THE FUTURE OF THE UK'S CO-OPERATIVE NUCLEAR RELATIONSHIPS

Hugh Chalmers and Malcolm Chalmers

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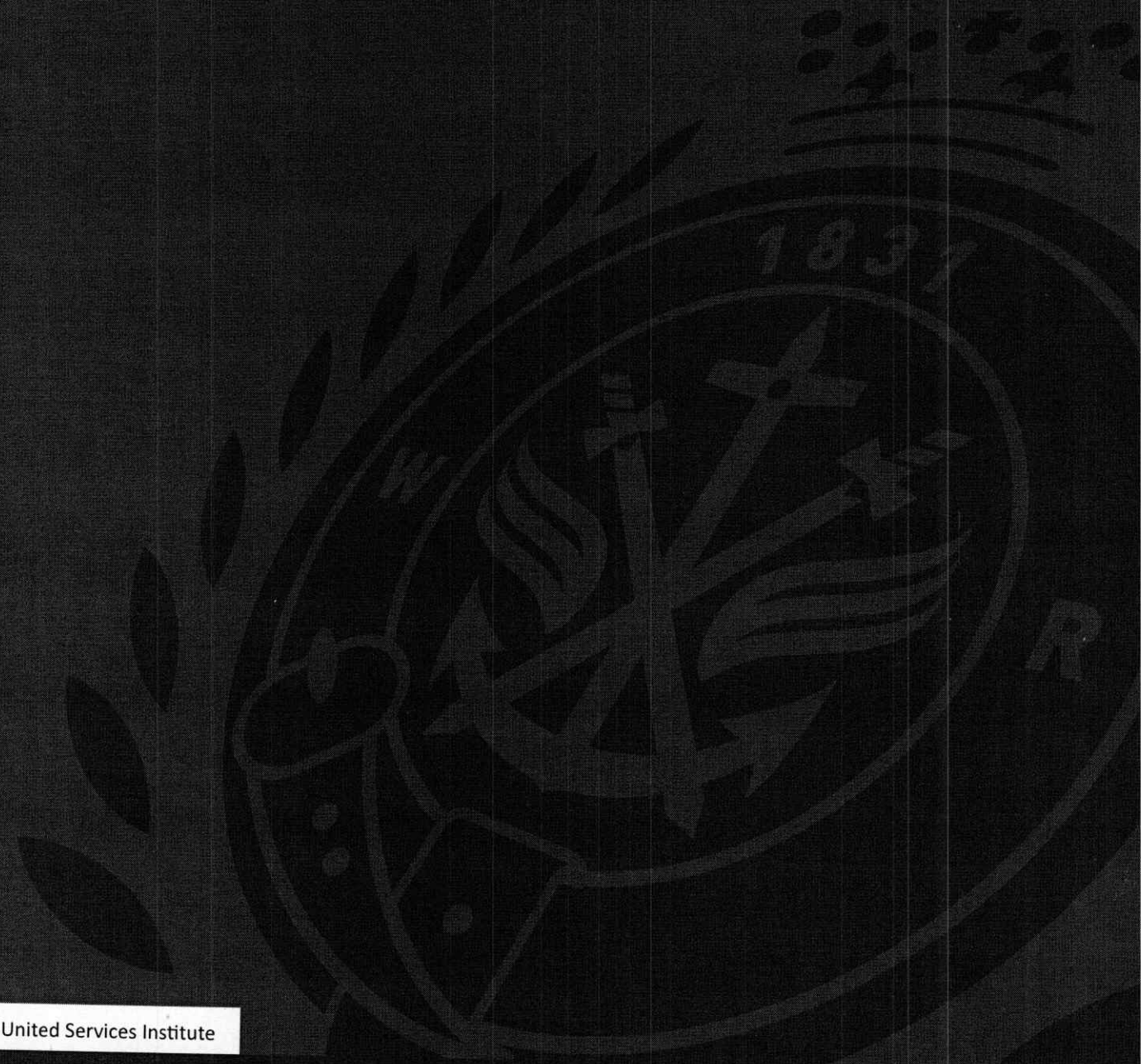

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This Occasional Paper is part of a series commissioned by the Nuclear Security Project (NSP) of the Nuclear Threat Initiative (NTI), which examines key factors that will shape the UK's nuclear forces over the course of the next decade.

Other papers within this series include an analysis of the pressures shaping the future of the UK's nuclear warhead; a discussion of the nuclear implications of an independent Scotland; and an analysis of alternative nuclear postures.

Each paper presents these factors within their historical context, and examines both the political and technical issues that drive them. Their role in shaping the future of the UK's nuclear forces is then discussed with reference to archival sources, research interviews and technical studies.

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Contents

Introduction

The UK's current nuclear force has been profoundly shaped by its longstanding co-operative relationship with the US. The resumption of nuclear co-operation in 1958 (shortly after the first test of a UK hydrogen bomb) enabled the UK to contain the costs of maintaining a nuclear force by drawing upon this relationship, which it has since expanded to cover many elements of its nuclear force. Meanwhile, this relationship with the US has also been joined by a nascent nuclear relationship with France.

The UK will soon face a number of decisions relating to the future form of its nuclear force and how this force will be supported. As the outcome of these decisions will inevitably be shaped by the pressure to cut costs, this Occasional Paper discusses whether the UK might seek to mitigate this pressure by significantly expanding its nuclear relationships.

It is important to note that these relationships are not dictated purely by financial considerations; rather, they are also sensitive to a number of doctrinal, political and technical dynamics. This paper therefore outlines the UK's existing nuclear relationships and explores the dynamics that have shaped them, before discussing how the UK might approach nuclear co-operation in the future. There could be financial incentives for expanding the UK's nuclear relationships into the areas of its nuclear force that do not currently draw heavily on co-operative arrangements – such as the design, manufacture and integration of nuclear submarines and their components,[1] and the upkeep of supporting infrastructure and UK-based expertise. However, this paper argues that these relationships are unlikely to expand significantly beyond the piecemeal development of existing arrangements.

