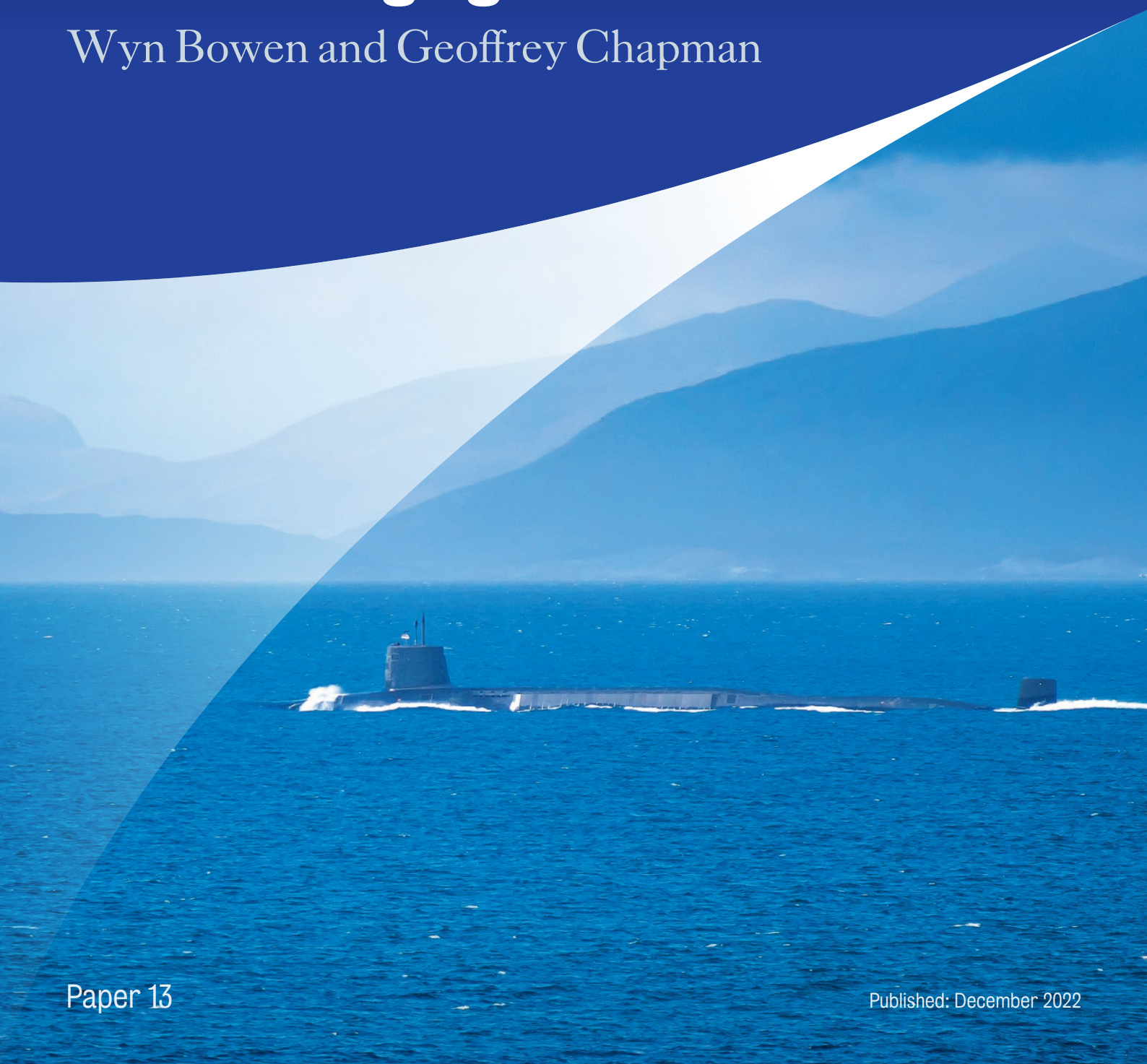
FREEMAN AIR & SPACE INSTITUTE

KING'S College LONDON

ISSN 2754-0510

The UK, Nuclear Deterrence and a Changing World

Wyn Bowen and Geoffrey Chapman



Paper 13

Published: December 2022

About the Freeman Air and Space Institute

The Freeman Air and Space Institute is an inter-disciplinary initiative of the School of Security Studies, King's College London. The Freeman Institute is dedicated to generating original knowledge and understanding of air and space issues. The Freeman Institute seeks to inform scholarly, policy and doctrinal debates in a rapidly evolving strategic environment characterised by transformative technological change which is increasing the complexity of the air and space domains.

The Freeman Institute places a priority on identifying, developing and cultivating air and space thinkers in academic and practical contexts, as well as informing, equipping and stimulating relevant air and space education provision at King's and beyond.

The Institute is named after Air Chief Marshal Sir Wilfrid Freeman (1888–1953), who was crucially influential in British air capability development in the late 1930s and during the Second World War, making an important contribution to the Allied victory. He played a central role in the development of successful aircraft including the Spitfire, Lancaster and Mosquito, and in planning the wartime aircraft economy – the largest state-sponsored industrial venture in British history.

FREEMAN
AIR & SPACE
INSTITUTE

The UK, Nuclear Deterrence and a Changing World

Wyn Bowen and Geoffrey Chapman

About the Authors

Professor Wyn Bowen is a member of the Department of War Studies, King's College London, and Co-Director of the Freeman Air & Space Institute in the School of Security Studies at King's. Bowen is also currently a Visiting Scientist in the Center for Global Security Research at Lawrence Livermore National Laboratory in California. Previous roles have included Head of the School of Security Studies (2016-2022), Head of Department/ Dean of Academic Studies, Defence Studies Department, based at the Joint Services Command and Staff College, UK Defence Academy (2014-16) and Director of the Centre for Science and Security Studies (2007-2014) at King's. Bowen's research and teaching interests focus on nuclear/ WMD security broadly defined, deterrence and coercive diplomacy. He has authored/co-authored numerous publications including books on Libya's nuclear programme, US policy towards missile proliferation, American security policy, Iran's nuclear behaviour and G8 threat reduction. Bowen is currently completing a project with Matthew Moran and Jeffrey Knopf examining US/western deterrence failure and coercive diplomatic success vis-à-vis chemical weapons use in Syria.

Dr Geoffrey Chapman is a Research Associate at King's College London's Centre for Science and Security Studies (CSSS). His research examines British nuclear security in the aftermath of Brexit and the Coronavirus pandemic, with a focus on British sub-strategic nuclear options. His doctoral thesis examined the role of tacit knowledge in shaping outcomes within Britain's nuclear weapons programme.

Abstract

In late March 2022, some five weeks after Russia's full-scale invasion of Ukraine on 24 February, and against the backdrop of Moscow's nuclear threats and related signalling to deter the direct involvement of NATO in support of Kyiv, the UK Chief of the Defence Staff (CDS) Sir Tony Radakin publicly referred to a 'sharpness coming to the nuclear debate at the moment'. Both at the time and since CDS's remark, the nuclear dimension to the Ukraine war has shone a very bright light on nuclear threats including nuclear coercion, and the future role of nuclear deterrence within the western alliance to address pressing security challenges in Europe and elsewhere. The 'sharpness' is further framed by growing concerns in the West about the burgeoning nuclear capability and ambitions of China, and likely also North Korea's continued momentum towards operationalising its nuclear forces. This paper examines evolving nuclear threat variables, developments at the NATO level and in US nuclear thinking and planning, and what this might all mean for the UK's own nuclear posture moving ahead.

Introduction

In late March 2022, against the backdrop of Moscow's nuclear threats and signalling to deter the direct involvement of NATO in support of Kyiv prior to and following Russia's full-scale invasion of Ukraine, the UK Chief of the Defence Staff (CDS) Sir Tony Radakin publicly referred to a 'sharpness coming to the nuclear debate at the moment'.[1] US President Joe Biden even claimed in early October that, 'For the first time since the Cuban Missile Crisis, we have a direct threat to the use of nuclear weapons, if in fact things continue down the path they'd been going'.[2] Within the western alliance, then, the war has shone a bright light on the growing potential for adversaries like Russia to use nuclear threats, not just to deter, but also to compel, other countries to achieve their objectives in regional conflict scenarios whether in Europe or further afield.

In the first major review of national security since the UK left the European Union and re-branded itself as 'Global Britain,' the March 2021 Integrated Review (IR) noted 'the intensification of competition between states' and the 'growing contest over international rules and norms'. It had emphasised that 'Russia will remain the most acute direct threat to the UK' and highlighted that 'China's increasing power and assertiveness internationally' is 'likely to be the most significant geopolitical factor of the 2020s'. On the nuclear front specifically, the IR noted that unnamed nuclear states are 'significantly increasing and diversifying their nuclear arsenals' and 'investing in novel nuclear technologies and developing new 'warfighting' nuclear systems which they are integrating into their military strategies and doctrines and into their political rhetoric to seek to coerce others'.[3] Russia, China and North Korea were not specifically singled out, but this was a reference, at the very least, to Russia and China, and their programmes to modernise, expand and diversify their respective nuclear arsenals. These programmes illustrate how the utility of nuclear weapons has clearly grown in Russian and Chinese strategic thinking and planning, particularly as this relates to Moscow and Beijing prevailing in regional conflicts.

