Office of the Director of National Intelligence
Washington, DC 20511

SEP 19 2014

Mr. Steven Aftergood
Federation of American Scientists
1725 DeSales Street, NW, Suite 600
Washington, DC 20036

Reference: FOIA Request DF-2010-00031

Dear Mr. Aftergood:

This is in response to your 23 December 2009 email to the Office of the Director of National Intelligence (ODNI) (Enclosure 1), in which you requested, under the Freedom of Information Act (FOIA), copies of two ODNI SHARP (Summer Hard Problem Program) reports from July 2009.

Your request was processed in accordance with the FOIA, 5 U.S.C. § 552, as amended. A thorough search of our records and databases located documents responsive to your request.

ODNI reviewed one of the documents (Enclosure 2) and determined that material must be withheld pursuant to the following FOIA exemptions:

- (b)(1), which protects properly classified information under Executive Order 13526, Section 1.4(c);
- (b)(3), which applies to information specifically exempt by statutes, specifically 50 U.S.C. § 3024(i), which protects intelligence sources and methods from unauthorized disclosure; and
- (b)(5), which protects privileged interagency or Intra-Agency information.

If you wish to appeal ODNI's determination on this request, please explain the basis of your appeal and forward to the address below within 45 days of the date of this letter.

Office of the Director of National Intelligence
Information Management Office
Washington D.C. 20511

The Department of Energy (DoE) also conducted a review on the material and determined that the document contained Restricted Data (RD), which has been redacted under Title 5, U.S.C. §552(b)(3) as containing information about weapon design. Enclosure 3 defines the justification for withholding this information, as well as instructions for submitting an appeal of the DOE determination.

Please be advised that one document originated with another agency. Because we are unable to make determinations as to the releasability of other agencies' information, the document has been referred to the appropriate agency for review and direct response to you.

If you have any questions regarding the denial of ODNI information, email our Requester Service Center at DNI-FOIA@dni.gov or call us at (703) 874-8500.

Sincerely,

for Judith M. Strother

Jennifer Hudson
Director, Information Management Division

Enclosures

SHARP 2009

Transforming Nuclear Attribution: Culture, Community, and Change

September 2009

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unredacted title, per para 205.2.4.1.1 NTNF Classification Guide 05/09/2014

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(U) EXECUTIVE SUMMARY

(U) A group of 30 experts from the government and private sector met in Tempe, Arizona in August 2009 to study the topic of nuclear attribution under the auspices of the Summer Hard Problem Program (SHARP), sponsored by the Office of the Director of National Intelligence (ODNI). Participants included intelligence analysts, members of law enforcement, scientists, academics, and subject matter experts in national security policy, proliferation, terrorism, law, crime, behavioral psychology, and other specialties. (See Appendix D for a list of participants). The study focused on communication challenges confronting three distinct communities involved in preparing nuclear attribution assessments for executive branch leadership. Information collected and analyzed by those communities – technical nuclear forensics (TNF), law enforcement (LE) and Non-Title 50 organizations, and the Intelligence Community (IC) – must be fused to formulate an overall attribution assessment in a time-crisis environment with mostly incomplete and evolving information.

(FOUO) At SHARP, the participants role-played several nuclear attribution scenarios while immersed in microcosms that combined law enforcement, intelligence, and technical communities. Leveraging this microcosm environment, the participants were tasked with creating their best all-source attribution assessments. These experiences of identifying, developing, working with best practices for attribution in the SHARP microcosm enabled the participants to scale up their findings to assist in maximizing success of deploying a new national attribution capability (e.g. an [redacted] The SHARP key findings fall into four broad areas: culture, people, information sharing infrastructure, and [redacted] function and structure:

- Culture: At least three distinct communities or "kingdoms" (IC, LE, and TNF) will be involved in a nuclear attribution investigation. SHARP recommends several measures, such as information sharing, team-building, joint exercises, common training, common lexicons, and persistent social networking. Such measures will institutionalize the right practices, behavioral norms, and collaboration that will be required of a multidisciplinary team working seamlessly to produce attribution assessments.
- People: SHARP suggests that a program of training, rotational assignments, and mentoring be developed in order to build a sustainable cadre of cleared analysts with the right expertise to work the nuclear attribution account. Additional cleared specialized experts should be leveraged through a virtual architecture, and expertise from the open source world should be leveraged through technical means such as crowd-sourcing.
- Information Sharing Infrastructure: SHARP recommends that a formal study be conducted to more comprehensively identify and prioritize options for mitigating information sharing impediments. The normal way of doing business is too slow and exclusive to bring the full capacity of the distributed law enforcement, intelligence, and technical communities to bear on the problem in the quickest manner. Tools and approaches must be developed and deployed now that, when activated for a nuclear emergency, allow relevant players to share knowledge at the speed of technology, not at the speed of bureaucracy.
- [redacted] Function and Structure: The SHARP study developed a two-tiered model of the [redacted] – consisting of an executive level and a support group – and recommends adding two new responsibilities for the [redacted] 1) Develop recommendations for communicating crisis-related information with government entities (Congress, state, local, and foreign) and the public. 2) Establish a means to interface with consequence management constituencies.

(U) The findings of this SHARP are applicable to any operation where disparate communities or teams must work together to be successful in solving difficult and complex tasks.

(U) Key Findings

(FOUO) [redacted]

(U) Developing the Culture

(FOUO) [redacted]

Recommendations:

- **(FOUO)** [redacted]
- **(FOUO)** [redacted]
- **(FOUO)** [redacted]
- **(FOUO)** [redacted]

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(U) Developing and Leveraging People

Recommendations:

- **(FOUO)** [redacted]
- **(FOUO)** [redacted]
- **(FOUO) Executives and analysts within the core attribution community should** [redacted]
- **(FOUO)** [redacted]

(U) Developing the Infrastructure

(FOUO) [redacted]

Recommendations:

(FOUO) [redacted]

- **(FOUO)** [redacted]
- **(FOUO)** [redacted]

(U) Developing the [redacted] Structure

(FOUO) [redacted]

(FOUO) [redacted]

Recommendations:

- (FOUO) [redacted]
- (FOUO) [redacted]
- (FOUO) [redacted]
- (FOUO) [redacted]

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(U) SCOPE NOTE

(U) This report presents the findings and recommendations from the SHARP 2009 month-long session, "Assigning Attribution in Nuclear Forensics and Intelligence Analysis." The nuclear attribution SHARP session engaged approximately 24 total government and external experts, including nuclear scientists, forensics examiners, policy experts, cognitive / neuroscientists, behavioral scientists, proliferation experts, and intelligence and law enforcement analysts. The SHARP report represents the views and analytic findings of a diverse group of participants in tackling the hard problem of how to integrate three information streams – technical nuclear forensics (TNF), law enforcement (LE), and the intelligence community (IC) – to formulate rapid and credible assessments, which may be based on incomplete or time-evolving information, in support of nuclear attribution.

(U) The study focused on identifying strategies and solutions to overcome challenges in producing effective multi-community-authored assessments supporting attribution. LE, TNF, and IC each use distinct terminology and has its own way of thinking about the problem and manner of assessing uncertainties. Yet, their assessments and conclusions have to be fused and presented to policy-makers cohesively and cogently in order to:

- Provide the maximum amount of information and insight as to the source and perpetrator(s);
- Convey the results in a form that best meets the need of leadership;
- Make as clear as possible the confidence levels and uncertainties that should be attached to findings; and
- Effectively present alternative analyses and explanations for available information.

(U/FOUO) [redacted]

(U/FOUO) [redacted]

(U) The final report is structured to convey findings and recommendations to the DNI on key factors that play in effective integration and communication of multi-community attribution assessments. As a result, the final report is presented as a compilation of articles, each addressing a key factor in the attribution process. The SHARP participants self-assembled themselves into teams to write the articles within, and in many instances, participants contributed to several articles.

(U) The findings from the SHARP 2009 Nuclear Attribution session are applicable to any mission where disparate communities must work together using incomplete and evolving information, and the conclusions must be effectively conveyed to decision-makers.

(U) INTRODUCTION TO THE ARTICLES

(U) The SHARP report is a compilation of articles that address key issues associated with successfully conducting multi-community-authored attribution assessments that would then be communicated to decision-makers. Taken as a whole, the articles would assist in developing and deploying a seamless team to producing rapid and credible attribution assessments based primarily on the information streams from the technical forensics, law enforcement, and intelligence communities.

(S) [redacted]

(S) [redacted]

(FOUO) [redacted]

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(U) ASSUMPTIONS

(U//FOUO) [redacted]

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(U) [redacted]

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[redacted]

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(U) Recommendations

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(U) NEED TO COMMUNICATE

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(U) Communication Concepts

(S//NF) [redacted]

(U) Communicating Attribution Assessments

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(U) Public Release

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Recommendations

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(U) EXPRESSING UNCERTAINTIES IN CRISES

(U//FOUO) [redacted] Specifically, the intelligence, LE, TNF, and policy communities have each, over time, established different lexicons utilizing quantitative and qualitative descriptors to express uncertainties. Dr. Charles Weiss has categorized some of these disparate lexicons and summarized them the table below[1], [2]:

Scales of scientific certainty

Level	Bayesian probability (%)	IPCC scale	Informal Scientific Scale	Scale based on legal standards of proof	Legal situation where standard of proof applies
10	100	(not in scale)	Firmly established, explains a broad range of phenomena	"Beyond any doubt"	Exceeds criminal standard
9	99	"Virtually certain"	Rigorously proven	"Beyond a reasonable doubt"	Criminal conviction
8	90–99	"Very likely"	Substantially proven	"Clear and convincing evidence"	Quasi-penal civil actions, such as termination of parental rights
7	80–90	"Likely"	Very probable	"Clear showing"	Granting temporary injunction
6	67–80		Probable	"Substantial and credible evidence"	Referring evidence for impeachment
5	50–67	"Medium likelihood"	"If I must choose, this seems more probable than not"	"Preponderance of the evidence"	Most civil cases
4	33–50		Evidence is increasing but not preponderant	"Clear indication"	Proposed as criterion for nighttime, X-ray or body cavity searches
3	10–33	"Unlikely"	Plausible, backed by some evidence	"Probable cause", "Reasonable belief"	Field arrest; search incident to arrest; search warrant; arraignment or indictment
2	1–10		Possible	"Reasonable, articulable grounds for suspicion"	Stop and frisk for weapons
1	<1%	"Very unlikely"	Unlikely	"No reasonable grounds for suspicion," "Inchoate hunch"	Does not justify stop and frisk
0	0%	(not in scale)	Violates well established laws	Impossible	Action taken could not possibly have resulted in the crime being charged

Given the lack of a common objective standard for expressing uncertainty, policy- and decision-makers often are unsure how to interpret the meaning of information being conveyed to them or what degree of action the analysis warrants.

(U) The discussion of uncertainty usually centers on two distinct methods of expression. One is scientific uncertainty based on statistical analysis of numeric data, utilizing measures such as mean, median, standard deviation, and confidence interval. The second is subjective uncertainty, which does not lend itself to quantitative expression. In most cases, policy- and decision-makers are dealing with subjective expressions of uncertainty. This presents a difficulty, since subjectivity results in inconsistencies in interpretation.

(U) For nuclear-related events, significant uncertainty may persist for some time, as the scientific/statistical findings may not be available early on and will be subject to change as

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the data are analyzed and interpreted. TNF findings are a combination of comparative statistics from isotopic ratios, measured levels of trace elements/molecules, shielding and packaging materials, and ancillary artifacts associated with the material package. The comparative isotopic ratios are based on analyzing the degree of agreement between measured ratios for the sample in hand and databases on such ratios for worldwide nuclear materials. Experienced nuclear scientists then make judgments on the most likely associations, taking into account other artifacts of the sample.

(U) The judgments resulting from this process are presented in terms of the most likely to less likely matches to various possible sources, including some indication of confidence level. The confidence levels are a combination of the statistics of measurements and seasoned judgments on how closely the data fit with the sources in the worldwide information base. Conveying this process as background to a decision-maker in a crisis may not be practical, but [redacted] should be prepared to do so in various levels of detail.

(U) Intelligence analysis is often a qualitative process involving the integration of observed facts, the views and opinions of government officials, and information from human sources of varying reliability, in the context of historical data and common knowledge. Rarely does a single observed fact drive a conclusion. Each of these sources of information has an associated level of uncertainty.

(U) Law enforcement combines laboratory evidence with admissible circumstantial evidence, eyewitness testimony, information from informants, and documentary evidence to build a case against a defendant. Measures of uncertainty for the legal system are referred to as "standards of proof." In the criminal justice system, conviction requires the highest level of certainty: proof beyond a reasonable doubt.

(U) A challenge for the integrated IC, LE, and TNF communities, then, is how to aggregate the various means for reaching conclusions with a meaningful way to present levels of confidence. A common lexicon for expressing uncertainty and confidence would be ideal. However, an externally imposed wholesale transition to a new, common method of uncertainty expression is unlikely to succeed. [redacted] as a newly-established entity, has an opportunity to establish a standard method for the expression of uncertainty. Approaches to doing this are detailed in the section entitled (U) ORGANICALLY GROW A LEXICON.

(U) The development of a common lexicon will ease the work [redacted] and enhance comprehension by decision-makers. It also provides a basis for a common language of uncertainty across all communities. This will not require that the individual communities abandon their current standard approaches, but will facilitate enhanced collaboration.

(U) A Proposal for Developing Standards of Uncertainty [redacted]

(U) Of the approaches to stating uncertainty, the legal standards might provide a starting point for expressing aggregate uncertainty in Nuclear Attribution. These legal standards or equivalents could be used to represent confidence associated with the combined inputs from LE, IC and TNF. The legal model also may be useful to the policy community in terms of standards of proof that should be met in recommending actions that employ national and domestic security levers of influence. These levers include, for example: judicial, diplomatic, intelligence, military, and economic.

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(U) The US judicial system uses a time-tested way of conveying uncertainty in reaching judgments on criminal and civil cases. These uncertainties are represented by standards of proof such as beyond a reasonable doubt, clear and convincing evidence, and preponderance of the evidence. Furthermore, standards of proof directly relate to verdicts which, in turn, a judge uses to decide on sentencing in criminal trials. The jury is made aware of what level of uncertainty must prevail in rendering a verdict on the basis of all evidence, testimony, and arguments presented during trial proceedings. In addition, the jury can request any additional information needed to be thorough and confident in reaching their verdict.

(U) The types of evidence provided to a jury during the course of a trial include statistical-based forensic findings, symbolic logic arguments crafted by attorneys for both sides of the case, testimony of experts, and testimony by defendants and witnesses. In a sense, the judicial system already has had to deal with a span of evidence much like would be the case in WMD attribution and has developed a set of standards to convey confidence in aggregate findings. Furthermore these standards, when met, correlate with a specific range of sentences that a judge may render.

(U) Discussing how the judicial uncertainty schema might be of use for [redacted] characterization of uncertainty and confidence in findings requires crossing the wall between WMD findings and possible US actions – the dreaded policy prescription guideline. In US national and domestic security, the range of responses for given threats and actions against US domestic and foreign interests has been well-characterized through experience. In the diplomatic area, actions include suspending diplomatic relations, recalling the ambassador, imposing sanctions, and issuing demarches. Intelligence actions include covert operations, covert propaganda, infiltration of collection devices, and various forms of covert influence. Military responses can include declaring war, surgical strikes, sending in special operations forces, and complaining through the attaché system. Economic actions could span embargos, cutting off selected trade, economic sanctions, and complaints to the World Bank.

(U) Stepping away from policy proscription concerns for a moment, if [redacted] a judgment that it was virtually certain that the AQ group in an area of Pakistan were responsible for the WMD event, then the President's advisers likely would have "find and bomb the camp" in their recommendations. These advisers also would have a range of options, perhaps all the way down to "do nothing yet." At the other end of the spectrum, one would expect a very high level of confidence before considering a nuclear attack by the US. For each category of WMD event, from yield-device to minor contamination, the President's advisers will come forward with a range of options, depending on the confidence of the judgments they receive [redacted]. If the [redacted] assessment were weak or consisted of multiple hypotheses, then queries certainly would follow on what additional information is necessary to hone the assessment.

(U) As a first step toward establishing a standardized method of expressing uncertainty, we recommend that [redacted] be exposed to the existing lexicons on uncertainty. This step can be followed by the group going through a process of identifying a set of standards of proof. These standards of proof would be defined to convey uncertainty and confidence consistent with the risks inherent in a plausible range of actions that the President's advisers might recommend. Representatives from the President's advisory entities should be part of this exercise. As with the judicial system, the resulting standards of proof would not define the policy response (or analogously, the sentence in a criminal case). The standards of proof would represent the fact the there is sufficient confidence in findings to support a full range of response options. The President and advisor entities will drive the actual response.

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(U) In response to an actual event, [redacted] would evaluate the specific hypotheses, levels of confidence, and alternative interpretations presented by the aggregated LE, IC, and TNF assessments. If the findings are diverse in interpretation, the [redacted] could ask the community to iterate based on additional information accumulated over a finite period of time.

(U) If a specific hypothesis is not strongly supported by the evidence and one or more alternatives are admissible, [redacted] should have a practiced operational means for reaching some form of closure, if possible. This could take the form of a pro-side and con-side debate of the supporting evidence and the level of confidence associated with each hypothesis. The IC, LE, and TNF advisers would respond to information requests. If no refinement in findings is possible, then the policy community would be informed of the possibilities, associated confidence levels, and what information would be needed to resolve or significantly enhance the group's findings.

(U) Whether analysis or information assessments originate from the LE, IC, or TNF communities, each implicitly or explicitly works through questions critical to expressing confidence. In essence these questions are:

- What is known?
- What is unknown?
- What do we think?
  - Are there several hypotheses?
  - Is there one hypothesis that is more compelling than the others?
  - Are there dissenting or contrary hypotheses?
  - What is the line of argument for or against?

(U) Using the above as a standard format to report findings [redacted] would [redacted] help to convey levels of certainty. Having the audience's attention and the time to walk through these or equivalent questions and associated discussions would be the most desirable situation. Uncertainty would be communicated in plain English vice a "catch phrase" or statistical statement, interpretation, or individual experience.

(U) What Next?

((U) [redacted]

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(U) Recommendations

(U) [redacted]

(U) Lessons from Previous Studies on Uncertainty

(U) Among many published reports on conveying uncertainty, one has particular applicability to how [redacted] might approach the problem of developing a method of expressing uncertainty. That report, "Uncertainty Communication, Issues and Good Practice"[3] is recommended as a starting point for developing a method of expressing uncertainty in [redacted] assessments. The report provides guidance on communicating uncertainties and draws upon insights from the literature, from an international experts' workshop on uncertainty communications, and from several uncertainty experiments. Especially significant is that this report focuses on communication to non-technical audiences, with special attention to policy-makers.

(U) The report expresses several important principles. First is understanding that the target audience may be under extreme time constraints and generally will have non-technical backgrounds. These facts formulate the overarching character of the communication, which consists of a primary layer, where the bottom line assessments are presented, and a secondary layer, where the detailed data and logic are presented. Most communication time will be spent on the primary layer. If a written format is used, the audience will typically self-select the primary layer to read, skipping much of the secondary layer. Consequently, communication of uncertainty must be done in this primary layer; otherwise it may not ever be seen by the target audience.

(U) A second principle is that the audience will process the uncertainty within their personal frame of reference and according to their biases and heuristics. The report clearly emphasizes that non-technical audiences will tend to relate better to verbal expressions of uncertainty than numerical expressions. Thus, there is some risk that qualitative expressions could lead to different interpretations by different people. This principal is discussed extensively in the report.

(U) For the audiences to make sense of the uncertainties, it helps if they understand how the assessment was conducted. It is not merely a matter of reporting the uncertainties themselves, but the uncertainties also need to be properly reflected in the formulation of the main messages that are conveyed. Specifically, when communicating uncertainties to the policy-maker, the following items should be addressed:

- Reporting types of uncertainties and how they propagate to the outcomes.

- How uncertainty was dealt with in the analysis.
- Implications of uncertainties.

(U) The report identifies some important considerations in communicating the main message. Specifically:

- As assessments evolve, explain any inconsistencies with prior assessments.
- Report minority views and clearly label them as such.
- State the essential conclusions in a clear and concise form.
- Do not make statements that you cannot back up to a satisfactory level.
- Aim for policy-relevant conclusions
- Integrate uncertainty information into the formulation of the main message.
- Explain that additional information may not always reduce the uncertainty.
- Explain that assessments could change as new information becomes available.

(U) ORGANICALLY GROW A LEXICON

(U) To enable rapid and credible attribution among the primary communities of intelligence, law enforcement, and technical nuclear forensics, a common lexicon is required to ensure that key conclusions with their associated levels of confidence are properly formulated among the communities and conveyed to the decision-makers. Presently, a common lexicon does not exist among the primary communities. Each community has developed its own way of conveying conclusions with their corresponding confidence levels. Based on discussions at SHARP 2009 and taking cues from lexicons arising from massive social networks, we suggest a method to implement a nuclear attribution lexicon.

(U) Recent history has demonstrated successes of diffusing language change in large-scale social networks. For example, approximately 10 years ago, terms such as "website," "browser," "wiki," "blogs," "tweets," "broadband," or "weblink" were not as widely used across all US demographics as they are today. Today, these new terms have diffused across much of the US demographics mainly due to a large segment of the population (a social network) that is engaged in internet-related activities. The diffusion speed of new language, which is lexicon-related, is proportional to the size of the network. Research has shown that regular and small-world networks will show gradual diffusion in language changes, while random and scale-free networks exhibit rapid diffusion.[4] Similarly, network influences aid in the implementation of a lexicon among separate communities.

(U) Network factors are dominant in organically growing a common lexicon among separate communities. For example, for a massive social network, such as World of Warcraft, the common lexicon was grown by large numbers of persons frequently using specific terms with specific meanings. In time, the lexicon is developed and implemented by the sheer number of people (i.e. millions) using and accepting these terms and their meanings within their network. However, the nuclear attribution communities do not have a massive social network to drive the use and acceptance of a common lexicon. Instead, a similar effect of organically growing a common lexicon can be accomplished by increasing the frequency of interactions among the communities using specific terms. Research has shown that children's vocabulary increases dramatically with the number of interactions (i.e. network size).[5] Similarly, the lexicon is grown by implementing a large number of person interactions using specific terms, or if that is not possible, implementing a large frequency of person interactions in a smaller network to achieve the desired effect.

(U) To develop and implement a common nuclear attribution lexicon among the primary communities, the frequency of person interactions using the specific terms would need to be increased. At present, the primary nuclear attribution communities of technical nuclear forensics, law enforcement, and intelligence embark on average bi-annual or longer time interval exercises, which are too infrequent to simulate the number of interactions used by a massive social network in generating a successful lexicon.

(U) From a sociolinguistic perspective, the development of specialized language or "lexicon" serves two primary purposes: to allow the group members to communicate clearly with each other, often about specialized concepts and topics to a degree beyond what everyday language facilitates, and to identify in-group vs. out-group members.[6] That is, evolution of language functions as a key indicator of formation of a group. The degree to which a common lexicon emerges from these interactions is a measure of success for genuine community-building within the nuclear attribution arena.

(U) RECOMMENDATIONS

- (U) The following recommendations are presented to enable implementation of a common nuclear attribution lexicon among the primary communities and are based on the demonstrated success of lexicons developed in massive social networks:
- (U) Since the primary nuclear attribution communities are small and crossed, much more frequent interactions among the communities are recommended to create the similar effect of developing a common lexicon with many interactions in a massive social network.
- (U) The increased frequency interactions among the communities could take the form of monthly or bi-monthly secure, web-based, virtually-linked mini-exercises on a particular facet of the attribution process to calibrate the communities with the specific terms and their meaning.
- (U) The mini-exercises should be brief (e.g. ~2 hours) to foster and stage development and acceptance of a common lexicon and to minimize disruptions to ongoing mission areas.
- (U) Promulgate a mechanism for ongoing communication and interaction, in addition to the mini-exercises, to further facilitate development of a common lexicon indicative of a growing community. Virtual means of interaction may be best suited, as community members are geographically dispersed.

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(U) SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE

(U//FOUO) In a nuclear/radiological attribution scenario impacting the United States, it is the US President's responsibility to decide what the US strategic response will entail. As the President may have limited insights on the capabilities and limitations of Law Enforcement (LE), the Intelligence Community (IC), and technical nuclear forensics (TNF) to resolve attribution questions [redacted] must provide each new President (and his senior advisers) an understanding of the capabilities and limitations to ensure informed decision-making.