The Future of the UK's Nuclear Force

The UK's *Vanguard*-class nuclear submarines, on which nuclear-armed Trident missiles are now deployed, are expected to be retired during the latter half of the 2020s. Anticipating the long lead-times involved in developing a replacement submarine system, the current coalition government announced in its 2010 Strategic Defence and Security Review that it would 'begin the work of replacing its existing submarines'.[2] To date, this work has primarily involved laying the design and administrative foundations for a replacement submarine system,[3] with the go-ahead for its production subject to a final 'Main Gate' decision in, or shortly after, 2016. Spending on the concept and assessment phases of the project as of March 2012 amounted to some £1.1 billion,[4] while a further £2.8 billion is due to be spent between April 2012 and December 2016.[5]

The outcome of the Main Gate decision will be shaped by pressures to minimise the cost of a successor submarine. Estimates made in 2006 suggest that an equivalent of the current system – based around four submarines

maintaining a continuous patrol – could cost £15–20 billion (£17–23 billion at 2013/14 prices) to acquire.[6] By the early 2020s, the UK could be spending as much as a third of its planned budget for new equipment on its submarine and deterrent capital programmes.[7] The UK government also stated in 2006 that these expenditures will be accompanied by costs associated with the eventual decommissioning of new submarines and the acquisition of associated missile systems,[8] and that a further £1.5 billion (£1.7 billion at today's prices) per annum is likely to be required to operate the future nuclear force.[9]

Nuclear Co-operation: Then and Now

Over its fifty-five-year duration, the UK's nuclear relationship with the US has eased the financial burdens of being a nuclear-armed state. It is not surprising, therefore, that the UK has again turned to its nuclear relationships to mitigate the costs of maintaining its nuclear force into the future.

The nuclear relationship between the US and the UK was born during the Second World War through the US-led Manhattan Project. However, in transferring the military-led wartime programme to a civilian authority after the end of the war, the 1946 US Atomic Energy Act cut off the communication of any restricted nuclear information to foreign nationals. This led to a twelve-year period of nuclear opacity between the two allies.

Despite the UK's repeated efforts, Congress only lifted this restriction in 1958, under the strategic shadow cast by the launch in the previous year of the Sputnik satellite, which heralded the imminent creation of a Soviet ICBM capability. By this point the UK had already independently developed thermonuclear weapons. Thus, in July 1958, conscious of the need to secure the US's relationship with its main ally in Europe, the US Congress amended the 1946 Atomic Energy Act, and within a day both the US and the UK had signed the Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defence Purposes (known as the Mutual Defence Agreement – the MDA).[10]

Scientific Collaboration under the 1958 US-UK Mutual Defence Agreement

The 1958 MDA has now evolved into the central vehicle for UK-US collaboration on military nuclear science. It allows for the exchange of sensitive nuclear information, such as that relating to warhead development, manufacture and maintenance, and other areas such as nuclear propulsion reactors.[11] These information exchanges are undertaken through a series of Joint Working Groups (or JOWOGs), which bring together personnel from US and UK nuclear laboratories to discuss specific technical issues, and are augmented by mechanisms for site visits. These technical exchanges, which are regulated on both sides by national entities and steered by high-level 'stocktake' meetings every eighteen months,[12] are still highly active. More

than 1,500 visits by staff of the UK Atomic Weapons Establishment (AWE) were made to equivalent US nuclear facilities between 2007 and 2009.[13]

Historically, the MDA has allowed the UK to draw upon US facilities and materials in the development and maintenance of its nuclear warheads. Material-sharing arrangements under the MDA have in the past provided the UK with approximately 14 tons of highly enriched uranium (HEU); more than the UK's entire domestic production to date,[14] and enough for approximately 520 warheads.[15] This allowed the UK to cease the domestic production of military HEU in 1962. The MDA also allowed the UK to conduct joint nuclear tests at US facilities, thus avoiding many of the costs and complications it had encountered during its earlier, independent tests on UK-owned islands in the Pacific Ocean.[16]

The UK's current scientific collaboration with the US plays a role in the maintenance of both nations' nuclear warheads, with the UK AWE involved in the development of life-extension programmes for US warheads,[17] and the US involved in maintaining the reliability of British Trident warheads.[18] Since ratifying the Comprehensive Nuclear Test-Ban Treaty (CTBT) in 1998, the UK has been able to draw upon the US's more extensive database of nuclear test results, its facilities for hydrodynamic and subcritical tests,[19] and the expertise of its scientists to better assure the safety, effectiveness and longevity of the UK's nuclear warheads without recourse to testing.[20] While the UK maintains an independent domestic capability for this work, collaboration between the two countries under the MDA has evolved to the extent that the boundary between the design and construction of UK and US warheads has blurred. First, to keep its warheads compatible with the US-supplied Trident D5 missile (discussed below), the UK has adopted a number of US-origin, non-fissile warhead components, such as the Mk4A re-entry vehicle and warhead detonation system.[21] This system was developed as an element of US warhead life-extension projects,[22] and has subsequently been retrofitted onto UK nuclear warheads. Furthermore, a report from a US nuclear laboratory also suggests that the UK implements a US warhead, rather than developing an 'anglicised' version of a US warhead.[23]

Technology Collaboration under the 1963 Polaris Sales Agreement

By the 1960s, UK co-operation with the US on nuclear delivery-vehicle design (undertaken through the MDA) had progressed sufficiently to enable the UK to secure the use of the US Polaris submarine-launched ballistic missile, which would become the primary strategic delivery vehicle for the UK's warheads. The 1963 Polaris Sales Agreement (PSA), which is overseen by a Joint Steering Task Group,[24] has since been modified to give the UK leasing rights to fifty-eight US-manufactured Trident D5 missiles, as well as allowing it to purchase associated launching systems and support services, drawn from the US pool held at US Naval Submarine Base Kings Bay, in Georgia.

Under the original terms of the PSA, the UK provided the US with, amongst other things, a contracted payment for the capital cost of the missiles and their associated equipment, and a portion of the costs of US missile research and development.[25] In addition, the UK's nuclear force has been made available to NATO's Supreme Allied Commander Europe (SACEUR),[26] who can make a request for its use to the UK's prime minister.[27] Later, as part of the Trident update to the PSA in the early 1980s, the US also agreed to fix the UK's contribution to Trident research and development costs at 5 per cent. In return, the US was allowed to create an air base on the UK-owned island of Diego Garcia to host some of its strategic air forces, and for the UK's payment of all staffing costs associated with US air-defence systems installed around US air bases in the UK.[28]

In return, the UK avoided the time-consuming and costly enterprise of designing and manufacturing an indigenous strategic delivery vehicle and all associated launching and firing mechanisms.[29] Furthermore, since amending the PSA to incorporate the acquisition of the Trident D5 missile, the UK has drawn its missiles from the common pool held at the Kings Bay base, and utilised US radar infrastructure to monitor the test-firing of a UK-operated missile every two-to-three years, thereby avoiding the significant costs of developing the domestic infrastructure necessary to store, maintain and test these missiles.

As a result of these arrangements, the UK maintains very little technical infrastructure for the manufacture and servicing of Trident D5 missiles. While the *Vanguard*-class submarine can use these missiles independently, the Royal Navy is therefore reliant on US infrastructure for the maintenance of the Trident system in the medium-to-long term. In principle, since the Trident system is the UK's only nuclear force (in contrast to the US's 'triad' of nuclear capabilities), the emergence of a disabling technical fault in the Trident D5 system would mean that the UK would no longer have an operable nuclear force. In practice, however, there appears to be little official concern over such an eventuality.