In response to the 'evolving security environment', the IR noted that nuclear weapons will remain 'the ultimate guarantee to our security, and that of our allies', and that the UK will continue to 'declare our nuclear and offensive cyber capabilities to Allies' defence under our Article 5 commitment' to NATO. The IR also initiated specific changes to the UK nuclear posture. These included raising the UK's overall Trident Submarine Launched Ballistic Missile (SLBM) warhead stockpile cap from 225 to 260[4]; in 2010 a more benign security environment had previously enabled the UK to state that it would reduce the overall number from not more than 225 to not more than 180 by the mid-2020s.[5] The 2021 IR continued to emphasise ambiguity around the exact circumstances in which the UK would resort to nuclear use, and it also stated that the UK would no longer provide numbers on its operational warhead stockpile, including deployed warhead and missile numbers.[6] The changes reflected a perceived need to make small and relatively straightforward changes to enhance the 'credibility' of British nuclear deterrent forces at a time of growing concern about the evolving global nuclear picture. This did not appear to signal a sea change in UK perceptions of nuclear weapons utility, but at this stage, of course, Russia was still some 11 months out from launching a war of conquest against neighbouring Ukraine.

Like the 1998 Strategic Defence Review, which was updated with a 'new chapter'[7] following the unprecedented terrorist attacks on the US in September 2001, the 2021 IR is currently undergoing a 'refresh' to reflect the strategic implications of Russia's unprovoked invasion of Ukraine. With the current 'refresh' ongoing, it is timely to reflect on some of the issues that may frame British nuclear thinking and planning going forward both in the short and longer terms. The question that arises some 10 months after Moscow launched the largest war in Europe since 1945 – which has prominently featured Russian nuclear threats and signalling – is whether the UK government's own perception of the utility of nuclear weapons is now changing, as CDS's comments in March 2022 could appear to suggest? We will have to wait for the publication of the IR refresh to find out, but if the strategic conditions have already deteriorated since March 2021, further developments in reasonable worst-case scenarios may well need to be revised. Such scenarios will have to consider the increasing bellicosity of potential adversaries, their reliance on coercion based on nuclear threats and their potential for mutual support. Other orthodoxies of the UK's deterrence posture must also be considered: to what extent can the UK rely upon its allies for technical and material support as they face their own resource constraints? The fundamentals of the UK's current deterrent policies and systems should be assessed to determine whether they are now, or can remain, 'minimum,' 'credible' and 'independent' given the changing circumstances.[8] This is especially pressing given the timeframes involved in making decisions over defence acquisitions and the development of nuclear systems.

To get at these questions the paper is organised into three main sections. First, we examine the changing strategic context including the nuclear threat environment and alliance issues. Second, we examine the UK's current 'minimum credible deterrence' posture based on the Trident delivery system and how this could potentially be modified to address the evolving threat environment. Finally, we consider some of the nuclear capability options that could potentially be available to the UK alongside Trident going forward.

Changing strategic context: nuclear threats and alliances

There are arguably four main nuclear threat variables that characterise the changing strategic context from a western perspective. Taken together, the emerging nuclear picture appears bleak looking out 5-10 years.

First, there is the conventional and nuclear military threat posed by Russia. The relationship with Moscow has been deteriorating since the annexation of Crimea in 2014 and took a nose-dive with Moscow's decision to launch a multi-front attack designed to subjugate Ukraine in 2022. Russia's significant arsenal of strategic and non-strategic nuclear forces and the use of nuclear threats by President Putin and other senior figures in Moscow, and other forms of signalling (e.g. intercontinental ballistic missile (ICBM) tests; nuclear alert changes, 'out of cycle nuclear exercises',[9] unsubstantiated claims of Ukrainian chemical, biological, radiological and nuclear (CBRN) weapons) both to deter NATO's direct involvement in Ukraine, and as part of Russia's effort to terrorise and coerce Kyiv and the west, has been at the heart of the west's deteriorating threat perception.

Of particular concern in regional conflict scenarios is Russia's possession of nearly 2000 low-yield nuclear weapons deployed on a range of theatre and tactical-range delivery systems, including ballistic missiles, ground-launched cruise missiles, anti-ship missiles, anti-submarine missiles, torpedoes and depth charges.[10] There has long been a worry within the US defence establishment in particular that Moscow holds a significant advantage over the US and NATO in terms of the types of non-strategic targets it can hold at risk with these delivery systems. The Biden administration's recent Nuclear Posture Review released in October 2022 noted: '...we must be able to deter conventional aggression that has the potential to escalate to nuclear employment of any scale. Russia presents the most acute example of this problem today given its significantly larger stockpile of regional nuclear systems and the possibility it would use these forces to try to win a war on its periphery or avoid defeat if it was in danger of losing a conventional war.[11]

Most outcomes for how the current conflict in Ukraine will terminate are not positive in terms of nuclear issues and strategic stability. A Russia that believes itself to be victorious in Ukraine would see its aggressive actions and nuclear threats as vindicated and could view the rest of Europe as a weakened target, having expended substantial conventional military assistance to aid Kyiv. This would also send a terrible message to other countries about the potential efficacy of nuclear compellence in regional conflict situations. A prolonged conflict will lead to Russia's conventional forces continuing to be attritted on top of its significant combat losses to date in Ukraine. Regardless of the outcome in Ukraine, Russia will have little choice but to increase its reliance again on nuclear forces and nuclear threats, both strategic and non-strategic, as means to compensate for its conventional losses and poor performance, and as it seeks to reconstitute its conventional capabilities.[12] Alternatively, a Russian collapse into civil conflict and fragmented republics could lead to a much more dramatic re-enactment of the post-Soviet nuclear weapons security challenges. Although in recent weeks Russia has stepped back from[13] explicit nuclear threats, the use of a nuclear weapon, or weapons, to force a favourable outcome for Moscow would break the nuclear taboo and potentially set a higher bar for deterrence into the future.

On 20 March 2022, NATO Secretary General Jens Stoltenberg publicly stated that the alliance is now faced with a 'new security reality where Russia more openly contests core values of our security and are willing to use military force to achieve its objectives,' requiring the allies to build a long-term 'reset of deterrence and defence'.[14] The French 2022 National Strategic Review also recently highlighted the 'irreversibility of Russia's strategic choices... [making it] necessary to anticipate a confrontation with Moscow'.[15]

At the Madrid NATO summit in June 2022, the alliance's new Strategic Concept noted that 'Commensurate with the threats we face, we will ensure our deterrence and defence posture remains credible, flexible, tailored and sustainable'. This will include enhancing the Alliance's force posture including increasing the number of high readiness forces, expanding pre-positioning and stockpiling arrangements, expanding forward-deployed capabilities such as air defence, and pre-assigning forces to the defence of specific alliance countries.[16] A yet to be answered question arises related to how might the nuclear mission evolve in NATO's long-term deterrence reset particularly as it relates to Russia's non-strategic nuclear forces? The Alliance has long recognised this challenge and in June 2021, for example, the Brussels Summit Communiqué noted: 'Russia has continued to diversify its nuclear arsenal, including by deploying a suite of short- and intermediate-range missile systems that are intended to coerce NATO'. It further noted that 'Russia's nuclear strategy and comprehensive nuclear weapon systems modernisation, diversification, and expansion, including the qualitative and quantitative increase of Russian non-strategic nuclear weapons, increasingly support a more aggressive posture of strategic intimidation'.[17]

While NATO has clearly identified the challenge posed by Russia's advantages in non-strategic nuclear assets, and the risk that these might be threatened or used in regional European conflicts, it is unclear how the Alliance's nuclear posture might evolve to address this. For its part in its recent NPR the Biden administration noted that 'any changes in NATO's nuclear posture will be taken only after a thorough review within – and decision by – the Alliance'.[18] There have been arguments made since Russia's annexation of Crimea, and that significantly predate Moscow's invasion in 2022, that NATO should significantly update its nuclear posture, planning and exercising if the nuclear mission is to be credible, particularly vis-à-vis Russia's significant dominance over the Alliance in terms of non-strategic nuclear systems. Some commentators have proposed that NATO consider a range of options to update its nuclear posture in this respect.