(S//NF) [redacted]

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]

(U) CSI Effect: Preconceived Misconceptions

(U) The [redacted] decision-makers, and the public may have preconceived misconceptions regarding the type and degree of certainty of evidence available to support WMD attribution assessments. The criminal justice system has been challenged by this issue, as jurors have been exposed to contemporary television crime shows (e.g., Crime Scene Investigation, also known as CSI), and often expect irrefutable evidence to have been obtained, analyzed, and presented for a criminal conviction, all within 50 minutes. In a similar fashion, [redacted] and supporting analytical personnel may be confronted by unrealistic expectations from an alarmed public and an eager body of elected officials, all of whose concerns will be fueled by an aggressive media that may further fuel these misconceptions. In LE circles, this phenomenon is referred to as the "CSI Effect." It is important to convey to decision-makers that attribution and investigative speed often are constrained by the laws of science, in addition to adhering to prudent planning.[7]

(U) Mitigating the "CSI Effect"

(U) "Max Houck of West Virginia University complained of the 'CSI Effect' that has pushed expectations of crime scene investigations far beyond what is achievable."[8] "Jurors now expect us to have a DNA test for just about every case. They expect us to have the most

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advanced technology possible, and they expect it to look like it does on television."[8] This same level of expectation will influence decision-makers evaluating nuclear attribution assessments. It is important for the contributors to [redacted] to be cognizant of the unrealistic expectations of their customers, and develop ways to operate effectively in this environment. The LE community has experience that can be translated into the nuclear attribution environment. For example, here are some standard practices:

- (U) Know your capabilities. Conduct a self assessment of your organization's capabilities. Evaluate your capabilities. Determine how much time you need to conduct the appropriate testing or assessment.

- (U) Educate your partner(s) in an investigation on the capabilities and limitations of your organization.

(U) [redacted] customers may be reluctant to accept that attribution answers may remain unresolved for years, or possibly indefinitely. It is plausible that the result of an assessment of all available evidence and sources may not result in a definitive answer on the perpetrator and complicit actors.

(U) LE/IC: Risk of Being Wrong

(U//FOUO) [redacted]

- (U) Based upon collaborative or high-confidence intelligence, provide a clear analytical assessment where the findings support a single outcome.

Or,

- (U) Provide an alternative analytical assessment to the majority opinion, based upon inferential analysis or intelligence that may presently weakly support an alternative scenario, so that this view will not be lost as new information is gathered.

(U) The analyst/operator needs to be empowered to make decisions with a degree of built-in flexibility to enable, for example, the development of alternative assessments, and needs to be held accountable for his/her results. Simultaneously, the analyst/operator needs to be encouraged to think outside the box by operating without concern for punitive consequences.

(U) Empowering Personnel

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(U) MINEFIELDS AND MIND TRAPS IN THE ATTRIBUTION PROBLEM

(U) [redacted] It is charged with providing the best possible attribution assessment, under tremendous pressure and in the face of uncertainty, to provide key decision-makers with information that is accurate, reliable, and actionable. In order to effectively and accurately perform under these conditions, there are a number of considerations from a social-psychological perspective that must be addressed.

(U) Broadly speaking, in order to perform this most critical task, it will be essential [redacted] to:

- (U) Establish healthy productive group culture, norms, and networks
- (U) Build and maintain healthy, productive external relationships
- (U) Establish sound analytic processes, procedures, and methodologies
- (U) Develop the ability to craft and deliver message effectively
- (U) Adapt to and function effectively in a crisis environment

(U) The following articles discuss the importance of each of these elements, the potential obstacles to achieving success with each of them, and recommendations for how to overcome, or at least minimize, these obstacles. It will do so by addressing each of the following main questions:

1. (U) How can attribution analysis be improved [redacted] by taking into account various psychological or social factors?
2. (U) What sensitivities or constraints on real-life policy-makers should [redacted] be aware of or sensitive to in order to improve the effectiveness of our communications and the value of our attributions?
3. (U) How can [redacted] function better across the three attribution communities in terms of information sharing, lateral communication, and coordination?

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(U) THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS

(U) Accounting for Psychological and Social Factors that Degrade Response or Inhibit Information Sharing in [redacted] Analysis

(U) The judgments and decisions of the [redacted] will be subject to the same cognitive factors that influence everyday decision-making. [redacted] these may pose a variety of hazards and must be guarded against. This article summarizes these potentially problematic factors and recommends steps to counteract the hazards.

(U) Core Concepts in Judgment and Decision-Making

(U) Given a choice between two or more options, whether related to minor decisions or those of great import, like attribution analysis, how do we decide between the multiple options and their relative merits? At some level, the decision-making process appears straightforward: we consider those facts that we feel are relevant, weigh them in terms of importance, and reach a conclusion. In many ways, however, this is a "black box" process in which the relevant facts get poured in and an answer emerges. In this section, we unpack the "black box" and describe some of its internal processes that result in the emergence of judgments and decisions. We will also explore the implications of these normative processes on the decisions and judgments of adversaries, [redacted] and policy-makers.

(U) Rationality: Bounded and Otherwise

(U) Part of the attribution analysis will involve assessing the likelihood that a given group or individual would engage in actions of concern (e.g. smuggling or selling nuclear materials, or carrying out an attack of a given type). Such an analysis often begins with observations as to whether it would be rational for the individual or group to engage in that behavior. Analysts must bear in mind that assumptions of rationality or irrationality can be hazardous. Assessments of rationality/irrationality are generally made on the basis of the extent to which a given behavior is consistent with societal/cultural norms (related to religious beliefs, moral values, repugnance, etc.), arises from a decision-making process that follows a logical syllogism, or is consistent with what observers would view as providing favorable outcomes.

(U) The hazards of assuming rationality or irrationality are great, for the following reasons. First, analysis of the behavior of others from one social or cultural perspective may be invalid if it does not take into account the social and cultural standards of the actor. Second, rationality in real, rather than theoretical, terms is context-determined. The fact that a given behavior may be considered aberrant or irrational by the majority of people does not render it irrational on the part of the actor behaving within the context of the actor's experience. For example, individuals and groups can be behaving rationally even if the behavior is based upon misinformation or beliefs that are inconsistent with reality.

(U) Finally, utility-based approaches to rationality have been displaced by the concept of bounded rationality.[10] Taking into account that human beings have flawed memories and limited computational skills, Simon's theory was based on the notion that we use mental shortcuts and rules of thumb (see biases and heuristics, below) to allow us to compensate for our cognitive limitations. In developing the theory of bounded rationality, Simon described decision-making as a process of searching for alternative behaviors and choices that will

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result in the actor reaching his or her goals. It is a search process in which decision alternatives are discovered until a satisfactory alternative is found. Simon coined the term "satisficing" to describe this process: a choice that may not be optimal, but sufficiently fulfills the criteria necessary for reaching the actor's goals. This comes into play when judging the likelihood that a given party will become engaged in a certain activity. For example, an adversary faced with a range of options may choose one that may not appear optimal to those analyzing the behavior, but that sufficiently meets the adversary's criteria for some degree of success.

(U) Biases and Heuristics

(U) Analysts [redacted] those individuals and groups whose behavior they are analyzing, as well as those who will determine a course of action on the basis of the attribution assessment, make decisions based on heuristics, or rules of thumb, and biases.[11] As noted above, these are the mental shortcuts related to bounded rationality.

<u>(U) Biases</u>

(U) Biases summarized by Sunstein include the following:

(o) Extremeness Aversion: Given a range of alternatives from which to choose, people avoid extremes, which give rise to compromise effects. What is considered to be extreme is influenced by the frame in which the alternatives are presented. For example, in merchandise purchasing decisions, an individual presented with two similar items is more inclined to purchase the less expensive item of the two. However, this individual will tend to choose the more expensive of these when presented with a third similar item at an even higher price. The same behavior would be expected to hold true when individuals are presented with items related to courses of action or levels of certainty. In the context of attribution assessment, an outlier opinion offered by one member of the group may lead others to agree to a position that is more extreme than they may have initially chosen.

(U) Hindsight Bias: If an event occurs, there may be a tendency to believe that the event was inevitable. This in turn influences the extent to which the same event is viewed as likely to be repeated. This concept relates to the notion of "Black Swans," where low probability, high impact events in retrospect are believed to have been predictable.[12] Taleb argues that acts of terrorism, like shifts in the financial markets, are "Black Swans" that are in fact not predictable, but must be anticipated.

(U) Optimistic Bias: Sunstein suggests that human beings tend to be optimistic. Individuals and groups involved in attribution assessment, as a result of selection bias, are less likely to be prone to optimism. However, optimism bias may play a role in how an individual views the validity of his or her own decision-making methodologies and accuracy of his or her assessments and judgments. The most difficult assessment [redacted]ustomers to accept is that no answer may exist, which may conflict with an individual or group's optimistic bias. It also plays a role in how the public perceives risk of harm from illness and disasters.

(U) Overconfidence Bias: This refers to the phenomenon in which people, including almost all professionals, tend typically to have too much confidence in their own judgments, most likely due to insensitivity to the weakness of their underlying assumptions.[13]

(U) Status Quo Bias: Human beings tend to favor the status quo and require considerable incentive to depart from it. This relates to choices involving changes in behavior, including changes in decision-making strategies.

(U) Confirmation Bias: Believing is seeing. In addition to those discussed by Sunstein, confirmation bias is a major consideration [redacted] The psychological research is replete with demonstrations that context and framing directly influence how we perceive objects and events, from optical illusions to the behavior of individuals and nations. Modern geopolitics provides us with examples of leaders who interpreted events according to their preconceived beliefs about the groups or countries involved in those events, rather than upon actual data, e.g. the adamant belief by some administration officials that Iraq possessed WMD in spite of limited certainty on the part of the IC.

(U) Confirmation bias, also known as "belief perseverance" and "selective perception," is a concept that captures the fact that people tend to select and interpret information in a way that supports their existing worldview.[14] This concept applies to how thoroughly a person will read a report, i.e., a person who disagrees with the conclusion of a report may not read it at all, may read it superficially, or conversely, may read it in great depth in an effort to find fault with the conclusions.

(U) The CSI Effect: An additional source of bias may arise from expectations regarding the type and level of certainty of evidence provided by analysts to [redacted] decision-makers, and the public. The criminal justice system has confronted this issue as jurors, having been exposed to modern television crime shows, often expect irrefutable evidence that will have been obtained, analyzed, and presented for a criminal conviction, all within 50 minutes. "Jurors now expect us to have a DNA test for just about every case. They expect us to have the most advanced technology possible, and they expect it to look like it does on television."[7]

(U) Similarly, [redacted] the decision-makers [redacted] may have unrealistic expectations about the level of certainty of the information that analysts can provide, as well as the time frame in which it can be provided. Each of the three communities contributing to the assessment process needs to be prepared to deal with this environment of unrealistic expectations. How can this be done?

- (U) Know the customer. [redacted] contributing communities should establish a rapport with the ultimate customer. This will include establishing an agreed-upon lexicon to ensure that messages are clearly understood. This will be especially critical when communicating technical information to a decision-maker who has never been exposed to such information.
- (U) Know the capabilities of each analytic community. Each of the contributing communities should conduct a self assessment of its capabilities and limitations.
- (U) Educate the customer as to the capabilities and limitations of each contributing community.

(U) The most difficult assessment [redacted] customers to accept is that no answer may exist. The outcome from the assessment of all the evidence and sources may be that a definitive answer is not achievable.

(U) Heuristics

(U) In addition to biases, decision-making is influenced by heuristics. Heuristics are "rules of thumb" that help speed the decision-making process based on past experience and

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knowledge, both individual and institutional. They have been referred to as part of the "Adaptive Toolbox" of decision-making.[15] Sunstein describes the following heuristics:

(U) Availability: When an incident involving risk is active in an individual's memory, as a result of either severity or length of time since the occurrence, there is a tendency to overestimate the probability of that risk being realized. Probability of risk estimates gradually decrease over time. For example, popular estimates of a terrorist attack were extremely high immediately after 9/11, but have decreased over time, regardless of the actual geopolitical situation. Similarly, estimates of the likelihood of a workplace violence incident increase when such an incident has occurred within a similar community.

(U) Anchoring: Initial choices and probability judgments tend to serve as anchors in the decision-making process, even if they were made on the basis of imperfect information. Anchoring will take place early in the thought process and is a very powerful source of bias in thinking and can thus prevent an accurate attribution. Anchoring prevents us from seeing or accepting new information when it does not fit the world view we hold (i.e., our preconceived notions of who did it, who supplied it). As a result, it is important that analysts and decision-makers be aware of the weighting of initial judgments in order to be able to more fully incorporate new intelligence into the decision-making process.

(U) Case-based Decisions: When faced with alternative choices of uncertain value, people tend to reason on the basis of prior cases (i.e., how is this new case similar to or different from a similar prior case that was analyzed). This tends to limit creativity and the ability to incorporate novel information in the analytic process. Moreover, use of historical analogies (e.g., this will be another Vietnam or Munich) frame and anchor people into more rigid ways of analyzing data, resulting in significant distortions and biasing.

(U) Bounded Willpower

(U) Bounded willpower is a concept that recognizes human beings' desire for immediate gratification and reward. It speaks to the issue of impulsiveness, which in the case of attribution analysis and assessment can be thought of as a rush to judgment or premature closure. Once recognized, bounded willpower can be managed through a variety of mechanisms, including critical review by colleagues and members of other groups, as well as other checks and balances in the decision-making process.

(U) Bounded Self-Interest

(U) In addition to bounded rationality and bounded willpower, bounded self-interest is another factor that contributes to human behavior and disproves the notion that human beings pursue behaviors based purely on maximization of personal utility. People care about other people, and about causes and values, leading them to act in ways that may actually harm themselves as individuals, yet provide some other reward. This comes into play in at least two forms in the attribution analysis process. First, it applies to the analysis of the likely behavior of adversaries. Second, regarding the idea of attribution analysis as negotiation, whether an individual feels he or she is being treated fairly or unfairly in a bargaining process has an influence on the toughness of the stance that is taken by that individual in the ongoing bargaining process. As attribution analysis is a collaborative process, it speaks to the importance of establishing a culture of openness, respect, and objectivity [redacted]

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(U) Implicit vs. Explicit Decision-Making

(U) Analysts will make explicit decisions about what information is and is not important on the basis of their professional expertise. [redacted]. The decision as to the relative importance and meaning of a particular piece of information reflects the professional judgment [redacted] influenced by factors such as time pressure, severity of the threat, and recent social and political events, both foreign and domestic. These decisions, like explicit memories, can be explained by reference to specific data points and events (i.e., "I know that this is Cs-137 because the following analyses were run yielding the following results.")

(U) Decision-making, like memory, also occurs at the implicit level. Implicit memory, which is also called process memory, cannot be explained by reference to known specific prior experiences. Similarly, a host of other factors of which the decision-maker is not consciously aware can influence the decision-making process. These factors can be unique to the individual, who is reacting almost instantaneously and in light of past experiences and information, heuristics/biases, and subtle clues of agreement or disagreement from others engaged in the group decision-making process. Psychological experiments have shown that over time, gist information, i.e., a general sense of the meaning of a data set, is more persistent in memory and has a greater impact on behavior than verbatim information. For example, information that a particular radical group has been involved in attempts to traffic nuclear materials (although has never done so successfully) will persist in memory far longer than the details of the failed trafficking attempts.

(U) Implicit decision-making, like clinical judgment in medicine, is a form of intuition. Based on a combination of explicit knowledge and gist memory, it provides an informational infrastructure for decision-making of which the decision-maker may not even be aware. These are essential tools and add to the quality of decision-making in repetitive situations (i.e., conditions or events with which the decision-maker is familiar). However, when dealing with unique situations or where attempts are being made to deceive the decision-maker, they may actually hinder accurate assessments.

(U) With regard to the influence of the opinions of other members of a group deliberative process, individuals vary in terms of their ability to perceive and the extent to which they are influenced by the reactions of others. This is influenced by individual personality factors and life experiences, which in turn may be tied to such specific individual factors as variations in the functioning of mirror neurons in the brain. In addition to playing a role in anticipating the physical behaviors of others, mirror neurons are believed to play a role in the capacity for empathy, otherwise known as the understanding of another person's emotional response to a given situation. In the high stress setting of [redacted] deliberative process, a presenting analyst can be expected to be constantly reacting to the emotional cues of his or her audience. The ideal analyst would be one who has the capacity to incorporate both the data and more subtle cues provided from others, without his or her objective analytic capacities becoming overwhelmed.

(U) The Hazards of Bias, Heuristics, and Intuition

(U) Biases, heuristics, and intuition all have an impact on normative decision-making. As noted above, biases influence the manner and extent to which information is processed and treated. Heuristics have been referred to as part of the Adaptive Toolbox of decision-making and can speed the process and increase accuracy. They are especially helpful in situations

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where the problems and tasks are repetitive or do not vary widely, and where active attempts are not being made to deceive the analyst or decision-maker. Where such attempts are being made, as may be the case in events coming to the attention [redacted] or where the problems being analyzed are unique, these factors can have a negative impact on the accuracy of decision-making.

(U) The tasks of analysts serving [redacted] will be repetitive to some extent. This certainly will be true when it comes to analyzing forensic data. The attribution analysis itself, however, is less likely to be repetitive, especially in the case of major events. These events will be rare, but potentially devastating in their consequences. They fulfill the first two characteristics of Black Swans, and in hindsight many would attribute the third quality as well, that the occurrence was predictable. With low incidence phenomena, there is considerable risk in resorting to shortcuts that derive their validity from the similarity of current and past situations and the accuracy of the underlying data. In such situations, the Adaptive Toolbox may become the "Maladaptive Toolbox," leading to false conclusions reached with high confidence due to the explicit and implicit knowledge that comes with expertise, overconfidence bias, and confirmation bias. This is particularly problematic where the perpetrator has taken steps to deceive investigators in order to escape detection and identification. As such, factors that provide shortcuts for decision-making must be actively guarded against, and a careful balance struck between the utilization of biases, heuristics, and intuition, and recognition that [redacted] will be facing a Black Swan virtually every time it is called to action.

(U) Careful crafting of the message and consideration of the method of communication (including the communication of uncertainty) can contribute greatly towards combating the negative effects of biases, heuristics, and intuition. A detailed discussion of these techniques is found in the section of this report entitled, (U) EXPRESSING UNCERTAINTIES IN CRISES.

(U) Beliefs Are Possessions

(U) One challenge to the kind of thinking-outside-of-the-box that attribution questions may require is how we deal with either: (1) the pre-existing beliefs on the part of policy-makers (confirmation bias related to either the correctness of prior policy approaches or interpretations of the motivations of potential perpetrators), or (2) the prior institutional approaches that previously have been adopted to deal with the problem or issue (optimistic bias as related to previous SOPs or the historical manner in which the relevant organizations have interacted or handled these issues). Once beliefs have been adopted by policy-makers or implemented by organizations, they become possessions to cherish, protect against change, and adhere to even in the face of considerable evidence of failure or inadequacy vis-à-vis the problem. For attribution, it is important for policy-makers and organizations to avoid the trap of having these prior beliefs function unduly as anchors that prevent alternative or competing analysis from being considered. This is especially important, given the high policy consequences likely to flow from any assignment of WMD attribution.

(U) Anchoring and the Pressure to Round up the Usual Suspects

(U) There will almost certainly be a disconnect between the speed at which the national leadership must respond to the policy/political environment and the slower pace at which forensic evidence, technical analysis, and law enforcement investigations can proceed. This gives rise to an anchoring problem (i.e. a tendency to anchor on the usual suspects in

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attributing responsibility for an event). Given the magnitude of the likely national response to any substantial WMD event, those involved in the attribution process need to be cautious of leaping to conclusions ahead of the evidence, based on the emotions of the moment and the general tendency of people under stress to rely more on biases and available simplifying heuristics (such as stereotypes, ideology, pre-conceived belief structures, etc.) Two examples of this are provided by the Oklahoma City Bombing and the Centennial Park Bombing at the Atlanta Olympics. In the former, there was a rush to judgment that the perpetrator was a Middle Eastern male. In the latter, a security guard was falsely targeted as the perpetrator because he fit a supposed profile of those who would engage in such acts.

(U) Moreover, given the tendency toward anchoring and reliance upon simplifying heuristics, especially during times of heightened stress and crisis, it is important [redacted] to ensure that its ongoing presentation of the evidence does not unduly bias policy-makers. This is particularly important because the evidence may be relatively incomplete during the time frame when some retaliatory decisions of great consequence may be under consideration.

(U) In addition, related to this anchoring problem is the recognition that [redacted] analysis should avoid assuming or describing terror groups or national leaders from hostile states as being crazy or irrational, since this is almost invariably inaccurate (based on our own affect or emotion) and distorts our own analysis of their current and future behavior. At worst, it creates situations of self-deterrence on our own part or highly inaccurate predictions of what future behavior they may pursue against us. Almost without exception, national or terror group leaders are rational if you understand the context within which they operate and their own belief systems. Often, describing these individuals as crazy reflects a normative judgment, that by Western standards, their behavior is irrational. While that is perhaps so, leadership analysts routinely note that understood within their own country, regional, or group contexts, these supposedly crazy or irrational leaders are perfectly rational and predictable. Since a potentially critical task [redacted] may well be ascertaining motives among potential perpetrators, the likelihood of their involvement, or the credibility of possible follow-on attacks, it is important to adopt a more objective analytic frame in assessing these individuals. Anchoring to stereotypes of opponents is analysis by labeling, and distorts our understanding of the real threat environment.

(S//NF) [redacted]

(U) How We Perceive Risk

(U) The path-breaking work in the field of risk perception by Kahneman and Tversky has resulted in the development of prospect theory, which argues that choices are strongly influenced by whether the problem is framed in terms of potential gains or losses, with people being more risk averse in the domain of gains and more risk accepting in the domain of losses. In the nuclear deterrence context, for example, prospect theory suggests policy-makers placed in the position of obtaining potential gains (i.e. conquering a neighboring

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province or country, making a preemptive strike to disarm the retaliatory forces of their opponent, etc.), at the potential cost of the loss of their own current resources such as national survival or military and economic capabilities, would be expected to be highly risk averse. In contrast, policy-makers facing a situation framed as one in which they were facing potential losses (such as being invaded and conquered by another state, or facing destruction of their political regime or economic capabilities), would be expected to be highly risk accepting. In other words, prospect theory clearly shows that people are more willing to take risks to avoid losses than they are to obtain potential gains. A good illustration of this work is found in their book, "Judgment under Uncertainty: Heuristics and Bias."[16]

(U) [redacted] this is relevant to any discussion of how issues of uncertainty regarding intelligence or other kinds of assessments are communicated or considered by policy-makers. According to prospect theory, we must remain aware that attributions (or the policy responses likely to be called for by given types of attributions) that are framed in terms of losses will elicit far greater willingness to accept risk by decision-makers than will attributions framed in terms of gains.

(U) Hot Cognition

(U) In many of the contexts in which [redacted] will activate, especially cases of post-detonation or large-scale RDD incidents, the emotions of analysts and policy-makers alike will no doubt be running high. Hot cognition (affect or emotions) has an immense potential for distorting our perceptions of the environment and how we interpret information. It leads us to more extreme judgments of information, perhaps far beyond what they warrant. And it may lead us to fill in the gaps of missing or ambiguous information with emotional filler that could seriously distort our assessments. High degrees of affect are well-known for creating a polarizing effect on judgments and perceptions, pulling them toward whatever emotion (positive or negative) that exists until they reach the far ends of the continuum. The emotional response from the public and policy-makers in a WMD event is likely to [redacted] produce information faster than it becomes available, to reach attributions more quickly than is warranted, and to follow along with certain attributions of blame in the heat of that moment. It is important that [redacted] be aware of this hot cognition component, as it likely will be involved in all WMD scenarios,. [redacted] will need to structure itself to insulate itself and minimize the effects of hot cognition on its attribution efforts.

(U) Stress Effects on Analysts and Policy-Makers

(U) [redacted] the effect of high stress levels upon both analysts and policy-makers, and how these might affect attribution analysis also requires consideration. For example, individuals under high levels of stress in ambiguous information environments tend to rely heavily upon stereotypes, analogies, or pre-existing beliefs, rather than upon the information at hand, due to a perceived lack of time to reach decisions. Thus, in addition to the anchoring problem discussed earlier, high stress levels can serve to make these anchoring effects even more powerful. In addition, traditional group malfunctions associated with groupthink are seen as being partially triggered by high levels of stress in these groups. Taken in conjunction with the contraction of authority problem and the tendency of groups under pressure to have a collapsed time perspective, groups have a propensity to rush to solutions, have premature closure of debate, and bolster their pre-existing views, rather than challenge them during crisis. Janis and Mann's book, "Decision-Making: A Psychological Analysis of Conflict, Choice, and Commitment," provides a solid overview of many of the coping strategies (positive and negative) groups resort to in crisis contexts.[17] [redacted] frequent

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exercises involving simulated WMD incidents can help inoculate against some of these stress effects and will allow members to develop proper coping mechanisms, learn from mistakes, and be less likely overwhelmed by the stress of a real-life situation.

(U) Another effect of stress upon the surrounding problem environment [redacted] may be the problem of panic and mass sociogenic illness on the part of the public in response to a RDD or post-detonation situation (or one in which follow-on attacks are possible). There have been many situations in which an event occurs (i.e. Sarin attacks on Tokyo subway, Scuds landing on Israel during the First Gulf War) and medical facilities are nearly overwhelmed by people who imagine they have been exposed to harmful agents, even though they were not. For every one casualty actually caused by an event, as many as fifty other individuals may descend upon local medical facilities presenting with psychosomatic symptoms. Moreover, fear and panic may cause large populations to flee the location of the event or the perceived target location, further complicating response efforts. This matters for [redacted] due to the fact that the surrounding context is quite predictable, and will have an effect on senior policy-makers. Policy-makers will be under increasing pressure to take action of some kind, and will quite understandably become even more demanding of information [redacted]. This suggests the real need [redacted] to develop strong, active communication links to policy-makers, while allowing senior analysts to remain immersed in their analysis without being pulled away to answer questions. Assuring that the [redacted] has a robust capability in these attribution environments requires it to have a supporting communication/liaison ability that will allow it to function during such highly charged, stressful contexts.