In 2006, the Labour government secured the continuation of the Trident sales agreement until at least 2040, when the Trident D5 missile is expected to be retired.[30] The UK has been assured by the US that it would then be able to acquire any successor system that the US develops to replace the D5.[31] In anticipation of this replacement, and in a departure from previous arrangements, the UK is also collaborating with the US to develop a common missile compartment for a successor submarine, which will accommodate both the current Trident D5 missile and any replacement missile that the US might develop in the future. While the Labour government could not predict the running costs of operating a Trident successor missile precisely, it assumed that these will be of the order (in real terms) of the costs of the current Trident

D5 arrangement, which in early 2007 were given as approximately £1.5 billion (equivalent to approximately £1.75 billion today).[32] This arrangement has since been maintained by the current coalition government.

Scientific Collaboration with France

After a number of abortive attempts to initiate a similar relationship with France between the 1960s and 1980s,[33] Britain has since embarked on a limited nuclear relationship with its European ally through a treaty relating to joint radiographic and hydrodynamic facilities.[34] This treaty allows for co-operation – including through the exchange of classified information – in maintaining the safety and security of nuclear weapons, the certification of nuclear warheads, and the countering of nuclear or radiological terrorism.[35]

Through one part of this co-operation, referred to as the Teutates programme, the UK will have access to a joint radiographic and hydrodynamic testing facility (known as EPURE) currently under development in France. This will replace a similar planned facility at the UK AWE, and will examine the behaviour of nuclear materials in explosive conditions by using radiographic X-rays to monitor the detonation of materials representative of those within nuclear warheads. This facility will be supported by a Technology Development Centre (TDC) at the UK AWE. Once commissioned in 2014, the EPURE facility will allow both parties to conduct independent hydrodynamic tests in separate areas of the facility and, eventually, collaborative experiments over the fifty-year duration of the agreement. Until 2015, the UK only has to pay for the development of the TDC, after which all costs of the Teutates programme will be split equally.[36]

The Dynamics of the UK's Nuclear Relationships

Nuclear co-operation plays an important role in mitigating the costs of the planned replacement of the UK's nuclear force. In financial terms, the most significant area of this collaboration will be the integration of life-extended Trident D5 missiles and their associated launching systems into a successor system. The UK's efforts to maintain the reliability of its current warhead have already allowed it to delay decisions on the future of its stockpile, and further scientific collaboration with the US (and soon, to a lesser extent, with France) may allow the UK to again delay,[37] or even avoid, the estimated £2–3.5 billion that may be needed for a potential replacement warhead.[38]

However, the UK's nuclear relationships play a far less significant role in other aspects of its nuclear force. The design, manufacture and support of a replacement submarine remain largely an independent enterprise.[39] As a result, while the UK will be able to call upon US assistance in the maintenance of its missiles, it will have to rely upon continued investment in its own submarine capabilities in order to maintain existing operational capabilities. Furthermore, despite extensive US-UK warhead collaboration,

the UK still maintains an extensive domestic warhead infrastructure. While financial savings may have been an important driver behind the UK's nuclear relationships to date, there are a number of constraints that may overrule any financially motivated attempt to expand these relationships in the future, relating to the doctrinal and political interests of the UK, and its technical ability to explore further co-operation.

The Doctrine of 'Operationally Independent' Nuclear Forces

Considerations as to the necessary level of independence of the UK's nuclear force have served – and will continue – to restrict the potential for deepening its international nuclear relationships. For its force to present a credible deterrent threat, any potential adversary must be convinced that the UK government has the power to use this force however and whenever it wishes to. This point was stated clearly in the 2006 UK White Paper *The Future of the United Kingdom's Nuclear Deterrent*, which stated that the UK nuclear force 'must remain operationally independent if [it is] to be a credible deterrent'.[40] The paper then went on to emphasise that the UK can fire nuclear missiles and guide them to their targets without any outside help.[41]

However, by relying on the US for the provision and maintenance of its strategic missiles, the UK has already accepted a level of nuclear dependency that all other nuclear-armed states (including the US and France) have so far found unacceptable. While the UK can operate its nuclear force independently in the short term, it could not do so in the long term without US assistance or significant additional investment of its own. The Duff-Mason report produced for the UK Cabinet Office in December 1978, prior to the decision to adopt the Trident missile system (and to service it in the US), explicitly lays out this temporal formulation of independence. It recommends that the UK 'must be able to sustain our capability nationally *for a period of time*, to guard against the risk that a partner might seek to neutralise our capability for independent action by cutting off this support during a crisis.'[42]

To determine the duration of this required period of independent operation by the UK should the US curtail its co-operation, it is necessary to compare the time that the UK could continue to operate its nuclear force without external assistance with the time it would take the UK to reconstitute domestically any capabilities (such as missile-servicing infrastructure) that would be lost through the breakdown of co-operation. If the latter period (for replacement) were shorter than the former (for the degradation of capability), the UK should be able to maintain a continuous nuclear capability.

This can be framed in the context of the UK's operation of the Trident system. If the UK were to find itself no longer able to rely on the US for the servicing of its Trident missiles, it could probably continue to operate the missiles in its

possession for several years without their safe and reliable operation being seriously impaired. This would, one assumes, give it a good chance of being able to build servicing facilities of its own.

Any future US decision to refuse access to a successor missile, however, could present more serious problems, since it could take much longer to develop an entirely indigenous replacement missile system than to learn to service existing (and highly reliable) missiles. Yet, given sufficient notification of such a refusal (or the ability to extend the life of leased Trident missiles alone) and with enough resources, the UK would probably be able to develop such a system itself, as many countries have in the past. Furthermore, the very fact that the US had cut off co-operation (combined with other likely pressures resulting from the geopolitical scenario that had caused such a breakdown of relations) would be likely to buttress the strategic case for an independent capability.[43]

It is very hard to conceive of circumstances in which the US would wish to discontinue nuclear co-operation with the UK, given the wider implications that this would have for the bilateral relationship as well as the legally binding nature of the two countries' mutual obligations under existing co-operative arrangements.[44] Nevertheless, the perception that the UK might lack the ability for reconstitution in the unlikely event of a US cut-off could undermine its ability to favourably shape what is a rather asymmetric nuclear relationship. Furthermore, a greater technical dependence on the US may encourage potential future adversaries to believe that, in a protracted nuclear crisis, this dependence would constrain the UK's freedom of action, thereby undermining the fundamental deterrent rationale for the UK's continued investment in its nuclear force.