Writing in 2016, for example, Matthew Kroenig argued that, 'Unfortunately, NATO's current nuclear capabilities are not well suited for a tailored retaliation to a Russian de-escalatory nuclear strike. The yields of strategic warheads may be too large for a response to a battlefield nuclear strike, and using ICBMs, SLBMs, or strategic bombers from outside the theatre of battle could risk escalating the conflict to a catastrophic, strategic nuclear exchange. The dual-capable aircraft on which B61 nuclear gravity bombs are delivered would be highly vulnerable to Russian air defences, especially in the most likely contingencies close to Russian territory'. Kroenig outlined a range of potential options for redressing the capability shortfall including: 'placing lower-yield warheads on SLBMs and ICBMs; training European crews to participate in NATO nuclear strike missions; forward basing B61 gravity bombs in Eastern Europe; improving the survivability of the B61s; rotationally basing B-52 bombers in Europe; equipping dual-capable aircrafts to carry nuclear air-launched cruise missiles; developing a new sea-launched cruise missile; designating the planned long-range standoff weapon (LRSO) for delivery by both air and sea; and creating an SRSO, a shorter-range variant of the LRSO that could be delivered by NATO tactical aircraft in theater'.[19]

NATO 2022 Strategic Concept (excerpts)*

The fundamental purpose of NATO's nuclear capability is to preserve peace, prevent coercion and deter aggression. Nuclear weapons are unique. The circumstances in which NATO might have to use nuclear weapons are extremely remote. Any employment of nuclear weapons against NATO would fundamentally alter the nature of a conflict. The Alliance has the capabilities and resolve to impose costs on an adversary that would be unacceptable and far outweigh the benefits that any adversary could hope to achieve.

The strategic nuclear forces of the Alliance, particularly those of the United States, are the supreme guarantee of the security of the Alliance. The independent strategic nuclear forces of the United Kingdom and France have a deterrent role of their own and contribute significantly to the overall security of the Alliance. These Allies' separate centres of decision-making contribute to deterrence by complicating the calculations of potential adversaries. NATO's nuclear deterrence posture also relies on the United States' nuclear weapons forward-deployed in Europe and the contributions of Allies concerned. National contributions of dual-capable aircraft to NATO's nuclear deterrence mission remain central to this effort.

NATO will take all necessary steps to ensure the credibility, effectiveness, safety and security of the nuclear deterrent mission. The Alliance is committed to ensuring greater integration and coherence of capabilities and activities across all domains and the spectrum of conflict, while reaffirming the unique and distinct role of nuclear deterrence. NATO will continue to maintain credible deterrence, strengthen its strategic communications, enhance the effectiveness of its exercises and reduce strategic risks'.[20]

**The NATO 2022 Strategic Concept drew heavily on the NATO Warsaw Summit Communique of 1 July 2016, which had provided a fuller statement of NATO's nuclear posture than previous Summit communiques.*

At the Brussels Summit, NATO reaffirmed 'the imperative to ensure the broadest possible participation by Allies concerned in the agreed nuclear burden-sharing arrangements to demonstrate Alliance unity and resolve'.[21] NATO's long standing nuclear sharing arrangements – under which the US shares tactical nuclear weapons in wartime with a small number of allied countries for delivery on dual-capable aircraft (DCA) – has come under the microscope in recent years and during the Ukraine war. Indeed, Poland has stated that it is ready to deploy such weapons and aircraft on its territory as a result of Russia's actions in Ukraine;[22] thus far no such weapons have been deployed on the territory of former Warsaw Pact countries that are now part of NATO. Moreover, with Finland and Sweden set to join the Alliance an additional two countries will be opting to benefit from US nuclear security guarantees.

China is the second nuclear threat variable because of Beijing's growing strategic assertiveness and expanding nuclear capabilities. UK bilateral relations with China continue to decline amidst allegations of secret police stations, influence operations operating out of Confucius Institutes, assaults on protesters and demands to cut relations with Taiwan. The brief administration of Prime Minister Liz Truss was set to redefine China as a 'threat'.[23] More recently on 28 November 2022, during his Mansion House speech on foreign policy, the current Prime Minister Rishi Sunak noted that 'China is conspicuously competing for global influence using all the levers of state power' and that it 'poses a systemic challenge to our values and interests… a challenge that grows more acute as it moves towards even greater authoritarianism'.[24] NATO's new Strategic Concept this year also, for the first time, highlighted the direct challenge posed by China to the alliance. It notes the need to address 'the systemic challenges posed by the PRC to Euro-Atlantic security and ensure NATO's enduring ability to guarantee the defence and security of Allies'.[25]

China under President Xi has become increasingly assertive strategically, as evidenced by its bellicose statements and military exercises related to forceful unification with Taiwan. There is also Beijing's growing direct strategic competition with the US. The prospect of open US-Chinese hostilities has not been as pronounced for decades.[26] All of this is coupled with China's ambitious albeit opaque nuclear modernisation and expansion programme. In November 2021, the US Department of Defense (DOD) reported to Congress that China may expand its nuclear capability to approximately 1,000-warheads by 2030 on a range of strategic and theatre delivery systems.[27] In November 2022, the DOD subsequently reported that 'Beijing probably accelerated its nuclear expansion' in 2021 and its 'operational nuclear warheads stockpile has surpassed 400.' Based on China's defence modernisation plans and China's current pace of nuclear expansion, the 2022 report noted, 'it will likely field a stockpile of about 1500 warheads' by 2035.[28] China's nuclear expansion has led to speculation that China will eventually adopt a launch-on-warning posture,[29] and may increase Beijing's willingness to take greater risks over securing its perceived national interests in the Indo-Pacific region.

While the UK is unlikely to return to a leading role 'East of Suez', it has increased its Indo-Pacific presence. This has included a decision in July 2021 to permanently assign two Royal Navy offshore patrol vessels to the region,[30] and the deployment in 2021 of the aircraft carrier HMS Queen Elizabeth to the Indo-Pacific to lead a multi-national carrier strike group. In September 2021, the AUKUS 'enhanced trilateral security partnership' was also launched, under which Australia, the UK and the US resolved 'to deepen diplomatic, security, and defense cooperation in the Indo-Pacific region, including by working with partners, to meet the challenges of the twenty-first century'.[31] More recently on 9 December 2022, Prime Minister Sunak further announced a new partnership between the UK, Japan and Italy – The Global Combat Air Programme (GCAP) – 'to deliver the next generation of combat air fighter jets'.[32]

Nonetheless, as made clear in the recently released US National Security Strategy, Washington views Russia only as an 'acute' threat, whereas China is the predominant near-peer competitor.[33] Even as the war in Ukraine continues, the US is attempting to leverage action from NATO allies against China.[34] In the future the US will have to continue to dedicate more strategic nuclear forces to countering China's growing arsenal and reassuring Pacific partners.[35] Consequently, the UK's posture on nuclear deterrence, as well as that of France, will have to be more resilient in the face of the US focusing more resources on the Pacific, even as security in Europe could be further eroded. This will likely place greater pressure on the European allies' nuclear forces to carry a greater role vis-à-vis deterrence of Russia. The future challenge of potentially having to deter two hostile peer competitor nuclear states simultaneously – highlighted by China and Russia's self-described 'no limits' friendship – is something that strategic planners in the US and NATO are now actively thinking about.[36]

Adding to the complexity of nuclear issues in the Indo-Pacific region is North Korea, the third nuclear threat variable. Its recent missile tests and nuclear statements have demonstrated that Pyongyang continues to make progress towards operationalising its nuclear forces and in political terms it recently committed to the use of nuclear weapons at the outset of a conflict.[37] Tied to North Korea's continued bellicosity, its progress in operationalising its nuclear capability, and China's steep nuclear trajectory, the evolving nuclear picture in the Indo-Pacific region looks set to undergo something of a paradigm change in the next few years.

The fourth nuclear threat variable is Iran. The prospects of getting the Joint Comprehensive Plan of Action (JCPOA) resurrected have dimmed in recent months. This has increased concerns about Iran's nuclear capabilities and its potential to shift from a nuclear hedging strategy to a concerted effort to develop nuclear weapons, if at some point a political decision is taken to do so. Iran is likely to be learning many lessons from the Ukraine war on the role of precision conventional strike capabilities, given its assistance to Moscow in this area, but also on the nuclear dynamic of the conflict. Notably, Russian nuclear signalling may well have been seen as successfully deterring NATO from direct military involvement, or at least cementing NATO countries' lack of appetite for this post-Iraq and Afghanistan. Iran may learn that a nuclear weapons capability could potentially provide cover for it to be yet more assertive regionally, at the conventional and hybrid level, in pursuit of the regime's interests.

