

**Royal United Services Institute** for Defence and Security Studies

**Conference Report** 

### Papers from the 2015 Annual Conference of the UK Project on Nuclear Issues 4 June 2015

Edited by Timothy Stafford and Emil Dall







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### **Editors' Note**

These papers were presented by emerging experts from the UK Project on Nuclear Issues (UK PONI) at the 2015 UK PONI Annual Conference, held at the Royal United Services Institute in June 2015. The information contained in them is current at the time of writing in September 2015. The views expressed are the authors' own, and do not necessarily reflect those of the authors' institutions, UK PONI or the Royal United Services Institute.

### **Nuclear Powers and Terrorism** Challenges for Indo-Pakistani Strategic Stability

#### **Tahir Mahmood Azad**

Both India and Pakistan are de facto nuclear powers, and nuclear weapons have become an important part of diplomacy between them. Nuclear deterrence has played a significant role in maintaining an 'ugly stability' between India and Pakistan.<sup>1</sup> While neither aims at war, non-state actors can manipulate their relations, especially through terrorist activity. Any major terrorist action could (inadvertently) start a war between the two countries. There is no doubt that terrorist organisations have become a very serious threat in South Asia, as they have around the world. For this reason, among others, Pakistan is taking significant measures to fight terrorism and build good relations with India. At this stage, India must change its policy of consistently shifting blame onto Pakistan. Mutual trust and co-operation would be constructive in strengthening relations.

#### **Dual Threats: Terrorism and Nuclear Weapons**

There is no doubt that terrorism has come to pose a serious challenge to international peace and development, perhaps becoming one of the most serious non-traditional security threats to global peace. War-fighting strategies have been developed during the last few decades, and insurgencies and terrorist groups have undermined traditional security arrangements between states. Now states are facing both traditional and non-traditional security threats.<sup>2</sup> South Asia has suffered very serious challenges in this regard and terrorism is present in almost every regional state in various forms and degrees. Terrorists are engaged in a variety of brutal activities in the region, including targeted killing, suicide bombings, drug trafficking, kidnapping, violence and assassinations of key personalities.

In addition, terrorist organisations have taken advantage of the existing rivalry between Pakistan and India. There are dozens of militant groups in Pakistan. Similarly, there are 'more than 100 separatist and extremist armed groups' in India,<sup>3</sup> which has already banned thirty-five groups for unlawful activity.<sup>4</sup> Some of these groups have brought India and Pakistan to the brink of war on several occasions over the past decade. Terrorist groups are adopting advanced technologies

<sup>1.</sup> The term 'ugly stability' in relation to South Asia was introduced by Ashley J Tellis in *Stability in South Asia* (Santa Monica, CA: RAND Documented Briefing, 1997), p. viii.

<sup>2.</sup> Peter Hough has comprehensively discussed non-traditional security threats in his book *Understanding Global Security* (Abingdon: Routledge, 2008).

<sup>3.</sup> Aminesh Roul, '100 More Terrorist Groups Banned in India: What are India's Counterterrorism Priorities?', *Terrorism Monitor* (Vol. 8, No. 22, 5 June 2010), p. 6.

<sup>4.</sup> Ministry of Home Affairs India, list of banned organisations, correct as of 30 March 2015, available at <a href="http://mha.nic.in/BO>">http://mha.nic.in/BO></a>.

and tactics to accomplish their political objectives. In this regard, one aspect that has received inadequate attention is the relationship between terrorism and the regional politics of nuclear weapons. Would this strategic stability be undermined by terrorist groups?

Terrorist groups have penetrated South Asia's socio-political system. In Mohan Malik's view, 'non-state or anti-state actors have twice brought nuclear-armed Pakistan and India to the brink of a war since September 11 [2001], which could have escalated to the nuclear level'.<sup>5</sup> The first occasion was on 13 December 2001, when a terrorist attack targeted the Indian parliament. According to Chari, 'An estimated 800,000 troops, including its two strike corps, deployed on India's western borders, its Air Force units and satellite airfields were activated and the fleet moved into the northern Arabian Sea to join the western fleet for blockading Pakistan if required'.<sup>6</sup> On 30 December 2002, after the year-long border crisis came to an end, then-President Pervez Musharraf disclosed that he 'would have unleashed an "unconventional war" on India had a single Indian soldier crossed the border. In response, India's defence minister, George Fernandes, asserted that ""there will be no Pakistan left" if India used its nuclear weapons'.<sup>7</sup> It was the first time in the history of South Asia that two nuclear-armed neighbours were on the brink of nuclear war. Under serious global pressure, India was forced to pull out its forces; but this episode nevertheless had serious implications for the future of Pakistan–India relations. Both states struggled towards a peace process through bilateral talks and discussions.

The November 2008 Mumbai incident was another terrible incident in the history of India, crushing the peace process between Pakistan and India – and the second occasion on which the two countries almost found themselves at war. On 26 November 2008, ten terrorists with grenades and machine guns launched a series of attacks on major commercial and financial targets in Mumbai. It took three days for Indian security forces to defeat the terrorists, nine of whom were killed. At least 172 people were killed in this terrorist attack, which has also been referred to as 'India's 9/11'.<sup>8</sup> It was another serious attempt by terrorists to provoke India and engage the two nuclear neighbours in war.

However, Pakistan has reacted sensibly and avoided entering into a 'blame game' after various terrorists' attacks on its territory, such as those against its military installations, including the Peshawar school incident in December 2014, and various other attacks in which thousands of people have been killed.

#### Nuclear Terrorism: Theoretical Possibilities

What would be the consequences if a future terrorist attack targeted nuclear facilities? According to Jaspal, 'Nuclear terrorism could take many forms, any one of which would be a disaster by

Mohan Malik, 'The Stability of Nuclear Deterrence in South Asia: The Clash between State and Anti-State Actors', in Satu Limaye, Mohan Malik and Robert Wirsing (eds), *Religious Radicalism in South Asia* (Honolulu, HI: Asia Pacific Center for Security Studies, 2004), p. 322.

<sup>6.</sup> P R Chari, 'Nuclear Crisis, Escalation Control, and Deterrence in South Asia', Henry L Stimson Center, August 2003, p. 20.

<sup>7.</sup> P R Chari, Pervaiz Iqbal Cheema and Stephen P Cohen, *Four Crises and a Peace Process: American Engagement in South Asia* (Washington, DC: Brookings Institute Press, 2009), p. 195.

<sup>8.</sup> Angel Rabasa et al., 'The Lessons of Mumbai', RAND Corporation, 2009, p. 1.

any measure'.<sup>9</sup> It is vital to understand that there is a range of potential 'nuclear terrorism' scenarios, and that the each would come with a diverse range of consequences.<sup>10</sup> Generally, there are four scenarios of nuclear terrorism described by security analysts. These scenarios are applicable in relation to any nuclear power. We can also assume a fifth scenario particularly in the case of Pakistan and India.

#### 1. Buying or Stealing a Nuclear Weapon

The acquisition of a nuclear device by terrorist groups poses serious challenges to nuclearweapon states (NWS). The eventuality that a nuclear weapon is stolen and falls into terrorists' hands is highly unlikely in the case of India and Pakistan.

#### 2. Attack on Nuclear Power Plants and Nuclear-Weapons Facilities

In this case, terrorists might seek to accomplish their political objectives by striking a truck or light aircraft carrying high explosives near a critical part of a nuclear facility; they might also attack the facility with small arms, artillery or missiles before occupying it.<sup>11</sup> Pakistan and India have both increased the number of nuclear installations within their territory during the last few years. Given that India has a greater number of current and proposed nuclear installations than Pakistan, an attack on a nuclear facility is a greater risk for India.

#### 3. Radiological Dispersal Device (RDD)

Building and using a radiological dispersion weapon, or 'dirty bomb', would be the simplest option for a terrorist. Serious disorder would arise from the widespread panic over possible radioactive contamination and enduring health effects. A more dangerous radiological weapon could be prepared using the fissile materials required for a highly enriched uranium (HEU) or plutonium nuclear weapon.

#### 4. Building a Nuclear Weapon

One way for terrorists to obtain a nuclear weapon would be to produce the required fissile material themselves in order to build a nuclear device.<sup>12</sup> The most arduous part of creating a nuclear weapon is obtaining the fissile material required, arguably the most ambitious, most complicated and least likely step. Terrorist groups cannot make nuclear explosive material, which includes HEU and plutonium.<sup>13</sup> Terrorists do not have the technical and industrial

<sup>9.</sup> Zafar Nawaz Jaspal, 'WMD Terrorism and Pakistan: Counterterrorism', *Defence against Terrorism Review* (Vol. 1, No. 2, Fall 2008), pp. 103–18.

<sup>10.</sup> Michael A Levi, On Nuclear Terrorism (Cambridge, MA: Harvard University Press, 2007), p. 5.

<sup>11.</sup> Alex Schmid and Robert Wesley, 'Possible Causes and Motives of Nuclear and Radiological Terrorism', in Jeffrey Ivan Victoroff (ed.), *Tangled Roots: Social and Psychological Factors in the Genesis of Terrorism* (Amsterdam: IOS Press, 2006), p. 371.

<sup>12.</sup> Robin M Frost, Nuclear Terrorism After 9/11 (New York, NY: Routledge, 2005), pp. 41–42.

<sup>13.</sup> C D Ferguson, 'Nuclear Terrorism Fundamentals', in Magnus Ranstorp and Magnus Normak (eds), Unconventional Weapons and International Terrorism: Challenges and New Approaches (New York,

resources required to enrich their own uranium.<sup>14</sup> This scenario is least possible in relation to Pakistan and India.

### 5. Misunderstanding between Two Nuclear-Weapons States as a Consequence of Terrorism

It is a reality that terrorist groups have been successful many times in creating misunderstanding between Pakistan and India. According to William C Potter, 'It is believable that non-state actors or terrorists could instigate nuclear violence by indirect means involving deception'.<sup>15</sup> There are many factors that can further intensify the situation such as the nature of the bilateral relationship, traditional enmity, ideological differences and territorial disputes. Terrorist activity in the region can further destabilise the situation. As Potter notes, for example, 'terrorists can provoke a nuclear war in South Asia by inflicting conventional violence in India or Pakistan in such manner as to suggest the possibility of state complicity'.<sup>16</sup>

#### Implications and Concluding Remarks

A trust deficit has always prevented the two states from making progress in terms of peaceful negotiation. India does not trust Pakistan and blames it for any terrorist activity within its borders. The 2008 terrorist attacks in Mumbai are a prime example in this regard. According to Zeb, 'Within hours the tragic events started to unfold, New Delhi began implicating Islamabad. It seems that the India and Pakistan peace process is suffering from a classic spoiler problem'.<sup>17</sup> The possibility of war between these two neighbouring states remains very high. Both states have perceived each other as a serious threat since gaining independence, and this perception has stopped them from coming close to peace.<sup>18</sup>

During the last fifteen years, terrorists have been successful in creating misunderstanding between these two NWS. These terrorist groups demolished the bilateral dialogue and peace process between India and Pakistan. Now these terrorist groups pose a serious threat to regional stability. Indeed, any future major terrorist activity in India could be very dangerous in this regard. The whole region would suffer the consequences of war between Pakistan and India, and terrorist groups will gain more confidence and power through this deceptive tactic.

NY: Routledge, 2009), p. 124.

<sup>14.</sup> *Ibid*.

<sup>15.</sup> William C Potter, 'Countering the Threat of Nuclear Terrorism', in Jean du Preez (ed.), 'Nuclear Challenges and Policy Options for the Next U.S. Administration', James Martin Center for Nonproliferation Studies, Occasional Paper No. 14, December 2008, p. 31.

<sup>16.</sup> *Ibid*.

<sup>17.</sup> Rizwan Zeb, 'Makers, Breakers and Spoilers in India-Pakistan Peace Process', *Islamabad Institute of Regional Studies* (Vol. 28, No. 1, Winter 2009/10), p. 24.

<sup>18.</sup> Imran Sardar, 'Conflict Transformation: A Paradigm Shift in Indo-Pakistan Conflict', *Islamabad Institute of Regional Studies* (Vol. 29, No. 2, Spring 2011), p. 4.

#### Recommendations

- Terrorism is a common threat and as such needs to be addressed within the construct of a comprehensive counter-terrorism approach. There is a risk that any kind of conflict, limited war or military strike will lead to nuclear war in South Asia
- India should behave rationally when making decisions. Aggressive policies would aggravate regional instability
- Pakistan has witnessed many major terrorist incidents within its borders but it has not reacted aggressively against any state. By contrast, India has always linked terrorist incidents with Pakistan. Instead, India should refocus on confidence-building measures with a sincere approach
- Track II diplomacy between the two countries should be resumed
- Terrorist groups oppose the peace process between Pakistan and India. This reality needs to be understood, and the peace process should be guarded and pursued at all costs. If possible, a major third-party power should be involved in the peace process as a mediator
- Mutual assurances, transparency, monitoring cross-border flows, confidence building, nuclear security and assessing the scale of risk must all be pursued as part of efforts to diffuse tensions.

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### A Nuclear Procurement Channel for Iran Mission Impossible?

Michele Capeleto

On 14 July 2015, the successful outcome of the negotiations over Iran's nuclear programme was announced.<sup>1</sup> China, France, Germany, Russia, the UK and US (the P5+1) and Iran reached a 'nuclear deal', the Joint Comprehensive Plan of Action (JCPOA). This was subsequently endorsed by UN Security Council Resolution 2231 (2015), creating legal obligations for states to implement its provisions.<sup>2</sup> The JCPOA outlines the various conditions that the Islamic Republic needs to meet for the road ahead in relation to its nuclear programme, providing in exchange a timeframe for the removal of all nuclear-related sanctions. This paper addresses one specific provision of the JCPOA, namely the establishment of the 'procurement channel', which aims to regulate Iran's acquisition of nuclear-relevant items and activities in support of the programme. It is argued here that this complex instrument will be difficult to implement in its current form, mainly due to practical operational challenges, and further adjustments may be required.

#### **Recent Developments Concerning the Procurement Channel**

One fundamental provision of the JCPOA is the establishment of the procurement channel, which was only mentioned in brief in the framework agreement that the parties reached in April.<sup>3</sup> This new set of measures describes how the Islamic Republic should carry out its nuclear-relevant procurement activities in the future, so that confidence can be built and the risk of diversion from legitimate civilian nuclear use will be reduced. In brief, the JCPOA prescribes that the procurement channel should approve every Iranian acquisition of items listed in the most recent versions of the Nuclear Suppliers Group (NSG) Guidelines for Nuclear Transfers (that is, the NSG 'trigger list'), the NSG dual-use list and any non-listed item that governments consider to 'contribute to activities inconsistent with the JCPOA' – in other words, a 'catch-all' clause. In addition, services in support of these activities must be authorised via the channel.<sup>4</sup>

<sup>1.</sup> EU External Action Service, 'Joint Statement by EU High Representative Federica Mogherini and Iranian Foreign Minister Javad Zarif, Vienna, 14 July 2015', <a href="http://eeas.europa.eu/statements-eeas/2015/150714\_01\_en.htm">http://eeas.europa.eu/statements-eeas/2015/150714\_01\_en.htm</a>, accessed 30 November 2015.