(U) The organizational structure and operational design [redacted] also should take into account the well-documented physiological effects of sleep deprivation and working under high stress conditions. Occupational health professionals, especially those who have experience working with groups functioning under high stress conditions, should be consulted about work schedules, nutritional aspects of stress, and psychological support services.

(U) In addition to providing for services focusing on the health of [redacted] participants, efforts to reduce the impact of stress and other cognitive mind traps should include training exercises and simulations to educate [redacted] participants on the various cognitive factors that could undercut their attribution analysis. By using scenarios that highlight the dangers of anchoring and illustrate other cognitive traps that may alter analyses, [redacted] participants will be more aware of the problems and can learn to counter them as well.

(U) Summary Recommendations

- (U) [redacted]
- (U) [redacted]
- [redacted]
- (U) [redacted]

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(U) PERILS AND PITFALLS OF GROUPS

(U) [redacted] will face the challenge of melding disparate elements together to forge an appropriate organizational culture for its mission. Issues of identity and norms, group dynamics, and social networks must be addressed to enable efficient effective performance in times of stress. Similar to the air we breathe, we are surrounded by the culture (or cultures) we are part of, yet culture remains largely invisible to us and goes unnoticed until its norms are violated. This is simply "the way we do things," as well the underlying values, social norms, beliefs, and history of the groups and networks to which we belong. [redacted] as a group composed of members from a variety of organizations, professional disciplines, and traditions, will face the challenge of creating an appropriate culture for its mission, and melding these disparate elements together effectively.

(U) The nature of the interactions within [redacted] and the social networks which help underpin group and individual actions, also pose additional threats [redacted] In this section, we will capture key components of group culture, dynamics, and social networks to enable [redacted] to navigate across this potential minefield. Creating the right social environment for [redacted] is critical and will help establish a strong foundation for future performance

(U) This article will illuminate a number of pitfalls, including the challenges of overcoming a clash of cultures to forge a common group identity. This article will also cover the importance of building robust social networks across community boundaries, the dangers of group think and other maladaptive group dynamics, and the natural limitations of experts. Furthermore, it will also provide a number of recommendations for overcoming these challenges.

(U) Successful Culture in High Stress, High Ambiguity Environments

(U) While [redacted] faces challenges in integrating members from many different organizational cultures and communities, it has the advantage of being a newly created group, unencumbered with its own historical baggage. There is an opportunity to be successful and effective from the start, building a culture robust enough to cope with its inherent challenges. Creating a shared group identity which members value and relate to, with a base of healthy, appropriate norms for behavior and interaction enabled by inclusive social networks, will position it well.[18]

(U) Recommendation for [redacted] Culture

(U) We recommend actively promoting the following elements to help navigate the minefield of group interaction, and regularly evaluating the group and its members.

- Open communication and information sharing
- Minimal in-group status distinctions
- Inclusiveness (permeable boundaries for belonging, especially with regard to analytic aspects)
- Trust in intentions
- Common group identity
- Shared sense of goals and mission
- Role of devil's advocate or red teaming

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- Understanding the strengths and limitations of expertise (link to expertise section)
- Healthy interactive strategies, such as negotiation (link to negotiation section)

(U) Rather than conceiving itself as a team or group with specific members called in during a crisis, [redacted] can think of itself as the core, or hub, of a larger connected community of analysts, law enforcement, and more. Success in reaching this goal will require strong leadership that sets an example of cooperation, information sharing, and openness to new ideas and sources of information for the rest of the organization. These behaviors can be incentivized by making them part of the metric for professional success.

***(U) Social Networks and* [redacted]**

(U) [redacted]

(U) [redacted]

(U) Group Dynamics and Malfunctions

(U) Another factor is the potential for group dynamics or malfunctions to undercut [redacted] performance. During discussions involving its structure and membership, [redacted] will need to take into account how it will approach its analytic or investigative tasks, and how it will interact and communicate with other actors. Under normal, non-crisis situations (i.e., low threat to significant values, no time constraints, limited stress), groups have the luxury of exploring options and gathering information at a leisurely pace. Policy-makers will not be on the phone every ten minutes expecting results from analysts, and tests will not have to be rushed; nor will assessments be made on the basis of incomplete or partial information. The normal bumps that groups go through in terms of developing working or personal relationships, in getting to know one another so that disagreements can be expressed comfortably, and in obtaining an adequate understanding of the lay of the land (regarding the SOPs of the organizations involved, where information or expertise is housed, etc.), have time to be ironed out. It is unfortunate that in a crisis, groups – especially newly-formed groups or ones that seldom interact – do not have the opportunity to establish these links. This can lead to a substantial number of group malfunctions, problems of communication, and difficulties of interaction, not only within the groups themselves, but in communications with other groups as well.

(U) "Groupthink"

(U) A large body of academic research, including the well-known book by Irving Janis, "Groupthink"[19] and the Hart, Sundelius, and Stern, eds., "Beyond Groupthink"[20], has illustrated the many problems that can arise for groups placed within crisis policy contexts involving high threat, limited time, and high uncertainty. [redacted] may be faced with any number of problems pertaining to groups and should be mindful of the following: the stage of group development; group composition and the issue of expertise and status; the all-star problem; anticipatory compliance issues; and classic groupthink malfunctions.

(U) Stage of Development

(U) The stage of group development is a factor that has significant impact upon the performance of groups during crises. For example, Stern noted the problem of New Group Syndrome during the Bay of Pigs for President Kennedy, and how the onset of the crisis after only a few months in office had not allowed the national security group the President relied upon to adequately form or establish their footing. As a result, there was limited debate, largely uncritical acceptance of the intelligence and planning presented by the CIA and JCS, and an overall group process that would lead to what Janis later described as a policy fiasco. A more established advisory group surrounded Kennedy 18 months later. It had developed working relationships and knew the "lay of the land." It was not as vulnerable to the same new group problems and handled the Cuban Missile Crisis in an exemplary fashion. For the [redacted] it is critical that the attribution community views the group as one that is well established, familiar, unified, exercises routinely, and has strong communication systems in place. In the midst of a WMD crisis, it will be vital that these things are established beforehand, simply because there will be no time to learn it on the fly.

(U) Membership

(U) The issue of group membership (who the participants are within the group) is also potentially significant for [redacted]. Leaving aside the technical skills or expertise that members might require in the various [redacted] groups, there are basic issues of group dynamics to consider when these players come together to address the WMD attribution problem. For example, it has been widely demonstrated in social psychology literature that the status of individual group members plays a major role in determining which participants will dominate the discussions, and whether the group is able to think outside of the box on issues. Ideally, groups would not be top heavy with only one or two high status individuals, since this tends to reduce the participation of lower status group members, especially if their contributions or views conflict with the standard view held by the high status individuals. Also, if high status individuals are participating in these groups, it is recommended that there be balance from different organizations/institutions in order to prevent premature closure of discussions.

(U) Multi-disciplinary Advantage

(U) In terms of the classic groupthink malfunctions (i.e., those arising from highly cohesive, insular groups under high stress/high stakes decision contexts); it is possible that the multi-disciplinary/multi-organizational composition of [redacted] may reduce some of its vulnerability to these problems. By its very nature, [redacted] will be a less insular group, although efforts should be undertaken well ahead of its activation to ensure the kind of communication and building of healthy cross-organizational relationships that would better integrate the more insular, individual communities that comprise [redacted]. What is important, however, is to not overreact to the fears of groupthink in ways that would undermine effective intergroup coordination in a crisis. For example, a phrase commonly heard during discussions of [redacted] functions and organization is the idea of keeping the TNF analysts isolated from the IC or law enforcement efforts in order to maintain their objectivity. Yet given the overriding needs for information sharing and coordination that a real-life WMD incident would demand, this would be counterproductive.

(U) Indeed, the challenges of coordination, information sharing, cooperation across these three communities cannot be overstated, and if not facilitated will result in serious inefficiencies, lack of coordination, and breakdowns of communications that could be seriously detrimental to the [redacted] mission. So for example, while on one level it might make sense to maintain separation to reduce biases being introduced into the TNF from the IC or law enforcement efforts, this potential problem would be outweighed by the problems posed by lack of communication and coordination, and by the benefits that would be obtained by enhancing these elements. In addition, the multi-organizational composition [redacted] also should help to reduce the problems of anticipatory compliance – a group malfunction whereby group members try to please an external leader in advance by divining what information or feedback they would like to hear, rather than what the evidence supports.

(U) Expertise: The Good, the Bad, and the Ugly

(U) Also important to consider is the impact of perceived expertise within groups of decision-makers. As a rule, experts (or those group members perceive to be experts) tend to have far greater influence on group discussions, framing issues and alternatives, etc. than do non-experts (or those who perceive themselves to be less expert). As a result, group process can become skewed towards the views of only a few experts, and potentially valuable dissenting or alternative views from other group members can be self-censored. Within such groups, a serious consequence of this dynamic is the short-circuiting of more involved debates over evidence, reduction in the variety of input provided for group discussions, and premature closure of debate.

(U) For [redacted] other groups operating within the IC, LE, and TNF communities, it is important to assign a red team to challenge the expert assumptions and to encourage a wide consideration of options/views prior to closure. One solution to consider is the notion of having a "collector" within the group whose primary role is to speak individually with other members to elicit views and perceptions which can later be presented to the group as alternative hypotheses. An expert opinion should be carefully labeled and considered, and should be dependent upon the scenario at hand. One's area of expertise may not align with the actual event itself, since domains of expertise may be specific. The value added by having specific expertise, however, is the ability to rapidly synthesize information into meaningful chunks, recognize patterns in large sets of data, process information faster, and identify incongruent data.

(U) Studies have shown that small city or rural fire station commanders with twelve years of experience were less expert than those with only two years experience but who worked inner cities with multiple four-alarm fires per month.[21] This point also relates to the status issue, since participants with experience also may be perceived to have expertise by groups, when these may well be different things.

(U) The All-Star Problem

(U) A related problem for group dynamics and composition [redacted] is the "All-Star"

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problem. It has been observed in a number of professional level sporting events, that all-star teams – that is, teams created by joining the most exceptional players from across the league – rarely produce the best team overall. While their members have exceptional skills and are tremendous athletes individually, these all-star teams typically do not perform as well as expected, or nor do individual all-stars perform as well as they performed on their originating team.

(U) [redacted] we need to consider mechanisms for melding a genuine team out of a group of experts from different domains, with different organizational backgrounds, different cultures, different lexicons, and so on. Can we foster healthy, well-functioning social networks to enable efficient communication, work flow, and trust in a crisis? How should we assess success? This suggests that criteria for team membership should be a balance of expertise and the ability to work effectively with others. More often than not, positive group chemistry trumps individual dynamics. On the other hand, it may be possible to err on the side of expertise, so long as there is a skilled leader who can manage the personalities.

(U) Furthermore, for an all-star team, the needed types of experts are defined by the positions to be filled; pitcher, catcher, etc. [redacted] however, the exact types of expertise needed cannot be fully predicted. The need for contributions from specific, highly specialized experts may ebb and surge with the state of the problem. [redacted]

(U) All Expertise is not the same

(U) As teams of experts are selected, [redacted] it is important to create a mixture of differing types of expertise and should not be thought of only in terms of topical areas of specialty, but instead in terms of differing types of competencies.

(U) This recognizes that not all expertise is the same. Some types of competency are more focused upon accomplishing certain tasks, such as in TNR analysis of nuclear materials composition, whereas other types of competencies are broader in scope. One example would be the Director of a national laboratory overseeing and directing teams of individual technical analysts.

(U) [redacted] it is important that a mixture of expertise (task and general) is included within all of its subgroups. Given that narrow, topical expertise may find itself out of sync with an ambiguous, new threat environment, the inclusion of those with general competencies will help safeguard [redacted] flexibility to adapt to unique and unanticipated situations and preserve more thinking-outside-of-the-box capabilities. Also, having broad competencies included with those members with strong task competencies would add to [redacted] coordinating and information sharing capabilities.[22]

(U) What is Expertise?

(U) To be a genuine expert in a specific field, one must be much more than well-known and admired, or simply been around for a long time. An expert will be well-regarded by peers, able to render exceptionally accurate and reliable judgments in the domain, and will perform skillfully and economically while handling the atypical or unusual problems in their domain.[23] Some key points to remember are:

- Expertise requires extensive practice, often a decade or more.

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- Expertise is domain-dependent (i.e. chess experts know chess, but may be mediocre at backgammon).
- Expertise requires deliberate practice. Time of service is not enough; experts focus on specifically improving performance.
- Experts see differently. Sophisticated mental models of the problem allow experts to make distinctions, which others may not even be able to perceive.
- Experts can get trapped. Very deep expertise can lead experts to become inflexible, biased by their years of experience, and enamored of their intuition – ((U) Implicit vs. Explicit Decision-Making).
- Experts cannot go at it alone against multidisciplinary problems.[24]

(U) Experts can solve problems within their domain faster, and more accurately than less experienced or proficient individuals. And they usually perform best at solving known (but difficult) problems in their domain. [redacted] will undoubtedly be facing problems no one has actually faced before, so the tried-and-true methods may not be appropriate.

(U) Experts are adaptive. They have the capacity to fluidly and creatively adjust their problem-solving strategies, generate new ones, and find alternative perspectives. This will be a critical skill for the experts [redacted].

(U) Self-herding Cats?

(U) The challenges of bringing together a group of experts, or even mixing experts and generalists, have been observed many times in various circumstances (see the All-Star Problem). This is a task akin to herding cats. In groups with distributed knowledge and expertise, lower than average performance commonly has been found. But there seem to be factors that mediate this effect: the networks of social relationships among group members can minimize the problem.

(U) In complex situations where information must be pooled across several domains, decentralized networks featuring healthy working relationships among many members have been proven to be more effective than centralized networks. Centralized networks often are hierarchical structures, where most individuals tend to have just a few relationships which end up all flowing into a few prominent others.[25]

(U) It appears the advantage of decentralized, well-connected networks is that the flow of knowledge and information is maximized. Lack of shared baseline knowledge or expertise is overcome through connections to others who know what is needed. What would otherwise remain isolated pockets of knowledge can more easily be integrated. The existence and functioning of these networks can be studied, and methods used in social network analysis can better enable visualization and measurement of group structure and information flow.

(U) Recommendations for Handling Expertise Issues

- (U) Select for fluid expertise in your experts. Encourage and teach fluid expertise methods to all members of the group.
- (U) Acknowledge that expertise alone will not be sufficient to solve the problems [redacted] will face. Incentivize collaborative, instead of "all-star," behavior.
- (U) Build robust, decentralized social networks for information sharing. Measure and evaluate these social networks, and take steps to improve them as deficiencies are observed. Share results with the group.

- (U) Institutionalize these practices and metrics to shape the culture.

(U) Role of Negotiation

(U) In fulfilling its task, t[redacted] will be considering an array of ideas from these different communities that will be in competition at times. As noted previously, beliefs are possessions, often carefully guarded and reluctantly surrendered. Under situational pressures, including high emotion and stress, we tend to cling to what we know and believe, i.e., conclusions and decision algorithms that have held up in the past. The process of yielding a position or idea on a given subject is much like any other negotiation process. Two or more parties, all focused on the critical shared task of attribution analysis, will be taking different positions on a variety of questions. The resolution of those differences will require a give-and-take of ideas that will lead to a conclusion. As such, the concepts of bounded rationality, bounded willpower, and bounded self-interest described earlier will apply.

(U) Studies of the negotiation process have shown that participants in the process respond positively, and behave more generously and are more willing to consider the position of the other party when they feel they are being treated fairly. Markers of fair treatment can include being given an opportunity to participate fully in the decision-making process, attention and respect given to input, position in the hierarchy, honesty, and openness. Establishment of an [redacted] culture that fosters this behavior will result in a more collaborative and productive analytic and decision-making environment.

(U) The Critical Role of Exercises and Team-Building

(U) [redacted] should meet regularly for joint exercises to build relationships and the experience necessary for a real crisis. Across the three communities, the key challenge will be to improve information sharing, communications, and build relationships to facilitate cooperation and sharing between key personnel, prior to a real-life [redacted] activation. By identifying senior [redacted] representatives in advance, running exercises, and increasing awareness of agency-specific capabilities and information requirements, the group's performance in a real crisis will prove more fluid than without any preparation. This is due to the fact that if [redacted] is actually required for an incident, the normal learning curve of this important group will be reduced, thereby improving performance. Having representatives from the IC, LE, and TNF communities working closely together, sharing information in real-time, and serving as community-wide liaisons will speed analysis, enhance situational awareness [redacted], and reduce the risk of groupthink (which the communities might face if working as independent entities). Analysts at NCTC who have access to the data systems across these communities should support this effort. At different stages of an incident, this coordination and information sharing hopefully will allow [redacted] to perform far more efficiently at integrating the attribution process.

(U) Recognize the Need for [redacted] Inoculation of Personnel and Information Networks Prior to Events

(U) In considering how to structure [redacted] and facilitate communications, it is important for [redacted] personnel to stand up more frequently than just during a crisis. There need to be ongoing table top exercises and drills, as well as team-building activities, that help to familiarize people with each other (and build the personal relationships and trust necessary to facilitate communications and information sharing), and also create awareness of the unique

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challenges faced by [redacted] across different types of scenarios. One advantage of running simulations and other exercises is the inoculating effect on the participants: This inoculation may include reducing the need to learn who other people are in their groups, or in outside groups with which they will have to work. It also builds personal relationships that help encourage information sharing and a greater ability to challenge assumptions or arguments raised in group settings (since people with pre-established personal relationships have a greater comfort level in challenging assumptions and arguments raised by people they know well, as opposed to relative strangers).

(U) It also will facilitate the development of people who could become liaisons across the three communities, due to their increased awareness of the issues and information needed by the different communities and their personal relations and comfort zones. This is quite similar to how President Eisenhower organized the Policy Planning Board (PPB) on his NSC. He wanted his NSC policy planning staff to work on exercises and plans for scenarios that did not yet exist, primarily because this provided experience working those types of cases (thereby reducing stress when the cases happened in real life) and because it provided experience in interacting and challenging each others' assumptions. Eisenhower did not want his advisers trying to acclimate to a crisis context on the fly, nor to lack experience interacting and challenging each other (or him) during deliberations. He wanted that experience to exist prior to an event. This underscores the value of inoculation of groups [redacted], and it also suggests that it would be best not to have [redacted] interacting only during stand ups of actual WMD events; team members should be interacting continually.

(U)Establish Metrics to Ensure Effectiveness of Exercises and Training

(U) Exercises and training are essential to assuring healthy and effective group interactions and accurate attribution analyses. The effectiveness of these activities must be measured objectively, however. As mentioned elsewhere, this should include exercises under realistic, high stress conditions with active red teaming to challenge the [redacted] response capabilities. In addition, the performance of the group and individual members should be assessed by an unidentified observer so that participants do not behave differently around the observer (avoiding the "Hawthorne Effect"). Furthermore, there should be a thorough debriefing of the successes and failure of each exercise that will include an anonymous 360 degree evaluation of each participant. Finally, social network analysis should be conducted of email, telephone, and interpersonal communication among participating members to assess the extent and nature of their information sharing and sourcing.

(U)Preserve Splits that Present Differences of Opinion to Policy-Makers

(U) Much as President Eisenhower insisted that policy splits between departments or advisers be preserved in NSC papers produced by the Policy Planning Board, so that disagreements or uncertainties would not be papered over prior to his being able to consider the competing arguments, it is critically important that [redacted] products also preserve splits in reporting for senior policy-makers. Although there is the understandable desire to provide a consensus response for policy-makers, this is offset by the magnitude of the decisions and actions that senior policy-makers will have to take in response to a highly charged WMD event. Even if it adds to the uncertainty and ambiguity of the policy context, those very elements could be important factors for their consideration and assist in avoiding anchoring to the usual suspects, and other cognitive errors. Given the differing speeds at which the three communities likely will enter evidence into the system, reporting these disagreements (or areas where there is an argument for withholding judgment until further analysis is completed) would greatly benefit policy-makers by providing additional context for interpreting the data.

(U) Counter Debilitating Effects of High Stress Environment on AAG by Employing Stress Monitors

(U) Groups [redacted] operating in highly emotional and stressful environments, are at risk of having their attributions biased by the effects of hot cognition (the intense emotions of the moment) or by stress-based group malfunctions (i.e., the perception of short time, over-reliance on stereotypes and other shortcuts, premature anchoring, etc.). Having group members educated about the effects of stress and emotion on their cognition will help them to serve as stress monitors for any [redacted] group in which they serve by watching for debilitating symptoms in the group and warning against them during the attribution process.

(U) Emphasize Information Sharing and Enhanced [redacted] Coordination

(U) Given the overriding need for information sharing and coordination during a WMD incident, [redacted] should focus on taking steps to avoid inefficiencies in communication that could prove detrimental to the [redacted] mission. This should be given priority over concerns about groupthink. Any reduction in biases being introduced into TNF, for example, from the IC or LE efforts is far outweighed by the problems posed by lack of communication or coordination, and the benefits that would be obtained by enhancing these elements. As an organization composed of members from multiple agencies, both within and outside of Government, [redacted] is not the kind of unitary, insular organization susceptible to groupthink. Thus, the focus should be upon enhancing information sharing and coordination.

(U) Summary of Recommendations

(U) Promote a healthy culture

(U) [redacted] as a new organization, can seize the opportunity to explicitly shape an organizational culture designed to optimize functioning and mitigate or eliminate the effects of known negative factors. This culture could include behavioral norms and attitudes such as:

- Facilitate open communication and information sharing
- Minimize in-group status distinctions
- Practice inclusiveness (permeable boundaries for belonging, especially with regard to analytic aspects)
- Trust in intentions
- Create common group identity
- Establish a shared sense of goals and mission
- Incorporate a role of "devil's advocate" or red teaming
- Understand the strengths and limitations of expertise (link to expertise section)
- Practice healthy interactive strategies, such as negotiation (link to negotiation section)

(U) Maintain and grow social networks

(U) Among their many benefits, well-connected and well-structured social networks improve performance in groups facing complex problems. [redacted] members must maintain and leverage their existing networks while building new relationships both within and across group boundaries. Regular, formal assessments on network structure and individual position and performance within the network, using methods from social network analysis, will provide a

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means to evaluate the current functional status and suggest areas for improvement.

(U) Manage Expertise Effectively

(U) Expertise, while often critical, can be a double-edged sword in groups, generating conflict, rigidity, and excessive deference. To leverage expertise effectively, [redacted] should consider:

- Selecting for fluid expertise in its members, and encouraging and teaching fluid expertise methods to the group.
- Incentivizing collaborative, instead of all-star, behavior. Expertise alone is not sufficient. Metrics for individual success should include cooperative behavior and information sharing. Provide actionable feedback to individuals, such as a personal social network analysis.
- Building robust, decentralized social networks for information sharing [redacted] Measure and evaluate these organizational social networks, and take steps to improve them as deficiencies are observed. Share results.
- Institutionalizing these practices and metrics to shape the culture.

(U) Mitigate maladaptive group dynamics

- (U) Avoid over worry about groupthink, but also avoid insularity of perspectives. Consider membership criteria to create a balance within the group (across status, expertise, etc.) and recognize problems associated with newly formed groups.
- (U) Recognize the need for inoculation of personal and information networks prior to events and meet regularly for joint exercises to build the relationships/experience necessary before a real crisis.
- (U) Preserve splits involving differences of opinion in reporting to consumers and emphasize information sharing and enhanced [redacted] coordination.
- (U) Counter debilitating effects of a high stress environment [redacted] by employing stress monitors.
- (U) Select a mixture of experts with differing competencies (both task and general) for [redacted] subgroups to enhance flexibility in dealing with ambiguous environments and coordination across the three communities.

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(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD

(U) This article focuses upon key elements of the senior policy-maker environment and how these may pose challenges [redacted] in effectively communicating its attribution assessments. These elements include: how senior consumers may view threats and risk, differences in accessibility to inner circles, the right kinds of experts to communicate with them, and the importance of making [redacted] a key information hub for decision-makers.

(U) Understanding the Sensitivities and Constraints of Senior Policy-Makers

(U) One of the key challenges [redacted] will be to not only produce the highest quality attribution assessments, but also to understand that the consumers of its information (senior policy-makers) will be dealing with political issues and perspectives that may have significant impact upon [redacted] how its assessments are used. [redacted] it must understand that not all policy-makers use information and advice in the same ways. To maintain effective communication or input into the policy process, it is essential [redacted] to understand how policy-makers differ from one another and how they respond to crisis situations.

(U) We also must consider the state-of-mind of the decision-maker (as well as the analyst providing data and assessments to the decision-maker) subsequent to a high consequence event such as a nuclear detonation. They will be agitated, worried about family and friends, and may well be in a vengeful state-of-mind. In such contexts, would a decision-maker be willing to react with punitive actions, even if the certainty of the attributions or clarity of the evidence may not be there? Will their standard-of-proof change? Will the psychology associated with the event and the pressures for action reduce the decision-maker's standard of proof and his or her demanded level of certainty in the assessment process? We need to also consider the public demand for the government to take action in the aftermath of a catastrophic event. This can cause tremendous pressure to shorten timelines, and lower the threshold for action. It could be prudent to define certainty thresholds in advance of an event to help circumvent these phenomena.