The strain of factoring in evolving US direct nuclear deterrence requirements, and extended nuclear deterrence requirements to allies in NATO and in the Indo-Pacific, has been reflected in the intense debate in the US surrounding the recent Nuclear Posture Review released in October 2022.[38] The NPR noted that 'Deterring Russian limited nuclear use in a regional conflict is a high U.S. and NATO priority'.[39] It further noted that the US would 'work with Allies and partners to monitor Russian capabilities and doctrine and other aspects of the threat environment; enhance the readiness, survivability and effectiveness of the DCA mission across the conflict spectrum, including through enhanced exercises; strengthen the coherence of NATO's nuclear and non-nuclear capabilities and concepts to ensure they are mutually supportive; and achieve the broadest possible participation in NATO's nuclear burden sharing mission consistent with treaty commitments'.[40] The NPR also recognised that 'The United States and its Allies and partners will increasingly face the challenge of deterring two major powers with modern and diverse nuclear capabilities – the PRC and Russia – creating new stresses on strategic stability'.[41] It further noted: 'In a potential conflict with a competitor, the United States would need to be able to deter opportunistic aggression by another competitor', and recognised that 'a near-simultaneous conflict with two nuclear-armed states would constitute an extreme circumstance'.[42]

The NPR did not really focus on the demands that will fall on the US nuclear enterprise in the years ahead given the perceived Russian non-strategic nuclear challenge and the emerging two peer nuclear problem beyond relying on existing capabilities.[43] In August 2022, STRATCOM Chief Admiral Chas Richard had publicly spoken about more effort being required to think through how to deal with the 'three-party problem' – the US-Russia-China tripolar nuclear problem – noting that 'We have never faced two peer nuclear capable opponents at the same time who have to be deterred differently'.[44] Several senior US military leaders have also made arguments for a new submarine-launched cruise missile (SLCM-N) capable of delivering a low-yield nuclear warhead to help plug a perceived 'deterrence and assurance gap'. While this was included in the Trump administration's NPR in 2018,[45] it was subsequently scrapped by the Biden team in its NPR released in October 2022. In a letter to Congress in April 2022, Admiral Richard argued that 'To address this gap, a low-yield, non-ballistic capability to deter and respond without visible generation is necessary to provide a persistent, survivable, regional capability to deter adversaries, assure allies, provide flexible options, as well as complement existing capabilities. I believe a capability with these attributes should be re-examined in the near future'.[46]

Others have argued that the US should move away from the New START agreement. Frank Miller wrote in the *Wall Street Journal* that the US should move away from New START at the strategic nuclear level because it overly constrains the US as it moves into a future where it will face both a much more capable China in the nuclear domain, alongside Russia's existing nuclear threat.[47] In November, Miller, writing alongside several other former senior officials from Republican and Democratic administrations who have also worked on US nuclear strategy and planning, critiqued the Biden administration's NPR. They specifically flagged that the NPR does not ask and does not address the question of 'Can the U.S. continue to deter China, an aggressive Russia, or possibly a threat from both at the same time, with existing nuclear forces, or will it need to increase the force?' Among other elements, the authors also criticised the NPR for eliminating the 'hedge against an uncertain future' as a formal component of US planning – which has traditionally enjoyed bipartisan support – at a time of growing strategic uncertainty.[48]

All of this will build pressure for changes to the US nuclear force posture and how Washington approaches deterrence. In turn, this will have implications for NATO's nuclear posture, increasing the burden on the UK and France, as well as for arms control. Indeed, increasing asymmetries in the trilateral balance of capabilities of an expanding Chinese arsenal, the large number of Russian non-strategic nuclear weapons and a United States undergoing nuclear modernisation while improving anti-ballistic missile capabilities, will make meaningful progress on arms control ever more of a challenge.[49] With the prospects for any nuclear negotiations impaired following Russia's hostilities in Ukraine, and lack of progress in alternate forums such as the P5, 2026 could see 'the first day since 1972 without substantive, verifiable limits on the world's two largest nuclear arsenals.'[50]

The above nuclear dynamics are unfolding at a time when technological developments, and the growing complexity and interaction of multi-domain challenges – nuclear, space, cyber, and conventional air, maritime and land – are blurring boundaries, further eroding previous truisms in strategic stability and increasing the challenges of controlling escalation below and above the threshold of war. In this respect Rebecca Hersman has talked about the potential for 'wormhole escalation'.[51] An equally apt metaphor may be that proposed by Morgan *et al* likening escalation to 'traversing a treacherous ravine face or mountainside, with the bottom of the slope representing the most extreme level of escalation' where 'the challenge is to maintain control over this escalatory descent'.[52]

A pertinent example is the increasing availability of long-range, precision strike conventional munitions which has had a marked impact on the conflict in Ukraine, whether it be Ukraine's strike on the Kerch bridge and forcing the Black Sea fleet into harbour, or Russia's targeting of Ukrainian power infrastructure. The availability of such conventional capabilities to non-nuclear armed states, particularly in NATO, allows them to impact nuclear decision making as never before.[53] Conversely, to have a decisive impact on dispersed and armoured conventional forces, in Ukraine or elsewhere, multiple low yield nuclear warheads could be seen in some quarters as the optimal means to reverse a determined offensive.[54] The limitations of low-yield 'tactical' nuclear weaponry in proportion to their potential diplomatic costs in the event of their use means that escalation to nuclear weaponry could happen suddenly and on a more widespread scale if an adversary is committed to their use.[55] Further technological challenges include the increasing means to detect ballistic missile submarines,[56] advancements in missile defence and the corresponding development of novel delivery systems such as hypersonic glide vehicles.[57]

Trident and Minimum Credible Deterrence

Commissioned by the Labour government of Prime Minister James Callaghan, the Duff-Mason report of December 1978 paved the way for the procurement of Trident. The report identified the criteria required of an independent nuclear deterrent capability to replace the Polaris system. It assessed that, 'Over the next 30-40 years, our planning need not be geared to any nuclear threat beyond the Soviet Union'.[58] Some 44 years later, the Soviet Union has disappeared, and the UK and its western allies now confront a less powerful but more dangerous Russian Federation, and an emerging two peer nuclear challenge in the form of Russia and China. The Dreadnought decision extends the Vanguard/Trident concept for another 30-40 years out to the 2060s, some 80 years after the Duff-Mason report. The idea that this concept can remain credible over such a long period of dynamic change – and with the current deteriorating strategic security situation and increasingly stretched US direct and extended nuclear deterrence commitments – stretches credulity. In most probable scenarios London will likely need greater surety in the capabilities of its own nuclear arsenal to provide deterrence and assurance for itself and its NATO partners. How then might the UK potentially seek to further modify its current nuclear posture to help fill the 'deterrence and assurance gap' and the emerging two peer nuclear problem described above?

The UK has long had a policy of minimum credible deterrence and the calculation of what constitutes this was clearly revised in the 2021 IR with the warhead cap increase in response to the changing strategic context. Although the specific rationale behind the posture change was not made explicit, a greater number of warheads, and ambiguity over missiles and their configurations, could potentially allow for greater flexibility in Trident missile outloads in response to '"warfighting" nuclear systems... [that are being] integrat[ed] into...[adversaries'] military strategies and doctrines'.[59] This could include having some missiles with more warheads for greater penetration of missile defences, and other missiles fielding British sub-strategic warheads analogous to the Americans' W76-2.[60] An expansion in the fielding of sub-strategic warheads on Trident could be seen to offer an option for enhancing the 'credibility' of the UK's retaliatory options in the context of responding to Russian limited nuclear use in a regional context by providing an intermediate option below a full strategic exchange.

The logic of a British sub-strategic capability was historically premised on three main arguments. First, it provides escalation options and a 'weak link' between conventional weaponry and nuclear strategic systems. Second, it acts as a British contribution to NATO and provides assurance to allies. Third, it provides a credible deterrent against 'out of area' threats.[61] The least relevant contemporary justification is providing an 'out of area' capability. The IR warned that the UK could in the future consider nuclear use in response to 'weapons of mass destruction, such as chemical and biological capabilities, or emerging technologies that could have a comparable impact [to nuclear weapons]'.[62] As a hedge against these contingencies, Trident is already likely more than sufficient. In terms of providing assurance, the UK's contribution to NATO's nuclear mission has been a priority for London since 1962, the year the US agreed to sell Polaris missiles to the UK.[63] Following the end of the Cold War and NATO's 1991 Strategic Concept,[64] which called for a significant reduction in sub-strategic nuclear weapons, Britain retired the WE.177 free fall bomb and abandoned developing the stand-off Tactical Air to Surface Missile (TASM). Sub-strategic Trident was nonetheless committed to NATO.[65] However, since the retirement of the WE.177 from RAF service and its withdrawal from Europe, the UK has no way of visibly forward deploying its nuclear weapons to signal resolve.[66] This is a type of assurance that eastern member countries of NATO are now actively seeking given Russia's aggression against Ukraine.[67]

British use of the term sub-strategic Trident ceased to appear in published UK nuclear doctrine in 2006.[68] What became of the reduced yield warheads is unclear but in terms of discussing the policy implications of the capability, and communicating their deterrent value to adversaries, a refresh of the IR could be more explicit about potentially using Trident this way. This could be considered in terms of clarifying that the UK can act as a second centre of decision making for both strategic and sub-strategic nuclear contingencies, potentially providing additional assurance to NATO partners. Importantly, the Warsaw Summit Communique in July 2016 specifically noted that the UK and French 'separate centres of decision-making contribute to deterrence by complicating the calculations of potential adversaries'.[69] This was again highlighted in the new NATO Strategic Concept in June 2022.[70] But relying on Trident during a crisis for a sub-strategic response to limited nuclear use by an adversary would come with a high risk of misinterpretation. The delivery system is designed for strategic delivery and a nuclear-armed adversary detecting a Trident launch may assume the intent is such. This would increase the risk of unintended escalation, which could lead to the UK being self-deterred, and highlights the flaws in the 'sub-strategic Trident' concept.