<sup>2.</sup> UN Security Council Resolution 2231 (2015), S/RES/2231 (2015), 20 July 2015.

<sup>3.</sup> US Department of State, 'Parameters for a Joint Comprehensive Plan of Action Regarding the Islamic Republic of Iran's Nuclear Program', 2 April 2015, <a href="http://www.state.gov/r/pa/prs/ps/2015/04/240170.htm">http://www.state.gov/r/pa/prs/ps/2015/04/240170.htm</a>, accessed 1 June 2015.

<sup>4. &#</sup>x27;JCPOA Annex IV – Joint Commission', UN Security Council Resolution 2231 (2015), pp. 89–90.

All nuclear-relevant activities will be monitored, and the overall agreement promises to be well equipped to detect potential cheating in a timely manner.<sup>5</sup> Nevertheless, a high level of control comes at a price; in this case, operational complexity. There are three main factors that could complicate the functioning of the procurement channel: the composition of the body overseeing the mechanism; the difficulty in harmonising approaches to the 'catch-all' provision; and the need to ensure the support of and co-ordination with industry.

#### The Nature of the Procurement Working Group

The JCPOA prescribes that a dedicated Procurement Working Group (PWG) be tasked to 'review and decide on proposals' about exports of nuclear-relevant items and services to Iran.<sup>6</sup> The PWG will be a body attached to the Joint Commission (JC) that will oversee the nuclear deal overall, and thus it will also mirror its composition and rules. This means that the PWG will comprise representatives of each of the seven states that initially participated in the negotiations – the P5+1 and Iran – and that decision-making will be consensus-based.<sup>7</sup>

From a political perspective this is certainly a desirable choice, since it will grant representation to every stakeholder. However, from an operational standpoint, the work of the PWG will be subject to multiple risks. Because referrals to the PWG will be made by any potential exporting 'state' (rather than directly by the potential 'exporter'), governments will likely maintain their existing national licensing procedures, and simply add a notification requirement to the PWG's co-ordinator when applicable.<sup>8</sup> As such, the review process is fundamentally an export authorisation that must be granted by seven independent authorities in seven different states.<sup>9</sup>

The problem with this approach is that in many cases consensus may be difficult to achieve. Export authorisations, in general, are a form of restriction used by governments unilaterally to protect and support national interests. In other words, the assessment of whether an export is legitimate will not be fully based on technical parameters. Hence, even if common standards are imposed by various international regimes and the JCPOA, individual decisions of governments could easily be at odds.

Another operational challenge for the PWG will be the agreed timeline for referred export requests. According to the JCPOA, each referral must be assessed by all members of the PWG within twenty working days, unless an extension is requested – which would push the deadline to thirty working days.<sup>10</sup> It is still not clear if states are planning to implement any special procedure to ensure that the target timeline is met. Nevertheless, processing times for licence requests can vary across jurisdictions, and meeting this requirement may be more complicated than expected.

<sup>5.</sup> Ben Hubbard, 'Arab World Split Over Iran Nuclear Deal', *International New York Times*, 14 July 2015.

<sup>6. &#</sup>x27;JCPOA Annex IV – Joint Commission', pp. 89–90.

<sup>7.</sup> *Ibid*.

The designated co-ordinator is the high representative of the EU for foreign affairs and security policy.

<sup>9.</sup> Potentially eight, since transfers of nuclear end-use items will also require IAEA approval.

<sup>10. &#</sup>x27;JCPOA Annex IV – Joint Commission', p. 90.

For instance, in the past year the Export Control Organisation (the licensing authority in the UK) managed to process only 70 per cent of its licence applications within twenty working days.<sup>11</sup> Adding an additional and as yet ill-defined procedure to the daily workload of licensing personnel will likely only result in longer times, until a certain level of maturity has been reached. Besides, since 'each JCPOA participant will be responsible for its own costs of participating in the Joint Commission', it is important that each PWG member defines appropriate strategies and allocates sufficient resources to guarantee that the mechanism functions accordingly.<sup>12</sup>

Further to this, each exporting state will need to evaluate the readiness of its export-control system with regards to identifying the relevance to the JCPOA of any potential export and in making a serviceable referral to the PWG. Even though this may be a relatively small problem for exports/exporters of items in the NSG 'trigger list', given that these exports will be limited in numbers, the same logic does not apply to items in the NSG dual-use list. The potential number of such exports and exporters requiring a PWG review may be substantial, adding considerably to the workload of each of the participants.

In addition, in countries with a less mature export-control system nuclear-relevant exports may fail to be referred due to a company's low level of awareness in trade-compliance matters. More details of how referrals are meant to be made in practice should be provided, as working in a foreign language and the specific IT skills required may be a barrier for some personnel, unless they receive adequate training in time.

#### The Approach to the 'Catch-All' Provision

The history of Iran's nuclear programme demonstrates that many items currently not included in the lists of the NSG can be beneficial in developing a nuclear fuel cycle.<sup>13</sup> Thus, it should be no surprise that the JCPOA includes a provision allowing states to refer exports of non-listed items to the PWG.<sup>14</sup> It is likely that this 'catch-all' provision is intended to prevent past issues of 'below-control-threshold procurement' from being repeated.

Indeed, in its reports to the Security Council, the UN Panel of Experts established pursuant to Resolution 1929 (2010) concluded that Iran had previously relied on the 'procurement of non-listed, dual-use items as substitutes for controlled items' in order to advance its nuclear programme. These items, having been upgraded indigenously, could either serve as a substitute for controlled items or be used as parts of other items produced in Iran.<sup>15</sup>

<sup>11.</sup> Export Control Organisation, 'Export Control: Licensing Performance Dashboard', <https://www. gov.uk/government/publications/export-control-licensing-performance-dashboard/export-controllicensing-performance-dashboard>, accessed 30 November 2015.

<sup>12.</sup> JCPOA Annex IV – Joint Commission', p. 89.

<sup>13. &#</sup>x27;Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)', S/2014/394, 11 June 2014, p. 22.

<sup>14.</sup> JCPOA Annex IV – Joint Commission', pp. 89–90.

<sup>15. &#</sup>x27;Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)', S/2014/394, p. 22; 'Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)', S/2013/331, 5 June 2013, pp. 19–20.

With this in mind, the fundamental problem with the catch-all provision is that it does not clearly specify when it should be triggered. The text of the agreement only states that 'items that could contribute to activities inconsistent with the JCPOA' may be referred to the PWG; however, each government is given full freedom to determine if a transfer falls within the scope of this concept.<sup>16</sup>

Based on a comparative analysis of national lists of strategic goods, different interpretations of this provision should be anticipated.<sup>17</sup> As previously mentioned, control lists agreed at multilateral fora are not necessarily the same as those incorporated into national legislation. States can choose to expand the scope of these lists, and this has indeed been the case in some countries participating in the PWG.<sup>18</sup> These differences have the potential to generate tensions among participants over time, in particular given the requirement for consensus to make decisions.

It should be noted that the main argument here is not that this catch-all clause should be written off, since a certain level of flexibility is indeed necessary to avoid the need to update the lists subject to PWG approval in the event of technological change or following the realisation that an item may be functional to Iran. Still, because of the subjective nature of this catch-all trigger, a mechanism for approving these specific referrals on a less stringent basis than consensus might have been desirable.

#### Ensuring a Stable Environment for Industry

After a prolonged period of restrictions, the planned lifting of sanctions on Iran is expected to stimulate business interaction between the country and the rest of the world, leading to mutual economic benefits. For Iran, whose economy is largely dependent on exports, a normalised situation will help recovery from a deep economic crisis; for other countries, many companies will be able to operate again in the Iranian market and satisfy their appetite for growth.<sup>19</sup>

Enterprises directly affected by the JCPOA, though, will need to assess the benefit of doing business with Iran against the cost incurred in obtaining it. From a trade-compliance perspective, this benefit will come at a significant cost: a company willing to sell nuclear-relevant items will have to be confident enough that its export applications can satisfy not only the requirements of its own government's agency, but also those of the states participating in the PWG.

<sup>16. &#</sup>x27;JCPOA Annex IV – Joint Commission', p. 89.

As a reference, please note the existence of differences in control entries between the US Commerce Control List and the EU Dual-Use List. US Government Publishing Office, 'Electronic Code of Federal Regulations', <a href="http://www.ecfr.gov/cgi-bin/text-idx?SID=c13e01a1ff686f1500fb4856ff288366&mc=true&node=ap15.2.774\_12.1&rgn=div9">http://www.ecfr.gov/cgi-bin/text-idx?SID=c13e01a1ff686f1500fb4856ff288366&mc=true&node=ap15.2.774\_12.1&rgn=div9</a>, accessed 4 August 2015; EU Dual-Use List, Annex I to Council Regulation (EC) No. 428/2009, <a href="http://trade.ec.europa.eu/doclib/docs/2015/january/tradoc\_152996.pdf">http://trade.ec.europa.eu/doclib/docs/2015/january/tradoc\_152996.pdf</a>>, accessed 4 August 2015.

See, for instance, the UK Department for Business Innovation and Skills, 'Schedule 3 – Controlled Dual-Use Goods, Software And Technology', in 'UK Strategic Export Control Lists', April 2015, <a href="https://www.gov.uk/government/uploads/system/uploads/attachment\_data/file/422364/">https://www.gov.uk/government/uploads/system/uploads/attachment\_data/file/422364/</a> controllist20150417.pdf>, accessed 30 November 2015.

<sup>19.</sup> World Bank, 'Iran – Overview', <http://www.worldbank.org/en/country/Iran/overview>, accessed 30 November 2015.

Under the current deal, a single denial by any of the participants in the PWG would mean that the proposal would not have been approved. In this event, the proposal could be brought before the JC within five working days, pushing the final date for a decision to a maximum of forty-five working days (that is, approximately two months). The most important issue here is not time, but rather that the participants of the JC are the same as those of the PWG – and so a change in policy is probably not to be expected.

Therefore, unless companies are prepared to adapt their internal processes to satisfy these requirements, the procurement channel may be perceived as an additional, formidable burden – a potential game changer. This may be true in particular for risk-averse enterprises, for those companies that would require major adjustments in their internal compliance programmes, or for smaller companies driven away by the fear of having to pay a fine comparable to those of some recent enforcement cases that have made headlines in the media.<sup>20</sup>

Moreover, the JCPOA includes a mechanism that stipulates the rapid re-imposition of sanctions in the event of non-compliance by a participant country to the agreement. The 'snap-back' of sanctions would not be as immediate as is portrayed in the media, but this measure nevertheless increases the volatility of the overall situation – and will probably discourage all those enterprises that are not highly determined from grasping this new business opportunity.<sup>21</sup>

#### Conclusions

The JCPOA is certainly a landmark agreement whose diplomatic importance cannot be discounted. Given that the agreement has not long been in place, the challenges identified in this chapter will probably constitute only a partial, preliminary list. This is not only because these unprecedented agreements are difficult to benchmark, but also because, at this stage, national implementation processes have not yet begun – and their trajectories could significantly determine the interpretation of some grey areas in the JCPOA.

On a more positive note, even if these challenges are hard to address, they certainly are not impossible: with adequate political will, especially if corroborated by episodes reinforcing a mutual sense of progress, confidence between the parties could eventually be built.

Michele Capeleto is an MA Graduate of King's College London.

<sup>20.</sup> For a collection of these stories, see US Department of Commerce, Bureau of Industry and Security, 'Don't Let This Happen to You!!! An Introduction to the Consequences of Violating US Export Control Law', July 2015, <http://www.bis.doc.gov/index.php/forms-documents/doc\_ view/1005-don-t-let-this-happen-to-you-071814>, accessed 30 November 2015.

<sup>21.</sup> UN Security Council Resolution 2231 (2015), pp. 19–20; 'JCPOA Annex IV – Joint Commission', p. 92.

### How to Deal with North Korea's Nuclear Programme Lessons Learned from the Iran Nuclear Negotiations

#### Jinho Chung

Iran and a group of six nations have reached a deal to limit Iran's nuclear programme for the next fifteen years.<sup>1</sup> While the international community has devoted its attention to Tehran in recent years, North Korea has increased the size and sophistication of its nuclear arsenal. In this context, there is an argument that the Iran nuclear deal could be a positive influence on North Korea. Given the fact that the Iranian and North Korean cases are dissimilar in several aspects, the Iran nuclear deal is unlikely to serve as a *model* for the resolution of the North Korean nuclear issue. Yet analysing some key factors of the Iran nuclear deal could still help to shed light on how to deal with North Korea's nuclear programme. Hence, this paper will examine three core elements of the Iran nuclear deal: the international non-proliferation regime; the level of co-ordination amongst negotiators; and sanctions and incentives. Furthermore, the importance of addressing North Korea's nuclear issue as part of an international security agenda and setting up a new negotiation framework will be discussed as a potentially effective way of resuscitating the stalled nuclear talks with North Korea. In addition, unification of the North with the South will be explored as a potential means of achieving the denuclearisation of the Korean Peninsula in the long run.

#### Key Factors of the Iran Nuclear Deal

#### 1. An International Non-Proliferation Regime

The most important factor which led Iran to an agreement is that the country has remained within the international non-proliferation regime as a state party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and a member state of the International Atomic Energy Agency (IAEA). Despite considerable disagreement between Iran and the six world powers, under the framework of the international non-proliferation regime they could continue generating diplomatic opportunities to carry on dialogue, which ultimately contributed to bridging the chasm in understanding between the two sides.

By contrast, when the IAEA inspections discovered discrepancies between North Korea's initial declarations and IAEA findings, North Korea refused to accept a special inspection. The IAEA

<sup>1.</sup> Michael R Gordon and David E Sanger, 'Iran Agrees to Detailed Nuclear Outline, First Step Toward a Wider Deal', *New York Times*, 2 April 2015.

Board of Governors adopted a resolution which confirmed North Korea's non-compliance with its safeguards agreement and Pyongyang withdrew its IAEA membership in 1994.<sup>2</sup> In 2003, the US was informed that North Korea had a programme to enrich uranium in violation of the 1994 Agreed Framework. Washington decided to halt oil shipments to North Korea and Pyongyang withdrew from the NPT, blaming the US decision.<sup>3</sup> After three years in which it was outside of the international non-proliferation regime, unconstrained by international non-proliferation norms, Pyongyang conducted its first nuclear test in 2006.

