

This article was downloaded by: [Institute for Defence Studies & Analysis]  
On: 20 March 2014, At: 22:33  
Publisher: Routledge  
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered  
office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Strategic Analysis

Publication details, including instructions for authors and  
subscription information:

<http://www.tandfonline.com/loi/rsan20>

### The Threat of Nuclear Terrorism Requires Concerted Action

Mustafa Kibaroglu

Published online: 19 Mar 2014.

To cite this article: Mustafa Kibaroglu (2014) The Threat of Nuclear Terrorism Requires Concerted  
Action, *Strategic Analysis*, 38:2, 209-216, DOI: [10.1080/09700161.2014.884440](https://doi.org/10.1080/09700161.2014.884440)

To link to this article: <http://dx.doi.org/10.1080/09700161.2014.884440>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

## The Threat of Nuclear Terrorism Requires Concerted Action

Mustafa Kibaroglu

**Abstract:** The threat of nuclear terrorism should not be underestimated because it can have catastrophic effects if and when realised. Nor should the subject matter be politicised beyond a certain point because of its strong espousal by the United States, which has raised suspicions about whether the issue could be used as yet another instrument for asserting American hegemony. Institutionalisation of multilateral actions must therefore be supported and nuclear summit meetings must become the forums for addressing the doubts and concerns relating to the international initiatives.

### Introduction

Is terrorism backed by weapons of mass destruction (WMD) just hype or could it become a reality? There are numerous books, journal articles, op-eds and blogs in which authors have discussed the probability and the possibility of such an incident and put forward divergent views. Some authors argue that terrorism with WMDs is mere speculation and that it is unlikely that terrorist groups will be able to acquire such weapons or to build one of their own, pointing out the technical, scientific and institutional hurdles they would need to overcome. Others give a detailed rationale for why the issue must be accorded priority, by governments and relevant institutions around the world, because of the credibility of the threat, which should by no means be underestimated.

With the end of the Cold War, the strategic concept that had long rested on a delicate nuclear balance also lost relevance.<sup>1</sup> In the post-Cold War era non-state actors are acknowledged to be more sophisticated and much more determined to inflict deaths on a massive scale in order to get more public attention. The September 11 attacks are the most outstanding example that proved that terrorists would not hesitate to kill the masses in order to attain their objectives. This security risk comes from ‘organised groups with political, ethnic or religious agendas in their countries, state sponsors of terrorist organisations, and transnational groups with broader goals’.<sup>2</sup>

The likely use of nuclear, chemical or biological weapons in terrorist attacks is believed to pose a potential threat to world peace.<sup>3</sup> In line with this argument, some analysts and experts have pointed out the possibility of some states assisting terrorist organisations in their quest to acquire a nuclear weapon or nuclear material. Experts argue that ‘despite there being any number of sceptics, there is no theoretical reason why terrorists should not succeed in setting off a nuclear explosion, killing thousands of people in one of the great cities of the world’.<sup>4</sup> The former director general of the International Atomic Energy Agency (IAEA), Mohamed El Baradei, says that nuclear

---

Prof. Mustafa Kibaroglu has been Chair of the International Relations Department and Director of the Center for Eurasian Studies at Okan University in Istanbul since September 2011.

terrorism is a threat to international security as non-state actors are known to be seeking nuclear materials. He warned the international community that, ‘if they get it, they will use it’.<sup>5</sup> Experts also point out that the use of a ‘dirty bomb’ (i.e. a radiological weapon) could also be an option for non-state actors. This would not cause death on a massive scale, but it would have a huge psychological impact on citizens.<sup>6</sup> It is likely that the scale of terrorist attacks may be far beyond the capabilities of the individual states to prevent or handle.

In view of this, one sure way to eliminate the possibility, and thus the probability, of nuclear and radiological terrorism would be either to eliminate all nuclear and radiological materials or to keep them out of the reach of terrorist groups. However, this is hardly possible because of the existence of huge numbers of nuclear weapons, large stocks of fissile material that became available after the dismantling of weapons following the disarmament agreements between the United States and Russia, and the nuclear power and research reactors in many states. In this context, preventing unauthorised access by terrorists groups to nuclear and radiological material must be the primary goal of governments. In order to achieve this objective, various measures at different levels—from the individual to the global, and with a long-term as well as short-term vision—must be taken.