These factors may help to explain why, for example, the UK government's 2005 White Paper *Defence Industrial Strategy* stated that the UK will retain domestically 'all of those capabilities unique to submarines and their nuclear [reactors], to enable their design, development, build, support, operation and decommissioning';[45] a commitment reaffirmed in 2011.[46] The 2005 White Paper also stated that submarine sub-systems can only be acquired from abroad if there are appropriate assurances to guarantee supply.[47] As such, any proposals for expanding the UK's nuclear relationships to cover new aspects of its nuclear force are likely to have to work within such limitations.

Multilateral Politics

There are a number of bilateral and multilateral factors that will also restrain the expansion of UK nuclear co-operation with the US and France. As a member of the Nuclear Non-Proliferation Treaty (NPT), the UK's nuclear relationships are bound by the treaty's provisions and the manner in which these provisions are interpreted. In particular, under Article I of the NPT, the

UK and its nuclear partners are committed not to transfer nuclear weapons, or direct or indirect control of these weapons, to any recipient whatsoever.[48]

Non-nuclear-weapon-state parties to the NPT have previously objected that UK-US co-operation under the MDA violates this article.[49] However, the UK has rejected this argument on the grounds that neither nuclear weapons nor their control is transferred under the MDA, which also preceded the NPT, which was brought into force in 1970. Furthermore, a legal argument has been made that the UK's co-operation with the US under the MDA violates other provisions of the NPT that require nuclear-weapon states to pursue good-faith negotiations towards nuclear disarmament,[50] a concern echoed recently by some parties to the NPT in relation to the UK's nascent nuclear relationship with France.[51]

There is little to suggest that these objections have had any restraining influence on the UK's nuclear co-operation in the past. Even so, the UK would consider whether any expansion in its nuclear relationships with the US and France would be compatible with the NPT. While ambiguities exist in legal interpretations of the treaty, the nuclear-weapons states involved in deeper co-operation would need to take account of any possible negative effects that might result from future co-operative measures that appear to reopen the issue of NPT non-compliance.

Expanding the UK's nuclear relationship, particularly with the US, may also have an impact within NATO. As a part of NATO's nuclear deterrent posture, the independence – and therefore credibility – of the UK's nuclear force has an impact on both the Alliance itself and the confidence its members hold in the Alliance's nuclear strategy. While all NATO states agree that the Alliance must remain a nuclear one, some states have called for the withdrawal of US B-61 gravity bombs stationed in Europe. If, for whatever reason, these weapons were removed, the confidence of NATO member states in the credibility of the Alliance's nuclear strategy may become more sensitive to changes to the UK's nuclear force – which, in such a scenario, would be the only European nuclear force fully integrated into NATO structures.

The Quid Pro Quo *of Nuclear Co-operation*

The US may not accept any co-operative arrangement – such as basing the UK's nuclear force outside of Europe – that might degrade the reassurance provided by the UK's nuclear force to other NATO member states.[52] While the US-UK nuclear relationship is not formally based on reciprocity, in practice there has been a *quid pro quo* evident at every level of interaction,[53] and the US is unlikely to enter into any new co-operative arrangement that does not offer some reward. It is worth recalling that, until the Sputnik satellite presented the US Congress with a pressing nuclear threat, the UK's calls for the resumption of wartime nuclear co-operation went unheeded. Moreover,

since the relationship resumed the US has gained both tangible and intangible benefits as a result.

The clearest – if the least quantifiable – benefit to the US was the securing of its relations with its most important (and militarily capable) European ally, which played a critical role in NATO defences in Europe and the North Atlantic, while also making important contributions to joint security interests further afield. Specifically in the nuclear field, scientific interactions under the MDA provided the US with a complementary 'peer-review' capability, wherein alternative approaches to common problems could be compared and refined. More tangible rewards have been demonstrated through exchanges both under the MDA and the PSA, which provided the US with British plutonium as well access to British air and naval bases, and cemented the UK's nuclear contribution to NATO. Furthermore, the US has been able to bypass domestic regulations prohibiting certain hydrodynamic techniques by drawing upon the UK's ability to conduct such tests.[54]

In this light, it is useful to consider what the US might gain from expanding its nuclear relationship with the UK to support its current and future nuclear force. This consideration applies equally to the expansion of the UK's nascent nuclear relationship with France, which in turn depended to an extent upon the possibility of financial gain for France.[55]

It is possible to identify past instances where co-operation between the UK and the US suffered as a consequence of the relationship becoming too one-sided. For instance, the Labour government of Harold Wilson – which had publicly committed itself to the abandonment of nuclear weapons – suspended all new warhead design and testing work in the UK after its election in 1964.[56] While the government never fulfilled this commitment, there followed a number of years in which the UK's nuclear-weapon programme was kept in limbo, and the only work undertaken was to extend the life of its existing warheads. With the programme essentially stalled on the UK side, nuclear collaboration between the UK and the US began to dwindle – an outcome exacerbated by the UK's removal of all of its nuclear forces from bases east of Suez. By 1967, uncertainties over the future of the UK's warhead programme led the US to inform the UK that unless it intended to restart warhead-design and testing work, any US collaboration under the MDA would be 'strictly limited' to the Polaris missile and the provision of critiques on UK proposals for warhead re-entry vehicles.[57] Furthermore, the UK was informed that should this come to pass, this collaboration would 'almost certainly be the last' under the MDA.[58]

This downward trend in the US-UK nuclear relationship was only reversed when the UK reached the conclusion that Soviet developments in missile-defence technology required an update to the UK's nuclear forces. Having

ruled out the procurement of the US Poseidon missile (which could overwhelm Soviet defences with a number of independently targeted munitions), the UK opted to develop the Chevaline modification to the Polaris system, which was technically relevant to the US, and required a return to collaborative warhead-testing. By committing itself to exploring a new avenue of nuclear development that was of interest to the US, the UK was able to re-energise the nuclear relationship, and the two returned to joint nuclear testing in 1974.[59] This dynamic continues to keep the UK nuclear programme linked to that of the US: if UK nuclear warhead research were to slow (due to indecision or a lack of investment) or significantly diverge from the US (due to the pursuit of systems that are irrelevant to the US), this co-operative nuclear relationship may once again be put in jeopardy.