Beyond the sub-strategic element, what constitutes a minimum credible deterrent force in strategic nuclear terms could also need to be recalculated based upon what it is intended to deter and what it must achieve if deterrence fails. Historically, this has been premised on the 'Moscow Criterion' where the ability, despite any missile defences, to inflict unacceptable damage on the Soviet Union by targeting decision-making centres was the accepted minimum threshold.[71] This criterion may no longer stand. First, the recent actions of Putin in Ukraine demonstrate his contempt for Russian lives; to deter a bully not adverse to deliberately increasing nuclear risk may be seen as necessitating other means, more tailored for example to precisely targeting command and control nodes.[72] Second, if as it appears likely, we are moving towards a multipolar nuclear world with a two peer nuclear challenge, the existing capability of the UK's Trident system to inflict unacceptable damage on a single nuclear adversary may no longer be seen as sufficient.

Given that the UK Trident warhead cap has already been increased in the 2021 IR, one option that could be considered is adding additional warheads to existing and future planned platforms. Although many of the specifics are classified, the information available indicates the diminishing returns of going much beyond 260. A Trident D5 missile can carry up to a theoretical maximum of 14 warheads.[73] Britain will possess four Dreadnaught submarines with the capacity to carry 12 Trident missiles (16 for its existing Vanguard submarines). With one submarine on patrol and a second ready to deploy, this means that up to 336 warheads could be required for a full future outload, and more would be required to allow for a proportion to be undergoing maintenance. However, fully loading all missiles would be impractical; in reality, missiles carry reduced warhead outloads because it enables the missile to carry more countermeasures and/or have increased range. Some missiles could also carry sub-strategic warheads, which would only require one or several warheads per missile. As warheads loaded onto a single missile will strike within a limited 'footprint' area, increasing the destructive potential of the arsenal in this way would be relatively inflexible in operational terms. While likely a relatively cheap option compared to a new system, it is questionable what operational utility or extra deterrent value simply more warheads would achieve if the existing arsenal were able to provide sub-strategic options, destroy desired hardened targets, and penetrate existing missile defences. The ability to strike additional adversaries would therefore have to be accompanied with additional submarines and missiles.

A credible deterrent also rests on the technical capability to deliver nuclear force in combination with political intent. The UK is the only nuclear state to employ a single delivery system and therefore credibility depends on the ability to maintain SSBNs continuously at sea and for these submarines to remain undetected, which could become more challenging in a tripolar nuclear world. Within the western alliance, the US maintains a triad of nuclear forces while France has a dyad including a submarine launched long-range ballistic missile capability and an air-launched cruise missile capability, the latter providing a sub-strategic option. While it might be more economical to rely on a single nuclear leg, a deteriorating and increasingly complex and demanding nuclear threat environment might leave the UK overly susceptible to a set of systemic risks relating to multiple single points of failure with no to limited redundancy. A major technical fault with the submarines, warheads or Trident missiles could leave Britain's deterrent functionally inoperable. For example, in the early 1990s, worsening reactor problems with the Resolution class submarines led officials to express concern that solely relying on Vanguard submarines was putting all the nuclear eggs into one basket.[74] Any loss of submarines – due to enemy action, delayed repairs[75] or accidents[76] – could have similar consequences during future crises. Previously considered hedges to these types of concerns included a planned fifth Resolution class submarine in the 1960s[77] and fielding either WE.177 or its planned successor, TASM[78], although both options were cancelled for cost saving reasons.

In addition to the threat environment, a UK nuclear hedge also needs to be framed by taking account of alliance issues and domestic political considerations. The UK maintains that its nuclear weapons are 'operationally independent', but this belies its high reliance on technical cooperation and material support from the US for its missiles,[79] warheads,[80] submarines,[81] or potential alternative delivery platforms such as the F35.[82] In this respect British policymakers need to contemplate, and to factor into nuclear thinking, a future scenario in which the US becomes an unreliable security guarantor in the future, however unlikely this might be given Russia's actions in Ukraine and intensifying US competition with China. But the position of the US on key foreign policy issues such as extending security guarantees to like-minded countries in Europe and Asia is not as predictable as it once was. This has been framed most notably by the unpredictability of US policy under President Trump as it relates to NATO and going forward the potential for a similarly minded 'America First' Republican, to (re)enter the White House in January 2025. What would the US becoming an unreliable security guarantor, either temporarily or more permanently, do for British nuclear decision-making? While the UK faces its own domestic challenges – potential Scottish independence, serious economic issues, the opportunity costs of nuclear investments[83] and project delivery, and support for the industrial base within the defence nuclear sector – at least Whitehall has some agency over these issues.[84]

Although the UK continues to be able to provide 'substantial and material contributions' to the US nuclear programme under the 1958 Mutual Defence Agreement, the extent of technical dependency on the US for independent developments may be seen to require reconsidering.[85] UK independence has gradually receded over the course of time with the Atomic Weapons Establishment's ability to provide a 'successor system', if called upon, removed from its public mission statement some years ago.[86] Technical dependence is also extending to France, following the decision to cancel a UK-based hydrodynamics facility and to share a facility physically based in Valduc.[87] Rather than decrease, dependence on foreign partners, chiefly the US, looks set to increase with London dependent on Washington for cooperation on the W93 programme for the UK's successor warhead.[88] The recent US NPR committed to continuing the W93 warhead work and in that context to 'Continue to support the United Kingdom with its Replacement Warhead Program, Common Missile Compartment, and Mk7 aeroshell'.[89] But given the importance of this programme to the UK, and what appears to be the relative American apathy towards it, this may be a cause for concern; a modern day Skybolt crisis cannot be ruled out if US budgets become further strained.[90]

Beyond Trident?

As the strain on the US nuclear enterprise increases given the focus on China's nuclear expansion, the UK will likely come under growing pressure from Washington to take more of the NATO nuclear burden. The previous section outlined a range of relevant issues related to the UK's single existing nuclear delivery systems including opportunities, drawbacks and constraints. This raises the question of what other options might be considered by the UK as part of carrying a greater nuclear burden in Europe? The obvious options – notably for addressing the Russian non-strategic nuclear problem – focus on fielding a new cruise missile and using the F35 in a nuclear delivery mode.

Cruise missile

Development of a cruise missile leg would involve producing a warhead (likely originally designed for TASM) that had not been validated by live nuclear testing.[91] Nonetheless, this is something the Atomic Weapons Establishment has explored under Operation Herdick, where it tested creating a simulated nuclear cruise missile.[92] One option would be co-development of a delivery system with France. This was considered with TASM in the early 1990s[93] and would diversify the UK's sole reliance on the US. Successful non-nuclear projects of this nature include the Storm Shadow missile. However, in the 1990s, the then available French system, the ASMP, was rejected as inadequate. Co-development of an improved system, the ALSP, was not pursued.[94] The French air-launched system has since matured and continues to be developed with the upcoming ASN4G.[95] Given its large stand-off range, it would somewhat replicate the existing range characteristics of Trident, rather than provide new capabilities suited for forward deployment. Nevertheless, its procurement and public recognition as a sub-strategic capability could mean that its deployment pattern and flight profile would be very different to Trident, and hence potentially more distinguishable from a strategic delivery system. An intermediate capability could be the development of a nuclear capable output from the UK-France Future Cruise/Anti-Ship Weapon programme; however, any nuclear version would likely only be of interest to the UK and could require renegotiation of the project.[96]

F35 nuclear role

Rather than creating or co-developing its own air-launched system, a further option could include Britain's direct involvement in NATO's nuclear sharing arrangements. This arrangement would not be unprecedented – the UK operated US Thor missiles, as well as fielded US loaned tactical nuclear artillery and the Lance missile system during the Cold War. The UK already hosts US nuclear-capable aircraft at RAF Lakenheath, with nuclear storage bunkers there currently being renovated.[97] The UK also holds a veto over nuclear weapons use by NATO.[98] However, the current nuclear certified variant of the F-35 is the F35A, designed for conventional take-off and landings. Britain operates F35Bs which is a short take off and vertical landing variant. In comparison to the F35A, the F35B has smaller internal bomb bays which are reported to be too small to carry B61-12s – the nuclear weapons fielded in NATO nuclear sharing.[99] B61s could likely be carried externally, but this would undermine the F35Bs main advantage – its stealth capabilities – making the airframe more vulnerable to interception. Therefore, to credibly participate in NATO's nuclear sharing arrangements, the UK would probably have to acquire F35As as many Allies and partner countries are currently in the process of doing. The UK has ordered 74 F35Bs to date from its stated prospective offtake of a total of 138 F35 aircraft. Acquiring the F35A variant remains an option that would enable the UK to participate in NATO nuclear sharing arrangements.