#### 2. A High Level of Co-ordination

All five permanent members of the UN Security Council plus Germany participated in the negotiation process with Iran. They shared a common understanding that Iran 'going nuclear' would present a grave challenge to both regional and international security. With this clear goal, and unified will, they could engage in the negotiation process in an active manner. In contrast, the North Korean nuclear issue was, at first, handled by the 1994 Agreed Framework between the US and the DPRK alone.<sup>4</sup> Other permanent members of the UN Security Council did not exert their political and economic influence on the Korean Peninsula by participating in these negotiations. With respect to the Six-Party Talks which were established in 2003, although South Korea, Russia, China and Japan joined the negotiations, each participant was driven to do so by its own, differing national interests. For example, China was interested in maintaining North Korea's stability, Russia adopted a relatively passive attitude compared to other participants, and Japan was busy with its own agenda, namely the abduction issue.<sup>5</sup> Due to these differing national interests, the core of the issue was neglected for years. For example, the Six-Party Talks were designed to counteract the second North Korean nuclear crisis, which stemmed from North Korea's uranium-enrichment programme. However, the Six-Party Talks did not tackle this issue sufficiently and only touched upon its plutonium programme. As a consequence, North Korea unveiled its uranium-enrichment plant which was equipped with approximately 2,000 gas centrifuges to enrich uranium in 2010.6

#### 3. Sanctions and Incentives

Although limited, Iran has a civil society that can exert its political influence through the election process.<sup>7</sup> When the economic sanctions became severe, Iran had difficulties in selling its crude

<sup>2.</sup> IAEA, 'Fact Sheet on DPRK Nuclear Safeguards', 2014.

<sup>3.</sup> John S Park, 'Nuclear Ambition and Tensions on the Korean Peninsula', in Ashley J Tellis, Abraham M Denmark and Travis Tanner (eds), *Asia in the Second Nuclear Age* (Washington, DC: National Bureau of Asian Research, 2013).

<sup>4.</sup> Victor D Cha and David C Kang, *Nuclear North Korea* (New York, NY: Columbia University Press, 2003), pp. 136–45.

<sup>5.</sup> Kang Choi et al., 'Iran Nuclear Negotiations and Momentum for the Resolution of the North Korean Nuclear Issue', Issue Brief/Asan Institute for Policy Studies, May 2015.

<sup>6.</sup> Olli Heinonen, 'North Korea's Nuclear Enrichment: Capabilities and Consequences', 38 North, June 2011.

<sup>7.</sup> Choi et al., 'Iran Nuclear Negotiations and Momentum for the Resolution of the North Korean Nuclear Issue'.

oil, which hurt the nation's economy seriously. In particular, the impact of the sanctions on the middle class generated social pressure which led to the election of a moderate president, Hassan Rouhani, in 2013.<sup>8</sup> On the other hand, North Korea's quest for autarky has made sanctions less effective. In addition, China has shown its reluctance to inflict critical damage on North Korea through sanctions.<sup>9</sup> Further, given the fact that North Korea is a tightly controlled society, it is highly unlikely that citizens will press their interests through politics.<sup>10</sup>

What brought Iran to the negotiation table was the need to end its international isolation for economic reasons. North Korea's primary proliferation driver has been concerns about its security. North Korea's asymmetry in conventional force compared to its neighbours made its leaders consider nuclear weapons as the most effective way to deter potential coercion and aggression against Pyongyang. In addition, at the domestic level, aggravating a sense of crisis in relation to the outside world is a way to rally domestic opinion so as to strengthen regime authority at home. Therefore, North Korea would rather prefer to maintain its isolation, which plays an integral role in the survival of the regime.<sup>11</sup>

#### How to Deal with North Korea's Nuclear Programme

#### 1. Go Beyond the Regional Security Agenda

First, it should be noted that the North Korean nuclear issue is no longer merely a regional security concern.<sup>12</sup> North Korea set a precedent by withdrawing from the NPT. This is a serious threat to global security in the sense that it has undermined the basis of international non-proliferation norms. In addition, as the international community has allowed the status quo to continue, North Korea has incrementally increased the size and sophistication of its nuclear arsenal. In particular, North Korea claimed that it has developed the technology to miniaturise a nuclear device so that it can be mounted on its intercontinental ballistic missile (KN-08).<sup>13</sup> Also, North Korea recently claimed that it successfully tested a submarine-launched ballistic missile.<sup>14</sup> According to research from Johns Hopkins University's School of Advanced International Studies, North Korea currently possesses about sixteen nuclear weapons and could possess up to 100 in future.<sup>15</sup> There is an added risk of technology and material transfer to would-be proliferators

- 13. Anna Fifield, 'North Korea Says it Has Technology to Make Mini-Nuclear Weapons', *Washington Post*, 20 May 2015.
- 14. Sang-Hun Choe, 'North Korea Claims it Has Built Small Nuclear Warheads', *New York Times*, 20 May 2015.
- 15. Calum MacLeod, 'North Korea Expands Nuclear Arsenal, Chinese Experts Say', USA Today, 23 April 2015.

<sup>8.</sup> Farnaz Fassihi, 'Moderate Cleric Hassan Rohani Wins Iran Vote', *Wall Street Journal*, 15 June 2013.

<sup>9.</sup> Tae-Hyo Kim, 'Game Changer: North Korea under the Obama-Lee Partnership and Beyond', *Korea Observer* (Vol. 44, No. 2, 2013), p. 296.

<sup>10.</sup> George Perkovich, 'Why the Iran Nuclear Deal is Not the North Korea Deal', Carnegie Endowment for International Peace, April 2015.

<sup>11.</sup> David E Sanger, 'With U.S. Eyes on Iran, North Korea's Nuclear Arsenal Expanded', *New York Times*, 7 May 2015.

<sup>12.</sup> Choi et al., 'Iran Nuclear Negotiations and Momentum for the Resolution of the North Korean Nuclear Issue'.

around the world, which could spur not only proliferation but also nuclear-security concerns at the global level.

#### 2. A New International Negotiation Framework

The North Korean nuclear issue should therefore be dealt with as an item on the global security agenda. However, the previous negotiation frameworks such as the Agreed Framework and the Six-Party Talks remained at a regional level. Considering the importance of the international non-proliferation regime, the best scenario would be for North Korea to return to the NPT as a non-nuclear-weapon state (NNWS), which is highly unlikely. Therefore, as an alternative, a new negotiation framework should be devised to be as multilateral as possible, which will carry more weight to pressure Pyongyang. In this context, the participation of the EU could contribute significantly to the negotiations' progress by involving more diplomatic measures.<sup>16</sup> Also, all participants in the negotiation should seek to shape a unified and clear goal by co-ordinating their different interests.

#### 3. Denuclearisation of the Korean Peninsula through Unification

So far, approaches to resolving the North Korean nuclear issue have been focused on disabling its nuclear programme and facilities. The US has insisted that North Korea's genuine willingness to denuclearise should be a prerequisite for the negotiations between Pyongyang and Washington, whereas North Korea has sought US recognition of its nuclear-power status.<sup>17</sup> In this context, it seems there is no middle ground between the two sides. Moreover, given that North Korea's primary proliferation driver was rooted in security concerns, it is highly unlikely that North Korea would relinquish its nuclear programme while it perceives itself to be under threat. Pyongyang even revised its constitution to proclaim itself a nuclear state and established a national policy to advance its nuclear-weapon capabilities and its economy at the same time as the two main pillars of national development.<sup>18</sup>

In the face of such stalemate, a new approach should be considered. The possibility that the commencement of multilateral discussions about unification could ultimately lead to the denuclearisation of the Korean Peninsula should not be underestimated. Although there have been ups and downs in terms of the relationship between the South and the North, both sides share unification as a future goal. According to a survey conducted by the Korea Institute of National Unification in 2014, 69.3 per cent of those surveyed in South Korea said that unification is needed.<sup>19</sup> By giving greater priority to the unification issue, the denuclearisation issue could be addressed as a sub-item on the broader unification agenda. Although this would represent

<sup>16.</sup> Heinz Gaertner, 'North Korea, Deterrence, and Engagement', *Defense and Security Analysis* (Vol. 30, No. 4, 2014), pp. 340–42.

<sup>17.</sup> Jethro Mullen, 'North Korea Says it Can Miniaturize Nuclear Weapons', CNN, 20 May 2015.

Simon Mundy, 'US and China Seek to Restart Nuclear Talks with Pyongyang', *Financial Times*, 9 May 2015.

<sup>19.</sup> Sang-Hyun Lee, 'Seven in 10 South Koreans Say "Unification Needed", Yonhap News, 4 December 2014.

a change in approach and would consume a great deal of time and energy, it could assist in tackling the core of a problem.

#### Conclusion

The nature of the Iran nuclear talks is not exactly analogous to the situation regarding North Korea. However, analysing certain key factors of the Iranian case – such as the upholding of an international regime, a high level of co-ordination and the leveraging of effective sanctions and incentives – could help to pave the way for the resolution of the North Korean nuclear issue. Based on an analysis of what made the Iran nuclear negotiations successful, a new approach that considers the North Korean nuclear issue as a matter of global security – and that would therefore involve the participation of multilateral stakeholders – is necessary in order to avoid repeating mistakes. In this sense, discussions about potential unification could be another starting point from which to resuscitate the currently deadlocked nuclear talks with North Korea. The initiation of unification talks could be a legitimate process in terms of inter-Korea relations; but it could also be an opportunity to draw multilateral attention to the Korean Peninsula.

Now that the Iran nuclear talks have resulted in a deal, international attention is turning to Pyongyang. It is high time that the North Korean nuclear issue is pushed to the top of the international security agenda.

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### **Managed Instability** The NATO–Russia Strategic Relationship

#### **Thomas Frear**

The Ukrainian crisis, in particular the Russian annexation of the Crimean peninsula, has underscored in dramatic fashion the need for a reassessment of the Euro-Atlantic strategic environment. This reassessment will take many forms, with the most important part addressing those most dangerous of weapons: nuclear warheads and their delivery systems.

After the Cuban Missile Crisis of 1962 it took many decades for the statesmen and women of the two major Cold War alliances to construct a nuclear security architecture that rested on continual dialogue, mutual reassurance and a commitment to reduce nuclear stockpiles. The events of the twenty-first century have seen this architecture threatened as the NATO–Russia relationship has deteriorated, a process that has recently accelerated.

It is not an exaggeration to say that over the last year and a half the security situation in Europe has dramatically deteriorated, with the post-Cold War consensus – to the extent that this ever really existed – buckling under the strain. This deterioration has inevitably affected the nuclear relationship in Europe, and managing this change will be a major focus in the months and years ahead.

## Concepts of Strategic Stability and Assessing the Nuclear Threat

It should come as a surprise to nobody that NATO and Russia have inherently different views of what constitutes a stable strategic environment in Europe. This paper will very briefly outline these conceptions as well as the role nuclear weapons play in the military doctrines of the region's nuclear powers.

The Russian leadership views the current strategic environment as inherently unstable. This view is informed by Moscow's conception of the asymmetrical imbalance between Russia and NATO in conventional military terms. Put simply, the Russian military is inferior to that of the Atlantic Alliance in every sense, but particularly in terms of technology and military spending. This is compounded by specific programmes – in particular the US Prompt Global Strike initiative and missile defence – that Russia feels pose a direct threat to its nuclear capabilities,<sup>1</sup> which represent the only area in which Russia can match NATO.

Rossiskaya Gazeta, 'Военная доктрина Российской Федерации [Military Doctrine of the Russian Federation]', 30 December 2014, <http://www.rg.ru/2014/12/30/doktrina-dok.html>, accessed 15 July 2015.

The primary role of nuclear weapons has remained the same in the two most recent iterations of Russian military doctrine, issued in 2010 and 2014 respectively:<sup>2</sup>

Russia reserves the right to use nuclear weapons in response to a use of nuclear or other weapons of mass destruction against her and (or) her allies, and in a case of an aggression against her with conventional weapons that would put in danger the very existence of the state.

However, this position is somewhat undermined by the use of simulated nuclear strikes in Russian military exercises, which is consistent with a supposedly redundant feature of Russian military doctrine, the 'de-escalatory strike'.

NATO draws a very different conclusion from Russia in terms of the stability of the strategic environment and the role of nuclear weapons. As is firmly and frequently reiterated, the US Prompt Global Strike and missile-defence programmes are not aimed at neutralising Russia's nuclear arsenal, and in any case are simply not capable of doing so.<sup>3</sup> This suggests that the nuclear balance is viewed by NATO as being predominantly stable, although such a perspective is currently under stress.

NATO, at an alliance level, maintains little in the way of nuclear doctrine, with the 2014 Wales Summit declaration simply reiterating in formulaic language that nuclear weapons are the 'supreme guarantee of the security of the allies'.<sup>4</sup> This situation is unlikely to change due to a reluctance within the Alliance to expose disagreement publicly.

NATO nuclear posture is given a little more substance by the individual doctrines of the nucleararmed allies, with the US, France and the UK all clarifying that nuclear weapons are only to be used in extreme circumstances in order to defend themselves and their allies from a state aggressor. It is also important to highlight that NATO's nuclear-armed members do not maintain a no-first-use policy, supposedly to strengthen the credibility of extended nucleardeterrence guarantees.

#### The Current Nuclear Regime

It is not the place of this paper to discuss in detail the regime governing the Russia–NATO nuclear relationship, but it is necessary to highlight three key relevant aspects of the relationship. First, the 2011 New Strategic Arms Reduction Treaty (New START) provides a framework for limiting the number and deployment options of strategic weapons and, perhaps most importantly, provides mechanisms by which this can be monitored.<sup>5</sup> Secondly, the 1987 Intermediate-Range

<sup>2.</sup> *Ibid*.

<sup>3.</sup> Greg Thielmann, 'Strategic Missile Defense: A Reality Check', Arms Control Association, 21 May 2009.

<sup>4.</sup> NATO, 'Wales Summit Declaration', press release, 5 September 2014, <http://www.nato.int/cps/ en/natohq/official\_texts\_112964.htm>, accessed 15 July 2015.

<sup>5. &#</sup>x27;Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms', 8 April 2010, <a href="http://www.state.gov/documents/organization/140035.pdf">http://www.state.gov/documents/organization/140035.pdf</a>>, accessed 15 July 2015.