(U) [redacted] it is important to understand several issues regarding the sensitivities and constraints that are likely to apply to senior policy-makers upon the activation of [redacted]

(U) The [redacted] Analyst as Consultant

(U) [redacted]

(U) [redacted]

(U) [redacted]

(U) [redacted]

(U) The* [redacted] *Must Ask the Right Questions

(U) [redacted]

(U) [redacted]

(U) [redacted]

<u>(U) How Information Seeking Works</u>

(U) Resolving an information need is not simply just about finding a "nugget." It is dependent on a host of other factors and constraints. Information must be actively incorporated into the mind. New information has to be assimilated into a person's preexisting context, or state of information about the world. "Meaning construction" takes place when this new information can connect with what is already understood. Our ability to absorb new information is limited. People selectively attend to new information that connects, and may be oblivious to the rest.[27] Emotional states, such as stress and anxiety, as well as the degree of cognitive openness, can limit one's ability to wrestle with new information, especially if it conflicts with previously held beliefs.

(U) In the non-routine, hard problem world [redacted], information seeking will be part of a process. The early stages of information seeking are likely to show a marked lack of clarity and precision because the specifics of the problem are still imperfectly understood. Confusion, uncertainty, doubt and frustration are natural, and a desire to just drop it and move on to some other aspect of the problem needs to be tempered with realistic expectations of how information seeking actually works.

(U) Later, as new information gathering starts and understanding of the problem improves, one may experience relief and satisfaction that the needed information has been supplied. Conversely, one may experience disappointment that no resolution can be achieved, even though the information need is clear and focused.

(U) Paradoxically, only after you know your answer are you likely to know your question.

<u>(U) Performing a Reality Check on Information Seeking</u>

(U) From the perspective of the analyst [redacted] there is a complementary problem. The problem may transform from "what do I need to know to take action" into "what does my client really need me to provide?" By taking the perspective of analyst as consultant, it will require more than simply answering the questions that were asked. Optimal performance in information seeking in this context has to be oriented around knowing the mind of the client.

- (U) What is the goal or the "commander's intent?" Questions may be tailored to address what they perceive can be answered, instead of stating their actual goal.
- (U) What is the next action or decision to be taken?
- (U) What level of detail is truly needed?
- (U) Is there another authority/group beyond the current client to whom this information needs to be presented?

(U) The [redacted] activities will undoubtedly go beyond providing a single final assessment report. To handle new information needs in a dynamic environment, the process must be interactive and self-correcting to whatever degree possible, not "fire-and-forget." To confirm understanding of what is actually needed, [redacted] may choose to implement steps such as:

- (U) Provide interim feedback on the state of the work, and allow for course corrections.
- (U) Provide samples of answers – they will know it when they see it.
- (U) Rule out the irrelevant or superfluous with counter-examples.

<u>(U) Is it Safe to not Know?</u>

(U) Acknowledging ignorance, that is, lack of specific knowledge of expertise in a social environment, can be a risky proposition. Given the complexities of the [redacted] mission and operating environment, and its composition, both lack of joint expertise and of situation-

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specific pieces of information are a given. [redacted] will need to create a social norm that reaching out to gather information and expertise is not just appropriate, it is required. Acknowledging lack of perfect expertise, and taking action to rectify the situation, must be valued normative behavior.

<u>(U) Recommendations Relating to Asking the Right Question</u>

(U) Dealing with the social and psychological factors around information seeking will be critical [redacted] The following should be considered as potential methods to improve function:

(U) Providing education on the information seeking process, to avoid common pitfalls and overcome natural frustrations, and be able to optimize their own behaviors.
(U) Creating social norms that accept imperfect knowledge among members, and reward outreach to acquire the right knowledge and expertise.
(U) Tapping into the mind of the client.
(U) Incorporating interactive strategies to keep focused.

(U) [redacted]

(U) [redacted]

(U) [redacted]

(U) [redacted]

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[redacted]

(U) [redacted]

(U) Recognize that Pressure for Immediate (Short-Term) Political or Policy Responses Will Be Directly Proportional to the Magnitude of the Consequences Surrounding an Event

(U) In the event of a substantial WMD incident, policy-makers will feel tremendous pressure to respond publicly to an event (especially to a highly visible WMD employment resulting in substantial loss of life or contamination) by quickly ascertaining 'blame' or responsibility for the incident, implementing strategies for managing the response, and launching punitive actions against the perpetrator(s).

(U) Ahead of any WMD event, [redacted] should focus upon educating senior consumers about the reality that technical analysis, crime scene investigations, or IC efforts are likely to lag behind their desire for more rapid delivery of actionable information. This is where managing the expectations of policy-makers through pre-incident education is important so that realistic understandings of technical capabilities, how fast certain analyses are likely to take, etc. can be provided prior to the onset of a crisis situation (when tolerance for that type of learning will be extremely limited). Pre-event exercises (ideally including senior customers) would educate them regarding the reality of how fast they will receive actionable information.

(U) Recognize that Policy-Maker Tolerance of Risk (and willingness to accept various measures or estimates of certainty) Will Diminish as the Magnitude of Potential Consequences (On Either Action or Inaction) Increases

(U) Regardless of how many different standards or measures [redacted] might use to communicate varying levels of certainty to policy-makers about its findings, the actual consequences of an event (either real or potential) will cause a subjective shift on the part of policy-makers in how they will interpret this information. For example, faced with the chance that a nuclear device might be detonated in a major US city – and a 75% certainty expressed by the IC or law enforcement that the device could be seized and rendered safe from terrorists before it could be detonated – it is likely that policy-makers would consider a 25% chance of a nuclear explosion in an American city too large a risk to take at that moment.

(U) During the Cuban Missile Crisis, US Air Force and IC estimates that 90% of 'known' nuclear missiles could be struck with air power (while only about 67% of the missiles likely to be on the island had been found) provoked Defense Secretary McNamara to argue in the

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ExComm that even one missile launched at an American city was too great a risk for any President to take (and a consequence beyond acceptable imagining). When consequences for an action are high (in terms of physical, economic, military, or political blow back), the standard of certainty policy-makers are likely to demand will be greater than under other consequences. In contrast, if such a certainty level were expressed about the possible origins of the material found in an unexploded, interdicted RDD (for instance, from stolen medical equipment in the FSU), policy-makers might well view this as acceptable proof for taking actions like contacting the Russian government diplomatically to request information and assistance.

(S//NF) The attribution question may involve a spectrum ranging from successful interdiction of nuclear materials that failed to detonate (which allows greater time for investigations, more careful analysis, and a process that takes place out of the public view) to those involving significant, visible consequences (use of a Radiological Dispersal Device, also known as an RDD, or nuclear detonation). In those cases where substantial military retaliation (and an adverse impact on US interests might follow as a result), policy-makers are likely to insist upon a very high level of attribution certainty.

(S//NF) The hypothetical example of a likely connection to terrorist use of North Korean material in an RDD incident in Chicago illustrates this problem. Because any US military strike against Pyongyang could potentially trigger a reaction from the North (such as a new war on the peninsula or retaliation against Seoul or other regional allies), the probable consequences of the policy actions if the attribution is accepted would obviously temper how policy-makers would view the degree of certainty they would require regarding the evidence prior to taking action.

(U) Policy-makers facing substantial consequences for taking (or not taking) certain actions will be far more risk averse (and require far higher levels of confidence that the analysis is sound) than will those facing more limited or less significant costs. In those cases, lower levels of certainty may be acceptable, if the costs of such acceptance appear not to be prohibitive. As [redacted] considers various measures of certainty for attribution, it should take into account this basic reality: that risk acceptance on the part of policy-makers is closely bound to their perceptions of the consequences. It is part of the complex political-psychological context that will drive how policy-makers actually interpret the analysis from [redacted]

(U) The inherent imprecision of terminology for expressing levels of certainty together with the varying degrees of meaning individuals can assign to the same term suggests that making an effort to establish a shared understanding of terms relating to certainty is imperative. For example, different individuals show surprising contrasts in their interpretation of terms such as possibly, probably, likely, unlikely, and certainly. But even if the communities adopted legal terms such as beyond a reasonable doubt, clear and convincing evidence, and the preponderance of the evidence that have the appeal of familiarity to the listener, they still retain the same kinds of imprecision due to each individual's own subjective idea of what the terms mean. This is an area where [redacted] will have to move purposefully to induce the three communities to work more closely together to reduce the risk of miscommunication by establishing a common lexicon and definitions regarding levels of certainty.

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<u>(U) Understand that People Respond to Estimates of Risk Based Upon Whether These Are Presented in the Domain of Gains or Loses</u>

(U) Prospect theory notes that people are risk accepting when information (such as reports or data being presented to decision-makers) is couched in language emphasizing their loss of current possessions, status, etc., but risk averse when such information is framed in terms of gains that also requires risking current security or possessions. Thus, [redacted] Senior Level must exercise care in the labeling of various kinds of attributions, estimates of a current situation, or the chances of an operation being successful or not – since senior leaders will likely respond in prospect theory ways to the presented information.

(U) Not All Senior Policy-Makers Are the Same

(U) One of the major challenges [redacted] in providing information to senior policy-makers (including the President) is the reality that no single approach fits all policy-makers. Regardless of how [redacted] structures itself, sets up access channels to senior levels, or packages its assessments, these things will ultimately run up against the personal styles and characteristics of the policy-makers themselves. Like all individuals, senior policy-makers will vary greatly from one another in their needs for information gathering and debate (prior to making decisions), how much they feel the need to rely upon expert opinions prior to reaching decisions, and in their overall sensitivity to the surrounding policy environment.

(U) This is reflected in the broad leadership literature that has developed over the years in the fields of political psychology and Presidential studies. It chronicles the wide range of differences in how modern American Presidents (as well as foreign leaders) have structured and actually 'used' their advisory systems during crisis decision-making as a result of their own, unique individual differences (i.e., personality characteristics, style, prior background, etc.) Illustrating this point is the book, "The President and His Inner Circle: Leadership Style and the Advisory Process in Foreign Affairs," by Thomas Preston which profiles modern Presidents from Harry Truman through George H.W. Bush across foreign policy decision-making cases.[28] Here, the individual characteristics of these Presidents played a predictive role in shaping how they would structure and utilize their advisory systems during future crises.

(U) Different types of Presidents favored more or less open advisory systems, sought out more or less diverse sets of advisers, had widely varying needs for information or diversity of advice, and had differing needs for (or reliance upon) expert advice. In simple terms, this distinction can be thought of as a difference between leaders in terms of 1) the degree of control or personal involvement they required; and 2) their own personal need for information and sensitivity to the broader policy environment around them.

(U) Leaders who are more hands-on tend to delegate less to subordinates and want more personal engagement throughout the policy or decision process. Leaders having substantial policy experience or expertise in a given area would also be expected to be more engaged and to delegate less to experts. Presidents Eisenhower and GHW Bush, for example, were much more highly engaged throughout the policy process (and much less dependent upon the views of expert advisers in coming to their own judgments) in the foreign policy arena than they were in the domestic policy arena (where both had less experience and interest). In contrast, those with less personal experience or expertise in an area will be much more inclined to delegate to subordinates and will be more dependent upon expert advice in reaching conclusions. So for Presidents Truman or George W. Bush, who both lacked extensive foreign policy experience or knowledge, expert advisers around them had much more of an impact (and were delegated more of a role in policy formulation) than were advisers to President Eisenhower.

(U) [redacted] f one is dealing with an engaged, hands-on consumer (perhaps one who has substantial foreign policy experience), the attributions or analyses provided senior leaders may be used far more selectively than would be the case if the consumer were of the opposite type. Moreover, it is very important [redacted] to have educated the more hands-on or experienced leaders in advance of crises regarding [redacted] s abilities and value in attribution assessments, so that a pre-established relationship will be developed that thoroughly engages with that leader's desire for involvement.

(U) Similarly, less sensitive leaders, who see the world in more absolute, black-and-white terms, tend to be more ideological, rely more upon simple stereotypes or analogies to understand their problem environment (or the options presented to them), and tend to have more closed advisory systems populated by advisers who share similar beliefs and views as the leader (and have less diversity of view as a result). Historic examples of such American Presidents would include Presidents Truman, Johnson, Reagan, and G.W. Bush. More sensitive leaders (who show more differentiation in their environment, seeing the world in shades of gray and many perspectives instead of in absolutes) tend to have more open advisory systems, gather information from much more diverse sources (that both supports and contradicts their own views), and populate their advisory systems with a diverse group of advisers who do not share common views or positions. Historic examples here would include Presidents Eisenhower, Kennedy, GHW Bush, Clinton, and Obama.

(U) This distinction between sensitive and less sensitive styles is important for [redacted] if the consumer is a more sensitive type of leader, [redacted] will be operating in an environment more conducive for communicating information to senior levels (since these styles are more active in gathering information/advice from a broad array of sources), have more open advisory systems, and comprise actors who monitor their surrounding environments. As a result, the contraction of authority problem will be less severe for [redacted] and the problems of access to senior levels less complicated than it will be when providing assessments and attributions to less sensitive leaders. For these less sensitive leaders, [redacted] should anticipate a much more closed advisory and advice system and greater difficulty in communicating effectively to senior levels. [redacted] must recognize that greater barriers will exist to gaining the attention of policy-makers. For example, because less sensitive leaders tend to be more ideological, more likely to adopt stereotypes of opponents or analogies driven by personal experiences, and surround themselves with similar types of advisers in terms of beliefs, it will be very difficult to successfully communicate that the usual suspects might not be behind a given WMD incident, strong, pre-existing belief structures notwithstanding.

(U) Generally, discrepant information has a great deal of difficulty penetrating to senior policy-makers in such contexts and, even if it does, has the problem of gaining the attention of policy-makers (or perhaps more importantly) the perception of 'credibility' for them if it conflicts with pre-existing views. This is why having an informed, active [redacted] ctor as part of the inner circle for such leaders (who then provides credibility to [redacted] assessments due to their own status within the leadership group) becomes so critical. This relates to the idea noted earlier that beliefs are possessions and that a major hurdle in getting policy-makers to think outside of the box in attribution environments requires a willingness to challenge pre-

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conceived notions or views. [redacted] this will become most problematic when the consumers have less sensitive styles because those prior beliefs or modes of operation that previously were employed will represent a simplifying heuristic (or shortcut) to them. It will require more effort for an [redacted] attribution assessment that violates these to receive a fair hearing. More sensitive leader styles will be more amenable to considering these outside the box assessments and will not rely so heavily upon preconceived notions in framing or understanding the policy environment or situation.

(U) Bottom-line: If [redacted] is dealing with a President favoring a more open advisory process, diverse sets of advisors and extensive collection of advice and information – the task of obtaining access for providing attribution information will be far easier than it will be if advising the reverse style of leadership. Although prior education of the existing White House regarding capabilities, managing expectations, and setting up relationships for [redacted] technical advisers should be done in any event, with less sensitive leader styles and more closed advisory systems, this becomes critical to avoid serious communication problems in the event of a crisis. On the positive side, leaders with less expertise in an area will be more dependent upon expert advice or explanations of the problem environment, so with proper access, the analytic product [redacted] could be of great assistance and use for such leaders in understanding their situation and evaluating options.

<u>(U) [redacted] Must Calibrate Communications with Senior Consumers Based Upon the Way Different Leaders Structure Their Advisory Systems</u>

(U) Because the flows of access to senior-level inner-circles around policy-makers (such as the President) change from one White House occupant to the next [redacted] must take into account differences across consumers in terms of how they use advice, how much information they tend to gather, and how attentive are they to their environment in setting up their communication strategies.

(U) Leaders with closed advisory systems and tendencies toward limited (highly selective) information search will prove more difficult for [redacted] to communicate with effectively than will consumers with more open systems who actively seek out broader ranges of information.

<u>(U) As a result, [redacted] must establish communication</u> conduits to senior policy-makers [redacted]. These conduits must be sufficiently robust to perform effectively and maintain access in cases where leaders have relatively closed inner circles (or when the contraction of authority during a crisis makes even open systems more impermeable).

(U) The Contraction of Authority problem

(U) The Contraction of Authority problem reflects the reality that the inner circle around the national leadership tends to shrink during intense, high stakes crises to much smaller groups composed primarily of the closest personal advisers to the President. This occurs because of 1) time constraints, secrecy requirements, and the need for rapid decision-making often imposed by such crises; and (2) the desire of leaders for a comfort zone composed of their most trusted advisers during such times.

(U) [redacted] this contraction of authority could potentially pose serious problems for its ability to effectively communicate its attribution assessments and maintain the kind of ongoing contact necessary to keep policy-makers adequately informed of new developments as evidence continues to be gathered and evaluated during a crisis. Therefore, prior to the actual activation [redacted] during a WMD crisis, it is critical to work to create and maintain an access channel to senior policy-makers that can survive any contraction of authority during an event. This could be pursued by: 1) setting up the [redacted] organizational structure to include a senior Presidential adviser (someone who would be expected to remain within even the tightest crisis inner circle or have easy access to it), who would become an active [redacted] participant, take part in its exercises, and become a knowledgeable conduit for information to senior levels; 2) educating senior policy-makers at the highest levels about the [redacted] and the functions/information it can provide so that it is instantly thought of by these leaders (even during a time-constrained crisis) as the main resource for understanding the difficult questions they will face and coordinating the views across the IC, LE, and TNF communities.

(U) Using the Right Kind of Expert Advisers to Interact With Policy-makers

(U) Another challenge [redacted] is finding the right kind of messenger or conduit, not only for communicating the basic attribution information to senior policy-makers, but also for facilitating the ongoing back-and-forth interaction required [redacted] to assist in coordinating the IC, Law Enforcement, and TNF communities in ongoing attribution tasks. It requires that the right type of expert adviser(s) is still involved within that inner circle who can convey the available technical information [redacted] in a timely and effective fashion without distortion. Assuring the presence of such an expert would allow [redacted] policy-makers the best handle on the moment possible (as well as manage the expectations of policy-makers), given the available attribution information so that this sometimes technical data can be given its proper context in order to assist the White House to improve its situational awareness. This would require education of policy-makers prior to an event about the value of including such an adviser, and a set of protocols for identifying this individual in advance so that there is no disconnect between policy-makers and the best the technical community [redacted] have to offer during an intense, fast-moving crisis.

(U) Given that many senior policy-makers lack technical backgrounds (having business or political backgrounds instead), it is important [redacted] to be "bilingual," in the sense that they are conversant and understand the political/policy environment (and problems) faced by the White House, as well as the technical, scientific side of the attribution equation focused upon [redacted]. This would greatly facilitate a bridging of the gap between those whose focus (and comfort zones) are in the policy realm and those who come from a more scientific or technical community. Clearly, in a nuclear (or other WMD) attribution setting, it is of critical importance to reduce the chances of miscommunication or any lack of precision in the communication or understanding [redacted] data by policy-makers.

(U) The Role of Blame Avoidance Strategies and How These May Complicate the Attribution Question [redacted]

(U) [redacted] Whether it be the IC, the TNF, or law enforcement communities, or the senior policy-makers themselves – during a WMD incident, there will be a sensitivity and awareness regarding the potential political, institutional, or career damage that would result from attribution failures (for example, technical mistakes, incorrect interpretations of intelligence, or failure to pursue certain leads) and a desire to avoid divert – or even direct – blame were they to occur. Similarly, policy-makers themselves will be highly sensitive to the political damage that would result from policy mistakes (for example, mistaken attributions of blame resulting from retaliating against the wrong party, negative reaction to policy actions (even if the correct perpetrator was identified), failure to take action in the face of evidence later judged to be sufficient.

(U) The higher the potential or real consequences of the crisis incident, the greater the resultant emphasis upon blame avoidance strategies becomes – which in extreme circumstances could severely hamper trust and communication between the three communities [redacted] An excellent illustration of this area of research in crisis management that focuses not only upon crisis response, but also the management of response and its aftermath from a blame avoidance standpoint (both for institutions and policy-makers) is found in the book "Crisis and After: The Politics of Investigation, Accountability, and Learning."[29]

(U) Because of blame avoidance, policy-makers (or institutions [redacted]) might find themselves seeing to selectively process information during the attribution endeavor. For example, assume hypothetically that policy-makers had a desire to advance important peace talks or maintain cooperation with another country in a policy area of great importance to the United States, and an attribution assessment arose that potentially linked that nation to a domestic WMD incident. Depending on the severity of the incident, one could imagine in certain contexts policy-makers desiring to search the available error bars in the attribution evidence to introduce doubt (much like a competent defense attorney). This introduces 'politics' into the way in which attribution evidence is viewed by policy-makers, and certainly skews it in directions unrelated to the [redacted] focus on the IC, legal, or technical analysis.

(U) Similarly, if a particularly horrendous WMD attack occurred and there was a lack of clear evidence linking a perpetrator to the crime, there would be immense pressure on policy-makers to avoid being blamed by the public for doing nothing in response to the crime and to "round up the usual suspects," so as to give the public the perception of decisive, strong action. This gambit could result in policy-makers taking actions against parties based upon [redacted] attributions that had very low levels of certainty by selectively using bits of the evidence to point the finger in the desired direction. In fact, there are almost endless scenarios for how the blame avoidance game might be played or what confounding effects it could have upon the [redacted] attribution effort. This observation is not meant to denigrate any party, but merely to recognize that the attribution process [redacted] will not be conducted in a vacuum, and that politics – sometimes not directly related to the issue at hand – might play a role in how policy-makers actually will interpret or make use of any attribution data [redacted]

(U) Because a highly charged and ambiguous environment is likely to result from the circumstances surrounding the activation [redacted], and the political consequences of the attributions themselves and the policies or actions that senior policy-makers may take as a result, it makes sense to focus upon building sound, pre-existing relationships among the relevant actors within the [redacted] community and its key representatives to senior policy levels. Only levels of trust built on longstanding relationships among the parties, as well as knowledge and awareness of the technical capabilities (and analytic processes engaged in) by the [redacted] community on the part of policy-makers, will help prevent dysfunctions in performance during an event – where all the parties have to feel assured that they will not be "thrown under the bus" by the others.

(U) "Safety in Numbers?" The Hurricane Katrina Problem

(U) How many people died in Katrina? Early on, estimates flowed in from a variety of sources; hospitals, morgues, law enforcement, emergency management bodies, news services, unofficial Katrina web sites, and more. Some groups tried to aggregate data obtained from others, counting the same cases again and again. There were complexities in determining what constituted the categories defining how the person was killed. Individuals who drowned in the flood, or were crushed by debris were certainly included within those categories, but it is unclear how those who may have been killed in a car crash during evacuation, or succumbed to their preexisting medical conditions in the high-stress environment were categorized and counted.

(U) In an environment of information overload and time pressure, keeping one's eye on the ball versus constantly playing information catch-up, is a challenge. Dependence on human memory for keeping track of information (for example, to pull threads or follow themes), especially given the acknowledged limitations of human memory and cognitive biases, is destined to be inadequate, if not fail outright. From the technological perspective, the concept of an information clearinghouse is a step in the right direction, but an actual analytic environment for organizing, processing, and summarizing the data will be critical.

(U) Yet technology alone cannot solve the problem. The [redacted] and its supporting groups will need a common framework, or a set of common processes for their work, to help clarify that they are focused on the right things, and that gaps are being filled. It will be extremely important to remain focused on the key points:

- (U) What do we know?
- (U) What do we need to know, but do not?
- (U) Can we fill in the gaps? How?

(U) This will require more than personal discipline. Under pressure, procedures, processes, tools, group norms, and common situational awareness will be critical [redacted]. Having a scorecard to fill out may help provide some critical structure and focus in constructing an assessment. [redacted] Clarifying these goals/tasks will help to clarify work flow/processes/procedures, as well as help to define an appropriate analytic and information environment.

(U) The Surrounding Psychological Context for [redacted] Policy-Maker in WMD Attribution

(S) [redacted]

(S//NF) [redacted]

[redacted]

(S//NF) [redacted]

(U) Terrorists are "Adaptive Enemies" Who will try to "Muddy the Waters" to Complicate the Attribution Process by Increasing Ambiguity.

[redacted] In addition, information that evolves may have been purposefully distorted by the opposition, which might mislead investigators and conceal information about perpetrators and their actions. Terrorists should be considered the ultimate in adaptive enemies, who in the event of a WMD incident will inflict damage (both physical and psychological), as well as gain support and admiration among their followers. In many scenarios we would envision [redacted] terrorists likely will have a great interest in confusing and complicating our response, and magnifying the psychological effects of the incident. [redacted] This would be a particularly important consideration in the event that a state actor clandestinely supplied fissile material to a terror group. Terrorists may expressly attempt to leave an impression that more attacks are impending in order to generate fear in the public, as well as apply added pressure on policy-makers.