The Politics of Nuclear Co-operation

The broader political value of this 'pre-eminent' relationship may also restrain attempts to expand the UK's new co-operative relationship with France.[60] Nine years prior to the initiation of this new technical collaboration, it was argued that there was little reason to expect Anglo-French co-operation to offer any financial or technical advantage large enough to make it worthwhile endangering the dividends the UK enjoys from its co-operation with the US.[61] Indeed, such concerns were raised in the UK House of Lords in the wake of the 2010 UK-France agreement.[62]

In this particular instance, however, there was little risk of endangering the US-UK relationship, and the US has displayed very little objection to the Teutates programme. Matthew Harries identifies a number of potential reasons for this: first, collaboration on warhead-assurance activities such as hydrodynamic testing is a relatively narrow and uncontroversial area. Second, the US and France have quietly developed their own formalised nuclear relationship which may have relaxed US concerns in this case. Third, and perhaps most importantly, given the similarities between the US and UK warhead programmes, the US may benefit indirectly from the Teutates project if it can draw upon its results through the MDA.[63]

The Technical Limits to Co-operation

However, the US may not be so sanguine about any attempt to expand the UK's nuclear relationship with France beyond its currently uncontroversial bounds. The 1958 MDA (and indeed the 1963 PSA) contains provisions that restrict the dissemination of classified information or sensitive technologies obtained by one party from another to third parties. UK consideration of potential nuclear co-operation with France has always been coloured by these restrictions. When considering the future of the UK's nuclear deterrent in the late 1970s, the Duff-Mason report noted that UK weapon and propulsion technology is 'so inextricably mixed with technology of US-origin that some degree of transfer of the latter to the French would be involved under *any*

form of Anglo-French nuclear collaboration. The US attitude would therefore be crucial'.[64] This was of particular concern during the formulation of the Teutates programme under the 2010 treaty relating to Joint Radiographic/ Hydrodynamic Facilities, whose provisions for the exchange of classified information relating to warhead assurance overlap with some thematic areas of UK-US exchanges under the MDA. It is thought that the UK consulted its US counterparts on this issue in advance and, as discussed above, was not alerted to any overwhelming reason not to proceed with the project.[65]

The US may also have acquiesced to Anglo-French co-operation because it has little impact on broader US industrial or commercial interests. While these hold little sway over issues related to nuclear warheads, they may become far more relevant if the UK were to approach France for collaboration in the development, production and maintenance of joint ballistic-missile or submarine propulsion-reactor systems.[66] Patenting restrictions within the PSA and the MDA will complicate any collaboration that draws upon US-origin proprietary information obtained through these agreements. This has already proven to be the case with the UK's submarine propulsion reactors. For example, in testimony given to the UK Foreign Affairs Committee in 2010, former Ministry of Defence official Nick Witney stated that because of the UK's 'technical debt' to the US for the collaborative development of the UK's first nuclear propulsion reactor, all the UK has since received from this element of the MDA was 'an inhibition on being able to co-operate with the French in these areas.'[67]

Without a broader trilateral nuclear relationship between the UK, the US and France, it may not be possible for the UK to co-operate with both of its nuclear partners on similar aspects of nuclear technology. This leaves little space for new areas of nuclear co-operation with France. First, the UK is most unlikely to purge itself of all remnants of its collaboration with the US purely to pursue new aspects of its nuclear relationship with France. Second, the opportunities for new collaboration outside of the existing UK-US relationship are constrained by the UK's current minimalist approach to its nuclear force. Unlike its nuclear partners, and indeed all other nuclear-armed states, the UK is prepared to rely on a single delivery system: *Vanguard*-class submarines armed with Trident D5 missiles. As a result, the UK only operates one type of warhead and one model of nuclear-capable missile. In comparison, France operates both nuclear submarines and an air-based delivery system (therefore operating two warheads for two missile systems), while the US 'triad' consists of Minuteman ICBMs in addition to submarine- and air-based systems (eight warheads for four delivery systems).

However, if the UK were to *expand* its nuclear 'monad', any new delivery system acquired *in addition* to the Trident D5 would need to be armed with a suitable nuclear warhead,[68] opening up new areas for scientific collaboration

with the US, and potentially raising the issue of more substantive Anglo-French nuclear warhead collaboration. Yet such a prospect is effectively ruled out by the UK's clear commitments to maintaining only a minimal deterrent force, particularly if one bears in mind the UK's continuing fiscal austerity. For the foreseeable future, therefore, the UK's nuclear relationships will be limited to issues surrounding the development, operation and maintenance of a single nuclear delivery system and warhead.

The Future of the UK's Co-operative Nuclear Relationships

While there are elements of the UK's nuclear force that lie outside its co-operative nuclear relationships – such as the design, manufacturing and servicing of its submarines – these are all subject, to varying extents, to the constraints discussed above. If one considers each element in turn, it seems unlikely that a significantly more ambitious approach to nuclear co-operation will either offer notable cost savings or overcome the factors that constrain the UK's nuclear relationships.

Expanding the Teutates Model to New Elements of Warhead Infrastructure

While the UK and the US enjoy an almost symbiotic approach to the science behind nuclear warheads, the UK still retains a large domestic warhead infrastructure in the UK AWE. The Teutates programme undertaken jointly with France suggests that the UK is prepared to rely on certain non-domestic facilities for this work. However, it seems unlikely that this model could be replicated in other areas in such a way as to reduce the physical footprint of the UK's warhead infrastructure.

First, despite the flexibility of some articles of the NPT, the UK would not be able to preserve its current image of compliance if it were to use joint facilities in other states for activities physically connected to nuclear warheads, limiting this approach to only those that do not involve the handling of actual nuclear warheads. Having already invested in a number of such facilities, such as the Orion laser, there are very few others planned that could be cancelled under the Teutates model.[69] Second, given the paucity of savings such an approach might offer, there may be little reason for the UK to commit itself further to the joint development of facilities that overlap its existing capabilities, particularly when it already enjoys broad (though controlled) access to US facilities. Third, by increasing its exposure to risks of a breakdown in co-operation, the UK may find itself unable to reconstitute domestically those capabilities it abandoned through expanded collaboration before its nuclear warheads begin to experience operational difficulties.

Basing Nuclear Submarines Abroad

The Trident arrangement – under which UK submarines draw upon US facilities to install and service its Trident D5 missiles – could conceivably be

expanded to cover other aspects of maintaining the UK's submarine force. These could include the basic servicing and maintenance of the submarines themselves, and even the installation and removal of UK nuclear warheads. Any such arrangement that could similarly service the UK's conventionally armed *Astute* submarines would present an opportunity for the UK to reduce, or even remove, the costs associated with submarine facilities and expertise at its Devonport, Faslane and potentially even Coulport bases.[70]

However, domestic, bilateral and international factors all combine to rule out any such arrangement. Domestically, closing existing submarine facilities would have a significant economic impact on local employment, and would require a reversal of the commitment made in the 2005 *Defence Industrial Strategy* to retain the capability to support UK submarines domestically. It is also unclear, in this scenario, how quickly the UK could reconstitute domestic facilities in the event of a breakdown in co-operation, and whether its submarines would become inoperable in the intervening period.[71]

Furthermore, there is no reason to believe that either the US or France would be both willing and able to accept an arrangement that allows British submarines access to their respective facilities, particularly without reciprocal access for their own forces. In addition, adjusting or upgrading US or French facilities to service submarine sub-systems that are unique to the UK would be likely to reduce any financial benefit offered by such an arrangement, and involve the exchange of information that, while not necessarily classified, could be valuable and proprietary.