### **Measures against the threat of nuclear terrorism**

The long-term objective must be the total elimination of all nuclear weapons. For this to happen, nuclear non-proliferation efforts should not only focus on the supply side by taking and strengthening measures to make it as difficult as possible for states to buy or build such weapons, but should also focus on the demand side efforts to convince states that nuclear weapons no longer address their security needs.<sup>7</sup> Possessing nuclear weapons must be de-legitimised so that other states will not seek to proliferate in order to gain power or prestige.

Indeed, the de-legitimisation process actually started in 1996 when the International Court of Justice reinforced it by the advisory opinion that ‘the threat or use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and in particular the principles and rules of humanitarian law’.<sup>8</sup> Nonetheless, it has not yet had any significant effect on countries’ perceptions.

A gradual, step-by-step approach is more feasible, since it is very hard to overcome not only the political but also the technical obstacles. In the short term, new elements must be added to the non-proliferation regime by negotiating and concluding new treaties, conventions and protocols. Moreover, the verification mechanism of the Biological Weapons Convention (BWC) must be put in place at an early date, together with the universalisation of the Chemical Weapons Convention (CWC).

On the other hand, major non-proliferation measures complementing the Nuclear Non-Proliferation Treaty (NPT), such as limits on nuclear weapons testing and the production and use of related fissile material, need to be addressed in order to minimise the threat and risk of any possible use of nuclear weapons or fissile material by state and non-state actors. The entry into force of the Comprehensive Test Ban Treaty (CTBT) is significant for strengthening the nuclear non-proliferation regime. The CTBT is one of the ‘crucial building blocks’ for achieving non-proliferation goals. As of October 2013, there are 183 states that have signed the CTBT, of which 161 also ratified it. There are 13 non-signatories, the most important of which are

India and Pakistan. Both have argued that they would want to move towards a nuclear-free world if there was any real evidence that the world was moving towards nuclear zero. In this sense, US ratification of the CTBT is evidence of this process.<sup>9</sup> If all states can agree to sign and ratify this treaty and also provide financial and technical support for the functioning of the Comprehensive Test Ban Treaty Organisation (CTBTO), it would greatly facilitate the disarmament of nuclear weapons.<sup>10</sup>

The Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225) has been established to take effective physical protection measures.<sup>11</sup> It provides 'principles for securing loose nuclear materials and in turn preventing nuclear terrorism'.<sup>12</sup> Similarly, the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities, which entered into force in February 1987 and now has 148 state parties and 44 signatories, requires states to implement measures to prevent theft, diversion or sabotage of nuclear material while being transported internationally.

Additionally, the IAEA's Nuclear Security Guidelines, first issued in the 1970s, are of fundamental significance today. Although not mandatory, these guidelines are followed by most states and have been made a requirement through a number of bilateral agreements. The IAEA guidelines have been updated a number of times and have been reviewed again in 2011. A 2005 amendment extends the scope of the convention to nuclear material in domestic use and storage, and to the protection of nuclear facilities from sabotage.<sup>13</sup> In the same vein, the International Convention for the Suppression of Acts of Nuclear Terrorism, adopted in 2005 by the United Nations, by 115 signatory states with 79 ratifications, is another important mechanism that can strengthen the nuclear non-proliferation regime and defence against nuclear terrorism.

Another important goal is to prevent the unauthorised transfer of nuclear expertise through the movement of trained personnel, including those in retirement. The risk of such personnel being recruited by terrorist groups is a real problem that must be addressed before it is too late. In addition to states and international organisations, non-governmental organisations and the private sector must also be engaged, especially in addressing the inherent security risks associated with the export of advanced technologies, equipment and material. In this context, the IAEA's Illicit Trafficking Database Programme (ITDP), requiring voluntary notification by government authorities of illicit trafficking incidents, is a valuable source of information that helps member states to better understand threats and vulnerabilities.