(U) Summary of Recommendations

(U) Make [redacted] a valuable information hub for policy-makers, a one-stop shop for gathering the coordinated attribution information flowing from the three communities.
(U) Recognize that pressure for immediate responses will be directly proportional to the magnitude of the consequences surrounding an event.
(U) Recognize tolerance of risk by policy-makers (and their willingness to accept various measures or estimates of certainty) will be reduced as the magnitude of potential

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consequences (for either action or inaction) increases.
(U) [redacted] must calibrate communications with senior consumers based upon the way in which different leaders structure their advisory systems. Understand that not all leaders are the same.
(U) Understand that people respond to estimates of risk on the basis of whether these are presented in the domain of gains or losses.
(U) If attribution information presented to senior policy-makers diverges from their pre-existing, deeply held beliefs, more evidence will be required to gain their attention.
(U) For [redacted] to get the right answers, they must learn how to ask the right questions.
(U) Use the correct set of expert advisers to interact with policy-makers, those who are "bilingual" and understand the political/policy environment and problems faced by the White House, as well as the technical aspect of the attribution equation focused [redacted]

(U) THE RIGHT STUFF: HARVESTING EXPERTISE

(S//NF) Having examined the range of capabilities that the US Government will bring to the issue of nuclear attribution, we conclude that IC, LE, and TNF capabilities, as currently configured, are likely to result in *eventual* success. By this we mean that we are confident that these efforts would eventually result in identification of those who mounted and sponsored any nuclear-related attack on the US or engaged in related activities. We are far less confident that as currently configured these agencies will be able to *deliver meaningful, rapid success*. In the event of a nuclear attack or imminent nuclear strike, the LE, IC and TNF communities each stands a chance of uncovering meaningful and timely leads to the perpetrators. Current resources might succeed in interdicting an attack or, after an attack, providing the President with a quick and accurate identification of those responsible. However, in such a serious event, it is not sufficient to say that these resources *might* succeed.

(S//NF) The key question is what can be done to dramatically increase our chances of rapid success. Rapid success is important in any scenario, but vital in scenarios where we have an opportunity to interdict a nuclear device before detonation. We conclude that investments in individual attribution capabilities are necessary but not sufficient to make a real difference. Rather, the greatest progress will come from forming a seamless team from the IC, LE, and TNF communities. We must tear down the remaining impediments to teamwork in this arena.

(S//NF) [redacted]

- (S//NF) [redacted]
- (S//NF) [redacted]
- (S//NF) [redacted]
- (S//NF) [redacted]

(U) Integrating Expertise

(U) [redacted]

(U) Analytic Rotations for Cultural Awareness

(U) [redacted]

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[redacted]

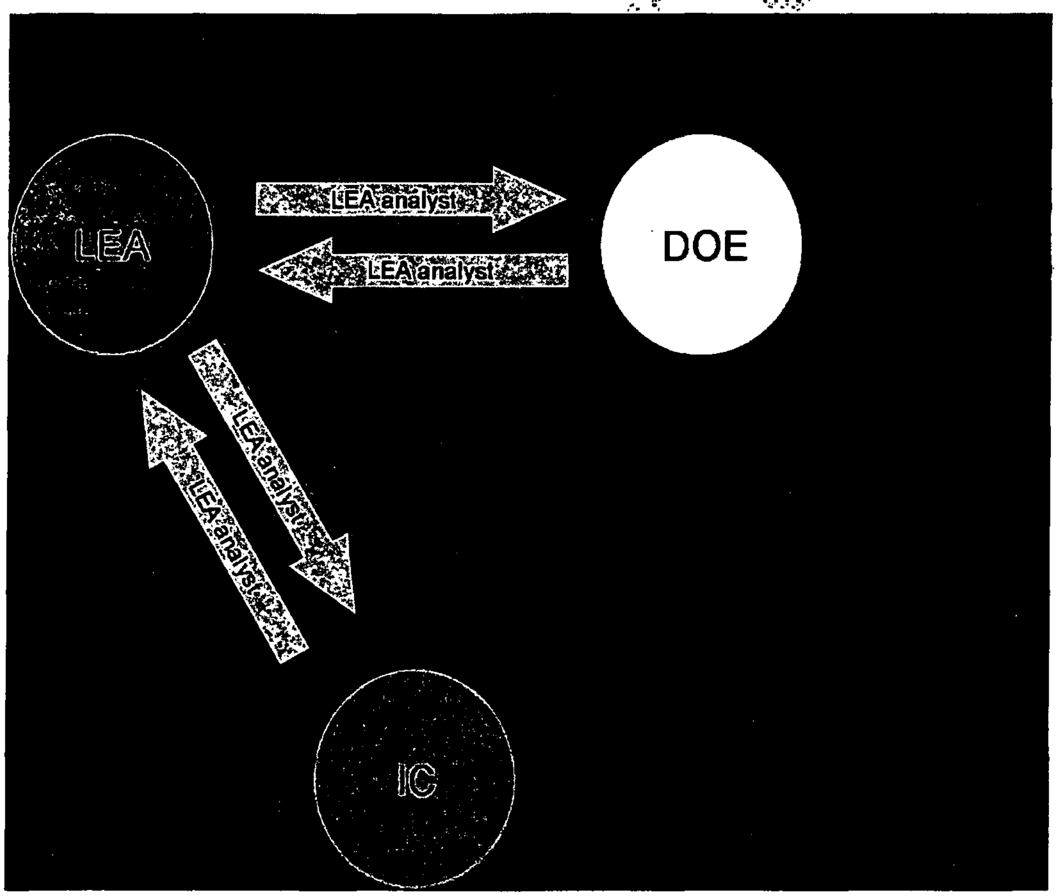
(U) [redacted]

[redacted]

(U) [redacted]

[redacted]

(U) The graphics below are an attempt to provide a representation of the three options described above.



(U) In this example, a senior LE analyst is chosen to serve in a rotational assignment at DOE. Following this tour, the analyst returns to LE-related duty. After a set period of time, the

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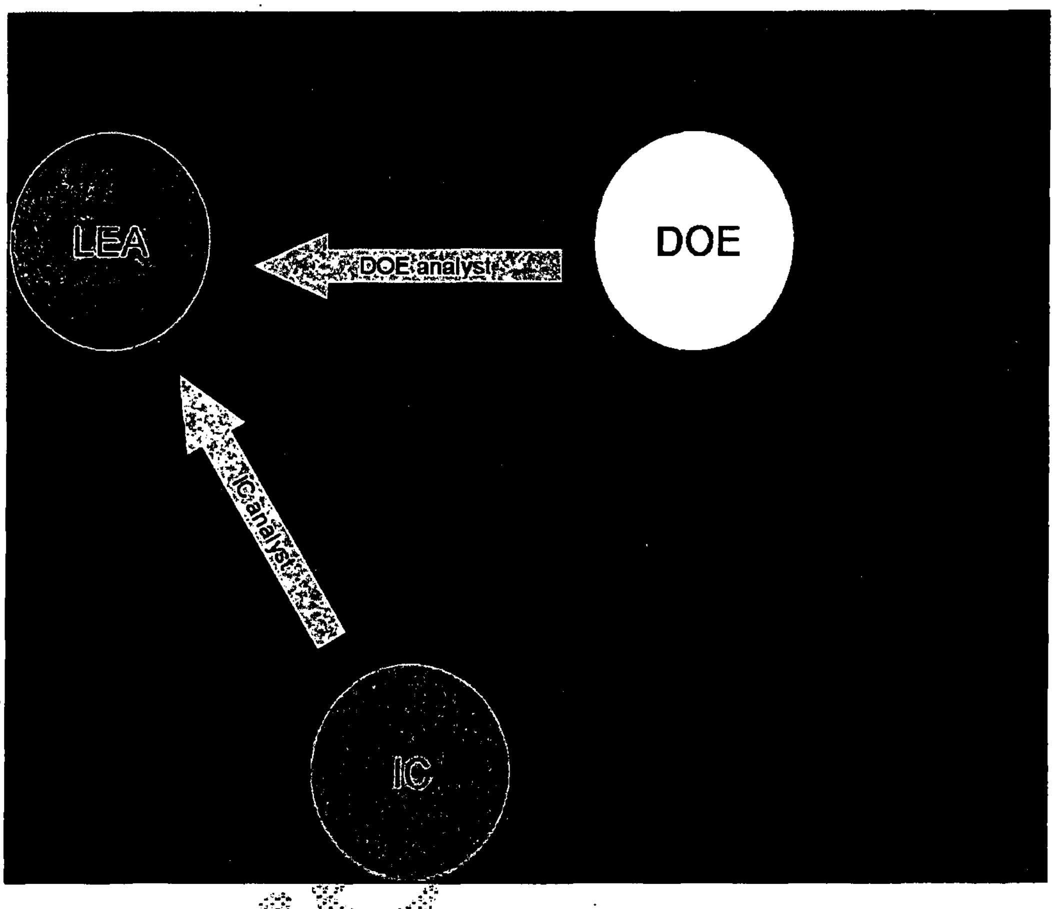
analyst serves another rotational tour in an applicable IC organization, returning to his or her home office with experience in both DOE and IC communities and better able to support [redacted] ssues.



(U) [redacted]

[redacted]

(U) [redacted]

(U) Drawing on the "Un-cleared" World

(U//FOUO) [redacted]

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[redacted]

(U//FOUO) [redacted]

(U) Red Teams are Essential

(U//FOUO) [redacted]

(U) Exercises and Training

(C) [redacted]

(C) [redacted]

[redacted]

(U) Collecting and Preserving Perishable Information

(U//FOUO) The information age has enabled a high percentage of citizens with instantaneous communications coupled with sound and photographic recording capabilities. Cable News Network (CNN) has exploited this new capability with their "I-Reports" in which anyone who sees something of interest can submit it for CNN's broadcast consideration. Stories that would otherwise be a mere verbal or written description are now documented in pictures and sound by the omnipresent public.

(U) In the case of a nuclear event, it is likely that individual private citizens will have images stored on cell phones or digital cameras that could help the attribution question. [redacted] should make arrangements in advance of any actual emergency that would give the public a way to send information to government servers for analysis. During an emergency, the public could be advised via public announcement or global text message, of the way to submit photos and other information they have that could shed light on the event. Technology now allows users effortlessly to include the date, time, and GPS location in pictures. Experience with the Space Shuttle Columbia crash debris recovery effort or the Hurricane Katrina response indicates a hugely sympathetic public anxious to contribute in response to a national emergency/disaster. Using this capability requires some advance planning, however.

(U//FOUO) A second source of perishable data is security cameras, traffic cameras, and closed circuit television (CCTV). If a nuclear/radiological attribution event were to occur within a metropolitan area of the Continental United States (CONUS), a collection and review of CCTV data would benefit an investigation to determine the who, what, where, and when aspects of the case. Throughout most major metropolitan areas there are a multitude of public and private CCTV systems. Most CCTV systems are designed to regularly delete old footage from their memory systems. The value of CCTV information became clear following the bombing of the London subway system on July 7, 2005. The subsequent investigation revealed surveillance footage of the suicide bombers parking their vehicle at the Edgeware Road subway station and entering the station. From the surveillance footage, the bombers were identified, greatly aiding the investigation and leading to discovery of the planning process for the bombing.

(U//FOUO) A system should be implemented that will preserve all relevant CCTV footage at the very outset of a nuclear/radiological attribution event to aid the investigation. The CONOPS should incorporate a process whereby [redacted] coordinates with the Department of Justice to ensure that a formal request for the preservation of records and other evidence pursuant to 18 USC. § 2703(f) pending further legal process is issued and/or the establishment of an agreement network through Interagency Governmental Agreements (IGA).

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(U) INFORMATION SHARING AMONG DISPARATE KINGDOMS

(U//FOUO) Successful attribution depends on pulling together data from a broad range of governmental and non-governmental sources and applying the skills of analysts working across a variety of disciplines and locations. A nuclear emergency would require that this work occur at unprecedented speed. More than any event we can envision, a nuclear emergency inside the United States would require that knowledge flow rapidly between the relevant responders. Current limits to information sharing exist for good reasons, including the need to protect sources, the need to avoid tainting legal prosecution, and the need to protect rights to privacy. These reasons will remain important in a nuclear emergency, but cannot be allowed to impede the higher priority of protecting thousands or millions of human lives.

(U//FOUO) By its nature, the normal method for cross-agency and distance interactions is largely a serial and often hierarchical process. This normal way of doing business is too slow and exclusive to bring the full capacity of the distributed law enforcement, intelligence, and technical communities to bear on the problem in the quickest manner. In a nuclear emergency, we will need these three communities (IC, LE, and TNF) to benefit from each others' knowledge as fast as technology allows. We must prepare IT tools and approaches now, that when activated for a nuclear emergency, allow relevant players to share knowledge at the speed of technology, not the speed of bureaucracy.

(S//NF) [redacted]

(U) Throwing the IT Switch

(U//FOUO) [redacted]

- [redacted]
- [redacted]

(U) ***Creating Quick Classified Channels***

(U) [redacted]

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[redacted]

(U) Capturing Low Confidence Data and Assessments

(U//FOUO) It is important that we protect against the loss of "low confidence" data and assessments that are easily overlooked in a crisis. Individual organizations may tend to dismiss low confidence data as "low value" data and not pass it up the chain or share it with the rest of the community. Taken as a whole, however, the collective picture drawn by integrating all of the data – including low confidence data – may open up new avenues of investigation or lend support to alternate hypothesis. Understandable organizational aversion to risk should not be allowed to be an impediment to integrating this data in real time into a single environment where it can be aggregated with other information and possibly provide additional value. However, once the augmentation group is formed and connected, it is essential that low confidence data, with proper caveats, be continually integrated into the assessment process.

(U) Continuity of Connectivity

(U) The connective process should be running continuously at a low level with regular alerts and exercises to test connectivity, transition to operational status, and to encourage the community to be interactive. In effect, this would be continually building and improving the system in anticipation of an event. Through participation in test alerts and transitioning to operational status exercises, [redacted] members will be familiar with the computer systems, applications and resources before a crisis starts. This type of approach has proven very successful in the NEST Program (Nuclear Emergency Search Program).

(U) Once the tools and protocols for the larger expert group have been established, the concept could be expanded to a much larger group of potential collaborators via parallel communication and security layering, but with the same focus of real-time participation and information sharing (as appropriate to the community of interest). In this fashion, the huge resource of unclassified information and brains might be engaged in a "hive" fashion that could be mining information and investigating hypotheses in parallel with the group selected [redacted] to work in the secure environment. This unprecedented engagement of information resources would be transformational and should be a consideration as [redacted] augmentation component becomes a concurrent collective and lessons are learned.

(U) Leveraging the Catalyst Project

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[redacted]

(U) [redacted]

(U) IT Interfaces That Enhance Interaction

(U) Information Technology (IT) is integral [redacted], as it facilitates communication and ultimately enables collaboration to produce effective and timely analysis. In order to leverage the benefits of the IT available [redacted], it will be important to plan and coordinate these tools before the start of an exercise or an actual crisis. There are two primary areas of concern in the use of IT as an enabler of communication [redacted]

1. Data sharing via common databases, and
2. Information sharing via social networking.

(U) Each of these areas shares some common challenges with regard to successful implementation:

- Particular clearances are needed for accessing agencies' data.
- Computer systems that can operate at a common level must be properly cleared.
- All members [redacted] must be familiar with the computer systems and applications before the start of a crisis.

(U) Data Sharing via Common Databases

(U) A number of organizations have proprietary interests in their particular databases. In light of this, it is advisable for the National Counterterrorism Center (NCTC) to maintain a separate listing of other existing databases that can be accessed through assigned points of contact (liaison officers).

(U) Information Sharing Through Social Networking Tools

(U) Tools are available now that, with some work, could help [redacted]). This wider [redacted] working group could consist of several hundred individuals from the intelligence, scientific, and law enforcement communities, all needing to share the same data in an integrated workspace but far from a common workplace. One possible near term approach to this issue could involve the use of existing classified network tools such as Intellipedia or A-Space. Special access [redacted] instances of these useful tools could provide properly cleared analysts with a place to discuss ongoing nuclear attribution activity, share assessments, build consensus and develop alternate assessments. Use of the existing infrastructure could provide a rapid, relatively inexpensive way to share information and build a more integrated analytical community. Once piloted, the infrastructure and tools might be extended over non-traditional elements such as state and local law enforcement and

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the broader technical community.

(U) There are many advantages to the use of social networking tools – Facebook and Intellipedia, for example – as opposed to the typical way of delivering data in the form of formal reports or serial distribution. One advantage is that information is organized topically as opposed to organizationally. The use of these tools allows for a collection of data in the form of what is known as a whole, rather than what an individual organization thinks based on its limited set of data.

(U) These tools also have an inherent ability to record the development of ideas on an issue through the archiving of previous assessments and the discussions that led to those assessments. The effect is to allow rich local data mining and a high degree of concurrency in sharing information and interaction, which can also serve to increase the likelihood of interactions across communities, a somewhat rare occurrence today. More interaction will help to create pathways that will improve our ability to harness the collective brainpower of the institutions involved.

(U) The Intelligence Community (IC) has established a number of new programs aimed at bringing "Web 2.0" technology to the Intelink user. "Web 2.0" is the second generation of Internet development and web design. It is characterized as facilitating communication, information sharing, interoperability, user-centered design and collaboration on the Internet. It has led to the development and evolution of web-based communities, hosted services, and web applications. Examples of Web 2.0 enabled products include social-networking sites, video-sharing sites, wikis, blogs, mashups, and folksonomies.

(U) One of the key concepts of Web 2.0, according to Internet experts John Batelle and Tim O'Reilly, is that customers are building your business for you by generating content – in the form of ideas, text, videos or pictures – that can be harnessed to create value. Users can own the data on a Web 2.0 sites and exercise control over that data. Web 2.0 sites encourage users to participate and add value to the application as they use it. This differs from earlier approaches, where content was static, users were merely passive viewers of finished products, and only the site owner could change the information.

(U) "Social Media" can be thought of as a fusion of technology and sociology, where modern technologies are used to bring people to connect and form relationships for personal, political, business, and professional uses. Web 2.0 technologies allow for a range of Social Media, such as that found in the Intelink applications A-Space, Jabber, Intellipedia, classified blogs, and other applications.

(U) [redacted]

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]

(U) [redacted]

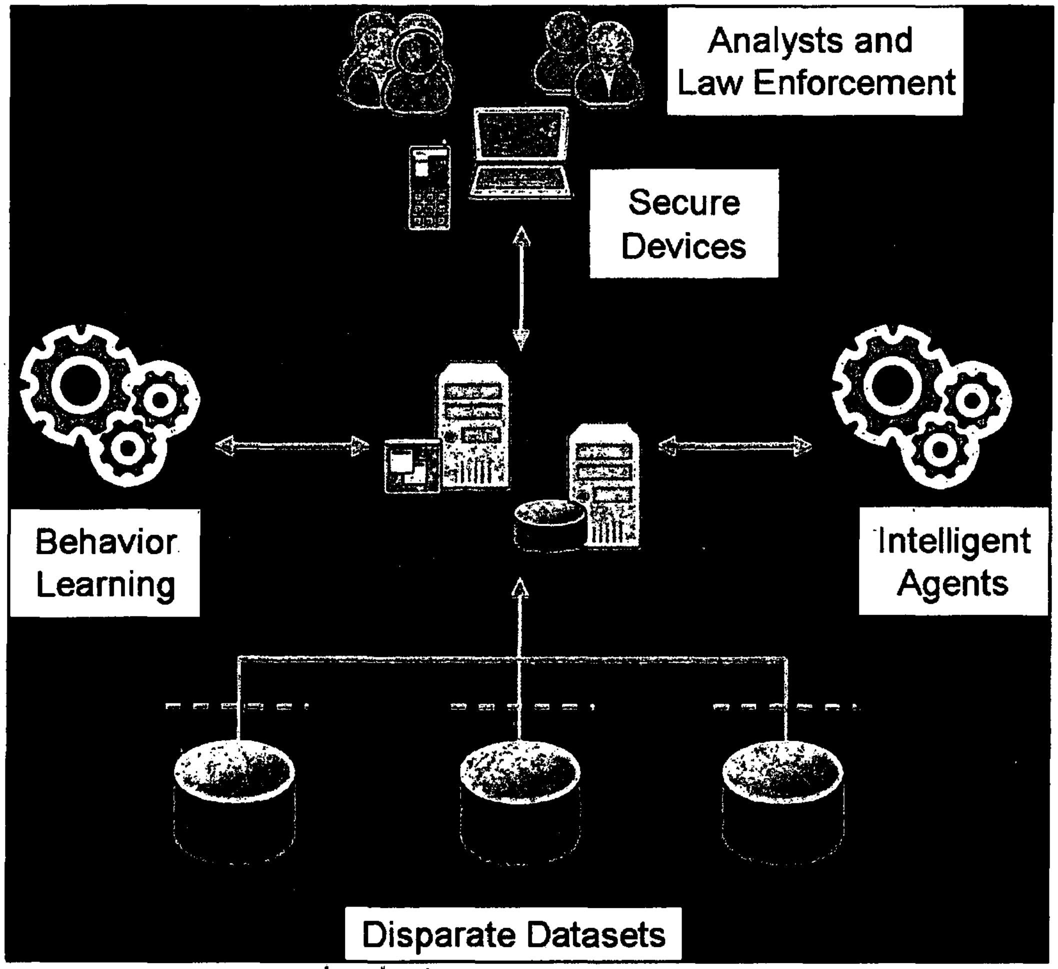
- (U) **Intellipedia** - This application is, in effect, a classified Wikipedia. Users are not anonymous and are able to create or modify web pages covering a wide range of topics.
- (U) **A-Space** - Analyst Space is a social media application where users can sign up to discussion groups and share information (including finished intelligence, all-source intelligence, open source information, and other types of media) with other users throughout the Intelligence Community.
- (U) **Jabber, Intelink Instant Messager** - These tools allow users to send short messages to individuals or user groups in a secure environment.

(U) Recommendations

- (U) Establish a concurrent work environment for all those who support [redacted] throughout the country and in law enforcement, intelligence, and technical communities (as in A-Space) to assure collective awareness, interaction, and integration of diverse data, including especially low confidence data.
- (U//FOUO) [redacted]
- (U) Provide networking equipment and capabilities to quickly tie disparate communities into a concurrent communication environment (through capabilities such as a STE phone and media-less terminals)
- (U) Use social networking tools to enable a collective approach of analyzing data. Test and further refine the network [redacted] through regular exercises and real events (at lower concern levels).
- (U) Test the possibility of expanding the collective beyond cleared and individually authorized people to the larger community in the unclassified environment to evaluate the benefit of engaging this huge resource.
- (U) Create universal standards for analysis coupled with a common protocol for reporting purposes. This would serve well in minimizing tradecraft differences among agencies.
- (U) [redacted] information sharing should take place within a common computer system interface cleared to the highest practical levels. However, given proprietary data among organizations, the NCTC should have a key to databases with assigned points of contact, through which access to individual databases may be enabled. The chosen [redacted] computer infrastructure should be configured as soon as possible, and all [redacted] members should be rapidly yet thoroughly familiarized, trained, and exercised on these systems, applications, and protocols.

(U) THE MIXED REALITY PERSPECTIVE

(U) This article was provided by members of the Mixed Reality SHARP group, which was meeting in the same facility as the Nuclear Attribution group. This article discusses the establishment of an infrastructure for supporting an [redacted] community of interest, which will facilitate rapid analysis of an impending or recent event.



(U) Intelligent Agents

(U) The technology concept for streamlining access to pertinent data, and facilitating communications across the [redacted] community, leading up to, during, and after an event involves three major components:

- (U) Data access,
- (U) An intelligent agent-based system and
- (U) Secure mobile hardware.

(U) Overcoming Classification Barriers

(U) Members of the [redacted] community should be provided with all of the data they need when they need it. Each piece of data should be tagged with the level of access required to view it. Tagging each piece of data will provide granular control over access to datasets. Rather than applying credentials to an entire dataset, which may exclude a user from all of the data contained within, tagging each piece of data ensures that users with the appropriate credentials will have access to the entire subset of the data for which they are cleared, even as their clearances change.

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(U) Enhancing Data Mining

(U) Software robots known as intelligent agents should be utilized to access and collect data on a user's behalf. By passively learning from users' behavior over time, the intelligent agents will anticipate the types of data to collect for each user. The robots will be able to access and store data beyond the users' level of clearance and will act as a proxy to this data so that all necessary data will already be in place for when a user may be granted more clearance to the data. Agents also will have the ability to proactively notify users that there is data pertinent to their interests to which they may not have access, and will tell users to whom they must speak to gain access. This approach will ensure no user has access to off-limits data prior to being granted more access while at the same time ensuring that the user will have access to pertinent data as soon as it is deemed necessary and properly granted.

(U) Secure hardware devices should be put in the hands of the [redacted] community, so that its members can access pertinent data, and each other, whenever and wherever required. Using this technology ensures that local law enforcement and on-the-ground personnel will have up-to-the-minute, secure access to intelligence, and may in turn provide intelligence and situational awareness to community members who may not be on-the-ground. Hardware exists today that uses mobile technology similar to the Blackberry in conjunction with cryptographic devices to ensure secure communications. Laptops also are available that provide the same capability but are slightly less mobile. In these solutions, data security is maintained by serving data from a remote server without storing any data locally.

(U) While the above discussion centers on technology, establishing an effective [redacted] network relies on a solid community of interested users. This community culture challenge requires an appropriate medium for key members to identify each other and discover individual expertise and interests. Regular communication between members will contribute to the success of the system.