Finally, even if the UK could reconstitute its domestic capabilities in the event of a breakdown of co-operation, such an arrangement would unavoidably create the impression that the UK's nuclear force was no longer operationally independent. This would be particularly true if the UK were to load and unload its nuclear warheads on foreign soil. To avoid a clear violation of Article I of the NPT, the UK would have to clearly segregate its warheads from the basing states, requiring the construction of separate facilities. This would potentially negate most of the financial benefits or rule out this option altogether – as in the case of the already compact L'Ile Longue base in France.[72]

Developing Common Submarine Sub-Systems

Aside from the Trident D5 missile, its associated launch systems and the common missile compartment, few other systems envisioned for a successor submarine will be procured through collaborative or co-operative arrangements.[73] Expanding the collaborative model demonstrated by the common missile compartment to encompass other submarine systems, such as reactors or drive systems, could allow the UK to share the financial burden of developing and procuring these systems.

Yet any such arrangement would be limited by the UK's requirement for a domestic submarine-production and support capability (as outlined in the 2005 *Defence Industrial Strategy*). An extreme approach may be to purchase submarine sub-systems 'off the shelf' from the US or France, thereby abandoning the UK's 2005 commitment but mitigating its financial implications as a result. A less extreme approach may be to uphold the UK's 2005 industrial commitment, but to design new sub-systems in collaboration with the US or France. If achievable, such an approach would mitigate the small costs associated with sub-system design and provide the UK with a broader and more reliable manufacturing base.

It is highly unlikely, however, that the UK would pursue the former option. Integrating a profusion of non-domestic systems into submarines would be extremely complicated, and would multiply the risks that the failure of any one such system would deny the UK's ability to operate its submarines independently. Furthermore, abandoning elements of the UK's domestic submarine-related industry could cost a significant proportion of the approximately 11,000 jobs dedicated to the replacement of the UK's current submarine.[74]

By maintaining domestic manufacturing and support capabilities, the latter option may mitigate the risks associated with system failures. However, the UK may be restricted to exploring such opportunities with the US alone. As described above, there are a number of constraints to information dissemination in the PSA and the MDA that have already frustrated attempts to explore nuclear-reactor collaboration with France, and could well have a similar effect on other submarine sub-systems. Negotiating the licensing and manufacturing rights of common systems between potentially disparate defence industries in the UK and the US will also present a number of complex and thorny problems.

Conclusion

While the UK's nuclear relationships will continue to play an important role in shaping its nuclear forces, it seems unlikely that this role will expand significantly in the near future. The UK has already gone further down the road of dependence than any other nuclear-armed state, notably in relation to missile procurement and servicing. Precisely because of this previous and ongoing collaboration, however, the scope for further steps is now constrained by the continuing commitment to maintain a politically acceptable level of operational independence. With the main investment decision for the *Vanguard* replacement programme due to be taken in 2016, and with the prospect of steep spending increases thereafter, some may continue to seek radical new co-operation measures as a means of alleviating these anticipated financial burdens. However, while existing arrangements (notably the MDA and PSA) have already yielded substantial economies for

the UK in its nuclear effort, opportunities for further large savings through co-operation now appear to be very limited.

Notes and References

1. While US-based General Dynamics Electric Boat provided specialist draughtsman support and management assistance to UK companies during the production of conventional *Astute*-class submarines, it is unclear what impact this co-operation will have on a successor submarine system. See Hansard, HC Written Answers, 'Submarines', Col. 1540W (17 November 2004). The authors are grateful to Dr Nick Ritchie for identifying this point.

2. HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review* (SDSR), Cm 7948 (London: The Stationery Office, October 2010), paras. 3–1, 3–13.

3. Ministry of Defence, 'The United Kingdom's Future Nuclear Deterrent: 2012 Update to Parliament', 2012, p. 3.

4. National Audit Office, *Ministry of Defence: The Major Projects Report 2012 Appendices and Project Summary Sheets*, HC 684-II (London: The Stationery Office, January 2013), p. 376.

5. *Ibid.* Based on total project spending on concept and assessment phases of £3.9 billion.

6. Inflation-adjusted from FY 2006/07 figures (using latest GDP deflator figures). See Ministry of Defence, 'The United Kingdom's Future Nuclear Deterrent'.

7. Malcolm Chalmers, 'Mid-Term Blues? Defence and the 2013 Spending Review', RUSI Briefing Paper, February 2013, p. 12.

8. HM Government, *The Future of the United Kingdom's Nuclear Deterrent*, Cm 6994 (London: The Stationery Office, December 2006), p. 26.

9. Inflation-adjusted from FY 2006/07 figures provided by House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The White Paper, Volume 1, Ninth Report of Session 2006-07*, HC 225-I (London: The Stationery Office, March 2007), para. 153.

10. John Simpson and Jenifer Mackby, 'The Special Nuclear Relationship: A Historical Chronology', in Jenifer Mackby and Paul Cornish (eds), *US-UK Nuclear Cooperation after 50 Years* (Washington, DC: CSIS, 2008), p. 12.

11. No official text of the MDA is available. However, an unofficial version compiled from US sources can be found on the former Acronym Institute website, <http://www.acronym.org.uk/dd/dd77/77mda.htm>, accessed 7 May 2013.

12. The US Joint Atomic Information Exchange Group (JAIEG) regulates the transfer of American information, while the UK Atomic Control Office in London and the UK Atomic Co-ordinating Office in Washington regulate the transfer of British information. See Office of the Assistant Secretary of Defense for Nuclear, Chemical and Biological Defense Programs, 'The Nuclear Matters Handbook', Expanded Edition, 2008, Chapter 8.

13. *Hansard*, HC Written Answers, 'Defence: Nuclear Weapons', Col. 503W (17 June 2010).

14. International Panel on Fissile Materials, 'Countries: United Kingdom', <http://fissilematerials.org/countries/united_kingdom.html>, accessed 7 May 2013.

15. Assuming, in line with International Atomic Energy Agency definitions, that one warhead can be produced from 25 kg of HEU.

16. Lorna Arnold, *Britain and the H-Bomb* (Basingstoke: Palgrave, 2001), Chaps. 10, 11. Between 1962 and 1992, it is thought that the UK conducted around twenty-eight collaborative nuclear tests with the US at their test sites in Nevada and Nellis Air Force Range. See Nuclear Weapon Archive, 'Joint US-UK Testing', <http://nuclearweaponarchive.org/Uk/UKTesting.html>, accessed 7 May 2013.

17. Interview with Steve Henry, Deputy Assistant Secretary of Defense for Nuclear Matters, by Michael Gerson, CSIS US-UK Nuclear History Project, 2008, available at *CSIS.org*, <http://csis.org/program/us-uk-nuclear-cooperation-after-50-years>, accessed 7 May 2013.