Nuclear Forces (INF) treaty prohibits the possession of intermediate-range nuclear-capable systems.<sup>6</sup> Thirdly, the NATO-Russia Council, at least before its suspension, provided a dialogue framework to discuss and manage the wider relationship, including nuclear issues.<sup>7</sup>

#### **Outstanding Threats**

There are a number of specific factors that have undermined the existing regime. The following list is by no means comprehensive, nor are all the issues listed new, but they have been made more prominent by the ongoing fallout from the Ukraine crisis. First is the challenge to the INF treaty system. There are a number of claims and counter-claims in this area but chief among them is the assertion by the US that Russia has breached the INF treaty by testing a new medium-range, ground-launched cruise missile.<sup>8</sup> Moscow has countered that US long-range drones and missile-defence systems that are capable of launching cruise missiles also violate the treaty.<sup>9</sup>

Second is the interminable issue of missile defence. Russia deems the deployment of US missiledefence systems to Europe as a threat to its ballistic-missile systems, putting them at a strategic disadvantage and thus destabilising the region. Indeed, the threat of a missile-defence system in Eastern Europe is believed by some to have been the catalyst for the Russian development of the R-500 cruise missile for the Iskander system. This was the system initially suspected by the US of violating the INF treaty.<sup>10</sup>

Third, and the primary focus of this part of the paper, is the role of dual-use delivery systems and tactical nuclear weapons. Discussion of the role of tactical, or non-strategic, nuclear weapons has been a persistent but low-key topic of discussion in NATO and civil society, but events in Ukraine have given the issue new salience. Tactical nuclear weapons remain unconstrained by international treaties, in stark contrast to the well-regulated intercontinental and intermediate-range categories, and information regarding their possible uses is scarce. Furthermore, whilst the number of US B-61 tactical nuclear systems hosted by European NATO members is broadly accepted to be around 200, the number and location of Russian tactical nuclear systems remain

<sup>6. &#</sup>x27;Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of their Intermediate-Range and Shorter-Range Missiles', 1 June 1988, <a href="http://www.state.gov/t/avc/trty/102360.htm#text">http://www.state.gov/t/avc/trty/102360.htm#text</a>, accessed 15 July 2015.

 <sup>&#</sup>x27;Founding Act on Mutual Relations, Cooperation and Security between NATO and the Russian Federation', 27 May 1997, <a href="http://www.nato.int/cps/en/natohq/official\_texts\_25468.htm">http://www.nato.int/cps/en/natohq/official\_texts\_25468.htm</a>, accessed 15 July 2015.

Tom Z Collina, 'Russia Breaches INF Treaty, US Says', Arms Control Association, 28 August 2014, <a href="https://www.armscontrol.org/act/2014\_09/News/Russia-Breaches-INF-Treaty-US-Says">https://www.armscontrol.org/act/2014\_09/News/Russia-Breaches-INF-Treaty-US-Says</a>, accessed 15 July 2015.

<sup>9.</sup> *Ibid*.

See Yury Fedorov, 'American Ballistic Missile Defence, Russian Iskanders and a New Missile Crisis in Europe', Chatham House Russia and Eurasia Programme Roundtable Summary, 22 May 2009, <http://www.chathamhouse.org/sites/files/chathamhouse/public/Research/Russia%20and%20 Eurasia/220509summary.pdf>, accessed 15 July 2015.

shrouded in secrecy. Numerical estimates range from 1,000 to 2,000, whilst the only assurance provided by the Russian authorities is that these weapons are held in 'central storage'.<sup>11</sup>

The prominence in news coverage of the movement of Russian dual-capable delivery systems in part reflects this worrisome ambiguity. Such concern may once have seemed exaggerated, but given the simulated use of nuclear strikes by such systems in recent Russian military exercises, these concerns appear ever-more vindicated.

As previously mentioned, such strikes are synonymous with the Russian concept of 'de-escalatory strikes', aimed at forcing an opponent either to accept a return to the status quo of the Cold War, when there was considered to be a symmetry between Russian and NATO capabilities, or to accept what Russia has termed in the past 'new political realities' – a status quo altered in Russia's favour. A feature of public Russian military doctrine between 2000 and 2010 was the persistence of simulated nuclear strikes in exercises, which, when combined with Moscow's rhetoric regarding its willingness to put nuclear forces on alert during the Crimea crisis, indicate that de-escalatory strikes may remain a feature of unpublished nuclear doctrine.

Lack of information in this regard can be severely destabilising. It can lead to a dangerous misinterpretation of Russia's actions, particularly during a period of confrontation marked by large-scale, high-tempo military exercises.

#### The 'Use' of Nuclear Weapons in the Ukraine Crisis

The Ukraine crisis provides an excellent case study for the political usage of nuclear weapons, but also highlights the inherent dangers of such nuclear signalling. Strategic nuclear weapons have played a constant role through the implicit limitation placed on NATO responses to Russia's actions in Ukraine, as well as through strategic nuclear exercises by both sides. However, it is the movement of dual-capable systems by both sides that has the biggest potential for further heightening the confrontation. Russia has been particularly active in this regard, having dramatically increased the number and geographical scope of its strategic-bomber flights as well as openly discussing the deployment of modern strategic bombers and ground-based missile systems to Kaliningrad and Crimea.

The map on the next page, taken from a European Leadership Network report on military encounters between Russia and the West last year, whilst not limited to dual-purpose systems, serves to illustrate the numbers of areas in which Russian and NATO militaries are in close proximity within a broadly unregulated environment.<sup>12</sup>

<sup>11.</sup> Gareth Evens, Tanya Ogilvie-White and Ramesh Thakur, *Nuclear Weapons: The State of Play 2015* (Canberra: Centre for Nuclear Non-Proliferation and Disarmament, 2015), p. 54.

<sup>12.</sup> Thomas Frear, Lukasz Kulesa and Ian Kearns, 'Dangerous Brinkmanship: Close Military Encounters Between Russia and the West in 2014', Policy Brief, European Leadership Network, November 2014.



Figure 1: Map Showing Incidents between Russian and Western Forces in Europe in 2014.

Source: European Leadership Network, <http://www.europeanleadershipnetwork.org/russia--west-dangerousbrinkmanship-continues-\_2529.html>, accessed 8 December 2015. Key: Red: high-risk incident; yellow: serious incident; blue: near-routine incident; green: miscellanies.

These actions are not necessarily direct threats, but serve to press those on the receiving end to be more amenable to Russian demands.

#### Prospects for the Future

First, it is important to qualify that the NATO–Russia nuclear relationship cannot be viewed in isolation. The poor state of relations as a whole means that prospective actions in the nuclear sphere must be incremental in order to achieve meaningful results. The issue of tactical nuclear weapons is one that needs to be discussed more openly in light of the Ukraine crisis. Primarily, efforts should focus on information sharing, both in terms of numbers and positioning, with mutual verification mechanisms. This is crucial to avoid escalation based on misunderstanding. It must be acknowledged, however, that previous US and NATO efforts in this respect have been rebuffed by Russia.

Second, it is important to emphasise that there is still value in the INF treaty. The US and Russia must now decide where to go next with their allegations, and if mutually acceptable action cannot be agreed upon there is a dangerous risk of escalation. The US is currently exploring military responses should Russian compliance not be forthcoming. These responses might involve a US breach of – or even a withdrawal from – the treaty, leaving it defunct and raising the prospect of an arms race.

Similarly, the value of upholding the New START must be emphasised. Both sides have highlighted its importance but it is worth noting that Russia now deploys more strategic warheads and

delivery systems than it did in 2011, and with New START due to expire in 2021, it is unclear in the present circumstances what might come next.

Finally, NATO must decide how to respond to Russian nuclear belligerence. One option – however unlikely – may be to increase the importance and visibility of nuclear weapons in NATO doctrine, somehow factoring nuclear weapons into the new force posture in Eastern Europe. This would, of course, be an escalatory move and would be at odds with non-proliferation rhetoric – not to mention the NATO-Russia Founding Act, to which all Alliance members are subscribed.

A second perspective is to accept that NATO cannot undo its conventional superiority over Russia, so perhaps the latter's belligerence will have to be accepted. If this is the case, then it must be better managed, establishing a fine balance between reassuring vulnerable NATO allies and entering a phase of successive escalation with Russia. This is a very difficult task, but at least the conversation has begun.

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### The Strategy and Challenges for UK Civil Nuclear Plant Life Extension

Andrew Gilmour

#### The Nuclear Pinch Point

Over the next decade, the majority of the UK's existing fleet of nuclear power stations are scheduled to be retired. Wylfa Power Station on Anglesey – the first set to close – is expected to cease generation of electricity by the end of 2015. Subsequent closures of the majority of the UK's advanced gas-cooled (AGR) nuclear stations are scheduled prior to 2025, as shown in Table 1. These closures will account for a loss of 7.1 GWe from the UK's electricity generating capacity,<sup>1</sup> and coincide with the closure of several fossil-fuel power stations.

Plant	Туре	Present Capacity	First Power	Expected Shutdown
Wylfa	Magnox	490	1971	2015
Heysham I	AGR*	1,155	1983	2019
Heysham II	AGR	1,220	1988	2023
	AGR	945	1976	2023
Hunterston B	AGR	960	1976	2023
Torness	AGR	1,185	1988	2023
Hartlepool	AGR	1,180	1983	2024
Dungeness B	AGR	1,040	1983	2028
Sizewell B	PWR**	1,198	1995	2035

**Table 1:** Nuclear Power Stations Operating in the UK.

*Source: World Nuclear Association, 'Nuclear Power in the United Kingdom', <www.world-nuclear.org>, accessed 1 July 2015.* 

\* Advanced gas-cooled reactor

\*\*Pressurised water reactor

To address both the closure of existing stations and an increasing domestic demand for energy, the UK's nuclear new-build programme aims to construct a new generation of nuclear power

<sup>1.</sup> World Nuclear Association, 'Nuclear Power in the United Kingdom', <www.world-nuclear.org>, accessed 1 July 2015.

stations to deliver safe, clean base-load electricity to the grid, with 15.6 GWe of new generating capacity currently planned or proposed at five sites, as shown in Table 2.<sup>2</sup>

Site	Proponent	Туре		Date in Use
	EDF Energy	EPR*	3,340	2023
Sizewell C	EDF Energy	EPR	3,340	Not known
Wylfa	Horizon	ABWR**	2,760	2025
Oldbury	Horizon	ABWR	2,760	Late 2020s
Moorside	NuGen	AP1000	3,405	Not known

**Table 2:** Nuclear Power Stations, Planned and Proposed.

Source: Nuclear Energy Agency, 'Status Report on Nuclear Power Plant Life Management', Committee for Technical and Economic Studies on Nuclear Energy Development and Fuel Cycle, 3 May 2000.

However, current projections for the connection of new nuclear power stations to the grid are such that the UK's generating capacity from nuclear is not expected to recover to its current levels until at least 2025. This represents a crucial pinch point in the delivery of base-load electricity, threatening the UK's ability to meet demand, and increasing the country's reliance on energy imports.

Furthermore, recovery from this pinch point depends upon the commercial realisation of these new-build projects. However, the construction of new nuclear power stations represents a significant undertaking, with both technical and economic challenges to overcome in order to achieve on-time connection to the grid.

#### **New-Build Challenges**

One of Europe's leading new-build projects, the Flamanville 3 European pressurised-water reactor (EPR), a Generation III+ PWR under construction on the northwest coast of France, is a clear example of the challenges in delivering an infrastructure project of this size. This nuclear plant, the same design as that to be built at Hinkley Point C, is currently more than five years late and more than €5 billion over budget.<sup>3</sup> Furthermore, the discovery of manufacturing anomalies in the reactor pressure vessel closure head,<sup>4</sup> a key safety-critical component, is likely to cause further delays. These challenges have placed Areva, the reactor vendor for this plant design, into severe financial difficulties, resulting in major redundancies and a corporate takeover of Areva's

<sup>2.</sup> *Ibid*.

World Nuclear News, 'Flamanville Costs up €2 Billion', 4 December 2012, <http://www.worldnuclear-news.org/NN-Flamanville\_costs\_up\_2\_billion\_Euros-0412127.html>, accessed 30 November 2015.

Autorité de Sûreté Nucléaire, 'Flamanville EPR Reactor Vessel Manufacturing Anomalies', 7 April 2015, <http://www.french-nuclear-safety.fr/Information/News-releases/Flamanville-EPR-reactorvessel-manufacturing-anomalies>, accessed 30 November 2015.

reactor design and services business by the country's state-owned nuclear-power organisation, Électricité de France.<sup>5</sup>

Given the UK's track record in delivering large infrastructure projects, such as the London Underground Jubilee Line extension, which was £1.4 billion over budget and two years late,<sup>6</sup> the current projections for the connection of new nuclear to the grid can be considered optimistic. Furthermore, the ability to achieve commercial realisation of such projects has been called into question, with the agreed strike price for electricity at Hinkley Point C, the most mature of the UK's proposed nuclear new-build projects, currently subject to legal challenges. The EU's approval of state aid for this project has been challenged by the Austrian government,<sup>7</sup> which claims that construction of the power station is not in the interest of all EU countries, and would act as a deterrent to investors in renewable technologies. This has resulted in delays to the final investment decision for Hinkley Point C. If the early or even on-time delivery of new nuclear cannot be relied upon, the benefits gained from the UK's existing nuclear fleet must be maximised to bridge the gap in the country's national energy supply.

#### **Principles of PLEX**

PLEX (plant life extension) is the term used to describe activities undertaken to allow a nuclear power station to continue to generate electricity beyond its original operating life. To achieve this, the operator will look to re-justify, repair, refurbish or replace nuclear structures, systems and components (SSC). PLEX is not a new practice for the UK civil nuclear industry, with EDF Energy having previously announced operating extensions to several of the UK's Advanced Gas-Cooled Reactor (AGR) fleet, most notably a ten-year extension to Dungeness B power station in Kent.<sup>8</sup>

The fundamental potential for successful PLEX is driven by the condition of those plant SSCs that are critical to the safety or reliability of the plant, or to cost, as shown in Figure 1.

PLEX activities undertaken by the operator are largely focused on these areas, by reducing conservatism in safety-case claims, reducing mechanical or thermal loads or, if possible, replacing components. Replacement is a significant undertaking; however, almost all of the

- 6. Keith Harper, 'Jubilee Line Cost Races towards Record Books at £330m a Mile', *Guardian*, 16 February 1999.
- 7. World Nuclear News, 'Austria Files Action against Hinkley Point Project', <http://www.worldnuclear-news.org/NN-Austria-files-legal-action-against-Hinkley-Point-project-0607201502.html>, accessed 30 November 2015.
- Nuclear Industry Association, 'EDF Energy Announce Ten Year Dungeness Life Extension', <http:// www.niauk.org/news/2147-edf-energy-announce-ten-year-dungeness-life-extension>, accessed 30 November 2015.

World Nuclear News, 'Areva Plans to Cut Costs by \$1.1 Billion by 2017', 4 March 2015, <http:// www.world-nuclear-news.org/C-Areva-plans-to-cut-costs-by-2017-04031501.html>, accessed 30 November 2015; World Nuclear News, 'EDF to Take State in Areva's Reactor Business', 4 June 2015, <http://www.world-nuclear-news.org/C-EDF-to-take-stake-in-Arevas-reactor-business-0406154. html>, accessed 30 November 2015.

sixty-five PWR power stations in the US have undergone replacement of their steam generators, at an average cost of \$165 million for a four-loop plant.<sup>9</sup> While this is a significant investment, the average life extension achieved by this activity is approximately twenty years.<sup>10</sup>



Figure 1: Influence of SSCs on PLEX Decisions.

Source: Nuclear Energy Agency, 'Status Report on Nuclear Power Plant Life Management', Committee for Technical and Economic Studies on Nuclear Energy Development and Fuel Cycle, 3 May 2000.