(U) Of note, the approach described above requires that data in the pertinent datasets be pre-tagged with access permission rights, requirements, and metadata concerning the data's content. While this is a tractable yet nontrivial task, further discussion is beyond the scope of this document. Similarly, the [redacted] network approach will require the sponsorship of senior leadership to address policy and organizational challenges, which is also beyond the scope of this appendix.

(U) Dynamic Analysis Process for [redacted]

(U) Very hard to nearly intractable intelligence problems usually go through an initial "stab" by a highly focused special analytical team. Outputs from the team's efforts are used to update collection requirements and sometimes result in the formation of a new entity to work the problem full time. After a long period of little progress or no real intelligence production, the problem may fall below day-to-day focus. If and when activities related to the concern about the issue remind consumers of the threat, then another focused look may be initiated.

(U) For certain classes of issues, failure represents catastrophic consequences. Issues of this nature require a level of focus that demands deep daily digs, even if the result is negative over long periods of time. Here, dedicating some resources to working the problem on a continuing basis is worth the effort. A dynamic approach to analysis and collection for hard to nearly intractable issues is illustrated in the attached chart.[30]

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[redacted]

(U) The dynamic analysis concept is straightforward. The first step involves creating a notional series of phases that any entity would use to start and achieve a particular objective. The actual steps would be based on whatever is known about the entity's ilk and the real world activities that would have to take place to achieve its objective. Under each phase or step, participants in the process brainstorm the manifestations of activities that must occur for an entity to proceed with its objective. In concert with this brainstorming, participants identify what might be collectible from any particular manifestation. For example, there would be a number of areas where information and phenomena would be generated in the course of arranging for a safehouse for a covert meeting of the "group-who-hates-potatoes." Someone would have to make the arrangements for a room or house, thereby leaving a paper trail. Some attendees might rent cars, another paper trail. Cars on their way to the meeting would cause Doppler shifts in local radio frequency signals. An upswing in anti-potato rhetoric might appear in internet media. Collectible information would be arrayed against the capabilities of existing collection resources. If a collection resource had the access and ability to collect the information, an appropriate requirement would be initiated. Alternatively, requirements already on the books would be updated if necessary. If collection were feasible but no capability yet existed, an associated gap-closing research objective might be initiated.

(U) When run on a continuing basis, the dynamic analysis process would constantly iterate the issue's evolutionary steps and possible manifestations. These iterations would be based on any enrichment in understanding the ilk of the target entity and specific intelligence information. A simple analogy is the constant process of writing and rewriting scripts for a movie as a movie director shoots and evaluates scenes or as the scriptwriter does more research.

(U//FOUO) Work on nuclear attribution is more than just picking up the pieces after an event takes place. Vigilance in working the issue before any harm takes place is a vital part of the job. Interdiction as early as possible should be the primary objective. Substantial resources should be dedicated to frequently revisiting what indications might emerge in LE, TNF, and intelligence data from motivation to the aftermath of a terrorism-based nuclear event. A dynamic analysis process should be among the responsibilities of the dedicated working group proposed for the [redacted] CONOPS.

(U) LEVERAGING LOCAL ASSETS

(U) Increasing Efficiency

(U//FOUO) [redacted]

(U) Teaming With Local Law Enforcement

(U) Local law enforcement may be the primary means of collecting human intelligence in a domestic nuclear event. Crucial initial information likely will be derived from local law enforcement. The Intelligence Community must ensure that local investigators are seen as valued contributors. The best means of accomplishing this is through proactive team-building with common training as a basis.

(U) The Bush Administration's "National Strategy for Information Sharing" (October 2007) directs the continued support of fusion centers at the state, local, and tribal levels. The following considerations are suggested as means of enhancing this crucial area of the criminal justice system.

1. (U) Aggressively foster expansion of the network of state and local fusion centers. Combine the efforts of the FBI Joint Terrorism Task Forces (JTTF) with the efforts of the local fusion centers to enhance the information sharing process in venues where both exist. Each agency in either or both a JTTF and local fusion center, within the constraints of mandated information classification restrictions, should be aware of the collection needs of their partner agencies.

2. (U) Provide technical tools and training to state and local law enforcements to enhance their abilities to recognize, collect, collaborate, analyze, and share information. The training should include a standard training protocol for LE to become familiar with Federal guidelines on information sharing, investigative techniques, and source development focusing on intelligence and terrorism data recognition and collection. This is effective not only in combating terrorism but likely will result as well in enhanced crime reduction. Historically, local detectives have done an outstanding job in developing street sources and criminal intelligence, so additional training to hone these investigators' abilities to recognize and pursue terrorism related data would result in potentially vital contributions.

3. (U) Develop and implement a nationwide intelligence liaison program linking federal/state/local/tribal law enforcement information sharing activities. The model of the Terrorism Liaison Officer (TLO) – developed at the Arizona fusion center – should be emulated nationally to support intelligence operations. This TLO program has proven to be an effective tool for disseminating information to all levels of law enforcement, and to

entities within the Intelligence Community.

(U) Arizona's TLO Program

(U) The Arizona fusion center created the Terrorism Liaison Officer (TLO) position to address the center's need to reach out to new enforcement entities throughout the state. The TLO has two intelligence-related duties. First, the TLO serves as a conduit between the fusion center and the TLO's home agency. In this role, the TLO identifies and disseminates pertinent information to his home agency including street level peers. Privy to the fusion center's collection needs, the TLO monitors his jurisdiction for this information and advises the fusion center of the relevant information. Second, the TLO serves as the "eyes and ears" of the fusion center when responding to an incident. The presence of the TLO on-scene provides observations, reporting and validation of information from a vetted source. This is invaluable for reporting on real world incidents and also for preventing unnecessary escalation for non-events.

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(U) CAN OTHERS UNDERSTAND YOUR DATA?

(U) Managing the Data

(U//FOUO) [redacted]

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-
-

(U) Data Characterization and Analysis

(U/FOUO) [redacted]

(U) [redacted]

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2. [redacted]
3. [redacted]
4. [redacted]

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5. [redacted]
6. [redacted]

(U) The following provides a framework of four general scenarios of nuclear/radiological events: pre-detonation, post-detonation, pre-dispersal, post-dispersal.

1. **Scenario of Pre-detonation:** Investigating and attributing a threat of nuclear detonation or interdiction of fissile material.
2. **Scenario of Post-detonation:** Investigation and attribution in the aftermath of a nuclear detonation.
3. **Scenario of Pre-dispersal:** Investigating and attributing a threat of radiological dispersal or interdiction of radiological material.
4. **Scenario of Post-dispersal:** Investigation and attribution during or in the aftermath of radiological dispersal.

(U) The following best practices are recommended:

- Maximizing information sharing and collaboration in a connected environment where "need-to-know" and security issues are remedied to the extent possible.
- Erring on the side of retaining and preserving information, including low confidence information.
- Applying analytic methods such as the Dynamic Analysis Process and Alternate Competing Hypotheses.

(U) Analytic Methods

(U) Dynamic Analysis Process – a "cradle-to-grave" methodology of activity awareness (see Appendix C)

(U) Analysis of Competing Hypotheses – an analytic tool for comparing alternative explanations, where all conceivable hypotheses are analyzed in a matrix against corresponding evidence. Each "hypothesis-evidence" pair is weighed to develop a probability or confidence level for each overall hypothesis.

(U) Data Modeling and Visualization

(U//FOUO) A key to solving any crime or mystery is the employment of effective methods to gather, analyze, and relate information about the case. In the process of collecting and fusing intelligence, the ability to visualize numeric and non-numeric information spatially and temporally is paramount. Laying out the information in graphical and/or tabular form, with associated confidence levels, and showing links to locations, movements, materials, actors, nation states, etc., can provide a rapid relational context. Maps may be utilized to show not only locations but concentrations, correlations, directions, distances, domains, flows, routes, vicinities, and countless other geospatial relationships. By the same token, event time lines can be graphed to visualize time sequences and intervals. Additionally, the temporal information can be mapped to graphically show the effects and nuances of evolving events.

(U//FOUO) Insofar as efficiencies are gained and time lines met, the ability to graph and visualize may include the full array of classic information visualization methods, such as pie charts, bar charts, and scatter plots as well as relational data linage graphs, ephemeral "fly-throughs," and virtual renderings of scientific data. [redacted] should employ data visualization techniques that enable robust analysis and offer timely illustrative presentation graphics that accurately portray current analytical findings.

(U//FOUO) [redacted]

(U) Using Metadata to Foster Information Sharing Among Separate Communities

(U) In order to facilitate ready sharing of information among well-established communities, metadata could be used to ensure that community-determined relevant information is available to all cognizant parties involved in the attribution process. By leveraging metadata successes implemented by other communities, the use of metadata would facilitate and accelerate effective data and information sharing among the nuclear attribution communities as designed and developed to meet each community's needs.

> **(U) What Is Metadata?**
>
> (U) Metadata typically refers to distilled information that describes the semantic content of a piece of information [1]. An example of metadata in nuclear forensics is the geometrical parameters of a cluster of isotopic measurements (e.g. major and minor radii, standard deviation ellipses, etc). A cluster may comprise thousands of raw measurements, but the geometrical parameters that enable the cluster to be defined are the metadata. In support of data interpretations, one would match a questioned sample with the signature families that are denoted by the cluster "cloud," not with the actual raw measurements, i.e. match with the signature family, not the data points.

(U) Metadata is formulated within each community by their experts, and the originating community determines what information can be distilled into metadata to be shared with others. The strategy is that communities will drive the metadata development process so that they are comfortable with the metadata constructs that will be available and shared. Metadata also is used in directing data and information searches into a manual search mode using simple contact information cards. For example, a "library card" with contact information would be inserted into a metadata database so that an analyst would know whom to contact for more information that may be relevant to his or her task, when the additional information cannot be shared automatically via a database.

(U) Metadata also is used to facilitate and accelerate knowledge discovery among disparate collections of data and information, as it provides standardized data constructs for latent pattern analysis. For example, the MASINT[31] community, via the MASINT Standards Working Group of the National MASINT Management Office (NMMO), has deployed common metadata templates for all MASINT executive summaries. The use of common metadata templates enables formulating metadata from the MASINT executive summaries to aid in finding commonalities and hidden themes in the MASINT summaries.

(U) Similar to the MASINT community, many other disciplines are using metadata to enable effective information sharing within their community and also across separate communities. The following general recommendations have been identified to facilitate successful implementation of metadata to enable effective sharing among communities.

- (U) Explicitly designate ownership of a classification: whoever is the original source of the data is always correct with respect to the application of the metadata to its description.[32]

- (U) Ensure agreement between researchers and domain specialists: although researchers may be more consistent, their interpretations of the metadata may differ from specialists who have direct experience of the specific domain.[33]

- (U) Ensure consistent quality of meta-tagged data items: it is important to refine data and information that does not provide sufficient contextual information to enable metadata to be formulated in a consistent manner.[32]

- (U) Ensure consistent training and skills of the metadata developers: formulating metadata from data items has been shown to be strongly influenced by previous experience with coding.

(U) RECOMMENDATION

(U) By leveraging metadata successes implemented by other communities, the use of metadata would facilitate and accelerate effective data and information sharing among the nuclear attribution communities as designed and developed to meet each community's needs.

(U) HOW TO BEST USE TNF INFORMATION

(U) Managing Expectations: What Can We Expect From TNF and When Can We Expect It?

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(S//NF) [redacted]

(S//NF) [redacted]

(U) A post-detonation IND event can be accepted as having the most dire consequences for the public, and, consequently, as posing the greatest pressures for timely and accurate attribution. Therefore, this section presents suggestions for best practices and other considerations for managing expectations for just such an event. These suggestions can be adapted to improve expectation management for the other nuclear attribution scenarios, such as a pre-detonation event, the interdiction of an IND or an RDD prior to detonation, the detonation of an RDD, or the interdiction of nuclear materials where no device is evident.

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(U) Pre-Detonation vs. Post-Detonation

(S) [redacted]

(U) TNF Support to IND Attribution

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(U) TNF: Common Misconceptions

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(S//NF) [redacted]

(S//NF) [redacted]

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(S//NF) [redacted]

(U) TNF: Exercising to Dispel the Myths

(U/FOUO) [redacted]

[redacted]

(U) Recommendations

- (U) [redacted]
- (U) As part of nuclear event exercises, realistic TNF data should be provided to the [redacted] to clearly show both the capabilities and the limitations of TNF data.
- (U) [redacted]

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(U) Limiting Bias in Technical Data Interpretations

(U) [redacted] ***Sharing Information with the TNF Team***

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(U//FOUO) [redacted]

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(U) How Post-Detonation TNF is Produced

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(S//NF) [redacted]

(U) [redacted]

(U//FOUO) [redacted]

- [redacted]
- [redacted]

(U) Incorporating TNF Results into [redacted] Assessments

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[redacted]

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(FOUO) PUTTING IT ALL TOGETHER: PROPOSED FUNCTION AND STRUCTURE [redacted]

(S//NF) [redacted]

(U) When to Initiate the Formal Process

(S//NF) [redacted]

> **(U) WMD Attribution: What Is It?**
>
> (U) [redacted] "WMD Attribution is the capability and process to identify the nature, source, perpetrator, and pathway of an attempted or actual WMD attack. This includes rapid and comprehensive coordination of intelligence reporting, law enforcement information, technical forensics information, and other relevant data streams to evaluate adversaries' capabilities, resources, supporters, and modus operandi in the context of a recently completed or attempted WMD attack(s)."

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(U) Proposed [redacted] Responsibilities

(U) [redacted]

1. [redacted]

2. [redacted]

(U) [redacted]

(U) Proposed Structure of the [redacted]

(S//NF) [redacted]

(U) A Two-Tier Structure is Needed

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(U)* [redacted] *Executive Level

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(U)* [redacted] *Support Group

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(C) [redacted]

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(U//FOUO) [redacted]

(U) Required Access to Information

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[redacted]

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(U) Recommendations

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- (U) [redacted]

(U) BUILDING THE NUCLEAR ATTRIBUTION COMMUNITY 2030

(U) In examining the nuclear attribution problem, SHARP highlighted the fact that doing attribution well requires a broad and robust community of experts working together seamlessly, but in reality nuclear expertise is often sequestered behind physical, virtual, and policy walls.

(U) To improve information sharing and create a true community of analysts, a variety of traditional and modern approaches can be used. None of these approaches are cost free, and all require overt action and endorsement by senior management. However, by starting with a variety of approaches and scaling up those that work, effective methods can be found. By building a community, nuclear analysts and scientists will benefit from building and strengthening collaboration across the wider intelligence, nuclear forensic, and law enforcement communities, with an attendant improvement in their analysis.

(U) Emerging computer technology along with traditional mentoring can be merged to produce a robust, distributed community of nuclear experts interlinked through social networking. The goal is to achieve four major objectives:

- Enable Knowledge and Information Sharing
- Bridge the Nuclear Expertise Generation Gap
- Sustain a Common Lexicon
- Implement Virtual Exercises

(U) Trade Shows: Virtual and Real

(U) For the nuclear community to overcome geographic and organizational sharing impediments, it is necessary to develop real world and virtual professional / social information sharing environments. Nuclear experts are not immune to the human tendency to associate only with individuals or co-workers with similar interests. The blending of social networking technology and semi-annual or annual nuclear analytical workshops will create a community of trust and lend itself toward a collaborative environment.

(U) A real world example of such a nuclear analyst network is the Project on Nuclear Issues (PONI) hosted by the Center for Strategic & International Studies (CSIS).[34] The goal of PONI is to "build and sustain a networked community of young nuclear experts from military, national laboratories, industry, academia, and policy communities." PONI hosts four major conferences where young experts across the community present their ideas on issues ranging from US nuclear weapons stockpile issues, foreign nuclear programs, to technical nuclear forensics and attribution. PONI also hosts smaller events with guest speakers and maintains an online blog.

(U) Due to the public nature of PONI, there is limited involvement with the Intelligence Community. All discussions at the conferences are held at the unclassified level. PONI, however, serves as an inspiration and a possible forum to model after for the USG nuclear community. The proposed USG nuclear network will provide intelligence analysts with similar opportunities at the appropriate classification levels.

(U) Recommendations

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- (U) Develop a nuclear analyst social network, where nuclear analysts from the intelligence, law enforcement, and nuclear forensic communities could participate. Rather than a working group, this is a support network designed to bridge the expertise and age gap within the nuclear community. This could lead to the development of local "chapters" throughout the US or subculture to the analytical community.
- (U) Create a "virtual community" of nuclear experts by leveraging emergent social networking technology. Regularly scheduled informal chat sessions can be held on the appropriate computer systems. The only limitation in this scenario would be access to appropriate classified computer networks and systems.
  - (U) Such a community could include the use of classified or unclassified networks to conduct meetings using privately hosted sites such as Second Life.
  - (U) Classified seminars, briefings, and exchanges could be organized using A-Space or other social networking tools.
  - (U) Virtual world platforms, such as Second Life, could be adapted or ported to SECRET networks or JWICS to conduct simulations at the classified level.

(U) Bridging the Nuclear Expertise Generation Gap

(U) There is a recognized and widening experience and age gap between senior and junior analysts in the federal government, a gap that is most evident and critical within the nuclear community.

(U) "The number of radiochemistry programs and radio chemists in United States National laboratories and universities has dramatically declined over the past several decades. The narrowing pipeline of qualified people into this critical field is a serious impediment to maintaining a robust and credible nuclear forensics program."[35]

(U) Senior analysts who are experienced in communicating technical information to senior policy-makers are retiring. This is a skill learned through experience and lost to the next generation of analysts as senior analysts retire.

(U) Recommendations

- (U) Initiate a program where junior analysts shadow senior analysts at high-level initiatives [redacted] to provide the next generation of analysts the experience in developing and presenting assessments to senior customers.
- (U) On a regular basis, provide information to junior analysts on current assessments, technical/intelligence gaps facing the community, and lessons learned from recent assessments.
- (U) Initiate training programs to instruct junior analysts in the tradecraft of writing and briefing senior customers.
  - (U) This could include training with Toastmasters, or other public speaking groups.
  - (U) Specialized training to teach junior analysts to write effectively on nuclear issues.
- (U) Initiate a training program, similar to an existing IC initiative, where junior analysts work and interact with scientists and analysts at the National laboratories.
- (U) Establish a formal nuclear mentoring program that pairs junior analysts with nuclear experts both inside and outside the US Government that includes formal / informal training programs and site visits.

(U) Communicate Today; Still Communicating Tomorrow

(U) As discussed in the Communications Section of this report, a common lexicon is required to ensure key attribution conclusions are properly formulated and communicated. The entire nuclear community will benefit from a common lexicon to communicate conclusions and associated uncertainty. A nuclear community network will foster the sustainment and adaptation of the nuclear lexicon for future generations, ensuring continuity of operations as the attribution community grows and matures (see the article "(U) ORGANICALLY GROW A LEXICON" for details on developing a nuclear attribution lexicon).

(U) Recommendation

- (U) In addition to the recommended monthly secure web-based, virtually-linked mini-exercises, encourage the virtual coordination of analytic products through technology, such as Intellipedia, "table top" exercises using virtual worlds, incorporating mixed reality features in crowd-sourcing interpretations, with the broader nuclear community to foster sustainment and adaptation of the nuclear attribution lexicon.

(U) When Reality Costs Too Much, Go Virtual

(U) Conducting nuclear terrorism exercises can be expensive. To mitigate the costs it may be possible to modify or adapt commercial software to allow nuclear analysts a new way of participating in exercises related to nuclear attribution. Platforms such as Second Life or a modified "first person shooter" video game could be used for scripted exercises. Analysts at remote sites around the world could log in to a secure network and interact with their peers in a variety of nuclear forensic scenarios such as:

- A pre-detonation search for nuclear materials smuggled into the US.
- Post-detonation gathering of information leading to an attribution assessment.
- Operations at a "virtual operations center" where inputs from the field and requirements from senior decision-makers are dealt with in real time.

(U) Advantages of virtual exercises include:

- No TDY required - [redacted] members could participate from home or their home offices, depending on the level of classification.
- Inexpensive - limited software development costs, no TDY costs, limited IT support.
- Allows for real time interaction.
- Available any time - could have multiple exercises every month if needed.
- Would build team cohesion - learn how people work in a simulated crisis.
- Troubleshooting – issues regarding protocols or procedures can be identified and fixed prior to an actual event.
- Expandable to whatever size required, within limits.
- Easy for exercise "referees" to view activity without being intrusive to action.
- Limited training required to learn how to use software.
- Generates interest and enthusiasm from the next generation of analysts in tackling today's attribution challenges.

(U) Some of the possible disadvantages of this approach may be:

(b) (1)

- People might not feel comfortable adopting the new technology.
- Less than perfect technology may not yet be immersive enough to make it seem really "real."
- There would be some IT and accreditation costs to host commercial software on classified networks.
- Participation may look like "goofing off" to certain managers who do not understand the purpose of the effort.

(U) Collaboration tools, such as wikis, could also be used for "virtual exercises" and could greatly reduce overhead and costs. No one would have to go TDY and people could fit their "moves" in when they had time available. The wiki could simply be a clearinghouse for "game" moves. The idea of a virtual exercise would cause far less disruption in day-to-day activities and would allow more frequent tests of the [redacted] process, costing only what it would take to form a small group of people to design the simulation with realistic information. These people would not even need to be physically located together. Exercises could be designed on a wiki over a period of time by allowing experts to contribute to the exercise as time permits. What would be very interesting is to use this to include a "red team" in the exercise who could respond to the IC's moves. They could change their actions depending on what the "blue team" did, providing for a more realistic scenario instead of a planned out one.

(U) Competition is Good

(U) Including competitive aspects to virtual exercises will accelerate creation and sustainment of a secure on-line attribution community. Analogous to "fantasy baseball," virtual attribution "teams" comprising individuals from different agencies, offices, and programs and would compete against each other in addressing attribution-relevant topics. Each virtual team could have a mix of TNF, IC, and LE expertise rather than only one discipline (e.g., a LE-only members' team). The composite mix of the teams coupled with the competitive environment would foster and accelerate 1) lexicon and semantics development between and among teams (see (U) ORGANICALLY GROW A LEXICON), 2) sharpen members' analytical tradecraft with sustained exposure to different perspectives, 3) foster collegial and team work habits that would morph into effective best practices during actual nuclear attribution events.

(U) Outlook

(U) Success in building the [redacted] of the future will require cooperation from all organizations involved and a commitment to growing and maintaining the next generation of nuclear experts needed to take the [redacted] into the future. For each recommendation chosen for implementation, we recommend a high level "Champion" be identified to shepherd the process into reality.

Recommendations

- The USG must start building a stronger nuclear community, not just as it applies to the attribution problem, in order to ensure sustainment of current capabilities into the future.

(U) SUGGESTIONS: REQUIRED RESOURCES

(S//NF) [redacted]

(U) Funding Neutral?

(S//NF) [redacted]

(U) Getting Blood from a Stone

(S//NF) [redacted]

(U) Scrubbing for Resources

(S//NF) [redacted]

(S//NF) Aircraft and AFTAC Support

(S//NF) [redacted]

[redacted]

(S//NF) [redacted]

(U) How Many Threats Will We Face?

(S//NF) [redacted]

(S//NF) There are a few fundamental assumptions that can frame the debate.