The cheapest and most expedient option to deliver a forward deployable sub-strategic capability could be the use of existing British Trident warheads in an air-dropped gravity bomb mode. This would require a modified arming and fusing mechanism, but could potentially use existing aircraft, such as F35s, as a delivery platform. This option was floated by a defence official in the 1990s as an ersatz replacement capability if Trident missiles became inoperable, but still came with the warning that costs would be 'very substantial'.[100] As this capability was considered in extremis, further factors may limit the viability of this approach; for example, the use of sensitive high explosives may pose a safety risk.[101] However, it would drastically reduce development and platform costs, and eliminate the need for missile development as categories of required capital spending. This path would come at the cost of a stand-off capability, it would depend on the stealthy characteristics of the F35 and it would have to fit internally within the F35B's cramped internal weapons bays. If the focus was on sub-strategic systems and the time frames are less pressing, alternative surface to surface options such as a nuclear capable version of the Precision Strike Missile could be explored but would replicate existing dependencies on the US.[102]

Budgetary considerations

The obvious current constraint on further nuclear enhancements is the poor fiscal environment. The proposed defence budget rise to 3% of GDP, amounting to £157 billion over eight years, has been cancelled.[103] While the Chancellor recently committed to maintaining the defence budget at least at 2% of GDP in his November statement, a weak pound and soaring inflation would make any new procurement project difficult to keep within budget. Even with these factors in mind, it is worth considering that nuclear defence spending amounts to some 6% of the defence budget, and this arguably makes it highly cost effective compared to conventional military alternatives.[104] But any increase to nuclear defence spending will inevitably come at the cost of the conventional side of the house at a time when the Alliance is looking to bolster conventional defences and deterrence against Russia.

It seems then that the more expensive options may not be economically practical. The unit cost of a Dreadnaught submarine is approximately £8 billion[105] and is likely to rise, and this would not include the accompanying additional expenses in terms of missiles, warheads, personnel and infrastructure. As construction has yet to start on the fourth Dreadnaught submarine, there would be a considerable time delay in delivering a larger capability through a fifth boat. This could be lessened, and the overall capability increased, by again delaying the retirement of Vanguard submarines as the Dreadnaughts become operational, but this would only increase the number of available platforms by the early 2030s and may pose safety risks as the Vanguard reactors age.[106]

In 2013, the then government's 'Trident Alternatives Review', projected air-launched alternatives to Trident to cost in the realm of £15 billion to bring to fruition.[107] Even at the time, the figures were judged to be low fidelity and were calculated as a replacement to Trident, rather than as an addition, and so must be taken as indicative not definitive. Nonetheless, the figure does indicate that delivering an air-launched cruise missile capability is likely to be seen as unaffordable.

On the F35A option, Germany's recent decision to purchase 35 F35As is indicative of the procurement cost if the UK went down this route. The aircraft will cost Germany $8.4 billion excluding additional expenses such as infrastructure, personnel and maintenance.[108]

The cheapest and most expedient option to deliver a forward deployable sub-strategic capability could be the use of existing British Trident warheads in an air-dropped gravity bomb mode.

If the UK sought to acquire the ASN4G from France it is unclear what price the UK could acquire it for. But it would likely prove highly expensive and given its large stand-off range, would somewhat replicate the existing range characteristics of Trident, rather than provide new capabilities suited for forward deployment.

Conclusion

In this paper we set out to provide insights into issues that will likely influence UK decision making about nuclear options moving forward both in the context of the IR 'refresh' and beyond. Among other things, these include a rapidly deteriorating nuclear threat environment and growing demands on the US nuclear arsenal for both for its own direct deterrence requirements and for extending deterrence to allies. It was argued this will bring growing demands on the UK to carry a greater nuclear burden within NATO as the two nuclear competitor situation evolves. Against this backdrop, the UK's minimum credible deterrence posture was considered and how this could potentially be further modified, as well as other possible options the UK might consider.

In his 28 November 2022 Mansion House speech, Prime Minister Sunak noted that 'today the pace of geopolitical change is intensifying' and 'our adversaries and competitors plan for the long term'. In response, he spoke about 'standing up to our competitors' and to do this 'through our diplomatic expertise, science and tech leadership, and investment in defence and security…', and 'by dramatically increasing the quality and depth of our partnerships with like-minded allies around the world'.[109] Nuclear is part of this response and Whitehall confronts important decisions if the UK is to maintain a credible nuclear deterrent capability in a deteriorating nuclear threat environment and working in close partnership with its nuclear and non-nuclear allies in NATO. As the paper has shown, perhaps the clearest challenge will involve how best to coordinate and work with allies in addressing the sub-strategic nuclear challenge, which has been illustrated so starkly in 2022 by Russia's nuclear threats in Ukraine, but also further framed by China's expanding theatre and strategic nuclear capabilities.

Endnotes

1 Institute of Government, 'The future of UK defence', 31 March 2022, www.instituteforgovernment.org.uk/events/defence
2 BBC, 'Ukraine war: Biden says nuclear risk highest since 1962 Cuban Missile Crisis', 7 October 2022, https://www.bbc.co.uk/news/world-us-canada-63167947
3 HM Government, CP403: Global Britain in a Competitive Age (2021), 76.
4 Ibid., 76.
5 HM Government, Securing Britain in an Age of Uncertainty (2010), 38.
6 HM Government, CP403: Global Britain in a Competitive Age (2021), 76.
7 UK Ministry of Defence, The Strategic Defence Review: A New Chapter (2002).
8 HM Government, CP403: Global Britain in a Competitive Age (2021), 76.
9 United States Department of Defense, 2022 Nuclear Posture Review (2022), 1.
10 Amy F. Woolf, Russia's Nuclear Weapons: Doctrine, Forces, and Modernization, CRS Report for Congress, Congressional Research Service, 21 April 2022, 21.
11 United States Department of Defense, 2022 Nuclear Posture Review (2022), 5.
12 AP, 'Putin says Russia could adopt US preemptive strike concept', 9 December 2022, https://apnews.com/article/putin-moscow-strikes-united-states-government-russia-95f1436d23b94fcbc05f1c2242472d5c
13 William Alberque, 'Russia is unlikely to use nuclear weapons in Ukraine', *IISS Analysis*, 10 October 2022, https://www.iiss.org/blogs/analysis/2022/10/russia-is-unlikely-to-use-nuclear-weapons-in-ukraine
14 Loveday Morris et al, 'As Mariupol faces a Russian onslaught, the hope for negotiations becomes murky', *Washington Post*, 20 March 2022, www.washingtonpost.com/national-security/2022/03/20/ukraine-russia-war-zelensky/
15 Republique Francaise, Revue Nationale Stratégique [Intermediate English translation] (2022), 10.
16 NATO, 2022 Strategic Concept (2022), 6.
17 Brussels Summit Communiqué, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 14 June 2021, https://www.nato.int/cps/en/natohq/news_185000.htm
18 United States Department of Defense, 2022 Nuclear Posture Review (2022), 14.
19 Matthew Kroenig, The Renewed Russian Nuclear Threat and NATO Nuclear Deterrence Posture, Issue Brief, Atlantic Council, February 2016, https://www.atlanticcouncil.org/wp-content/uploads/2016/02/Russian_Nuclear_Threat_0203_web.pdf
20 NATO, 2022 Strategic Concept (2022), 8.
21 Brussels Summit Communiqué, Issued by the Heads of State and Government participating in the meeting of the North Atlantic Council in Brussels 14 June 2021, https://www.nato.int/cps/en/natohq/news_185000.htm
22 Wojciech Moskwa and Jenny Leonard, 'Poland Says It Approached US About Sharing Nuclear Weapons', Bloomberg UK, 5 October 2022, https://www.bloomberg.com/news/articles/2022-10-05/poland-is-in-talks-with-us-about-nuclear-weapons-president-says?leadSource=uverify%20wall
23 Dan Sabbagh, 'UK to designate China a 'threat' in hawkish foreign policy shift', *The Guardian*, 11 October 2022, www.theguardian.com/politics/2022/oct/11/uk-to-designate-china-a-threat-in-hawkish-foreign-policy-shift
24 Prime Minister Rishi Sunak's speech to the Lord Mayor's Banquet, delivered 28 November 2022, https://www.gov.uk/government/speeches/pm-speech-to-the-lord-mayors-banquet-28-november-2022
25 NATO, 2022 Strategic Concept (2022), 5.
26 Christopher Twomey, 'The Fourth Taiwan Strait Crisis is Just Starting', *War on the Rocks*, 22 August 2022, https://warontherocks.com/2022/08/the-fourth-taiwan-strait-crisis-is-just-starting/ & William Yang Taipei, 'Will China's emboldened Xi Jinping take a gamble on Taiwan?' *DW*, 11 August 2022, www.dw.com/en/will-chinas-emboldened-xi-jinping-take-a-gamble-on-taiwan/a-63683310
27 United States Department of Defense, Military and Security Developments Involving the People's Republic of China 2021 (2021), Report to Congress, publicly released November 2021, VIII, https://media.defense.gov/2021/Nov/03/2002885874/-1/-1/0/2021-CMPR-FINAL.PDF
28 United States Department of Defense, Military and Security Developments Involving the People's Republic of China 2022 (2022), Report to Congress, publicly released 29 November 2022, IX https://www.defense.gov/News/Releases/Release/Article/3230516/2022-report-on-military-and-security-developments-involving-the-peoples-republi/
29 US Department of Defense (2021), Ibid., 90.
30 Zoe Tidman, 'UK to permanently assign two warships to Asian waters', *The Independent*, 20 July 2021, https://www.independent.co.uk/news/uk/politics/uk-warships-asian-waters-permanent-b1887124.html
31 Joint Leaders Statement on AUKUS, 15 September 2022, The White House, https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/15/joint-leaders-statement-on-aukus/
32 Press release: PM announces new international coalition to develop the next generation of combat aircraft, 9 December 2022, https://www.gov.uk/government/news/pm-announces-new-international-coalition-to-develop-the-next-generation-of-combat-aircraft
33 The White House, National Security Strategy (2022), 12.
34 Henry Foy and Demetri Sevastopulo, 'US steps up pressure on European allies to harden China stance,' *Financial Times*, 29 November 2022, www.ft.com/content/1ac334c2-4ef5-480e-9863-5d9f00daa16b
35 Alexander Mattelaer, 'Rethinking Nuclear Deterrence: A European Perspective', *CSDS Policy Brief*, 23 May 2022, https://brussels-school.be/sites/default/files/CSDS%20Policy%20brief_2213.pdf
36 Jimmy Quinn, 'NATO Warns about 'No-Limits' Partnership between Russia and China,' *National Review*, 30 June 2022, www.nationalreview.com/corner/nato-warns-about-no-limits-partnership-between-russia-and-china/
37 Jesse Johnson, 'North Korea trumpets training for 'tactical' nuclear strikes,' *Japan Times*, 11 October 2022, www.japantimes.co.jp/news/2022/10/11/asia-pacific/north-korea-tactical-nuclear-weapons-drills/
38 United States Department of Defense, 2022 Nuclear Posture Review (2022)
39 Ibid. 5.
40 Ibid. 14.
41 Ibid. 4.
42 Ibid. 12.
43 Ibid. 11
44 Theresa Hitchens, 'The nuclear 3 body problem: STRATCOM 'furiously' rewriting deterrence theory in tripolar world', *Breaking Defense*, 11 August 2022, https://breakingdefense.com/2022/08/the-nuclear-3-body-problem-stratcom-furiously-rewriting-deterrence-theory-in-tri-polar-world/
45 Office of the Secretary of Defense, Nuclear Posture Review, February 2018, XII, https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF
46 Joe Gould, 'US Strategic Command chief: Sea missile cancellation opens 'deterrence and assurance gap', *Defense News*, 5 April 2022, www.defensenews.com/pentagon/2022/04/05/us-strategic-command-chief-sea-missile-cancellation-opens-deterrence-and-assurance-gap/