Nuclear forensics, which involves the analysis of nuclear material recovered from the radioactive debris following a nuclear explosion so as to identify the sources of the material and the industrial processes used to obtain them, should be another area of focus. The ability to identify and trace specific nuclear materials and techniques would be a strong deterrent in respect of nuclear terrorism. Today, there is no precedent for a terrorist attack with nuclear weapons. However,

... if such an event would ever occur, there will be an urgent need for attribution and prosecution of those responsible. One of the most important tools available for attribution of the event is known as the nuclear forensic analysis—a rapidly developing field of science which has its roots in the field of verification of arms control treaties and intelligence gathering by the national technical means.<sup>14</sup>

Advanced methodologies and sensitive equipment 'capable of providing more data on a weapon's design, yield and other parameters' are available and they could

be employed to obtain information relating to the origin of the nuclear material used in a nuclear explosive device set off in an act of terrorism, and to provide a 'nuclear fingerprint' that may be utilised to identify the source of the material.<sup>15</sup>

Terrorists do not need to produce and detonate radiological or nuclear weapons only in order to achieve their goals. Cyber-attacks by sophisticated terrorists on the command and control systems of nuclear-armed states are a significant threat, notwithstanding the major efforts being made by governments to fend off such threats. Moreover, cyber-attacks on defence systems could be quite possible with today's sophisticated technology.<sup>16</sup> It was to address such challenges that the UN General Assembly in December 2008 approved the creation of an intergovernmental panel of experts. Cyber-attacks of this nature may include faking a nuclear attack, faking a command signal to launch an attack, posting false claims of responsibility on accessible government websites, disrupting and corrupting with false information emergency communications between governments to deal with tense or ambiguous situations, and in addition massively disrupting disaster relief operations in the event a warhead is actually launched. Nuclear command and control systems are inherently weak in relation to cyber warfare, because nuclear weapons are spread across multiple locations. All computers in any way connected to the internet are susceptible to infiltration and remote control. Computers that operate on a closed network may also be compromised by various hacking methods. System vulnerabilities are of the utmost concern for the newer nuclear weapon states, or those who may acquire them in the future.<sup>17</sup>

### **Multilateral efforts to prevent nuclear terrorism**

The 'Global Partnership against the Spread of Weapons of Mass Destruction' is one of the multilateral efforts initiated in Kananaskis, Canada by the Group of Eight (G-8), namely the industrialised countries such as Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States. The G-8 member states announced that their priorities are, first, the destruction of chemical weapons; second, the dismantling of decommissioned nuclear submarines; third, the disposal of fissile materials; and finally, the employment of former weapons scientists in Russia.<sup>18</sup> The programme is meant to assist countries in their efforts against the spread of weapons and materials of mass destruction, starting with Russia.<sup>19</sup> The Global Partnership, which started with G-8 members, has expanded in a short time. Other industrialised countries such as Japan, Norway, Sweden, the Netherlands and Finland also joined the partnership the following year.<sup>20</sup>

The Global Partnership evolved from the Nunn-Lugar Cooperative Threat Reduction (CTR) Programme initiated by US Senator Sam Nunn (Democrat, Georgia) together with Senator Richard Lugar (Republican, Indiana). The Nuclear Threat Reduction Act, also known as the 'Nunn-Lugar Act', achieved comprehensive cooperation between the United States and the Russian Federation on critical issues such as storage, transport and dismantling of nuclear weapons in the former Soviet republics. After September 11, 2001, threats posed by transnational terrorist organisations gave rise to concerns about the security of WMDs in Russia. These concerns led other countries to find additional funds for the US-led Nunn-Lugar CTR initiatives that paved the way for the Global Partnership. The goal of this programme was similar to the Nunn-Lugar CTR programme and it generated more funds for nuclear security and the destruction of non-nuclear WMD stockpiles. Priority was given to the

dismantling of nuclear submarines and eliminating chemical weapon stockpiles.<sup>21</sup> 'One of the strengths of the Global Partnership has been its issue specific regional focus.'<sup>22</sup> This makes the programme more credible in the eyes of the Russians because it gives them control over the issues that need to be given priority.