1. [redacted]
2. [redacted]
3. (U) [redacted]
4. (U) [redacted]

(S//NF) [redacted]

(b) (1)
(b) (3)

[redacted]

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]

(U) [redacted]

(U//FOUO) [redacted]

- [redacted]
- [redacted]
- [redacted]

(U) APPENDIX A: Index of Recommendations and Findings

(U) Recommendations (Not in any order)

(U/FOUO) [redacted]

(S//NF) [redacted]

(U) Applying Catalyst to Nuclear Attribution
An information technology (IT) solution – based on the Catalyst program – is recommended to allow a single "switch" to be thrown that will give all relevant players in the emergency the access to information and information tools he or she needs. Based on a subset of the Catalyst concept, the architecture and modalities for interactive information sharing and analytic exchange across the IC communities could be readily created to improve the quality and speed of the analytical work dealing with a credible WMD threat or event. In addition to the obvious agility and potential for synergy, it is expected that this capability could reduce the assessment time and improve accuracy more than almost any other approach. While the Catalyst Project is focused on the Intelligence Community, the concept of a fully interactive community with concurrent awareness, connectivity, and access to appropriate elements of the total database can be readily extended to include law enforcement and technical forensic elements. Planning carefully and providing appropriate permissions prior to an event can allow the rapid forming of a large virtual working group that can much more quickly integrate and evaluate data and can facilitate rapid overall synthesis and suggestions for additional collection and analysis. **[(U) INFORMATION SHARING AMONG DISPARATE KINGDOMS]**

(U) [redacted]

(b) (1)
(b) (5)

(U) Using New Internet and Media Technologies to Enhance Information Sharing
[redacted] should ensure that the channels for sharing information and expertise that will be required to make a credible attribution assessment are in place and regularly exercised so that they can be used effectively and immediately in the event of a nuclear event. The use of new Internet technologies, e.g. Web 2.0, and new media technologies should be strongly considered as a means for achieving this goal. **[(U) INFORMATION SHARING AMONG DISPARATE KINGDOMS]**

(U) [redacted]

(U) The Technical Event Manager (TEM)
Access to all-source information early in the analytic process may unduly bias the technical analysis. This risk can be mitigated, and the benefits of information sharing maintained, by providing event-related all-source information to the Technical Event Manager (TEM). This will maintain the benefits enumerated in the planning and interpretation of the technical data and provides context for the technical analyses. [*(U) Limiting Bias in Technical Data Interpretations*]

(U//FOUO) [redacted]

(U) Nuclear Community 2030
Start a nuclear analyst social group, where all nuclear analysts from the intelligence, law enforcement, and nuclear forensic communities can participate. This would not be another working group, but a support network intended to bridge the expertise gap within the nuclear community. This would be geographically limited, but "chapters" in different parts of the country could form and begin to socialize. Augment the traditional social groups with the use of emerging social networking technology to create a "virtual community" of nuclear experts who hold regular, informal chat sessions on the appropriate computer systems. The only limitation in this scenario would be access to appropriate classified computer systems. Most analysts have access to at least SECRET level computer systems, and many have access to JWICS. Establish a formal nuclear mentorship program, where junior analysts are paired with nuclear experts both inside and outside the US Government. Modify or adapt commercial software to allow nuclear analysts a new way of participating in exercises related to nuclear attribution. Consider the use of programs such as Second Life or a modified "first person shooter" video game as a platform for a scripted exercise. Use social networking tools as a means to create virtual exercises with adaptable adversaries to test the [redacted] process for attribution. **[(U) BUILDING THE NUCLEAR ATTRIBUTION COMMUNITY 2030]**

(U) Crowd Sourcing

(b) (1)
(b) (3)

To consider the benefits of "crowd sourcing," test the possibility of expanding the collective beyond cleared and individually authorized people to the larger community in the unclassified environment to evaluate the benefit of engaging this huge resource. [(U) **THE RIGHT STUFF: HARVESTING EXPERTISE**]

(U) Characterizing TNF Capabilities and Limitations

(U) An existing limitation of interpreting TNF data is due to an incomplete knowledge of foreign nuclear materials stocks, foreign nuclear weapons design, and an infinite design trade-space for IND designs. In addition to studying the capabilities and limitations of producing TNF data, a separate study should be conducted – possibly under the auspices of the JAEIC – to characterize our posture to interpret TNF in the context of what is known, and what is not known about nuclear materials and designs. Such a study should identify means to reduce or eliminate these deficiencies. [(U) **HOW TO BEST USE TNF INFORMATION**]

(S//NF) [redacted]

(U) Findings

On the topic of Sharing and Fusing Information:

- (S//NF) [redacted]
- (S//NF) [redacted]
- (S//NF) [redacted]
- (S//NF) [redacted]
- (U) [redacted]

On the topic of Lexicons and Communication:

(b)(1)
(b)(3)

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (S//NF) [redacted]
- (U) [redacted] cross-pollination and a fundamental understanding of the LE/IC/TNF communities to ensure an informed decision-maker. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) Use terminology universally recognized and accepted when communicating internally and externally. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) Prevent the "CSI Effect" by communicating and educating the customer. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) Speed of technical nuclear analysis can only proceed as fast as the laws of physics allow. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) Differences in culture can apply additional pressure to a pressurized situation, which can spin "What do we know?" and "How do we know it?" out of control. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) Make informed intelligence-driven decisions, by find multiple sources of information to support exiting data and to capture differing perspectives. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE]**
- (U) [redacted]
- (U) [redacted]
- (U//FOUO) [redacted]
- (U//FOUO) [redacted]

[redacted]

- (U//FOUO) [redacted]
- (U) Since the nuclear attribution primary communities are small and closed, much more frequent interactions among the communities is recommended to create the similar effect of developing a common lexicon with many interactions in a massive social network. [(U) **ORGANICALLY GROW A LEXICON**]
- (U) Promulgate a mechanism for ongoing communication and interaction, in addition to the mini-exercises, to further facilitate development of a common lexicon indicative of a growing community. Virtual means of interaction may be best suited, as community members are geographically dispersed. [(U) **ORGANICALLY GROW A LEXICON**]
- (U) Information Technology (IT) is integral [redacted] effort, as it facilitates communication and ultimately enables effective and timely analysis. In order to leverage the benefits of the IT available [redacted], it will be important to plan and coordinate these tools before the start of an exercise or an actual crisis. [(U) **INFORMATION SHARING AMONG DISPARATE KINGDOMS**]
- (U) [redacted] information sharing should take place within a common computer system interface, cleared to the highest practical levels. However, given proprietary data among organizations, the NCTC should have a key to databases with assigned points of contact, through which access to individual databases may be enabled. The chosen [redacted] computer infrastructure should be configured as soon as possible, and all [redacted] members should be rapidly yet thoroughly familiarized, trained, and exercised on these systems, applications, and protocols. [(U) **INFORMATION SHARING AMONG DISPARATE KINGDOMS**]
- (U/FOUO) [redacted]
- (U/FOUO) [redacted]
- (U/FOUO) [redacted]

On the topic of Collaboration:

- (U) Collaboration teams should be identified and begin working together to establish effective working relationships prior to an actual nuclear related event. [(U) **INFORMATION SHARING AMONG DISPARATE KINGDOMS**]

(b) (1)
(b) (3)
(b) (5)

- (U) It also is recommended that collaboration should not extend down to the those involved with basic generation of data in order to prevent initial bias or cause data generation to be diverted away from what may be eventually proved to be valuable information. **[(U) INFORMATION SHARING AMONG DISPARATE KINGDOMS]**
- (U) Have working groups meet often and practice not only on exercises but real world events. **[(U) THE RIGHT STUFF: HARVESTING EXPERTISE]**
- (U) [redacted]

[redacted]

- (S//NF) [redacted]

[redacted]

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]

(b) (1)
(b) (5)

[redacted]

- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- (U) [redacted]
- [redacted]

On the topic of Training and Exercises:

- (U) The increased frequency interactions among the communities could take the form of monthly or bi-monthly secure, web-based, virtually-linked mini-exercises on a particular facet of the attribution process to calibrate the communities with the specific terms and their meaning. [(U) **ORGANICALLY GROW A LEXICON**]
- (U) The mini-exercises should be brief (e.g., ~2 hours) to foster and stage development and acceptance of a common lexicon and to minimize disruptions to ongoing mission areas. [(U) **ORGANICALLY GROW A LEXICON**]]
- (U) Explicitly train [redacted] members on issues of biases, heuristics, intuition, bounded rationality, etc. [(U) **THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS**]
- (U) Members of the [redacted] should be selected based upon criteria that include the ability to be aware of, and counterbalance, the influence of heuristics and internal biases. [(U) **THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS**]
- (U) Include elements and activities invoking biases and cognitive mind traps that undercut attribution analysis into formal exercises – (to be included in quarterly

simulations or other exercises for [redacted] [(U) **THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS**]

On the topic of Avoiding Analytic Minefields

- Do not lose objectivity by deviating from the established investigative plan. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE**]
- (U) Lower level employees should be empowered to make certain decisions and be held accountable for them or without concern for negative consequences/punishment. [(U) **SPLIT SECOND DECISION-MAKING: A LAW ENFORCEMENT PERSPECTIVE**]
- (U) Build into the decision-making process critical review by colleagues and members of other groups, as well as other checks and balances, to mitigate rush to judgment (bounded willpower). [(U) **THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS**]
- (U) Create structures and processes to enable [redacted] to insulate itself (to whatever degree is possible) from the effects of extreme affect (hot cognition) on its attribution efforts. [(U) **THE ROAD TO HELL IS PAVED WITH NORMATIVE COGNITIONS**]
- (U) The [redacted]hould develop means to mitigate maladaptive group dynamics. [(U) **PERILS AND PITFALLS OF GROUPS**]
- (U) The [redacted] should avoid over worry about groupthink, but avoid insularity of perspectives, consider membership criteria to create balance within group (across status, expertise, etc.), and recognize problems associated with new groups. [(U) **PERILS AND PITFALLS OF GROUPS**]
- (U) The [redacted] should recognize the need for inoculation of personal and information networks prior to events and meet regularly for joint exercises to build the relationships/experience necessary before a real crisis. [(U) **PERILS AND PITFALLS OF GROUPS**]
- (U) The [redacted] should preserve "splits" involving differences of opinion in reporting to consumers and emphasize information sharing and enhanced [redacted] coordination. [(U) **PERILS AND PITFALLS OF GROUPS**]
- (U) The [redacted] should counter the debilitating effects of a high stress environment on [redacted] by employing stress monitors. [(U) **PERILS AND PITFALLS OF GROUPS**]
- (U) The [redacted] should select a mixture of experts with differing competencies (both task and general) for [redacted]ubgroups to enhance flexibility in dealing with ambiguous environments and coordination across the three communities. [(U) **PERILS AND PITFALLS OF GROUPS**]

Best Practices Recommended f[redacted]

- (U) Assimilating, analyzing, consolidating, summarizing, and reporting nuclear forensics information must be a two-pronged iterative process – continually building the case and succinctly reporting findings. Employ dynamic analysis methods that weigh hypotheses against evidence. As time permits, use data modeling and visualization tools to gain deeper insights and accentuate reporting. [(U) **CAN OTHERS UNDERSTAND YOUR DATA?**]

(b) (1)

- (U) Leveraging metadata successes implemented by other communities. Use of metadata would facilitate and accelerate effective sharing of data and information among the nuclear attribution communities as designed and developed to meet each community's needs. [*(U) Using Metadata to Foster Information Sharing Among Separate Communities*]
- The Administration might request authorization/appropriation of an [redacted] operational fund, to be available if/when [redacted] is formally mobilized during a Level One or Two Threat. **[(U) SUGGESTIONS: REQUIRED RESOURCES]**
- (U) The [redacted] needs to recognize that pressure for immediate responses will be directly proportional to the magnitude of the consequences surrounding an event. Through exercises, the [redacted] should educate senior consumers about the reality that technical analysis, crime scene investigations, or IC efforts are likely to lag behind their more rapid desire for actionable information. **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) The [redacted] needs to recognize how consequences affect risk tolerance of policy-makers. **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) The [redacted] must calibrate communications with senior consumers based upon the way different leaders structure their advisory systems **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) The [redacted] needs to understand that people respond to estimates of risk based upon whether these are presented in the domain of gains or losses. **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) The [redacted] needs to recognize that if attribution information being presented to senior policy-makers diverges from their pre-existing, deeply held beliefs, more evidence will be required to gain their attention **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) For the [redacted] to get the right answers, they must learn how to ask the right questions. Dealing with the factors around information seeking will be critical to the [redacted] and its supporting layers. They should consider: Education on the information seeking process, to avoid common pitfalls and overcome natural frustrations, and be able to optimize their own behaviors; creating social norms that accept imperfect knowledge among members, and reward outreach to acquire the right knowledge and expertise; getting into the "mind of the client" and incorporating interactive strategies to keep information seeking focused. **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- The [redacted] should use the "right" kind of expert advisers to interact with policy-makers **[(U) BRINGING THE RIGHT BROOMSTICK TO THE WIZARD]**
- (U) Promote a healthy culture: The [redacted] as a new organization, can seize the opportunity to explicitly shape an organizational culture designed to optimize functioning and mitigate or eliminate the effects of known negative factors. This culture could include behavioral norms and attitudes such as: open communication and information sharing, minimal in-group status distinctions, inclusiveness (permeable boundaries for belonging, especially with regard to analytic aspects, trust in intentions, common group identity, shared sense of goals and mission, role of devil's advocate or red teaming, understanding the strengths and limitations of expertise (link to expertise section), and healthy interactive strategies, such as negotiation (link to negotiation section). Consultation from occupational health professionals should be obtained regarding mitigation of the physiological aspects of stress. **[(U) PERILS AND PITFALLS OF GROUPS]**
- (U) Maintain and grow social networks: Well-connected and well-structured social networks, among their many benefits, improve performance in groups facing complex

problems. [redacted] members must maintain and leverage their existing networks while building new relationships both within and across group boundaries. Regular, formal assessments on network structure and individual position and performance within the network, using methods from social network analysis, will provide a means to evaluate the current functional status and suggest areas for improvement. **[(U) PERILS AND PITFALLS OF GROUPS]**

- (U) The [redacted] needs to manage expertise effectively. Expertise, while often critical, can be a double-edged sword in groups, generating conflict, rigidity, and excessive deference. To leverage expertise effectively, the [redacted] should consider:
  - (U) 1. Selecting for fluid expertise in its members, and encouraging and teaching fluid expertise methods to the group.
  - (U) 2. Incentivizing collaborative, instead of all-star behavior. Expertise alone is not sufficient. Metrics for individual success should include cooperative behavior and information sharing. Provide actionable feedback to individuals, such as a personal social network analysis.
  - (U) 3. Building robust decentralized social networks for information sharing across the entire [redacted]. Measure and evaluate these organizational social networks, and take steps to improve them as deficiencies are observed. Share results.
  - (U) 4. Institutionalizing these practices and metrics to shape the culture. **[(U) PERILS AND PITFALLS OF GROUPS]**

(U) APPENDIX B: Attribution Terms

A

(U) **Accelerator Mass Spectrometry (AMS)** - A mass spectrometry technique that uses a high-energy particle accelerator to measure rare isotopes. The technique was originally developed to measure ^{14}C in small samples. Recently, AMS has been applied to measuring uranium and plutonium. Like other forms of mass spectrometry, AMS requires extensive chemistry to dissolve the sample and to separate and purify the element for analysis. AMS instrumentation is large, complex, and expensive, and is found in only a small number of laboratories around the world. AMS excels at measuring exceedingly small isotope ratios (e.g., AMS can measure the $^{14}C/^{12}C$ ratio to as small as $1x10^{-15}$). AMS can detect as few as 1,000,000 atoms of plutonium, and can measure isotope ratios to better than 1-part-in-100 precision for larger samples.

(U) **Activity (or Radioactive Activity)** - The decay rate of the radioactive isotopes present in a sample. The activity is measured by detecting the alpha particles, beta particles, or gamma rays emitted by decaying isotopes in the sample. Activity is measured in units of decays per time, including Bequerel, Curie, and dpm. The term "specific activity" refers to the activity per mass of sample, element, or isotope. See also beta particle, alpha particle, and gamma ray.

(U) **Actinide Element** - A group of elements on the periodic table of elements that includes uranium, plutonium, thorium, neptunium, americium, and curium. These elements are chemically similar and have been grouped with the lightest element of the series, actinium (hence the name actinides). The actinides have elements with high enough atomic weights that fission becomes significant. The actinides are also chemically similar to another group of elements, the lanthanide elements (also called the rare-earth elements).

(U) **Activation Analysis** - A technique for measuring trace quantities of elements in material by making them radioactive by neutron irradiation. The result is an elemental signature, or fingerprint, that can be used to determine the elemental composition of the sample. Activation analysis, or neutron activation analysis, is often used in forensic investigations. The radioactivity of the activated sample is usually negligible. Activation analysis requires irradiation in a reactor, radiochemistry to separate each element for analysis (although some elements can be detected without radiochemical separation), and radiation detection to measure the amount of radioactivity produced by the activation. Both beta particle and gamma ray detection are used for analysis.

(U) **Activation Products** - Generally, radioactive isotopes produced by neutron irradiation of a material. An example is the production of radioactive cobalt (^{60}Co) by irradiation of stable cobalt (^{59}Co).

(U) **AEA** - See alpha energy analysis.

(U) **Age-dating** - A process of measuring the amount of decay of a radioactive isotope in a material to determine the length of time between the time of analysis and when the material was last chemically altered. The amount of decay is determined by measuring the decay product (or daughter isotopes) of the radioactive isotope (often called the parent isotope). Both mass spectrometry and radiation detection methods are used to measure the amount of parent and daughter isotopes in a sample. An example: measuring the parent isotope ^{234}U and the daughter isotope ^{230}Th to age date uranium.

(U) **Airborne Radioactivity** - any radioactive material suspended in the atmosphere.

(U) **Alpha Particle Radiation** - A positively charged particle made up of two neutrons and two protons, emitted during the radioactive decay of certain radioactive isotopes. Alpha particles emitted by the decay of radioactive isotopes, which include most uranium and plutonium isotopes, have specific energies that are characteristic to the specific isotope and decay scheme. Alpha particles travel approximately one inch in air and can be stopped by thin layers of light material such as a sheet of paper. While alpha particles pose no direct or external radiation threat, they can pose a serious health threat if ingested or inhaled.

(U) **Alpha Energy Analysis (AEA)** - a radiation detection technique that measures the energies of alpha particles. Alpha particles emitted by the decay of radioactive isotopes have specific energies that are characteristic to that isotope and decay scheme. AEA can be used to identify specific radioactive isotopes and to determine the amount (or activity) of that isotope in a sample. AEA normally requires chemical dissolution and purification of the sample. The detector types include solid-state detectors, gas proportional detectors, liquid scintillation detectors, and solid scintillation detectors. AEA can detect quantities of radioactive isotopes as small as 0.001 dpm.

(U) **Alpha Spectrometry** - Another name for Alpha Energy Analysis or AEA.

(U) **AMS** - See Accelerator Mass Spectrometry.

(U) **Analysis Class** - A term that describes the level of effort applied to the forensic sample and the degree to which the forensic data can be interpreted. The analysis classes are ordered in the sequence of their execution: detection, identification, characterization, and attribution. That is, an event happens, something is detected, samples are taken, and material is identified, the material is characterized and, if needed, the forensic data are combined with other information for attribution.

(U) **Atomic Absorption Spectrometer (AAS)** - A technique that measures light absorption to identify and determine the amount or concentration of an element in a sample.

(U) **Atomic Vapor Laser Isotope Separation (AVLIS)** - AVLIS uranium enrichment technology is based on the fact that ^{235}U atoms and ^{238}U atoms absorb light of different frequencies. Although the absorption frequencies of these two isotopes differ only by a very small amount (about one part in a million), dye lasers can be tuned so that only the ^{235}U atoms absorb the laser light. As the ^{235}U atom absorbs the light, its electrons are excited to a higher energy state. With the absorption of sufficient energy, a ^{235}U atom will eject an electron and become a positively charged ion. The ^{235}U ions may then be deflected by an electrostatic field to a product collector. The ^{238}U remain neutral and pass through the product collector section and are deposited on a tails collector. Although AVLIS technology appears promising, it has proven to be extremely difficult to master and may be beyond the reach of even technically advanced states.

(U) **Attribution** - Nuclear attribution is the assignment of responsibility for the intended or actual use of nuclear or radiological materials/devices in criminal acts or acts that threaten national security.

(U) **Autoradiography** - The process of making a photographic image or map of the radioactivity of a surface. This technique is widely used in biochemistry and genetic studies; it is also used to study oil paintings. The radioactivity of the activated surface involved is usually very low. Autoradiography is extremely useful for locating radioactive particles (sometimes called "hot particles") in samples, so that the particles can be isolated and analyzed individually. Autoradiography offers an alternative to fission track analysis for particle location and identification.

B

(U) **Background Radiation** - Radiation from natural and man-made sources, including from natural radioactivity in the environment, cosmic rays, and from radioactivity released from nuclear power plants, nuclear production activities, and nuclear weapons testing.

(U) **Backscatter** - A method of identifying material or measuring coating thickness by measuring the amount of radiation reflected back from a beam projected into the material.

(U) **Becquerel (Bq)** - A measure of the intensity of radioactivity. One Becquerel is one decay (or disintegration) per second of a radioactive isotope. 1 Bq equals: 2.70×10^{-11} Ci or 60 dpm.

(U) **Beryllium (Be)** - A chemical element that has several useful nuclear properties, including a high cross-section for reflecting neutrons and a high cross section for absorbing alpha particles and producing neutrons. Beryllium metal can be used as a neutron reflector in nuclear weapons. When exposed to a strong alpha emitter (such as ^{210}Po), beryllium metal will generate neutrons, which can initiate a chain reaction in a critical mass of fissile material.

(U) **Beta Detector** - One of several types of radiation detectors that detect and measure beta particles emitted from radioactive isotopes. The detector types include solid-state detectors, gas proportional detectors, Geiger counters, liquid scintillation detectors, and solid scintillation detectors. The most sensitive beta detectors can detect activities of 0.1 dpm or less.

(U) **Beta Particle Radiation** - An electron that has been emitted from a nucleus. A beta particle typically has an energy between 0.001 and 4 MeV. Its penetration in material is short, but nuclides deposited on the skin can be an external radiation hazard. Beta emitters deposited within the body are a serious internal radiation hazard.

(U) **Bismuth (Bi)** - A chemical element that can be irradiated by neutrons to form ^{210}Po, which can be used in neutron initiators for nuclear weapons.

(U) **Boosting** - The use of a DT reaction to produce 14 MeV neutrons to enhance the fission in a nuclear weapon. Boosting can greatly enhance the efficiency of a fission weapon.

(U) **Boron (B)** - A chemical element that has a high cross-section for absorbing neutrons. Boron is used as a neutron absorber in control rods to control nuclear reactors.

(U) **Bulk Analysis** - The analysis of macroscopic amounts of material to determine the concentrations of elements and isotopes in that sample.

(U) **Burn up** - A term used to characterize the extent of use of nuclear reactor fuel. Burn up is a measure of how much of the fissile isotope (usually ^{235}U) has been consumed in nuclear fuel. Typical units are megawatt days per ton of uranium fuel.

C

(U) **Cadmium (Cd)** - A chemical element that has a high cross section for absorbing neutrons. Cadmium is used as a neutron absorber in control rods to control nuclear reactors.

(U) **Carbon Composite** - A material consisting of carbon fiber "cloth" impregnated with epoxy resin. Carbon composites have high strength and light weight, and can easily be shaped prior to the application and setting of the epoxy. The mechanical and manufacturing properties are highly useful for gas centrifuge manufacture. Carbon composites also are used extensively in aircraft and missiles.

(U) **Centrifuge** - A rotating vessel that can be used for the enrichment of uranium. A device that applies centripetal force to a sample, usually via motor-driven rotary motion of the sample. There are many different kinds of centrifuges, often for specialized purposes in research laboratories, medical labs, and material research. (See also gas centrifuges).

(U) **Ceramic** - A hard, pottery-like material with a high resistance to heat (e.g., oxides or carbides of metals). Fuels for nuclear reactors operating at high temperatures are often ceramics (e.g., uranium dioxide, uranium carbide).

(U) **Characterization** - Identification of material and device properties. This information is vital to performing attribution, but it also may be sufficient in and of itself to perform attribution.

(U) **Chemical Assay** - Chemical titration and controlled potential coulometry are standard methods for determination of the element concentrations of uranium, plutonium, neptunium or other major components of nuclear fuel material for accountability measurements or accountability verifications. In chemical titration, the sample is made to react with an exactly measured amount of a selective reagent of known composition, leading to the completion or characteristic end point of a well known stoichiometric reaction. Titration methods are designated according to the mode of detection and the end points. In controlled potential coulometry, the element to be analyzed is selectively oxidized or reduced at a metallic electrode maintained at a suitably selected potential. The number of electrons used in the oxidation or reduction is a measure of the amount of element present in the sample. The precision and accuracy of these methods is better than 0.1%. They are well established and used routinely in nuclear accountancy and safeguards laboratories. They therefore can be very effective for the characterization of interdicted material, provided that samples of at least a few tenths of a gram can be made available.

(U) **Contamination** - The deposition of unwanted material of any type (radioactive or chemical) on the surfaces of structures, objects, or personnel.

(U) **Conventional Forensics** - The application of forensic science to conventional criminal cases. More specifically, conventional forensics is the scientific analysis of samples, things, and people with the goal of linking places, people, things, and events. Conventional forensics includes the analysis of fingerprints, DNA, fibers, hairs, paint chips, pollen, etc. See also Forensic Science.

(U) **Counter (or Radiation Counter)** - A radiation measurement system that reads out the counts or count rate directly, in contrast to a dosimeter, which reads out in units of radiation dose.

(U) **Critical Mass, Critical, Criticality** - The smallest mass of fissile material that will allow a self-sustaining nuclear chain reaction, or criticality. At criticality, the absorption rate of neutrons is just balanced out by the production of new neutrons by fission. The critical mass depends on the type of fissile isotope, its chemical form, geometrical arrangement, and density; the amount of material needed is decreased if the material is compressed. Nuclear power reactors need to operate at criticality to produce electricity. Nuclear weapons are based on highly supercritical designs.

(U) **Curie (Ci)** - A unit of radioactive decay that is based on the activity of one gram of radium. 1 Ci equals 3.7×10^{10} Bq or decays per second or 2.22×10^{12} dpm.

D

(U) **Daughter Isotope** - A radioactive isotope (called the parent isotope) decays into another isotope which is called the daughter isotope or decay product. The daughter isotope can be either stable or radioactive, depending on the parent isotope.

(U) **Decay** - The spontaneous transformation of one nuclide into a different nuclide. Decay may involve the emission of alpha particles, beta particles, positrons, or gamma rays from the nucleus; the capture of electrons by the nuclear, or fission of the nucleus. A decay process is characterized by a half-life (i.e. the time for half of the atoms of a radioisotope to undergo decay). Also called "radioactive disintegration."

(U) **Decay Product** - The outcome of radioactive decay. See daughter isotope.