47 Franklin C. Miller, 'Outdated Nuclear Treaties Heighten the Risk of Nuclear War US policy makers have lost sight of the crucial link between arms control and deterrence', *Wall Street Journal*, 21 April 2022, www.wsj.com/articles/outdated-nuclear-treaties-new-start-treaty-russia-putin-china-xi-heighten-risk-nuclear-war-missile-test-ukraine-deterrence-11650575490

48 John R. Harvey, Franklin C. Miller, Keith B. Payne, Bradley H. Roberts and Robert M. Soofer, Assessing the Boden 2022 Nuclear Posture Review', *Real Clear Defense*, 16 November 2022, www.realcleardefense.com/articles/2022/11/16/assessing_the_biden_2022_nuclear_posture_review_865108.html

49 'Toward a New Nuclear Arms Control Framework Arrangement', Issue Briefs, *Arms Control Association*, Volume 14, Issue 7, October 26, 2022, www.armscontrol.org/issue-briefs/2022-10/toward-new-nuclear-arms-control-framework-arrangement

50 Jessica Rogers, Matt Korda, Hans M. Kristensen, 'Nuclear Notebook: The long view – Strategic arms control after the New START Treaty', *Bulletin of the Atomic Scientists*, 9 November 2022, https://thebulletin.org/premium/2022-11/nuclear-notebook-the-long-view-strategic-arms-control-after-the-new-start-treaty/

51 Rebecca Hersman, 'Wormhole Escalation in the New Nuclear Age,' *Texas National Security Review*, Summer 2020, https://tnsr.org/2020/07/wormhole-escalation-in-the-new-nuclear-age/

52 Forrest E. Morgan, Karl P. Mueller, Evan S. Medeiros, Kevin L. Pollpeter, Roger Cliff, *Dangerous Thresholds: Managing Escalation in the 21st Century*, RAND 2008, 17-18.

53 David Blagden, 'Strategic stability and the proliferation of conventional precision strike: a (bounded) case for optimism?,' *The Nonproliferation Review*, 2020 27:1-3 & Joshua H. Pollack, Cristina Varriale & Tom Plant, 'The changing role of allied conventional precision-strike capabilities in nuclear decision making', *The Nonproliferation Review*, 2020 27:1-3

54 William Alberque, 'Russia is unlikely to use nuclear weapons in Ukraine', *IISS Analysis*, 10 October 2022, https://www.iiss.org/blogs/analysis/2022/10/russia-is-unlikely-to-use-nuclear-weapons-in-ukraine

55 Ibid.,

56 Natasha Bajema, 'Will AI Steal Submarines' Stealth?,' *IEEE Spectrum*, 16 July 2022, https://spectrum.ieee.org/nuclear-submarine

57 See for example: Andrew Futter, 'Disruptive Technologies and Nuclear Risks: What's New and What Matters', *Survival*, 64/1 (2022), 99-120.

58 TNA, Duff-Mason Report, 7 December 1978, Part I, Para 3, 1, DEFE 19/275.

59 HM Government, CP403: Global Britain in a Competitive Age (2021), 76.

60 Nuclear Information Service, 'Ukraine, nuclear risks and the UK's lower-yield capability,' 2 November 2022, https://www.nuclearinfo.org/comment/2022/11/ukraine-nuclear-risks-and-the-uks-lower-yield-capability/

61 TNA, 'Report on the Findings of the Theatre Nuclear Weapon Policy Steering Group', undated, DEFE 25/678

62 HM Government, CP403: Global Britain in a Competitive Age (2021), 77.

63 Defence Nuclear Organisation, Ministry of Defence, Corporate report: The United Kingdom's future nuclear deterrent: the 2021 update to Parliament, 16 December 2021, https://www.gov.uk/government/publications/the-united-kingdoms-future-nuclear-deterrent-the-2021-update-to-parliament/the-united-kingdoms-future-nuclear-deterrent-the-2021-update-to-parliament

64 Jack Mendelsohn, 'NATO's Nuclear Weapons: The Rationale for 'No First Use'', Arms Control Today, July-August 1999, https://www.armscontrol.org/act/1999-07/features/natos-nuclear-weapons-rationale-first-use

65 TNA, Chief of the Defence Staff to Supreme Allied Commander Europe, 18 October 1993, DEFE 25/1016

66 'UK Withdraws Tactical Nukes From Service', *Arms Control Today*, March 1998, www.armscontrol.org/act/1998-03/uk-withdraws-tactical-nukes-service

67 Julian Borger, 'Poland suggests hosting US nuclear weapons amid growing fears of Putin's threats', *Guardian*, 5 October 2022, www.theguardian.com/world/2022/oct/05/poland-us-nuclear-wars-russia-putin-ukraine

68 See for example: Ian Davis, 'The British Bomb and NATO: Six decades of contributing to NATO's strategic nuclear deterrent', SIPRI and the Nuclear Education Trust, November 2015, 23, http://nuclearedu cationtrust.org/sites/default/files/NATO%20Trident%20Report%2015_11.pdf

69 NATO Warsaw Summit Communique, 9 July 2016, https://www.nato.int/cps/en/natohq/official_texts_133169.htm

70 NATO, 2022 Strategic Concept (2022), 8.

71 Geoffrey Chapman, 'Britain's Deterrent and the 'Moscow Criterion',' *RUSI Project on Nuclear Issues Blog*, undated, https://ukponi.rusi.org/britains-deterrent-and-the-moscow-criterion/

72 Heather Williams, 'What we got wrong about nuclear risk reduction,' *The Hill*, 23 May 2022, https://thehill.com/opinion/national-security/3497843-what-we-got-wrong-about-nuclear-risk-reduction/