The impact of the condition of SSCs on life extension is greatest, however, where their replacement is not possible. Two of the most safety- and reliability-critical components on the AGR nuclear island – namely, the reactor core and steam generators – are irreplaceable on the AGR design (unlike its PWR counterpart), and it is here that the greatest technical challenges for PLEX exist, as justification for continued operation of these components beyond their planned life must be given despite the fact they cannot be replaced.

#### **PLEX Technical Challenges**

The AGR, which is unique to the UK, is graphite-moderated and carbon dioxide gas-cooled. The graphite reactor core provides a number of key safety functions – namely, neutron moderation, channels for movement of control rods for reactor control and channels for adequate cooling of the fuel.

<sup>9.</sup> Helmut Hirsch, 'Nuclear Power Plant Ageing and Plant Life Extension', report presented to Global2000, Vienna, February 2001.

<sup>10.</sup> International Atomic Energy Agency, *Cost Drivers for the Assessment of Nuclear Power Plant Life Extension* (Austria: IAEA, September 2002).

However, the properties of, and stresses on, the graphite bricks which make up the core are changing over time, resulting in two unique ageing mechanisms: weight loss and cracking. Some of the weight loss and cracking mechanisms found in the graphite bricks had not been predicted, and the prediction of known mechanisms is challenging as it can vary considerably, both within and between bricks.

Difficulties in predicting the progression of these mechanisms could drive the need for increased physical inspection to ensure that the integrity of the reactor core is maintained and to provide the evidence required for justification of PLEX. If more frequent inspection is required, this could increase the length of planned outages or even introduce additional outages, reducing the revenue-generating time spent connected to the grid and hence the economic benefit of continued operation.

In addition, specific issues have already been experienced on AGR stations due to the ageing of boiler structures, including cracking of the boiler spines at Heysham I and Hartlepool,<sup>11</sup> which has been widely reported in the media and has led to significant operational downtime. The ageing of various parts of the boilers has required the development of unique inspection techniques and the implementation of additional safety systems to protect against the failure of these structures.

In order to address the technical challenges associated with continued operation, EDF Energy expenditure on existing generating capacity totals approximately £650 million annually,<sup>12</sup> which represents a significant financial investment, and requires collaboration with the operator's Technical Support Alliance (TSA) partners to deliver this investment.

#### The Need for a Strategy

Currently, the decision to extend the life of the UK's existing nuclear fleet is at the discretion of the operator, which is also expected to bear the financial and technical burden of delivering this life extension. A PLEX decision will therefore be driven by the commercial viability of recouping this investment through additional years of electricity generation, and while additional generating time will, in principle, be lucrative for the operator, there are a number of external factors which present a risk to the PLEX decision.

In the US, several nuclear power stations have closed early, prior to reaching even the end of their original design life, and many more are at risk due to unfavourable economic conditions and a reduction in wholesale energy prices due to the surge in extraction of shale gas.<sup>13</sup> Whilst

<sup>11.</sup> Office for Nuclear Regulation, 'Assessment of the Heysham 1 Reactor 1 2013 Periodic Shutdown', ONR-HYA-13-035, 2013.

<sup>12.</sup> HM Government, 'Nuclear Industrial Strategy: The UK's Nuclear Future', 2013, <<u>https://www.gov.uk/government/uploads/system/uploads/attachment\_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf</u>>, accessed 30 November 2015.

<sup>13.</sup> House of Lords Economic Affairs Committee, 'The Economic Impact on UK Energy Policy of Shale Gas and Oil', 3rd Report of Session 2013–14, HL 172, May 2014.

shale gas is not expected to have as significant an impact on the UK's energy market, it is one of a number of risk factors that the operator will consider when making any PLEX decision.

Given the importance, however, of maximising the operational life of the UK's existing nuclear power station fleet, and the commercial sensitivity to economic and market uncertainties, PLEX must be converted from a commercial to a strategic decision. To achieve this, a complete and coherent national strategy for PLEX is required.

#### National PLEX Strategy

The national strategy for PLEX is required to cover four key areas: focusing on opportunities; engagement in R&D; understanding of the capability of 'UK plc'; and facilitating financial incentive.

Across the UK's fleet of AGR power stations, variations in design and operating history give rise to variations in the scope for PLEX, and a unique set of technical challenges and issues at each station. Strategic collaboration is required to identify the PLEX opportunities which offer the greatest benefit to national energy supply and to drive these as focus areas for PLEX.

Several major R&D programmes are conducted in the UK, including but not limited to the areas of waste management and nuclear fusion, with some government funding to support many areas. However, R&D on PLEX-related topics is largely funded by the operator, which spends approximately £30 million per year on average on research programmes which address specific industrial interests, such as graphite ageing mechanisms.<sup>14</sup>

At a national level, the UK government's 'Review of the Civil Nuclear R&D Landscape 2013' did not identify PLEX as one of its priorities relating to nuclear energy.<sup>15</sup> This position is disproportionate to the importance of PLEX in bridging the gap in the UK's national energy supply over the next decade. Therefore, strategic involvement in R&D relating to PLEX is required to facilitate collaboration across key research institutes and areas, and to ensure that nuclear energy policy relating to PLEX is optimally underpinned by R&D.

Furthermore, 'UK plc' comprises a number of organisations with unique capabilities in several areas of science, technology and engineering which are of potential benefit to delivering PLEX, including the operator's TSA partners. Therefore, a comprehensive understanding of the collective capability of 'UK plc', and strategic involvement in the utilisation of this capability to deliver PLEX, is required.

However, the decision to pursue PLEX activities is currently driven by the question of commercial viability, and therefore strategic involvement is required to create the correct economic conditions to facilitate and incentivise this decision. The case for providing financial incentives, through a form of government subsidy such as direct funding or guarantees, must be considered in order to counter the effect of short-term decision-making in a free market.

<sup>14.</sup> HM Government, 'Nuclear Industrial Strategy'.

<sup>15.</sup> HM Government, 'A Review of the Civil Nuclear R&D Landscape in the UK', 2013.

Such a national strategy would deliver a focused roadmap for the delivery of PLEX where the greatest benefit can be gained, providing the data and resources required, but most importantly, facilitating the conversion of a commercial decision made by a single, private organisation into a strategic decision made by a collaborative group, for the benefit of the country.

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### The Decision to Drop the Bomb Remembering the Physicists

#### **Emerson Moreno**

On 6 August 1945, the world witnessed the dawn of a new era when Hiroshima was completely destroyed by a single bomb. The key scientific figure behind that bomb was a supremely intellectual physicist, Robert Oppenheimer.

There were many factors surrounding the decision to drop the bomb, but one factor often overlooked is the influence of those who brought us into the age of the atom: the physicists. By considering the perspective of these people at that time, this paper aims to raise questions as to why someone would choose to work on weapons of mass destruction. It also asks the question of how these physicists should be remembered seventy years on. Robert Oppenheimer said that 'the physicists have known sin and this is knowledge which they cannot lose'. So should we remember them in this way? As people attempting perhaps to open Pandora's Box? Or as people simply caught in the struggle between scientific revolution and war? Whatever their intentions, these physicists' influence would ultimately shape the nuclear world as it is today.

To set the scene, it was in the 1920s that the atom was yielding its secrets to the likes of Einstein, Rutherford and Bohr – secrets that in 1938 would lead to the startling discovery of fission, immediately set to revolutionise nuclear physics. Parallel to this discovery there was a war raging across the Atlantic and on the day after the attack on Pearl Harbor, the US joined it by declaring war on Japan and Germany. It was feared that Germany was already pursuing a project to make an atomic bomb even before Einstein told Roosevelt that such a thing was possible in practice.

So the race to build the bomb began. General Leslie Groves appointed Oppenheimer as director of the Manhattan Project, who then assembled venerated experts in the fields of science and mathematics. Those experts brought along their students who marvelled at the opportunity to work alongside those they had only seen on the covers of their textbooks. Inside their makeshift houses, Edward Teller would play his grand piano, disturbing more Nobel laureates in a single night than he could have done anywhere else in the world. Los Alamos started as a few families hand-picked by Oppenheimer, but soon it was to be a walled city of over 6,000. Never before was there such an assembly of great intellect focused on one task: in this case, to produce a practical military weapon in the form of a bomb in which the energy is released by a fast neutron chain reaction – a task that for many seemed simply to be to end the war as quickly as possible.

Fast forward a few years to the arrival of Victory in Europe Day and it was found that the German atomic bomb project had not even gained momentum. With no other dangerous competitor in the race, was this a good time to stop the project? Physicist Robert Wilson questioned whether

with Germany out of the picture, perhaps what they were doing was morally wrong, and set up a meeting focused on the impact of their work on civilisation. Oppenheimer argued that it would be better that the world knew about the possibility of an atomic bomb rather than it be kept a secret, especially at a time when the UN was being formed. All agreed on demonstrating the weapon so that the UN was formed with the awareness of this horrible thing to come.

At the beginning of the project there was barely enough plutonium in the world to cover the head of a pin. In early summer 1945, roughly 10 pounds of it arrived at Los Alamos – minus the price tag of approximately \$1 billion. Preparations for a test began with no one truly knowing what to expect from the outcome. Talks even considered the possibility that the explosion would ignite the atmosphere and destroy the planet. Speculation aside, however, on the morning of 16 July 1945, the world experienced its first nuclear explosion – the Trinity test.

Seeing the inferno of Trinity dwarf the mountain ranges of Alamogordo, New Mexico would send a chill down anyone's spine, and it did so with the physicists. Oppenheimer expressed his fear when he said, 'we knew the world would not be the same'. He would then go on to describe perfectly his own situation with a fitting quotation taken from the Hindu scripture the Bhagavad-Gita: 'Now I am become death, the destroyer of worlds'.

So the task was complete; the bomb had been made. Next on the national agenda was to win the war – but somewhere in between those events the bomb would have to be deployed and create a truly horrific experience for the people on the receiving end.

So what about an alternative, perhaps a demonstration, possibly using an uninhabited island near Japan to display the weapon's power? Or invite members of Japan's government to bear witness to an explosion? All such questions formulated by the physicists were soon to be shut down. Oppenheimer would respond with the rhetorical question: 'What if it didn't work?' Certainly, the bomb's true havoc and horrific effects could not be truly understood from the safety of a demonstration.

At the time of the Trinity test, then US-President Harry S Truman was in Potsdam. It was here that Oppenheimer hoped Truman would open up to Russian leader Joseph Stalin about the events taking place at Los Alamos. Leo Szilard – a Hungarian physicist who in 1939 had drafted the letter sent by Einstein to President Franklin D Roosevelt, warning that Germany might be pursuing a nuclear project and suggesting that the US do the same – created a petition signed by many well-informed scientists rejecting the idea of the bomb's use. Throughout the project, Niels Bohr had warned of a nuclear arms race should these weapons be used. Yet none of these efforts would affect the outcome. With the war raging on, the US took Japan's failure to respond to the Potsdam Declaration as a rejection of the ultimatum and as final justification to use the bomb.

On 6 August 1945, the city of Hiroshima was destroyed in a matter of seconds by a single bomb. The death toll was estimated to be up to 100,000, while countless others suffered burns, blindness and radiation sickness.

To see the pinnacle of their careers' work used to complete the Manhattan Project's mission stunned the physicists. Their initial sense of fulfilment at the fact that the war could now end was immediately followed by images of the citizens of Hiroshima. Upon hearing the news, physicist Hans Bethe said that it should never happen again.

Unfortunately, it did. The US followed through on its plan to cause maximum psychological destruction through quick-succession attack, and three days later 'Fat Man' was dropped onto the city of Nagasaki. After months of unprecedented conventional efforts and the dropping of two single bombs, the war came to an end on 15 August 1945, when Japan surrendered.

Truman later said, 'I never lost any sleep over my decision' – a decision, he said, that had ended the war and saved hundreds of thousands of young American lives. Had there not been a bomb, what would the outcome of the war have looked like?

Today we live in a world where control of nuclear weapons and non-proliferation are priorities; but the same cannot be said of 1945. Following the use of the two atomic bombs, Oppenheimer would publicly and adamantly argue for placing international controls on atomic weapons. He wanted to prevent the air force from abusing the weapons he had helped to create in order to end the war. It seemed that the tunnel vision of US political and military leaders in thinking they could maintain a monopoly on these weapons was preventing them from accurately assessing the world after the bombs' use.

The monopoly was short-lived however, as in 1949 the Soviet Union detonated its first nuclear bomb. In the years to come, Oppenheimer's vision of an international effort would disappear, along with his security clearance and access to government officials whom he had previously advised on nuclear issues. The 'father of the atom bomb' was no longer in the picture. In response to the Soviet tests, the US would favour Edward Teller's hydrogen bomb over international control. Nuclear stockpiles increased, tensions grew and the fears of physicists including Leo Szilard and Niels Bohr came to fruition as a nuclear arms race ensued.

In his later life, Einstein would say that his only regret was sending that letter to Roosevelt; but the justification was that there was a possibility the Germans would get there first. In the late 1960s, when asked for his views on President Lyndon B Johnson's planned talks to halt the spread of nuclear weapons, Oppenheimer simply replied, 'it's twenty years too late. It should have been done the day after Trinity'. Better late than never, in 1970 the Nuclear Non-Proliferation Treaty came into force.

Do we remember the physicists at the heart of the Manhattan Project in this bad light? The scientists were committed to a cause backed by an entire nation: winning a war. So, if it is a sin to fight wars at all then yes, label them as sinners. However, the physicists were people undertaking technical work to win a war. No scientist sets off in his or her career to cause harm – at the time of the Manhattan Project, scientists were following the path that had previously been laid before them by the likes of Einstein, Rutherford and Bohr. It is in their nature, their *wanderlust*, for them to follow and extend this path towards the next scientific revolution. It is

tragic that in the early 1940s the evolutionary path of science was heading for a collision course with military needs to abruptly win a war and it was only a matter of time before these two paths would wretchedly meet.

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### **Reactor in a Box**

### Unpacking the Potential of Small Nuclear Reactors

#### Lizzie Murray

Small modular reactors (SMRs) offer a cost-effective, innovative alternative to large nuclearpower sites. They maintain the benefits of large-scale plants (low carbon emissions, energy security and reliability) but are modified so that they are smaller in size and simpler in design, with the International Atomic Energy Agency (IAEA) setting the maximum power output of an SMR at 300 MWe.<sup>1</sup> All features of the SMR are internalised inside a small container, so that the module can be shipped – fully constructed – and 'plugged in' to provide electricity wherever necessary. The UK has a long, successful history of SMR production and now has the opportunity to become a world leader in the global, commercial SMR market.

#### Motivation

Energy demand worldwide is increasing, and future demand is likely to come from the developing world, where currently 1.3 billion people do not have access to electricity.<sup>2</sup> On the other hand, legally binding carbon-reduction targets drive countries to reduce CO<sub>2</sub> emissions. SMRs offer a reliable solution, capable of bridging the gap between demand for electricity generation and low carbon emissions.