Similarly, the Global Initiative to Combat Nuclear Terrorism (GICNT) is another US-led effort that was adopted in 2006. Both the United States and Russia initiated this and it was later expanded to include like-minded states who wanted to accelerate the war on terror. This served to supplement the Convention on Physical Protection of Nuclear Material (CPPNM). However, GICNT's focus is on the security of civil nuclear facilities rather than military ones. Specifically, it was created to protect nuclear power stations in case they were attacked by terrorists. In addition, it seeks cooperation from both the private and the public sector.<sup>23</sup> Moreover, in general this initiative concentrates on strengthening operational detection and forensics capabilities, among other areas. Furthermore, it is a rapidly expanding effort with 85 member nations and four official observers who are committed to working individually and collectively to implement a set of shared nuclear security principles.<sup>24</sup>

The Proliferation Security Initiative (PSI) is another US-led effort with over 100 member states, and is also meant to plug the gaps in the multilateral nuclear and non-nuclear security regime. Yet there are still several significant states that do not want to join because of concerns relating to 'the legitimacy of US-led interdiction activities that operate outside the UN framework'.<sup>25</sup>

Finally, there is the World Institute for Nuclear Security (WINS) that was set up in 2008. Its aim is to provide an international platform for nuclear security experts to meet and discuss how to implement best feasible practices in this area. It also focuses on persuading governors to enhance nuclear security. Both WINS and GICNT try to fill the gaps in the nuclear security regime. In other words, the aim of these institutions is to share information and experience among nuclear security professionals, as well as to promote training. In this respect,

... continuing attention needs to be paid to engaging the private sector in addressing the inherent security risks associated with exporting advanced technologies, equipment, and materials, to ensure that the security standards for nuclear facilities and materials are robust and that best security practices are discussed, shared in the form of codes of conduct, and implemented across the world.<sup>26</sup>

According to a Council on Foreign Relations working paper, it is mostly the US-led initiatives that try to plug the leaks in multilateral efforts, but they are sometimes not as successful as they are intended to be, since some significant countries, such as China, India and Pakistan, harbour suspicions that these are yet another component of the US objective of maintaining strategic dominance.<sup>27</sup> It seems difficult for some states to be convinced that US-led incentives also serve their purposes as well as US national interests.

### **The role of Nuclear Security Summit meetings**

In November 2012, officials from more than 50 nations gathered in Istanbul, Turkey to begin planning for the 2014 Nuclear Security Summit. This will be the third of its kind and will focus on preventing nuclear terrorism. The first summit was convened in April 2010 in Washington DC, with the participation of 46 heads of state and

government and the chiefs of international organisations. It was the largest such gathering since the end of World War II, and was inaugurated by US president Barack Obama. At the Washington summit, world leaders underlined the importance as well as the urgency of taking swift and effective measures against the threat posed by the possible passing of nuclear materials, such as Highly Enriched Uranium (HEU) and plutonium, into the hands of transnational terrorist networks. Hence, since the 2010 summit, Kazakhstan has reduced its stocks of HEU and plutonium that would be enough to make 775 nuclear weapons, Russia has ended its plutonium production and Ukraine has removed most of its HEUs. These are notable achievements by the countries in which the bulk of the world's nuclear material stockpiles are located, and are proof that success in this sphere is possible.

The success of the first summit paved the way for the second summit, which was convened in Seoul in March 2012. This had a record participation of 53 heads of state and government, as well as representatives from the UN, the IAEA, the EU and Interpol, and made many notable achievements. First, the summit set important timelines for advancing nuclear security objectives, such as declaring the end of 2013 as the target for states to announce voluntary actions on minimising the use of HEU, as well as 2014 as the year for bringing the 2005 amended CPPNM into effect. Secondly, the Seoul meeting revealed the necessity of addressing the two issues of nuclear security and nuclear safety in a coherent manner for the sustainable peaceful uses of nuclear energy by highlighting the need to better secure spent nuclear fuel and radioactive waste. Third, the summit set out specific measures to prevent radiological terrorism, an issue that had only briefly been touched upon at the Washington summit.