73 TNA, 'UK Strategic Nuclear Force – Note by the Secretary of State for Defence,' undated, AIR8/2846

74 TNA, 'Meeting with US of S(DP) – Sub-Strategic Trident', 1 November 1991, DEFE 25/812

75 Nuclear Information Service, 'MoD admits problems at Rolls-Royce could delay Dreadnought,' 1 August 2020, https://www.nuclearinfo.org/article/dreadnought-barrow/mod-admits-problems-rolls-royce-could-delay-dreadnought

76 Dominic Nicholls, 'Royal Navy nuclear-armed submarine forced to abort mission after catching fire,' *The Telegraph*, 7 November 2022, www.telegraph.co.uk/news/2022/11/07/royal-navy-nuclear-armed-submarine-forced-abort-mission-catching/

77 Andrew Holt, 'HMS Resolution and Britain's first maritime nuclear deterrent,' The National Archives Blog, 15 September 2016, https://blog.nationalarchives.gov.uk/hms-resolution-britains-first-maritime-nuclear-deterrent/

78 TNA, 'Nuclear Matters – Presentation by CSA/DCDP(N)/ACSA(N)', 11 December 1981, AIR 8/2846

79 BASIC, 'Trident Nuclear Weapon Submarines in the United Kingdom and the United States,' November 2013, https://basicint.org/wp-content/uploads/2018/06/basic_trident_briefing_nov2013_0.pdf

80 Matthew Harries, 'Dependent Deterrent? US Support for the UK's New Nuclear Warhead,' *RUSI*, 3 March 2021, https://rusi.org/explore-our-research/publications/commentary/dependent-deterrent-us-support-uks-new-nuclear-warhead

81 Nuclear Information Service, 'Extension of US-UK nuclear co-operation arrangements will support Trident replacement,' 25 October 2014, www.nuclearinfo.org/article/government-parliament/extension-us-uk-nuclear-co-operation-arrangements-will-support-trident

82 Forces.net, 'The F-35's Global Supply Chain,' 10 December 2015, www.forces.net/services/tri-service/f-35s-global-supply-chain

83 Andrew Futter and Bleddyn Bowen, 'A Perfect Storm?,' *RUSI Journal*, 2020, 165:5-6

84 Tom Plant and Dr Matthew Harries, 'No Go for GOCO: The UK Renationalises Its Nuclear Warhead Factory,' *RUSI*, 6 November 2020, https://rusi.org/explore-our-research/publications/commentary/no-go-goco-uk-renationalises-its-nuclear-warhead-factory

85 HM Government, Treaty Series No.41: Agreement for Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes (1958), 2.
86 Henrietta Wilson, 'Renewing Trident: Can the UK's Atomic Weapons Establishment Cope?,' *Disarmament Diplomacy*, 2008, 88 & Atomic Weapons Establishment, 'What we do', undated, www.awe.co.uk/what-we-do/
87 Tom Plant, 'Britain's Nuclear Projects: Less Bang and More Whimper', Commentary, *RUSI*, 22 January 2020, https://www.rusi.org/explore-our-research/publications/commentary/britains-nuclear-projects-less-bang-and-more-whimper
88 Matthew Harries, 'Dependent Deterrent? US Support for the UK's New Nuclear Warhead,' RUSI, 3 March 2021, https://rusi.org/explore-our-research/publications/commentary/dependent-deterrent-us-support-uks-new-nuclear-warhead
89 United States Department of Defense, 2022 Nuclear Posture Review (2022), 21.
90 Paul Burton, 'Bahamian Rhapsody: Nassau 1962 and Trident,' *RUSI Project on Nuclear Issues Blog*, https://ukponi.rusi.org/bahamian-rhapsody-nassau-1962-and-trident/
91 Nick Ritchie, 'Continuity / Change: Rethinking Options for Trident Replacement,' *Bradford Disarmament Research Centre*, June 2010, www.nuclearinfo.org/wp-content/uploads/2020/09/Continuity-Change.pdf
92 Geoffrey Chapman, 'Knowledge management and institutional development within the British Nuclear Weapons Programme, 1947-1993,' *King's College London*, May 2020, 238 https://kclpure.kcl.ac.uk/portal/files/153177769/2021_Chapman_Geoffrey_1115303_ethesis_VersionRedactedForPure.pdf
93 Bruno Tertrais, 'Entente Nucleaire: Options for UK-French Nuclear Cooperation,' *BASIC*, June 2012, 9. https://basicint.org/wp-content/uploads/2018/06/entente_nucleaire_basic_trident_commission.pdf
94 Ibid., 9.
95 Inder Singh Bisht, 'French Nuclear Air-to-Surface Missile Tested, Ready for Production,' *The Defence Post*, 31 March 2022, www.thedefensepost.com/2022/03/31/france-air-to-surface-missile-test/
96 Tom Dunlop, 'Future Cruise/Anti–Ship missile project moves forward,' *UK Defence Journal*, 17 February 2022, https://ukdefencejournal.org.uk/future-cruise-anti-ship-missile-project-moves-forward/
97 Hans Kristensen, 'NATO Steadfast Noon Exercise And Nuclear Modernization in Europe,' *FAS*, 17 October 2022, https://fas.org/blogs/security/2022/10/steadfast-noon-exercise-and-nuclear-modernization/
98 NATO, 'NATO's Nuclear Sharing Arrangements,' February 2022, www.nato.int/nato_static_fl2014/assets/pdf/2022/2/pdf/220204-factsheet-nuclear-sharing-arrange.pdf
99 Toby Fenwick, 'Retiring Trident,' *Centre Forum*, February 2015, 39. https://web.archive.org/web/20150717130357/http://www.centreforum.org/assets/pubs/retiring-trident.pdf
100 TNA, 'Future UK Nuclear Warhead Capability', February 1994, AIR 8/3882
101 Patty-Jane Geller, 'Who wouldn't want to Make our Nuclear Weapons Safer?' *The Heritage Foundation*, 10 March 2020, www.heritage.org/defense/commentary/who-wouldnt-want-make-our-nuclear-weapons-safer
102 Dylan Malyasov, 'United Kingdom might join the US Army's precision strike missile program,' *Defence Blog*, 2 February 2022, https://defence-blog.com/united-kingdom-might-join-the-us-armys-precision-strike-missile-program/
103 Malcolm Chalmers, 'From Famine to Feast? The Implications of 3% for the UK Defence Budget', *RUSI*, 2 September 2022, https://rusi.org/explore-our-research/publications/occasional-papers/famine-feast-implications-3-uk-defence-budget & Edward Malnick, 'Defence budget on course for £2.5 billion-a-year cut amid soaring inflation' *The Telegraph*, 29 October 2022, www.telegraph.co.uk/politics/2022/10/29/defence-budget-course-25-billion-a-year-cut-amid-soaring-inflation/
104 HM Government, 'Dreadnought submarine programme: factsheet' *Gov.uk*, 16 March 2021, www.gov.uk/government/publications/successor-submarine-programme-factsheet/successor-submarine-programme-factsheet
105 Ibid.
106 Toby Fenwick, 'Blowing up the Budget,' *BASIC*, September 2018, 7-8. https://basicint.org/wp-content/uploads/2018/12/2018.10.12-Blowing-up-the-Budget-Web.pdf
107 HM Government, 'Trident Alternatives Review,' *Gov.uk*, 16 July 2013, 7. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/212745/20130716_Trident_Alternatives_Study.pdf. Note – approximate cost derived from Chart A, air delivered capabilities minus maintaining 2 SSBNs.
108 Vivienne Machi, 'State Department approves $8.4 billion F-35 sale to Germany,' *DefenceNews*, 29 July 2022, https://www.defensenews.com/air/2022/07/29/state-department-approves-84-billion-f-35-sale-to-germany/
109 Prime Minister Rishi Sunak's speech to the Lord Mayor's Banquet, delivered 28 November 2022, https://www.gov.uk/government/speeches/pm-speech-to-the-lord-mayors-banquet-28-november-2022

About the Freeman Air and Space Institute

The Freeman Air and Space Institute is an inter-disciplinary initiative of the School of Security Studies, King's College London. The Freeman Institute is dedicated to generating original knowledge and understanding of air and space issues. The Freeman Institute seeks to inform scholarly, policy and doctrinal debates in a rapidly evolving strategic environment characterised by transformative technological change which is increasing the complexity of the air and space domains.

The Freeman Institute places a priority on identifying, developing and cultivating air and space thinkers in academic and practical contexts, as well as informing, equipping and stimulating relevant air and space education provision at King's and beyond.

The Institute is named after Air Chief Marshal Sir Wilfrid Freeman (1888–1953), who was crucially influential in British air capability development in the late 1930s and during the Second World War, making an important contribution to the Allied victory. He played a central role in the development of successful aircraft including the Spitfire, Lancaster and Mosquito, and in planning the wartime aircraft economy – the largest state-sponsored industrial venture in British history.

Find out more
kcl.ac.uk/research/freeman-air-and-space-institute
@freeman_air

Design by williamjoseph.co.uk | Approved by brand@kcl.ac.uk – July 2019