#### Advantages of SMRs

Reduction in cost is the foremost motivation behind the development of commercial SMRs.

Rather than the benefits of economies of scale, it is the economies of serial production that reduce SMR cost. Once a module is in place, it generates electricity and therefore revenue to pay for the installation of the next module. As each module is added incrementally, power output increases to meet demand, with no requirement for new facilities, reducing installation costs.<sup>3</sup> This approach allows the initial investment by the customer to be staggered. The timeline from manufacture to electricity generation is estimated to be three years for SMRs. This is much faster than for a nuclear plant, which typically takes five to eight years. The shorter timeline

<sup>1.</sup> International Atomic Energy Agency, 'Advances in Small Modular Reactor Technology Developments', September 2014.

<sup>2.</sup> International Energy Agency, *World Energy Outlook 2014* (France: International Energy Agency, 2014).

<sup>3.</sup> National Nuclear Laboratory, 'Small Modular Reactors: Their Potential Role in the UK', July 2012.

quickens cash flow following initial investment. This benefit is of huge significance to countries in the developing world where large amounts of capital are not readily available. The quality of the reactor components is also likely to be improved as a standardised design is manufactured, in contrast to current nuclear plants, which are modified to suit each site.

Installation of SMRs relies on the 'plug in and play' approach, making them suited to being hooked up to modest electricity grids. Fully constructed SMRs would be delivered as easily deployable, sealed units, requiring little interaction from the customer. When refuelling or decommissioning is required, the sealed unit would be shipped back to the manufacturer and a new module installed in its place. Certain SMR designs, such as the Toshiba 4S sodium-cooled reactor, do not require refuelling for up to thirty years.<sup>4</sup>

SMRs are considered in many ways to be safer than large, nuclear power plants. Many of the new designs have passive safety features, such as convection cooling, in contrast to current plants that rely on large, external cooling pumps. SMRs can also be placed underground, reducing vulnerability to external factors such as earthquakes and providing greater containment in the event of an accident.

#### SMR Development

There are more than forty-five different SMR designs worldwide, all at various stages of development. The designs can be broken down into four categories: light-water reactors; gascooled reactors; fast spectrum reactors; and molten-salt reactors. Light-water reactors are considered to be most mature in terms of technological development. These are simplified Generation III designs, currently used to generate electricity across the world. They are proven to be a reliable and safe nuclear-energy source with additional applications to district heating, desalination and plutonium management. The US company NuScale expects a working 45 MWe pressurised-water reactor to be commercially available by 2020.<sup>5</sup>

Fast spectrum and molten-salt reactors can burn spent fuel and actinides. Prototype fast reactor designs have been successfully tested in the past, such as the liquid-metal fast reactors in Dounreay, in Scotland, and the molten-salt reactor at Oak Ridge National Laboratory, Tennessee. These sites have since been decommissioned and the technology requires further development before it can be considered for commercial use. Advanced SMRs are not likely to be available until at least 2030. The UK has a long history of manufacturing and operating SMRs: Rolls-Royce has provided SMRs for submarine propulsion for fifty years and the UK has built several research fast reactors which have since been decommissioned. The UK is perfectly positioned to provide emerging SMR developers with knowledge and experience gained over many years. The US government has pledged \$452 million of federal funds to develop SMRs, a large portion of which has been granted to NuScale to produce a commercial, light-water SMR. NuScale in turn signed a partnership with Rolls-Royce in 2011 to provide manufacturing,

<sup>4.</sup> Toshina, 'Multipurpose Energy Station 4S', <http://www.toshiba.co.jp/nuclearenergy/english/ business/4s/features.htm>, accessed 2 December 2015.

<sup>5.</sup> See NuScale's website at <a href="http://www.nuscalepower.com/">http://www.nuscalepower.com/</a>, accessed 2 December 2015.

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support and guidance.<sup>6</sup> A large advantage for the UK is that SMR pressure vessels no longer require the use of large forgings, which currently only exist overseas. It is possible that SMR forgings, along with many other components, can be made in the UK. Indeed, it is predicted that the UK already has the ability to produce 70 per cent of the components required for a full SMR production line, and this could be increased to 80 per cent.<sup>7</sup> NuScale recently announced a new collaborative agreement with the Nuclear Advanced Research and Manufacturing Centre, based at the University of Sheffield, which is quickly developing the skills and capability to be a world leader in nuclear manufacturing and knowledge capability. The UK government has pledged its full support in driving the nuclear programme forward, with SMRs included as a key part of the UK's future energy portfolio, reflecting the government's awareness of its significance as a financial backer in driving SMR development. With financial support from the government, the UK has the potential to be a world leader in the SMR global market.

#### SMR Market Potential

The global merchant shipping industry is estimated to have a total power capacity of 410 GWe; thus there is huge market potential in shipping for SMRs. Nuclear-propelled sea vessels are already commonly used globally, with nuclear-powered Russian icebreaker ships clearing paths through the Arctic, for example. Without nuclear power, the quantities of diesel required to perform this task would be huge. In fact, merchant shipping accounts for 2 per cent of global CO<sub>2</sub> outputs, not to mention its responsibility for emitting further contaminants into the oceans. Cruise ships, which are essentially small, floating towns, are also increasingly popular. The amount of electricity they require, currently provided by diesel engines, constitutes not only a huge cost but also an environmental burden. SMRs provide a cleaner option. Of importance, however, is the fact that all nuclear-powered vessels currently at sea belong to the country that manufactured it, and that country is responsible for any accidents. The move to make SMRs commercially available therefore requires new legislation. Lloyd's Register, the international shipping standards organisation, is currently undertaking, in collaboration with a number of companies, a two-year feasibility study into what new legislation would be required to facilitate the introduction of commercially available nuclear-powered sea vessels.

For SMRs to become commercially available several challenges must be overcome. First, all of the SMRs are currently in the design stages, without a customer willing to make the initial investment. Predictions suggest that SMRs are unlikely to be cheaper per MW than existing nuclear plants, although they are likely to be cheaper or comparable in price to oil and gas and will certainly be renewable. In addition to this, the price per MW is likely to fall once units are produced via factory-style manufacturing processes.

<sup>6.</sup> NuScale Power, 'Partnering: A History of Nuclear Excellence and Innovation', <http://www. nuscalepower.com/aboutus/investorsandpartners>, accessed 2 December 2015.

<sup>7.</sup> National Nuclear Laboratory, 'Small Modular Reactors (SMR) Feasibility Study', December 2014.

As with any nuclear power plant, proliferation is a major cause of concern, particularly in the context of shipping. To combat this, new designs are likely to minimise this risk by internalising nuclear waste, which cannot be accessed easily by any party other than the manufacturer responsible for it. The development of breeder designs that consume plutonium and other dangerous actinides also lowers the risk of proliferation by reducing the amount of waste produced.

#### Conclusion

Small Modular Reactors offer a cost-effective alternative to the construction of large nuclear power plants. Typical outputs of 300 MWe, simplified design and production-line manufacturing mean that the market for SMRs has huge potential. SMRs represent a key part of the world's future energy mix and the UK, with its years of experience, has the potential to have the 'edge' in the global market.

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### Black Rain at Hiroshima and Nagasaki

### The Hidden Complexities of Nuclear-Weapons Effects

#### Joseph Schofield

The accounts of black rain at Hiroshima and Nagasaki are familiar to many who have studied the devastating effects of the 1945 nuclear combat strikes against Japan. Those seeking quantitative information on the subject will find, however, that such factual details are scant. The goal of this paper is threefold: first, to present the results of a compilation of reports, accounts and mentions of the phenomenon which will serve as a basis of understanding as to what physically occurred after the detonations. An assertion will then be developed that the precipitation observed at both cities was the result of the detonations themselves, followed by a brief discussion of the implications for predicting nuclear fallout.

Any discussion of nuclear fallout from weapons comparable to those dropped over Japan in August 1945 should begin with a consideration of the lethality of residual fallout as compared to other effects. The vast majority of casualties after both combat detonations were due to blast effects, incendiary effects and prompt radiation. While there is ongoing debate over the contribution of delayed fallout to the deaths of many Japanese citizens in the months and years after the end of the Second World War, the number of these debated cases is several orders of magnitude lower than the estimated 185,000 people who died as a result of the prompt effects of the two weapons.<sup>1</sup>

Documents describing the military planning of the nuclear-strike operations against Japan reflect this understanding of the relative scale of damage from prompt versus residual effects. A report published by Los Alamos National Laboratory studying the planning of the operations states that: 'Fallout was of little concern ... "Actual bomb deliveries are fused to explode at much greater heights than the July 16 shot and therefore a much larger fraction of the active material will condense out in the form of a fine smoke which will not drop down to the ground in any reasonable time"'.<sup>2</sup> Military planners did indeed consider nuclear fallout, but believed that residual radiation would be dispersed so broadly that any radioactive

<sup>1.</sup> Paul Vooson, 'Hiroshima and Nagasaki Cast Long Shadows over Radiation Science', *New York Times*, 11 April 2011; Helen Cleary et al., 'Fact File: Hiroshima and Nagasaki', *BBC News*, 2005.

William R Kennedy, 'Fallout Forecasting 1945–1962', Los Alamos National Laboratory, 1986; Joseph O Hirschfelder, 'Fate of the Active Material After a Nuclear Explosion' (declassified with deletions), LA-1027 Appendix 56, Los Alamos Scientific Laboratory.

material that eventually fell to the ground would contribute to an absorbed dose far below clinically significant thresholds. Historical technical analysis presented by a US-Japan Joint Reassessment report, among others, contributes to the view that this prediction was largely accurate, but that it also relied on the important assumption that no physical process, such as precipitation, would have deposited radioactive particulate locally before it could disperse in the atmosphere over time. It is important to note here that clear meteorological conditions were a requirement of both nuclear-strike operations, as supported by the abandonment of Kokura as the location for the second nuclear detonation due to cloud cover.<sup>3</sup>

After the detonation at Hiroshima, black rain was observed in the Koi-Takasu region just west of the detonation hypocentre. Survivors described the rain as being oily and gritty to the touch; the black colour a result of the scavenging of ash from burning buildings and debris. While no known primary measurements were taken, analysis suggests that 5–10 cm of black rain fell over the course of one to three hours, starting twenty minutes after the explosion.<sup>4</sup> Additionally, Japanese investigators taking measurements in the days after the Hiroshima detonation noted activity measurements that were 'considerably intense' in the Koi-Takasu region.<sup>5</sup> While lacking in quantitative detail, this does provide a clue towards answering the important question of whether the black raindrops contained the radioactive fission fragments and neutron-activated particulate that could constitute a significant health hazard. According to the US-Japan Joint Reassessment of Atomic Bomb Radiation Dosimetry in Hiroshima and Nagasaki, the calculated maximum cumulative dose from the black rain in this region, assuming it did contain radioactive fallout, would be in the range of 0.6–2 rad, a dose widely considered subclinical when not combined with other injuries.<sup>6</sup>

The black rain at Nagasaki fell in the general region around Nishiyama to the east of the detonation hypocentre, starting, as at Hiroshima, around twenty minutes after the initial explosion. In October 1945, areas within Nishiyama district were measured to be as much as twenty-five times more radioactive than the hypocentre area, further suggesting that the black rain that fell indeed carried with it radioactive material from the weapon.<sup>7</sup> The US-Japan Joint Reassessment calculated a maximum dose of 12–24 rad within the Nishiyama region, a dose which, while not necessarily lethal, is certainly more clinically significant than the range calculated for the Koi-Takasu region following the strike on Hiroshima.<sup>8</sup> This increased calculated maximum dose is most likely due to a difference in the total radioactive particulate

<sup>3.</sup> C Peter Chen, 'Atomic Bombings of Hiroshima and Nagasaki', World War II Database, <a href="http://ww2db.com">http://ww2db.com</a>>, accessed May 2015.

<sup>4.</sup> Mititaka Uda, 'The Report on the Atomic Bomb Damage in Hiroshima, Meteorological Conditions Related to the Atomic Explosion in Hiroshima City (Synopsis)' (English translation), Hiroshima District Central Meteorological Observatory, 1947.

<sup>5.</sup> Bunsaku Arakatsu, 'Report on Radiological Investigation of Hiroshima City Conducted for Several Days after the Bombing', Science Council of Japan, 1953.

<sup>6. &#</sup>x27;US-Japan Joint Reassessment of Atomic Bomb Radiation Dosimetry in Hiroshima and Nagasaki: Final Report, Vol. I', 1987, p. 224.

<sup>7.</sup> K Shinohara et al., 'Radioactivity on the Ground in Nagasaki City and Vicinity, Part II: Radioactivity Near the Nishiyama Reservoir, Vol. I', Japan Society for the Promotion of Science, Tokyo, 1953.

<sup>8. &#</sup>x27;US-Japan Joint Reassessment of Atomic Bomb Radiation Dosimetry in Hiroshima and Nagasaki.

from the two explosions, and not due to increased precipitation. In fact, there are estimates that less total precipitation occurred outside Nagasaki than occurred outside Hiroshima.<sup>9</sup> As previously mentioned, the clear-weather requirement for both nuclear strikes provides circumstantial evidence that rain would not have occurred naturally at the times shortly after each nuclear detonation. Analysis by the US Department of Energy decades later provides further sources of evidence for this assertion. Atmospheric data, while not directly available for either city on the days of the strikes, were interpolated from measurements taken in Tokyo and other regions to show that the meteorological conditions over both cities would have been such that rain would not have been reasonably forecasted.<sup>10</sup> A review of the detonation in both regions.<sup>11</sup> If we conclude that rain would not have occurred in these regions naturally on the respective dates and times of the two nuclear strikes, we are left with the implication that the nuclear detonations either directly or indirectly contributed to the induction of the observed precipitation.

Beginning from a basic meteorological principle that the induction of rain can occur as the result of an updraft of large amounts of warm air into a humid environment, we can discuss two significant elements of the atmospheric nuclear explosions over Hiroshima and Nagasaki. First, as with any atmospheric nuclear detonation, a large, hot fireball is introduced into the atmosphere within nanoseconds. Much unlike the fireballs produced by conventional bombs, fireballs from nuclear explosions can be thought of, without exaggeration, as near-celestial events; the temperatures of the initial fireball are of similar magnitude to that of the core of the sun, and while the fireball cools rapidly as its rises through the atmosphere, the temperature of this 'hot nuclear bubble' remains far greater than the temperature of the atmosphere several minutes after the initial explosion.

When detonations such as those of 1945 take place over urban areas, there is another important source of rising hot air to consider, which is the city-sized firestorm, or conflagration, occurring as a result of the thermal pulse from the weapon igniting a plethora of large fires that spread rapidly through a city. The devastating efficiency of this urban incendiary effect allowed the infernos at Hiroshima and Nagasaki to consume the majority of the cities within hours.<sup>12</sup> Given that the areas were both very humid and warm on the days when the detonations occurred,<sup>13</sup> it is reasonable to suggest that some combination of these two sources of hot air rising into the atmosphere contributed to the induction of black rain at both sites.