In addition to these achievements it must be noted that, compared to the Washington summit where 32 countries had made over 70 commitments on specific actions to enhance nuclear security (and nearly all of these have been achieved), over 100 commitments were made by participating countries at the Seoul summit.<sup>28</sup> Yet nuclear terrorism remains a serious threat that may have serious consequences in terms of loss of lives and damage to public and private institutions as well as to the economy. Hence, proper institutions are necessary to prevent the threat from becoming a reality. While the first two Nuclear Security Summits have gone a long way towards achieving this goal, the next summit in the Netherlands should not be the last one. Hence, it is imperative that more nations focus their efforts to secure and eliminate the most vulnerable stocks of fissile material, including those that are still housed in civilian facilities, bearing in mind that the four-year time limit set in Washington for securing all vulnerable nuclear materials will end in 2014.

There are no comprehensive standards of nuclear security that states must follow, nor are there international transparency mechanisms that would depend on the nuclear security efforts of individual states. This creates vulnerabilities that could be exploited by capable smugglers or terrorist groups. In their preparations for the 2014 Nuclear Security Summit, a group of committed nations should develop a gift basket wherein they together develop and commit to implementing steps that will strengthen standards and oversight of nuclear material security.<sup>29</sup> This would be a voluntary but critical step towards filling the gaps in global nuclear security.

## **Conclusion**

Building facilities to secretly produce HEU or plutonium is hopefully beyond the capability of terrorist organisations. Yet they may gain unauthorised access to such

facilities and seize enough material to use in their attacks. Thus, what must be done is simply to reduce the amount of existing stocks as well as to keep the remaining stocks out of the reach of terrorists. One might think that there is nothing to worry about, as long as world leaders are aware of these threats. Multiple summit events on an important subject are no doubt highly reassuring at the political level. However, much needs to be done at the lower levels of the state mechanisms around the world, especially in the areas of technical cooperation and intelligence sharing with respect to the safety and security of nuclear material stocks that would be enough to produce more than 100,000 nuclear weapons. While a significant proportion of these nuclear materials are kept in military installations that are relatively better equipped in terms of safety and security measures, there are also more than 100 civilian nuclear reactors in the world that use HEU or plutonium, as well as laboratories and other sensitive facilities that may be targeted by terrorists to access nuclear material for realising their evil plans. Hence, by simply investing in the safety and security of nuclear materials, the world may be a much safer place. For this to happen, first and foremost, it is necessary to start by acknowledging that the threat is real, and that no one is immune to it.

## Notes

1. It may be more appropriate to use the terminology of the age (i.e. the 1960s) where stability in superpower rivalry was believed to be due to the existence of a 'delicate balance of terror', labelled as such by Albert Wohlstetter, one of the leading strategists with RAND Corporation. See Albert Wohlstetter, 'Delicate Balance of Terror', in Philip Bobbitt, Lawrence Freedman and Gregory F. Treverton (eds.), *US Nuclear Strategy: A Reader*, The Macmillan Press, London, 1989, pp. 143–167.
2. 'International Crime Threat Assessment', Federation of American Scientists, December 2000, at <http://fas.org/irp/threat/pub45270chap2.html>
3. Guy Roberts, 'Preventing Weapons of Mass Destruction Terrorism: Building International Partnership to Meet the Challenge', in Osman Aytac and Mustafa Kibaroglu (eds.), *Defense against Weapons of Mass Destruction Terrorism*, IOS Press, Amsterdam, 2009, p. 9.
4. Peter Zimmerman, 'Do We Really Need to Worry? Some Reflections on the Threat of Nuclear Terrorism', *Defence against Terrorism Review*, 2(2), 2009, pp. 1–14.
5. Jack Boureston and Tanya Ogilvie-White, *Seeking Nuclear Security through Greater International Coordination*, Council on Foreign Relations, New York, March 2010, p. 1.
6. Radiological material is therefore considered as WMD by many experts and officials. Charles Ferguson and Michelle M. Smith, 'Response to Nuclear and Radiological Terrorism', NATO Workshop, Centre of Excellence Defence against Terrorism (COE-DAT), Ankara, January 14–15, 2010; Guy Roberts, 'Weapons of Mass Destruction and Terrorism', Paper presented at the International Symposium on Global Terrorism and International Cooperation—III, COE-DAT Ankara, March 15–16, 2010.
7. Gareth Evans and Yoriko Kawaguchi, 'Eliminating Nuclear Threats', Report of the International Commission on Nuclear Non-Proliferation and Disarmament, Canberra, November 2009, p. 251.
8. *Ibid.*, p. 59.
9. *Ibid.*, pp. 101–103.
10. The CTBTO has a budget of \$115 million and when fully completed (it is currently 75% ready) will have 337 monitoring stations on land and sea all over the world with seismic, radionuclide, hydro-acoustic and infrasound technologies. At the moment, those stations already send a constant flow of information via satellite to the International Data Center (IDC). Moreover, various states operate National Data Centres (NDCs) as well. CTBT provides on-site inspections (OSIs) if there is a suspicious event and this is approved by 30 of the 51 members of the CTBT's Executive Council.
11. Jack Boureston and Tanya Ogilvie-White, no. 5, p. 4.