18. House of Commons, *Official Report*, Col. 17W (23 March 2009).

19. Troy E Wade II, 'Nuclear Testing: A US Perspective', in Mackby and Cornish (eds), *US-UK Nuclear Cooperation after 50 Years*, p. 210. Hydrodynamic tests explore the behaviour of nuclear materials in explosive conditions by monitoring the detonation of materials chosen to represent those within nuclear warheads. Subcritical tests go one step closer to the real thing, by monitoring the detonation of weapons-grade plutonium, while ensuring no true nuclear explosion (characterised by a self-sustaining fission reaction within the plutonium) is created. For more information on subcritical tests see David C Conrad, 'Underground Explosions are Music to Their Ears', *Science and Technology Review* (July/August 2000), <https://www.llnl.gov/str/Conrad.html>, accessed 7 May 2013.

20. Interview with Stanley Orman, former Deputy Director, UK Atomic Weapons Establishment, by Tara Callahan, CSIS US-UK Nuclear History Project, 2008, available

at *CSIS.org,* <http://csis.org/program/us-uk-nuclear-cooperation-after-50-years>, accessed 7 May 2013.

21. *Hansard*, HC Written Answers, 'Trident Missiles', Col. 214W (8 December 2009); *Hansard*, HC Written Answers, 'Trident Missiles', Col. 1524 (28 March 2007).

22. Hans M Kristensen, 'Administration Increases Submarine Nuclear Warhead Production Plan', FAS Strategic Security Blog, 30 August 2007, <http://blogs.fas.org/security/2007/08/us_tripples_submarine_warhead/>, accessed 7 May 2013.

23. A report by Sandia National Laboratories announced a series of tests, the results of which would prove 'critical to the UK implementation of the [US] W76-1' warhead. See *Sandia Lab News*, 'Nuclear Weapons Engineering', March 2011, p. 3, <http://www.sandia.gov/news/publications/lab_accomplishments/_assets/documents/lab_accomp-2011.pdf>, accessed 7 May 2013.

24. *Hansard*, HC Written Answers, 'Nuclear Weapons', Col. 842W (3 December 2007).

25. Article XI, Polaris Sales Agreement, *International Legal Materials* (Vols. 1–51, 1962–2012). A breakdown of Trident D5 procurement costs between 1980 and 2005 can be found at HM Treasury, <http://www.hm-treasury.gov.uk/d/foi_trident_110806.pdf>, accessed 7 May 2013.

26. Polaris Sales Agreement, 'Note from the United States to the United Kingdom Regarding Polaris Sales Agreement', *International Legal Materials* (Vols. 1–51, 1962–2012).

27. While SACEUR can request it, their use can only be ordered according to the UK 'two-man rule', which requires the prime minister and a senior deputy to transmit a 'use request' to the relevant submarine captain. Kristan Stoddard, 'Maintaining the Moscow Criterion: British Strategic Nuclear Targeting, 1974–1979', *Journal of Strategic Studies* (Vol. 31, No. 6, December 2008), p. 899.

28. Kristan Stoddart, 'The Special Nuclear Relationship and the 1980 Trident Decision', in Mackby and Cornish (eds), *US-UK Nuclear Cooperation after 50 Years*, p. 95.

29. The final cost of the British development of the Chevaline upgrade for Polaris in the 1970s was over four times higher than originally expected. Stoddard, 'Maintaining the Moscow Criterion', p. 921.

30. The UK government has announced that the cost of its involvement in the US-led Trident life-extension programme will be some £250 million, which it believes is 'very significantly less than it would cost to acquire an alternative delivery system'. House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The White Paper, Volume 1*, para. 161.

31. HM Government, *The Future of the United Kingdom's Nuclear Deterrent*, p. 31.

32. *Ibid.*, para. 161. For a detailed breakdown of Trident D5 procurement costs between 1980 and 2005, see HM Treasury, <http://www.hm-treasury.gov.uk/d/foi_trident_110806.pdf>, accessed 7 May 2013.

33. Matthew Harries, 'Britain and France as Nuclear Partners', *Survival: Global Politics and Strategy* (Vol. 54, No. 1, January 2012), pp. 8–12.

34. HM Government, *Treaty between the United Kingdom of Great Britain and Northern Ireland and the French Republic relating to Joint Radiographic/Hydrodynamic Facilities*, Cm 7975 (London: The Stationery Office, November 2010). Hereafter, 'Treaty relating to Joint Radiographic/Hydrodynamic Facilities'.

35. *Ibid.*, Article 1.1.

36. *Ibid.*

37. For instance, the UK may be able to draw upon the results of a US study conducted at Lawrence Livermore National Laboratory that suggested that the plutonium cores of existing warheads may remain functional for up to 150 years – more than three times longer than initially thought. Bruce T Goodwin, 'Plutonium at 150 Years: Going Strong and Aging Gracefully', *Science and Technology Review* (December 2012).

38. Inflation-adjusted from FY 2006/07 figures provided by Ministry of Defence, 'The United Kingdom's Future Nuclear Deterrent: 2012 Update to Parliament', 2012.

39. Keith Hartley, 'Defence-Industrial Issues: Employment, Skills, Technology and Regional Impacts', BASIC Trident Commission, Discussion Paper 2, March 2012, p. 6. While US companies provided assistance during the production of conventional *Astute*-class submarines, it is unclear how this assistance might transfer to a replacement submarine programme.

40. HM Government, *The Future of the United Kingdom's Nuclear Deterrent*, p. 22.

41. *Ibid.*, pp. 22–23.

42. Emphasis added. The National Archives (TNA), DEFE 19/275, Duff-Mason report on factors relating to the further consideration of the future of the UK nuclear deterrent (commonly known as the 'Duff-Mason report'), December 1978.

43. This was one of the arguments made by Prime Minister Macmillan to President Kennedy at the December 1962 Nassau summit, at which the US agreed to supply Polaris to the UK. Macmillan made it clear that the alternative for the UK to US nuclear co-operation would unlikely be an abandonment of its effort to remain a nuclear-armed power.

Rather, a draft communiqué suggests that if the Polaris sale were to fall through, the UK would make a 'determined effort to build ... their own missiles', even at the expense of conventional defences, if necessary, 'so that the independent British power which has always been used in the spirit of the alliance should not disappear.' Richard E Neustadt, *Report to JFK: The Skybolt Crisis in Perspective* (New York, NY: Cornell University Press, 1999), p. 135.

44. According to available versions of the text of the MDA, only one of its articles – that relating to the transfer of classified information – can be terminated by one party alone. In this case, one year's notice must be given. An unofficial version compiled from US sources can be found on the former Acronym Institute website, <http://www.acronym.org.uk/dd/dd77/77mda.htm>, accessed 7 May 2013. No explicit withdrawal terms can be found within the publicly available version of the original 1963 PSA. See Polaris Sales Agreement, *International Legal Materials*.