<sup>9.</sup> Mititaka Uda, 'The Report on the Atomic Bomb Damage in Hiroshima'.

<sup>10.</sup> *Ibid*.; Charles R Molenkamp, 'Numerical Simulation of Self-Induced Rainout Using a Dynamic Convective Cloud Model', Lawrence Livermore Laboratory, 1980.

<sup>11.</sup> Molenkamp, 'Numerical Simulation of Self-Induced Rainout Using a Dynamic Convective Cloud Model'.

<sup>12.</sup> A Barrie Pittock et al., *Environmental Consequences of Nuclear War, Volume I* (Hoboken: John Wiley and Sons Ltd, 1985), pp. 3–5.

<sup>13.</sup> *Ibid.*, p. 4.

#### Figure 1: Region that Experienced Black Rain Following the Hiroshima Detonation.



Source: 'US-Japan Join Reassessment of Atomic Bomb Radiation Dosimetry in Hiroshima and Nagasaki: Final Report, Vol. I', 1987. Colour added by the author.

*Note: The purple stripes depict the approximate area of rainfall; the darker grey outlines the general area of conflagration.* 

Figure 2: Region that Experienced Black Rain Following the Nagasaki Detonation.



*Source: 'US-Japan Join Reassessment of Atomic Bomb Radiation Dosimetry in Hiroshima and Nagasaki: Final Report Vol. I', 1987. Colour added by the author.* 

*Note: The purple stripes depict the approximate area of rainfall; the darker grey outlines the general area of conflagration.* 

If the induction of rain is possible as the result of a nuclear explosion, it is fair to question why the phenomenon has not been observed more often, given that the US alone has tested hundreds of nuclear weapons in the atmosphere. As an attempt to address this discrepancy, we can categorise these test detonations into the two locations where the vast majority of them have occurred: the Nevada Test Site and the Pacific Proving Grounds. In the case of the former, there is consensus that precipitation would not be expected due to the extremely arid climate of the Nevada desert. With regards to the testing site in the Pacific Ocean, the answer is not so clear. Information on the subject is extremely scarce. However, a 1980 study authored by Charles Molenkamp and sponsored by Lawrence Livermore National Laboratory does touch briefly on the subject. According to the report, induced precipitation may indeed have been the result of many of the lower-altitude tests in the Pacific; however, 'observers were situated 10 or more miles upwind of the detonation point and would not have seen precipitation falling from the base of the nuclear cloud if it occurred'.<sup>14</sup> If true, it is unfortunate for the purposes of understanding this subject that no measurements of precipitation were attempted as part of these tests.

Given that any testing of nuclear weapons is extremely unlikely in the foreseeable future, we are left to attempt to answer these questions through the rigorous development of models capable of accurately predicting this phenomenon. While the environmental-science community has given us exceptional models for predicting the transport and dispersion of hazardous materials through the atmosphere, the prediction of fallout deposition following an atmospheric nuclear detonation should be considered as being distinctly different from the deposition of other materials because of the extreme temperatures involved, the upward motion of large amounts of air and the feedback of these thermal effects into the environment. Current operational models for predicting nuclear fallout fall short of being able to incorporate these physical processes, and some used by agencies in the US have alarmingly low fidelity for predicting the fundamental transport and dispersion of the particulate even before considering these complicating factors. This author is proud to have been a part of research into the viability of more robust models capable of predicting induced precipitation under the guidance of Steven Fiorino at the Air Force Institute of Technology. The development of advanced operational nuclear-fallout models is also being undertaken by numerous agencies including Los Alamos National Laboratory in the US and the Atomic Weapons Establishment in the UK.

While the lethality of residual radiation from atmospheric nuclear fallout should be kept in perspective in relation to the prompt effects of a combat nuclear detonation, relevant agencies must have the ability to predict the deposition of such fallout accurately. Current operational models may perform reasonably well when compared against test detonations from the Nevada Test Site; however, the need for further development is highlighted by the observation of radioactive black rain after both of the only two combat detonations the world has ever seen. In addition to first-hand accounts, there is physical evidence that black rain occurred at Hiroshima and Nagasaki, and that the precipitation did in fact scavenge radioactive

<sup>14.</sup> Molenkamp, 'Numerical Simulation of Self-Induced Rainout Using a Dynamic Convective Cloud Model'.

particulate from the nuclear cloud to the ground in a localised manner. Analysis suggests that the thermal effects of the weapon induced this phenomenon, although further research is needed to determine the balance of causality between the rising fireballs themselves and the hot air that billowed upwards from city-wide conflagrations below. Given that a worst-case nuclear-weapons scenario involves a detonation in an urban environment, it is important that we treat the black-rain phenomenon at Hiroshima and Nagasaki not as an elusively vague and mysterious concept, but rather as a source of informative insight into a hidden complexity of nuclear-weapon effects.

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### The Future of the UK's Nuclear-Weapons Programme

### **Domestic and International Considerations**

**Rachel Staley** 

The future of the UK's nuclear-weapons system featured heavily in the lead-up to the general election in May 2015. However, much of the discussion centred upon a binary 'yes' or 'no' debate, used to define political positioning. Trident was typically linked to national security or, conversely, it was linked to a deep source of moral embarrassment and financial waste. The debate lacked critical analysis of how Trident links to the UK's global role and its ability to moderate strategic competition.

With the current Conservative government and most Labour MPs likely to vote in favour of renewal, there is seemingly no doubt that the forthcoming Main Gate decision on the successor submarines, scheduled for early 2016, will pass. However, it is still important to consider the wider domestic and international implications of such a decision, including for the union of the UK and its international non-proliferation and disarmament obligations.

Although the UK will almost certainly replace Trident, the government still maintains an official policy of sustainable nuclear disarmament, which it says can only be achieved 'through a multilateral process'.<sup>1</sup> The challenge for the UK is that the fine balancing act between deterrence and disarmament is not sustainable indefinitely.<sup>2</sup> With the number of nuclear warheads having already been cut under the coalition government of 2010–15, the UK is limited in the numerical reductions it can now make whilst retaining a credible deterrent. This is compounded by the crisis within the international nuclear non-proliferation and disarmament regime, which has little to show from the 2015 Nuclear Non-Proliferation Treaty (NPT) Review Conference.

#### Background on the Trident System

The UK possesses four *Vanguard*-class submarines, each carrying up to forty nuclear warheads mounted on eight operational Trident II D5 missiles when on patrol.<sup>3</sup> The government committed

<sup>1.</sup> HM Government, '2010 to 2015 Government Policy: Nuclear Disarmament', Policy Paper, updated 8 May 2015.

<sup>2.</sup> See John Simpson, 'Deterrence, Disarmament, Non-Proliferation and UK Trident', Trident Commission Discussion Paper 4, British American Security Information Council, March 2013.

Michael Fallon, Written Statement to the House of Commons on 'Nuclear Deterrent', HCWS210, 20 January 2015, <a href="http://www.parliament.uk/documents/commons-vote-office/January%20">http://www.parliament.uk/documents/commons-vote-office/January%20</a> 2015/20%20January/3.DEFENCE-nuclear.pdf>, accessed 2 December 2015.

to maintaining continuous at-sea deterrence and beginning the work of replacing its existing *Vanguard* submarines in December 2006. As part of the deal that resulted in the formation of the coalition government in May 2010, an official review of alternatives to the Trident programme was carried out. The Trident Alternatives Review, published in 2013, implied that none of the alternative systems and postures that were reviewed offered the same degree of resilience and effectiveness under similar criteria as the current system, which is defined by continuous at-sea deterrence.<sup>4</sup>

The service-life of the current *Vanguard* submarines has been extended; the first successor submarine is scheduled to enter into service in 2028.<sup>5</sup> The Main Gate decision is likely to include an indication of the number of submarines to be built, though this may be subject to further review.<sup>6</sup> However, Defence Secretary Michael Fallon stated in June 2015 that the government is 'committed to replacing all four Vanguard submarines with new submarines that will serve this country until at least 2060'.<sup>7</sup>

It is believed that the existing warhead will remain in service until the late 2030s, but that a decision on warhead replacement may need to be made by the end of this Parliament. The Trident Alternatives Review projected a timeline of seventeen years and a bill of £4 billion in 2012 prices.<sup>8</sup>

#### **Budgetary Considerations**

Chancellor George Osborne stunned many with his budget announcement in early July 2015 that committed the government to increased defence spending at a minimum of 2 per cent of GDP and an annual, joint security fund of £1.5 billion until 2020.<sup>9</sup> The Trident system will cost  $\pounds 2-4$  billion per year (in 2012 prices) over the lifetime of the successor system into the 2060s.<sup>10</sup> The heaviest capital spend will fall between 2018–30; in these years, 20–30 per cent of the whole defence capital budget, shared between the three services, will be spent on Trident renewal. It can be argued that a nuclear deterrent is worth the cost. However, as concluded by the Trident Commission, 'in these times of high pressure on public finances and on the defence budget in

6. *Ibid*.

7. Michael Fallon, *Hansard*, HC Debates, Col. 886, 8 June 2015, <http://www.publications.parliament. uk/pa/cm201516/cmhansrd/cm150608/debtext/150608-0001.htm>, accessed 2 December 2015.

- 8. Hugh Chalmers, 'The Bang Behind the Buck: Replacing the UK's Nuclear Warheads', RUSI Occasional Paper, May 2014, p. 1.
- George Osborne, 'Summer Budget 2015 Speech', House of Commons, 8 July 2015, <a href="https://www.gov.uk/government/speeches/chancellor-george-osbornes-summer-budget-2015-speech">https://www.gov.uk/government/speeches/chancellor-george-osbornes-summer-budget-2015-speech</a>, accessed 2 December 2015.
- 10. Malcolm Rifkind et al., 'Concluding Report', Trident Commission, British American Security Information Council, July 2014, p. 19.

<sup>4.</sup> HM Government, 'Trident Alternatives Review', 16 July 2013, p. 10, <https://www.gov.uk/ government/uploads/system/uploads/attachment\_data/file/212745/20130716\_Trident\_ Alternatives\_Study.pdf>, accessed 2 December 2015.

<sup>5.</sup> Gavin Thompson (ed.), 'Key Issues for the 2015 Parliament – Chapter 8: Defence and Security: Replacing Trident', House of Commons Library, May 2015, pp. 118–19.

particular, it would be irresponsible to automatically assume it'.<sup>11</sup> Responsible decision-making requires reflection upon the opportunity costs and consequences both today and in the future.

#### Responsibly Assessing Nuclear Weapons in the 2015 SDSR

Officials in Whitehall developing the National Security Strategy (NSS) and the SDSR, both released in November 2015, will need to consider how nuclear weapons fit into the equation. The NSS will outline the type of threat and response guiding planners to which those capabilities outlined in the SDSR are designed to respond, as well as be framed within the limits imposed by the Spending Review to be published on 25 November.

The prime minister's comments to the Defence Committee in 2014 that this year's reviews will probably echo much of what was written in 2010 may come under considerable pressure.<sup>12</sup> The strategy will need to reflect the significant changes in the strategic environment in the European, Middle East and North African space, and the challenges of uncertainty, instability, extremism, climate change and global power shifts. A good and responsible review will approach complexity of threat and response in an adaptive and inclusive manner, ready to reconsider established thinking and to be honest about its unavoidable shortcomings. A thorough review of the priorities for the armed forces and further commitment to the Atlantic Alliance is also clearly necessary. The government may not be willing to fully review its commitment to Trident renewal, but will need to explain in the SDSR how the system and its posture is justified and integrated with other elements of its security and defence strategy, fully outlining the details of its risk-management strategy (from safety of complex systems to long-term damage to international regimes). This should include establishing the conditions for multilateral disarmament and a commitment to maintain this as a top priority for the UK.

#### **Domestic Political Considerations**

The Scottish dimension brings a particularly important quality to this Parliament. The Scottish National Party has fifty-six out of fifty-nine Scottish seats and vehemently opposes Trident in Scotland. When it comes to a vote on Main Gate, there could well be fifty-eight Scottish MPs voting against.<sup>13</sup> While these votes are unlikely to determine the immediate outcome, it will be the clearest signal of differences in opinion and perspective between Scotland and England at a sensitive political moment for the Union, with wounds still fresh after a very close referendum vote on Scottish independence in 2014.

<sup>11.</sup> *Ibid*.

David Cameron, Oral Evidence Before the Liaison Committee, HC 939, 14 January 2014, <a href="http://data.parliament.uk/writtenevidence/WrittenEvidence.svc/EvidenceHtml/5219">http://data.parliament.uk/writtenevidence/WrittenEvidence.svc/EvidenceHtml/5219</a>, accessed 2 December 2015.

<sup>13.</sup> Alex Salmond spoke in a debate on Trident safety in the House of Commons, claiming that fifty-seven out of fifty-nine Scottish MPs would vote against Trident renewal – although there could actually be fifty-eight, with only the single Conservative MP voting in favour. See *Hansard*, HC Debates, 8 June 2015, Col. 901, <http://www.publications.parliament.uk/pa/cm201516/cmhansrd/cm150608/ debtext/150608-0001.htm>, accessed 2 December 2015.

This dimension has also prompted calls for the Main Gate decision to be taken early, before the end of 2015.<sup>14</sup> If the government decides to go ahead with the Main Gate vote in the spring of 2016, it could coincide with the May 2016 Scottish Parliament elections and put pressure on Labour candidates in Scotland just as their Parliamentary colleagues in Westminster are voting in favour of the successor system. A party that votes in favour of Trident renewal could be painted as putting the interests of English voters above their Scottish counterparts. This could turn into a test for the union of the two nations and fuel future calls for another referendum on independence.

#### The International Context

The 2015 NPT Review Conference ended in May without a final consensus document. This was ostensibly because of differences over convening a conference on a WMD-free zone in the Middle East, an issue linked to the indefinite extension of the treaty adopted at the 1995 Review and Extension Conference.<sup>15</sup> The failure to reach a consensus reflects a broader dispute over the direction of the global nuclear disarmament and non-proliferation agenda. This raises doubts over the commitment both to the 2010 NPT Review Conference's sixty-four-point action plan and to the wider treaty itself.<sup>16</sup> It is deeply troubling that progress has stalled and there is no roadmap for the future.

In a parallel development, 121 countries have signed up to a pledge to explore legal ways to prohibit nuclear weapons.<sup>17</sup> This may not be the game changer that many people wish it to be, but 'a vigorous process of de-legitimisation of these weapons, and their increasing marginalization as a tool of security policy, is clearly under way'.<sup>18</sup> Some states and advocacy organisations are in the process of 'building a new normative understanding of the "illegitimacy" of continuing the possession of nuclear weapons'.<sup>19</sup> It would be irresponsible for UK policy-makers to ignore or condemn this movement if it gathers pace amongst states.