12. Ibid., pp. 4–5.
13. Gareth Evans and Yoriko Kawaguchi, no. 7, pp. 84–85.
14. Vitaly Fedchenko, 'Nuclear Forensic Analysis as a Response Tool to Nuclear Terrorism Even', in Osman Aytac and Mustafa Kibaroglu, no. 3, pp. 127–134.
15. K. J. Moody, I. D. Hutcheon and P. M. Grant, *Nuclear Forensic Analysis*, CRC Press, Boca Raton, FL, 2005, pp. 203–205.
16. Gareth Evans and Yoriko Kawaguchi, no. 7, p. 4.
17. Ibid., p. 28.
18. Paul Walker, 'Looking Back: Kananaskis at Five: Assessing the Global Partnership', *Arms Control Today*, June 2002, at <http://www.armscontrol.org/print/2703>
19. Jack Boureston and Tanya Ogilvie-White, no. 5, p. 7.
20. Valdimir Orlov (ed.), *Global Partnership against the Spread of Weapons of Mass Destruction*, PIR Center, Moscow, 2006, p. 33.
21. 'Statement of G-8 Leaders', G-8 Information Center Munk School of Global Affairs, University of Toronto, <http://www.g8.utoronto.ca/>.
22. Jack Boureston and Tanya Ogilvie-White, no. 5, p. 7.
23. 'Announcing the Global Initiative to Combat Nuclear Terrorism', The White House, July 15, 2006, at <http://www.acronym.org.uk/docs/0607/doc09.htm>.
24. 'The Global Initiative to Combat Terrorism', US Department of State, at <http://www.state.gov/t/isn/c18406.htm>
25. Jack Boureston and Tanya Ogilvie-White, no. 5, p. 8.
26. Gareth Evans and Yoriko Kawaguchi, no. 7, p. 119.
27. Jack Boureston and Tanya Ogilvie-White, no. 5.
28. '2012 Seoul Nuclear Security Summit: Key Facts', p. 3, at [https://www.nss2014.com/sites/default/files/documents/key\\_facts\\_on\\_the\\_2012\\_seoul\\_nuclear\\_security\\_summit.pdf](https://www.nss2014.com/sites/default/files/documents/key_facts_on_the_2012_seoul_nuclear_security_summit.pdf).
29. For more on this, see 'Improving Nuclear Security Regime Cohesion: Summary Report & Initial Policy Recommendations', Nuclear Security Governance Experts Group (NSGEG), at [http://www.stanleyfoundation.org/nsgeg/Improving\\_Nuclear\\_Security\\_Regime\\_Cohesion.pdf](http://www.stanleyfoundation.org/nsgeg/Improving_Nuclear_Security_Regime_Cohesion.pdf)