45. Ministry of Defence, *Defence Industrial Strategy*, Cm 6697 (London: The Stationery Office, December 2005), pp. 70–71.

46. Ministry of Defence, 'The United Kingdom's Future Nuclear Deterrent: The Submarine Initial Gate Parliamentary Report', May 2011, p. 7.

47. Ministry of Defence, *Defence Industrial Strategy,* pp. 70–71.

48. 'Treaty on the Non-Proliferation of Nuclear Weapons (NPT)', Article I, available at the UN Office for Disarmament Affairs, <http://www.un.org/disarmament/WMD/Nuclear/NPTtext.shtml>, accessed 7 May 2013.

49. A draft report from Main Committee 1 of the 1995 NPT Review Conference noted that 'there are variations in the interpretation of certain aspects of [this provision] which may have resulted in transfer of nuclear weapons in violation of the spirit and objective of [this provision]'. This provision was excluded from the final committee report. See Draft Report of Main Committee I, NPT/CONF.1995/MC.I/1, 8 May 1995, available at <http://www.un.org/depts/ddar/nptconf/20fe.htm>, accessed 7 May 2013.

50. Rebecca Johnson, 'Renewal of US-UK Nuclear Cooperation "in Breach of NPT" Say Eminent Lawyers', Acronym Institute for Disarmament Diplomacy, 31 August 2008, <http://www.acronym.org.uk/articles-and-analyses/renewal-us-uk-nuclear-cooperation-in-breach-npt-say-eminent-lawyers>, accessed 7 May 2013.

51. See, for example, Statement by Mohammad Mahdi Akhondzadeh, Deputy Foreign Minister and Head of Delegation of the Islamic Republic of Iran at the First Session of the Preparatory Committee of the 2015 NPT Review Conference, 2 May 2012, <http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/npt/prepcom12/statements/2May_Iran.pdf>, accessed 7 May 2013.

52. When accepting the extension of the PSA in principle, then-US President George W Bush stated that the US attaches 'great importance to the maintenance of an *operationally independent* nuclear force capability by the United Kingdom' (emphasis added). 'Annex 2: Exchange of letters between the Prime Minister and the President of the United States of America', in House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The White Paper, Volume I*, p. 789.

53. Simpson and Mackby, 'The Special Nuclear Relationship', p. 4.

54. The UK had developed a hydrodynamic testing technique which could monitor the implosion of non-fissile (and therefore not weapons-usable) plutonium, which was a far better material for testing than non-plutonium equivalents. At the time, the US Congress had prohibited any hydrodynamic testing with plutonium of any form (both fissile and non-fissile). See interview with Stanley Orman, former Deputy Director, UK Atomic Weapons Establishment, by Tara Callahan, CSIS US-UK Nuclear History Project.

55. Harries, 'Britain and France as Nuclear Partners', p. 15.

56. Simpson and Mackby, 'The Special Nuclear Relationship', p. 19.

57. John Walker, *British Nuclear Weapons and the Test Ban 1954–1973* (London: Ashgate Publishing, 2010), pp. 300–01.

58. *Ibid.*

59. Simpson and Mackby, 'The Special Nuclear Relationship', p. 16.

60. HM Government, *Securing Britain in an Age of Uncertainty*.

61. Michael Quinlan, 'The Future of Deterrent Capability for Medium-Sized Western Powers in the New Environment', *IFRI Proliferation Papers* (No. 4, Autumn 2001).

62. House of Lords, *Official Report*, Col. WA172 (15 November 2010).

63. *Ibid.*, p. 18.

64. Emphasis added. TNA, DEFE 19/275, Duff-Mason report.

65. Harries, 'Britain and France as Nuclear Partners'.

66. For instance, a UK shift from the Trident D5 missile to a joint UK-France missile would complicate the UK's relationship with the US for at least two reasons. First, Lockheed Martin (the US manufacturer of the Trident D5 missile) would suffer a small, but by no means trivial, loss of business. Second, any suggestion that the UK had transferred

missile technology acquired through the PSA to France might sour relations with the US and its defence industry.

67. 'Section 3: Key Areas of Co-operation', in House of Commons Foreign Affairs Committee, 'Global Security: UK-US Relations', Sixth Report, March 2010, para. 136.

68. The prospect of the UK moving its nuclear forces from a submarine-only system to an air-only system will be discussed in forthcoming RUSI analysis of the UK government's 'Alternatives' study.

69. The UK AWE site-development plan suggests that only one facility could follow the Teutates model: Project Pegasus (which handles radioactive materials).

70. It has previously been proposed that should Scotland vote for independence, the rest of the UK might seek to replace the services supplied at Faslane and Coulport (both in Scotland) at US or French bases. See House of Commons Scottish Affairs Committee, 'The Referendum on Separation for Scotland: Terminating Trident – Days or Decades?', Fourth Report, October 2012, p. 19.

71. Even with significant planning, the UK's nuclear-armed submarines may only be able to patrol for six months before some shore-based servicing or maintenance would be required.

72. John Ainslie, 'Trident: Nowhere to Go?', Campaign for Nuclear Disarmament, February 2012, p. 18.

73. A 2011 press release suggests that there is a collaborative arrangement between the UK and the US for the integration of sonar arrays and respective combat systems. See Sam LaGrone and Richard Scott, 'Strategic Assets: Deterrent Plans Confront Cost Challenges', *Jane's Navy International* (December 2011).

74. Keith Hartley, 'Defence-Industrial Issues', p. 14.

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THE FUTURE OF THE UK'S CO-OPERATIVE NUCLEAR RELATIONSHIPS

Hugh Chalmers and Malcolm Chalmers

The UK's longstanding co-operative nuclear relationship with the US has enabled it to contain some of the costs of maintaining an independent nuclear force. Several important decisions on the future of this force are due to be taken soon, both on plans for a new generation of missile submarine, and on the possible replacement of the UK's nuclear warhead. Historical experience suggests that such junctions in the UK's nuclear evolution can be an opportunity to realise further cost savings by expanding the UK's co-operative nuclear relationships.

This paper argues, however, that significant expansion of the UK's nuclear relationships is now unlikely. The government's commitment to maintain a credibly independent force (one that could, hypothetically, operate without foreign assistance for an extended period of time) limits the extent to which it can further increase technical dependence on the US or France. The commitment of the UK, US and France to the Nuclear Non-Proliferation Treaty limits options in relation to sharing of nuclear warheads. The uniquely constrained shape of the UK nuclear force – with only one warhead type on one delivery system – further reduces the options for cost-saving collaboration.

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