On 14 July 2015, Iran and the E3+3/P5+1 negotiating body announced that they had reached a Joint Comprehensive Plan of Action (JCPOA) on Iran's nuclear programme.<sup>20</sup> While many have

- 16. Wilfred Wan, 'Why the NPT Review Conference Outcome Matters', United Nations University, Centre for Policy Research, 10 March 2015, <a href="http://cpr.unu.edu/why-the-npt-review-conference-outcome-matters.html">http://cpr.unu.edu/why-the-npt-review-conference-outcome-matters.html</a>, accessed 2 December 2015.
- 17. As of 21 December 2015. See ICAN, 'Humanitarian Pledge', International Campaign to Abolish Nuclear Weapons, <a href="http://www.icanw.org/pledge/">http://www.icanw.org/pledge/</a>, accessed 2 December 2015.
- Denise Garcia, 'Humanitarian Security Regimes', International Affairs (Vol. 91, No. 1, 2015), pp. 55–57, <a href="http://www.chathamhouse.org/sites/files/chathamhouse/field/field\_publication\_docs/INTA91\_1\_04\_Garcia.pdf">http://www.chathamhouse.org/sites/files/chathamhouse/field/field\_publication\_ docs/INTA91\_1\_04\_Garcia.pdf</a>>, accessed 2 December 2015.

20. See EU, 'Joint Comprehensive Plan of Action', European Union External Action Service, 14 July 2015, <a href="http://eeas.europa.eu/statements-eeas/docs/iran\_agreement/iran\_joint-comprehensive-">http://eeas.europa.eu/statements-eeas/docs/iran\_agreement/iran\_joint-comprehensive-</a>

<sup>14.</sup> Admiral Lord West, a Labour peer, spoke on this notion during remarks given at a Global Strategy Forum event on 14 July 2015.

<sup>15.</sup> See 'Decisions and Resolution Adopted at the 1995 NPT Review and Extension Conference', Inventory of International Nonproliferation Organizations and Regimes, Center for Nonproliferation Studies, 2002, <a href="http://cns.miis.edu/inventory/pdfs/npt95rc.pdf">http://cns.miis.edu/inventory/pdfs/npt95rc.pdf</a>, accessed 2 December 2015.

<sup>19.</sup> Ibid., p. 74.

welcomed this deal as a major step forward in terms of transparency and non-proliferation, it should not be assumed that it paves the way for the international community to successfully enforce strict assurances and inspections on non-nuclear-weapon states without nuclear-weapon states also abiding by their own NPT commitments to engage in serious and urgent nuclear-disarmament negotiations.<sup>21</sup> The JCPOA could become a catalyst for the international non-proliferation and disarmament regime to regain momentum in establishing the conditions for a sustainable future without nuclear weapons.

#### The Future of Disarmament and UK Contributions

For almost sixty years, the UK has attempted to sustain a twin-track policy of nuclear deterrence and disarmament. When in December 2006 the government placed before Parliament the original decision to start the Trident renewal programme, it also announced initiatives to kickstart international diplomacy on disarmament. Not long after, it started the P5 process and the UK–Norway verification project. These have had limited impact and there remains a deep impression that commitment to progress on the disarmament track is half-hearted.

Now that the Main Gate decision appears locked in, what realistic space is there for the UK to make offers in pursuing global nuclear non-proliferation and disarmament? In 2014, the Trident Commission concluded that whilst it may not be the time for the UK to disband its nuclear capability, 'it would be beneficial to initiate studies into the conditions that would facilitate a safe move to threshold status, and its associated technologies'.<sup>22</sup> It went on to say that this 'could assure other nuclear weapon states currently unable to imagine the transition to a world unambiguously free of nuclear weapons that there are way stations that offer security against reversals in the process'.<sup>23</sup> In the absence of agreement this summer in New York and the lack of optimism around multilateral processes, it is critical to consider proposals aimed at creating the conditions whereby this country never again has to consider yet another nuclear-weapon system beyond the successor submarines.

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plan-of-action\_en.pdf>, accessed 14 July 2015.

<sup>21.</sup> Paul Ingram, 'Iran Deal: Now We Must Change Direction', British American Security Information Council, 20 July 2015, <a href="http://www.basicint.org/blogs/2015/07/iran-deal-now-we-must-change-direction">http://www.basicint.org/blogs/2015/07/iran-deal-now-we-must-changedirection</a>, accessed 2 December 2015.

<sup>22.</sup> Rifkind et al., 'Concluding Report', p. 41.

<sup>23.</sup> Ibid.

# What Use is a Treaty that's Not in Force?

### The UK and the Comprehensive Test-Ban Treaty

#### David Sully

On 6 April 1998, the UK ratified the Comprehensive Test-Ban Treaty (CTBT), becoming one of the first P5 states to do so. A total of thirty-six Annex 2 States<sup>1</sup> have now deposited their instruments of ratification out of a total of forty-four required to bring the treaty into force. The remaining eight Annex 2 States whose ratifications are required (China, the DPRK, Egypt, India, Iran, Israel, Pakistan and the US) are not expected to ratify the treaty in the near future. As a result, critics, including national governments, have questioned the treaty and its relevance to the disarmament framework.

Given these uncertainties, it is only sensible that the UK, as one of the biggest technical and political contributors, should ask the question 'What use is the treaty?' This paper seeks to explore and explain the challenges that the UK faces in this regard and why the CTBT and the associated Comprehensive Test-Ban Treaty Organization (CTBTO) remain relevant today.

#### Background to the Treaty

The CTBT is the successor to the 1963 Partial Test-Ban Treaty (PTBT) which banned nuclear testing in the atmosphere, underwater and in outer space. Opened for signature in 1996, the CTBT expanded the scope to prohibit all nuclear explosions anywhere, by anyone. Prior to this, over 2,000 nuclear test explosions were conducted for military or peaceful purposes since 1945. Since 1996, both India and Pakistan have conducted nuclear tests (in 1998), but they have also since maintained a moratorium on further testing. This decline in testing can be directly attributed to the treaty, with only the DPRK going against the trend (conducting nuclear tests in 2006, 2009 and 2013).

The treaty itself was completed after protracted negotiations in the Conference on Disarmament. A formulation was agreed whereby all those states that were identified as possessing nuclear research and/or power reactors and which had participated in the negotiations would be classed as Annex 2 States. Furthermore, all of these Annex 2 States would need to deposit their instruments of ratification in order for the treaty to enter into force (EIF) and for it to become legally binding.

<sup>1.</sup> This refers to those states that formally participated in the 1996 session of the Conference on Disarmament to negotiate the CTBT and possessed nuclear power or research reactors at the time.

As of June 2015, the CTBT had 183 signatory and 164 ratifying states. Some of the eight remaining Annex 2 States yet to ratify can, from the UK's perspective, be considered the 'usual suspects' that have historically been less involved in nuclear-disarmament regimes. However, the failure of other Annex 2 States to ratify the treaty has been more of a surprise – for example, China and, most unusually, the US. As a close partner of the US, this presents the UK with unique challenges.

#### The Comprehensive Test-Ban Treaty Organization

The CTBT is unusual in that it established an organisation specifically to monitor the test ban, the CTBTO. Based in Vienna, the organisation has an extensive International Monitoring System (IMS); a network of stations and laboratories around the world, using four types of detection technology – seismic, infrasound, hydroacoustic and radionuclides. The system is designed to detect signatures from a nuclear explosion anywhere on the planet at any time and to provide a high level of credible evidence, narrowing down the location of the test to within an area of 1,000 km<sup>2</sup> area anywhere on earth. Of a total 321 planned stations (of which the UK hosts twelve), 85 per cent are already operational and send information to the CTBTO's International Data Centre (IDC). The spread of stations is shown in Figure 1.



**Figure 1:** Map of the Stations and Laboratories in the CTBTO's International Monitoring System.

The UK considers the system to be a proven capability. It has successfully detected signatures from each of the three DPRK tests, and has even been used to estimate the payload. It does this in an open-source format, with the detections, workings and conclusions are all transmitted to member states for review.

#### Entry into Force

Despite twenty years of effort, the treaty has yet to come into force. The UK has been a strong advocate for this outcome, as it directly plays in to the country's national interests. In particular, a fully ratified treaty would:

- 1. Be legally binding and enforceable. Were a country to conduct a nuclear test, it would be easier to take action against it through international fora
- 2. Act as a deterrent. An in-force CTBT with full funding and an established verification regime would facilitate a more accurate detection mechanism from which it would be extremely difficult to conceal a nuclear test explosion. Should a state wish to develop a nuclear weapon and test that it works, it would have to take a conscious decision to go against the international norm, in full knowledge that the explosion would be detected. Furthermore, there would be an added deterrent that an unbiased UN organisation would put together an evidence- and science-based case
- 3. It would allow for on-site inspection. Described as the 'final verification measure', this would involve the deployment of a team of CTBTO inspectors to a particular location to determine whether or not a nuclear explosion had taken place. It is deliberately designed as an intrusive measure that would make it all but impossible to conceal a nuclear test.

#### What Use is a Treaty that Has Yet to Enter into Force?

The UK government's political efforts regarding the CTBT is focused on achieving EIF. However, given the number and diversity of Annex 2 States yet to ratify the treaty, this is unlikely in the immediate future. This presents a huge challenge to the UK, leaving the question of whether continuing to pursue this goal would be worthwhile. From a legal and political perspective, lack of EIF in some ways seems to be a millstone around the neck of the treaty. I have personally been asked what the point of the treaty is by other delegates more than once.

However, from a UK perspective the fact the treaty has not yet entered into force does not stop it from being effective. The CTBT has largely achieved the objective of stopping nuclear testing, a previously common occurrence, while the CTBTO has a proven detection capability. We should therefore look to gain as much as possible from the treaty and the associated organisation. This does, however, require positivity, creative thought and a certain degree of opportunism.

The reasons for positivity are:

- 1. The CTBTO allows UK nuclear experts opportunities for research and development, and ways to increase understanding of verification work. This is of direct relevance to the UK's nuclear-disarmament objectives and work
- 2. There is genuine collaboration between nuclear- and non-nuclear-weapons states. Under the banner of the CTBTO, experts from backgrounds as diverse as Brazil, Iran, Israel, Russia, the US and the UK regularly collaborate on projects. It is truly unusual and allows the building of trust and transparency. Furthermore, this collaboration is open to

any member state, allowing those with fewer resources access to some of the world's most-talented experts

- 3. The open-source nature of the CTBTO's monitoring system. Every country gains access to the same data at the same time, meaning the data are less open to accusations of bias and measurements can easily be checked and verified
- 4. Despite not being complete, the IMS and the IDC already act as a deterrent. Under this system, states are unlikely to be able to conduct a nuclear test covertly
- 5. The CTBTO does something politically that the UK would not be able to do independently or with its allies. This is due to the CTBTO's political reach and extensive coverage
- 6. Most importantly, the CTBTO is good value for money. According to the UN scale of assessments (as determined by the UN General Assembly), the UK's annual contribution to the CTBTO is just over \$6 million.<sup>2</sup> For this, it has access to the CTBTO's global infrastructure, currently worth approximately \$1 billion, as well as real-time monitoring around the world.

#### Challenges for the UK

The most obvious and pressing issue for the UK with regard to the CTBT is the lack of US ratification. The US is a great contributor to the CTBTO and has previously stated that it wants to ratify. The reasons for it doing so are compelling. Other Annex 2 States insinuate that US ratification is a precondition of their own, meaning that some of the very same countries that the UK (and the US) has sought to pressure in terms of nuclear disarmament have an excuse not to ratify the treaty. Furthermore, some of the original US concerns about ratification have been met. For example, a previous concern that nuclear explosive testing was the only way to safeguard nuclear weapons appears to have been overridden by the effectiveness of the US' Stockpile Stewardship programme.<sup>3</sup> Lastly, it could be argued that if a decision was made to conduct a nuclear test explosion, pulling out of the treaty would likely be the least of the issues when compared to internal litigation, loss of international reputation and the risk of triggering a further round of nuclear tests by other states. In sum, ratification might enable the US to shift international political attention and pressure onto other Annex 2 States and to strengthen its own position.

The second challenge to be addressed is the perception of certain delegates and countries that lack of EIF means the CTBT is useless or 'stillborn'. This is a major issue, not least because it breeds apathy concerning the treaty. It is therefore essential to engage with both nuclear- and non-nuclear-weapons states to communicate why the treaty is nevertheless of great importance and relevance to them. If these states engage more with the CTBTO, everyone stands to benefit.

<sup>2.</sup> UN Committee on Contributions, 'Assessments', <http://www.un.org/en/ga/contributions/ assessments.shtml>, accessed 16 December 2015.

John Kerry, remarks made at the US Department of Energy's Stockpile Stewardship event, 21 October 2015, <a href="http://www.state.gov/secretary/remarks/2015/10/248421.htm">http://www.state.gov/secretary/remarks/2015/10/248421.htm</a> >, accessed 16 December 2015.

The UK is sometimes accused of not doing enough in the disarmament and non-proliferation sphere. I feel this is far from the truth. The country abides by each and every commitment it has made, including with regard to the CTBTO. It goes beyond the minimum effort required, not just in terms of funding, but also in the time invested by UK experts and equipment donated, such as for the Integrated Field Exercise held in Jordan in 2014. Unfortunately, this is not the same story for every state. Among the first to accuse the UK of not abiding by its commitments are the very states that have not made their own contributions, do not send experts and do not engage. In my role, I have to be confident in the UK's position and go on the front foot when addressing other countries' failure to abide by a treaty they have signed up to.

The focus on building up a more complete and effective verification system must also be sustained. However, this is a challenge in itself given the current economic climate, in which increasing the budget of a UN organisation is not an option. It is important, however, to push back against the argument that the budget should be cut or the system 'mothballed' completely purely on the political basis of non-EIF.

The UK has played – and will continue to play – a leading role in promoting the adoption of technological advances to improve the reliability and effectiveness of the monitoring system and opposing those seeking to prevent or slow down this process. A recent example can be seen in objections to research into the release of radionuclides into the atmosphere during the production of medical isotopes, which has a direct impact on the ability of the IMS to detect trace elements from nuclear explosions. These objections are often driven by suspicion or political intentions – for example, to limit the ability of the CTBTO. The UK supports an objective analysis of what can benefit the CTBTO, but this means being constantly aware of the intent of other countries and ensuring its voice is heard in the debate.

However, the biggest challenge facing the UK diplomatic mission in Vienna, and the government more widely, is to pursue all of these actions within the UN system, with the aim of maintaining consensus and encouraging countries to buy in to the treaty. This requires an investment of time and effort in order to convey the UK's message clearly and precisely.

The overall goal of the UK government can therefore be summed up as trying to shift the argument from a theoretical one of 'the treaty is never going to be in force so it is not worth expending effort on' to a practical one of 'perhaps it is not what we had in mind, but it is working, so let us make the most of it'. In this respect, the UK must continue to promote pragmatism over ideology.

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This paper is written from the personal perspective of a UK diplomat with direct responsibility for the UK's daily interaction with the CTBTO, and does not represent official UK policy.