(U) **Deliberate Signature** - A signature, such as the isotopic composition of HEU that is controlled and specified. Deliberate signatures are essentially product specifications.

(U) **Depleted Uranium, D-38,,or DU** - Uranium with a concentration of ^{235}U smaller than that found in nature (0.72% atom%). It is largely obtained as a by-product or "tails" of the uranium enrichment process or obtained from spent (used) fuel elements. This material has low specific radioactivity and poses no significant risk to human health. It often is found in aircraft as counterweights and in boats as ballast material. It is also used in anti-tank or armor-piercing ammunition to enhance penetration.

(U) **Detonator** - A device that initiates the detonation of a charge of high explosive by subjecting it to percussion by a shock wave.

(U) **Deuterium (D)** - An isotope of hydrogen in which the nucleus has one proton and one neutron (normal hydrogen has no neutrons). Deuterium is useful as a neutron moderator (in the form of heavy water) and has nuclear properties that are useful for thermonuclear or fusion reactions.

(U) **Discovery Class** - A term that describes at what stage a nuclear or radiological event was discovered. The underlying assumption is that the unfolding of an event consists of a sequence of processes that lead from the planning to the execution of an event.

(U) **Dirty Bomb** - An explosive device that is intended to spread radioactive material from the detonation of conventional explosive . See also "Radiological Dispersal Device (RDD)."

(U) **Dose** - A general term for the amount of radiation absorbed over a period of time.

(U) **dpm (decays per minute)** - A convenient unit of radioactive decay. 1 dpm equals 0.0167 Bq or 4.50×10^{-13} Ci.

(U) **DT Reaction** - A thermonuclear or fusion reaction between the hydrogen isotopes deuterium (D) and tritium (T) that produces 14 MeV neutrons. The DT reaction requires the least amount of energy to initiate and is used as a source of high energy neutrons for boosting fission weapons and for thermonuclear weapons.

E

(U) **Electromagnetic Isotope Separation (EMIS)** - A process that uses strong magnetic fields to separate ionized uranium isotopes. The EMIS process works like a mass spectrometer, but on a much larger scale. EMIS was the major process used by the US during the Manhattan Project for the production of ^{235}U for the bomb dropped on Hiroshima. Individual units were known as calutrons, and some are still in service to supply small quantities of various isotopes for research purposes. In 1991, the Iraqis were discovered to be developing EMIS technology for uranium enrichment.

(U) **Electron** - A negatively charged particle which has a mass of about 1/2000 of a neutron. One or more electrons surround the nucleus of an atom. A positively charged electron is known as a positron.

(U) **Electron Microscopy** - A technique that uses a high-energy, finely focused beam of electrons to image samples at very high magnification. Features as small as 10 nanometers (1×10^{-8}meters) can be resolved. Two common versions are scanning electron microscopy (SEM), which images the sample surface by reflection of the electron beam, and transmission electron microscopy (TEM), which images the interior of the sample by electrons that pass through the sample. SEM and TEM are analogous to reflected and transmitted optical microscopy. Many SEM and TEM instruments are equipped with x-ray detectors, which are used to measure the elemental compositions of the samples. See Electron Microprobe Analysis.

(U) **Electron Microprobe Analysis (EMPA)** - A technique that uses a high-energy, finely focused beam of electrons to induce x-ray fluorescence in samples at very high magnification. The induced x-rays have energies that are specific to the elements in the sample. The measurement and analysis of the induced x-rays provides information on the elemental composition of the sample. EMPA instruments work like scanning electron microscopes (SEM) and can resolve elements at resolutions down to about 1 micrometer. EMPA can detect elements at concentrations above 0.01 weight percent, depending on the element and the composition of the sample.

(U) **Electron Volt** - Also called an eV. A unit of energy often used in the measurement of nuclear and atomic radiation. One eV equals 1.60 x 10^{-19} Joules or 3.83 x 10^{-20} calories.

(U) **Enriched Uranium** - Uranium in which the abundance of the ^{235}U isotope has been increased above the natural amount (0.72 atom%). Most light-water reactors use uranium enriched to 2 to 5% of ^{235}U.

(U) **Enrichment** - The process of increasing the concentration of one isotope of an element relative to the other isotopes. In a typical enrichment process, the natural feed material is separated into a product stream (enriched) and a tails (depleted) stream for waste.

(U) **Event Class** - A categorization of the type of nuclear or radiological event. The classes are: nuclear yield event, failed yield event, explosive RDD event, non-explosive RDD event, source emplacement event, interdiction event.

(U) **Exemplar** - A sample that serves as a model or standard. For nuclear forensic purposes, an exemplar would be a material of known origin and pedigree.

F

(U) **Fallout** - Airborne radioactive particles from the cloud produced by the explosion of a nuclear weapon.

(U) **Fissile** - An isotope that can have its nucleus split, releasing a vast amount of energy.

(U) **Fissile Material, Fissile Isotope** - An isotope that readily fissions after absorbing a neutron of any energy, either fast or slow. Fissile materials are ^{235}U, ^{233}U, ^{239}Pu, and ^{241}Pu. ^{235}U is the only naturally occurring fissile isotope.

(U) **Fission** - The splitting of the nucleus of a heavy atom into two lighter nuclei. It is accompanied by the release of neutrons, x-rays, gamma rays, and the kinetic energy of the fission products. It is usually triggered when the nucleus is hit with a neutron, but in some cases can be induced by protons and other particles or gamma rays. Some isotopes decay spontaneously by fission, where an isotope naturally decays by fission without a neutron trigger. Spontaneous fission can occur in isotopes such as ^{238}U, ^{240}Pu, and ^{252}Cf (see spontaneous fission).

(U) **Fission Products** - The radioactive and stable isotopes produced by fission. Each isotope produces a unique pattern of isotope masses. In addition, the pattern of the isotope masses depends on the energy of the neutron spectrum. Three neutron energy ranges are of interest: fission spectrum (neutrons produced directly from fission), thermal (neutrons that have been slowed or moderated have thermal energies), and 14 MeV (which are produced by the fusion reaction of tritium and deuterium). Generally, the analysis of fission products focuses on the analysis of radioactive isotopes.

(U) **Fission Spectrum Neutron** - The energy of neutrons produced by the fission process. Typical energies of fission spectrum neutrons are in the 1 to 3 MeV range.

(U) **Fissionable Material** - Commonly used as a synonym for fissile material; the meaning of this term has been extended to include material that can be fissioned by fast neutrons only, such as ^{238}U.

(U) **Fission Track Analysis** - A method for finding particles that contain uranium or plutonium by fissioning a small amount of the fissile isotope and detecting the fission tracks produced in a detector. Also called Lexan screening, because Lexan plastic is used to detect the fission tracks. This method uses optical microscopy to locate and isolate particles of interest in nuclear forensic samples. The production of fission tracks requires neutron irradiation, which is usually done in a research reactor.

(U) **Fission Weapon** - A weapon designed to produce blast, thermal radiation, and nuclear radiation through the fissioning of fissile material (e.g., ^{235}U and ^{239}Pu). The complete fission of one pound of fissionable material has a yield equivalent to 8,000 tons of TNT.

(U) **Forensic Science** - The comprehensive scientific analysis of physical and biological evidence in the context of civil, criminal, or international law. The goal of forensics is to link people, places, things, and events. See also conventional forensics.

(U) **Fourier Transform Infrared (FTIR) Spectrometry** -A high-resolution infrared spectrometry technique that employs an optical interferometer to simultaneously detect and analyze a wide range of infrared wavelengths. The data are analyzed by performing a Fourier Transform, which is a mathematical process to convert intensity as a function of the interferometer position to intensity as a function of energy (i.e., inverse wavelength). FTIR became feasible with the advent of modern computers and computational algorithms. FTIR is useful for analyzing a variety of materials in solid, liquid, and gaseous form.

(U) **Fuel Element** - A rod, tube, plate, or other mechanical shape or form into which nuclear fuel is fabricated for use in a nuclear reactor.

(U) **Fuel Fabrication Plant** - A facility where the nuclear material, such as enriched or natural uranium, is fabricated into a ceramic material called uranium dioxide in a form suitable for use as fuel in a nuclear reactor.

(U) **Fuel-grade Plutonium** - Plutonium produced in nuclear reactors that has between 7% and 19% ^{240}Pu relative to other isotopes of plutonium.

(U) **Fuel Pellets** - Typically, sintered (or fused) and ground cylinders of uranium dioxide, about 1/2 inch long and of various diameters, are stacked in tubes to form the fuel pins or rod.

(U) **Fusion** - The opposite of fission, in which two light nuclei atoms – typically deuterium and/or tritium – combine to form a heavier nucleus with the release of a substantial amount of energy. Extremely high temperatures, resulting in highly energetic, fast-moving nuclei, are required to initiate fusion reactions.

(b)(3) per DOE SRD, TCG-NAS-2 Topic 506.4

(U) [redacted]

G

(U) **Gamma Ray Emitter** - A material that emits gamma rays (high-energy photons). ^{60}Co is a strong gamma ray emitter.

(U) **Gamma Ray Radiation** - Also called gammas, for short. High-energy electromagnetic radiation emitted by nuclei during nuclear reactions or radioactive decay. Many radioactive isotopes emit gamma rays and these gamma rays have specific energies that are characteristic to the specific isotope and decay scheme. Gamma rays have high energy (generally 30 KeV to many MeV) and a short wave length. Shielding against gamma radiation requires thick layers of dense material, such as lead. Gamma rays are potentially lethal to humans, depending on the intensity of the flux.

(U) **Gamma Spectrometry** - A detection system that measures the energy of gamma rays emitted by a radioactive sample. The gamma ray energy and intensity is used to identify the radioactive isotope and the amount of the isotope in the sample. The detector types include solid-state detectors, gas proportional detectors, and solid scintillation detectors. The most common type of solid-state detector uses a large, high purity, single crystal of germanium (also called HPGe). A solid scintillation detector often uses large crystals of sodium iodide. The most sensitive gamma spectrometer can detect activities of 0.1 dpm or less.

(U) **Gas Centrifuge** - A uranium enrichment process that uses rapidly rotating cylinders (gas centrifuges, also called rotors) to enrich ^{235}U. Uranium hexafluoride (UF_6) gas is fed into a gas centrifuge and rotated at high speed. The centrifugal forces produced by the rotation cause the heavier ^{238}U to migrate toward the outside of the rotor and the lighter ^{235}U to migrate towards the center. Gas removed from the center is slightly enriched in ^{235}U and gas removed from near the outside of the rotor is slightly depleted in ^{235}U. The separation efficiency is increased by a relatively slow axial countercurrent flow of gas within the centrifuge. The countercurrent flow process produces further enrichment by concentrating enriched gas at one end and depleted gas at the other. Feed UF_6 is introduced near the middle of the rotor, and enriched and depleted UF^6 are removed near the ends. The separation capacity of a single rotor increases with the length of the rotor and the rotor wall speed (i.e. with increasing rotation rate). Consequently, centrifuges consisting of long, high-speed rotors are the goal of centrifuge development programs, subject to materials and mechanical constraints. A typical gas centrifuge plant can have thousands of rotors, connected in series. Gas centrifuges must be constructed of very strong materials, such as carbon fiber or high-strength aluminum or steel alloys. The gas centrifuge process is much more energy efficient than gaseous diffusion.

(U) **Gaseous Diffusion** - This isotope separation process is based on the fact that the lighter isotopes of ^{235}U gas diffuse through a porous barrier at a faster rate than the heavier isotopes. This method requires large plants and enormous amounts of electrical power. China, France, Russia, Great Britain, and the United States have used this isotope separation process.

(U) **Gas Proportional Detector** - A radiation detector that detects beta particles or gamma rays by the ionization they produce in a gas. Gas proportional detectors can measure the energy of the gamma ray and are used in gamma spectrometry. The most sensitive gas proportion detectors can detect activities of 0.1 dpm or less.

(U) **Geiger Counter** - A radiation detector that can detect beta particles and gamma rays. The Geiger counter is widely used for radiation detection measurements for health physics and radiation safety.

(U) **Glow Discharge Mass Spectrometry (GD-MS)** - In glow discharge mass spectrometry (GD-MS), the sample serves as the cathode of a glow discharge (argon is usually the support gas). The sample is sputtered by argon ions, and the sputtered neutrals from the sample diffuse into the plasma. In the plasma, the neutrals are ionized either by electron impact or, more typically, by collision with metastable argon atoms (penning ionization). GD-MS can be an effective technique for directly measuring bulk samples, such as dirt. GD-MS is highly quantitative, suffering from very few matrix effects. It can be fused as a sensitive survey tool with detection limits ranging from less than 1 ppb to a few ppm, depending on the element. However, it lacks the precision associated with radiochemistry, TIMS, or ICP-MS. It also can provide misleading results for some heterogeneous samples, since the sampled volume is small, and there is no sample homogenization provided by dissolution or a similar process.

(U) **Graphite** - A form of carbon. Graphite is used as a neutron moderator in some nuclear reactors. Such reactors can run on natural uranium and are useful for producing weapons-grade plutonium. Most of the US weapons-grade plutonium was produced in graphite-moderated reactors at the US Department of Energy's Hanford Site in Washington state.

(U) **Green Salt** - Green Salt is the term used to describe uranium tetrafluoride (UF_4) which is a green crystalline solid compound of uranium. UF_4 is generally an intermediate in the conversion of uranium hexafluoride (UF_6) to either uranium oxides (U_3O_8 or UO_2) or uranium metal. It is formed by the reaction of UF_6 with hydrogen gas in a vertical tube-type reactor or by the action of hydrogen fluoride (HF) on uranium dioxide.

H

(U) **Half-life** - The amount of time needed for half of the atoms of a radioactive material to disintegrate or decay.

(U) **Health Physics** - The science concerned with recognition, evaluation, and control of health hazards resulting from ionized radiation.

(U) **Heavy Water** - A form of water in which the hydrogen has been replaced by deuterium. Heavy water is used as a neutron moderator in some nuclear reactors. Such reactors can run on natural uranium and are useful for producing weapons-grade plutonium. Some of the US weapons-grade plutonium (and most of the tritium) was produced in heavy-water-moderated reactors at the US Department of Energy's Savannah River Site in South Carolina.

(U) **Highly Enriched Uranium** (HEU) - Uranium that contains 20 atom % or more ^{235}U.

(U) **High Explosives (HE)** - Energetic materials that consist of chemical compounds or mixtures of compounds that when properly initiated evolve large volumes of gas in a short period of time and produce a high pressure shock wave that is capable of shattering or compressing surrounding media. Examples of HE compounds suitable for nuclear weapons include:

(U) HMX (cyclotetramethylenetetranitroramine)
(U) RDX (cyclotrimethylenetrinitroramine)
(U) PETN (pentaerythritol tetranitrate)
(U) TATB (triamino-trinitrobenzene)
(U) TNT (trinitrotoluene)
(U) Tetrya (trinitrophenylmethylnitroamine)

(U) All of these HE compounds consist of organic compounds with attached nitrogen oxide (or "nitro" groups), which are responsible for the explosive character of these compounds. For nuclear weapon applications, these (or similar) compounds are usually blended with inert binders (such as plastic) to obtain a physical form of the HE compound that can be molded or machined into the desired shape.

(U) **HPGe Detector** - A type of gamma ray detector that uses a large crystal of high purity germanium to detect gamma rays. HPGe detectors can measure the energy of the gamma ray and are used in gamma spectrometry. HPGe detectors must be cooled to cryogenic temperatures, such as by using liquid nitrogen, to work properly. Hence, HPGe detectors are not easily made portable. The most sensitive HPGe detectors can detect activities of 0.1 dpm, or less.

I

(U) **IC** - Intelligence Community.

(U) **ICP/MS** - See Inductively-coupled-plasma mass spectrometry.

(U) **ICP/OES** - See Inductively-coupled-plasma optical emission spectrometry.

(U) **International Atomic Energy Agency (IAEA)** - An independent, intergovernmental, science and technology-based organization of the United Nations that serves as the global focal point for nuclear cooperation. The mission of the IAEA is to verify through its inspection system that its member States comply with their commitments under the Non-Proliferation Treaty and other non-proliferation agreements, to use nuclear material and facilities only for peaceful purposes.

(S//NF) [redacted]

(S//NF) [redacted]

(U) **Inadvertent Signature** - A signature, such as a trace element or isotope that is present in a material that is otherwise unimportant to the use of the material. An example would be a trace amount of plutonium found with an HEU sample. This trace Pu would have no bearing on any of the material properties of the HEU nor does its concentration in the HEU pose any issues for its bulk nuclear properties. The trace Pu would not be controlled, but it would be a signature of the process that produced the HEU.

(U) **Inductively-coupled-plasma Optical Emission Spectrometry (ICP/OES)** - An instrument used for elemental analysis that uses a hot plasma to vaporize elements for optical spectrographic analysis. The normal method of introducing the sample into an ICP/OES is by dissolving the sample, generating an aerosol from the solution and feeding the aerosol into the hot plasma. The hot plasma causes many of the elements to emit light at characteristic wavelengths. The spectrographic analysis of the emitted light is used to determine what elements are present in the sample and their concentrations in the sample. ICP/OES uses the same type of plasma torch as used in an ICP/MS. ICP/OES can detect elements down to part-per-billion to part-per-million levels.

(U) **Inductively-coupled-plasma Mass Spectrometry (ICP/MS)** - A mass spectrometry technique that uses a hot plasma to vaporize and ionize elements for mass analysis. The normal method of introducing the sample into an ICP/MS is by dissolving the sample, generating an aerosol from the solution, and feeding the aerosol into the hot plasma. ICP/MS was initially developed in the early 1980s and has been developed into a general technique for analyzing the elemental compositions of samples, as well as the isotopic composition of individual elements. ICP/MS is primarily used for bulk analysis. The technique normally requires extensive chemistry to dissolve the sample and to separate and purify the element for analysis. However, for particle analysis, small, micrometer-sized particles can be loaded directly onto a filament for isotopic analysis of uranium and plutonium – no chemistry is used and the atoms are vaporized directly into the carrier gas and transported to the plasma. ICP/MS can detect as few as 100,000 atoms of plutonium, and can measure isotope ratios to better than 1 part in 1000 precision for larger samples.

(U) **Ion Microprobe Mass Spectrometry** - A mass spectrometry technique that uses a focused ion beam to remove (or sputter) atoms from a sample for analysis in a mass spectrometer. The ion microprobe can analyze the elemental and isotopic composition of small pieces of material without the need to perform any chemistry on the samples, which is different from other types of mass spectrometry. The technique can analyze areas smaller than 1 micrometer (or micron) in diameter, can detect elements at concentrations as low as one part-per-billion, and can measure the isotopic compositions of elements to precisions better than one part in 1,000. Also called secondary ionization mass spectrometry or SIMS.

(U) **Ionization** - The removal or addition of an electron from an electrically neutral atom or molecule, thus leaving a positively or negatively charged ion, respectively.

(U) **Ionizing Radiation** - Any radiation that causes the removal of electrons from atoms or molecules, thereby producing ions.

(U) **Isotope** - Atoms of the same chemical element but with different numbers of neutrons in their nucleus. An isotope is specified by its atomic weight and a symbol denoting the chemical element, such as ^{235}U for uranium with 235 neutrons and protons. Isotopes can be either stable or unstable (radioactive).

J

K

(U) **KeV** - Kilo-electron-volt (1,000 electron volts): a unit of energy often used in the measurement of nuclear radiation such as gamma rays, alpha particles, beta particles, and neutrons, and atomic radiation such as x-rays. See also electron volt and MeV.

(U) **Known Sample (K)** - A sample of known origin and attributes, which is used in the forensic comparison with an unknown or questioned sample. The known sample has been previously analyzed and documented and the information is likely to have been incorporated into a database. See Questioned Sample (Q).

(U) **Krypton (Kr)** - A chemical element with atomic number 36. It is a noble gas that occurs in trace amounts in Earth's atmosphere. There are 20 known isotopes of Kr. Naturally occurring Kr is made of 5 stable isotopes and one slightly radioactive isotope. ^{85}Kr is a radioactive isotope produced by the fission of uranium and plutonium and is produced by nuclear reactors and nuclear explosions.

L

(U) **Lanthanide Element** - A group of elements (also called the rare-earth elements) on the periodic table of the elements that includes lanthanum, neodymium, cerium, and samarium. These elements are chemically similar and have been grouped with the lightest element of the series, lanthanum (hence the name lanthanides). The lanthanides are important to nuclear forensics because they include many important fission products, which can be interpreted to determine the fissile isotope and to determine the energy spectrum of the neutrons that produced the fission. The lanthanides are also similar to another group of elements, the actinide elements.

(U) **LEA** - Law Enforcement Agencies.

(U) **Liquid Scintillation Detector** - A radiation detector that detects alpha particles or beta particles by the light they produce in a liquid. Liquid scintillation detectors can measure the energy of the alpha particles or beta particles and are used in alpha spectrometry. The most sensitive liquid scintillation detectors can detect activities of 0.1 dpm or less.

(U) **Lithium** - A chemical element that has nuclear properties that are useful for thermonuclear or fusion reactions. Lithium is also used as a target for production of tritium.

M

(U) **Maraging Steel** - Maraging steel is an important component in the design of gas centrifuge rotors. It allows for the very high rotor wall speed necessary to separate ^{238}U from ^{235}U. This type of steel (which has a high cobalt content) is the most popular rotor material for proliferant countries to use in building isotope separation facilities.

(U) **Mass Spectrometer** - An analytical instrument used to measure the composition of a sample based on the atomic (or molecular) weights (masses) of its constituents. Some mass spectrometers can accurately measure the isotopic composition of samples. Different types of mass spectrometers include:
(U) Accelerator mass spectrometer - AMS
(U) Inductively-coupled-plasma mass spectrometer - ICP/MS
(U) Ion microprobe mass spectrometer (also called a secondary ionization mass spectrometer - SIMS)
(U) Thermal ionization mass spectrometer - TIMS

(U) Each type of mass spectrometer has a specific range of elements (hence isotopes) it can analyze and associated detection limits, as well as requirements for sample preparation chemistry and handling.

(U) **Material Signature** – "Material signatures" include all characteristics of a particular material, whether the characteristics are specifications or nor – i.e., the material "fingerprint." "Material signatures" include "process signatures", but also include inadvertent or unspecified signatures. Inadvertent signatures are unimportant as specifications for the process and, hence, are not under deliberate control. Evaluation of material signatures has the potential to identify where (hence, by whom) the material was made. An important point is that "the interpretation of material signatures requires extensive databases to reveal the origin of the materials." "Exemplars – that is, examples from known processes and locations – are essential." See Process Signatures.

(U) **MeV** - Mega-electron-volt (1,000,000 electron volts): a unit of energy often used in the measurement of nuclear radiation such as gamma rays, alpha particles, and neutrons. See also eV and KeV.

(U) **Micron** - A micrometer or one-millionth of a meter (1 x 10^{-6} meter). See micrometer.

(U) **Micrometer** - One-millionth of a meter (1 x 10^{-6} meter). The wavelength of yellow light is 0.5 micrometers.

(U) **Molecular Laser Isotope Separation (MLIS)** - There are two basic steps involved in the MLIS process. In the first step, UF_6 is irradiated by an infrared laser system operating near the 16 mm wavelength, which selectively excites the $^{235}UF_6$, leaving the $^{238}UF_6$ relatively unexcited. In the second step, photons from a second laser system (infrared or ultraviolet) preferentially dissociate the excited $^{235}UF_6$ to form $^{235}UF_5$ and free fluorine atoms. The $^{235}UF_5$ formed from the dissociation precipitates from the gas as a powder that can be filtered from the gas stream. In terms of the gas flow for the MLIS process, gaseous $^{235}UF_6$ is mixed with a carrier gas and a scavenger gas is expanded through a supersonic nozzle that cools the gas to low temperatures. Hydrogen or a noble gas are suitable as carriers. A scavenger gas (such as methane) is used to capture the fluorine atoms that are released as a result of the dissociation of $^{235}UF_6$ molecules. Like AVLIS, MLIS technology appears promising bus has proven to be extremely difficult to master and may be beyond the reach of even technically advanced states.

(U) **MOX-Grade Plutonium** - Mixed Oxide fuel, which contains both uranium and plutonium oxides. MOX fuel is made using plutonium extracted by reprocessing spent power reactor fuel and typically has greater than 30% ^{240}Pu.

N

(U) **Nanometer** - One-billionth of a meter (1 x 10^{-9} meter); abbreviated nm. Atoms are about 5 nm in diameter.

(U) **Neptunium (Np)** - A metallic radioactive element with atomic number 93. Neptunium is found in trace quantities in uranium ores and is also produced synthetically in nuclear reactions.

(U) **Neutron** - The neutron is an electrically neutral particle of nearly the same mass as the proton. Neutrons are one of the three basic particles that make up the atom, the others being protons and electrons. Neutrons as released by fission and can be produced by other nuclear reactions, such as bombardment of beryllium by alpha particles. Neutrons can be absorbed by paraffin, hydrogenous material, or by very thick layers of lead.

(U) **Neutron Initiator** - A device that emits a burst of neutrons to start a chain reaction in a critical mass of fissile material. The initiator triggers the nuclear detonation once the critical mass has been assembled by high explosives.

(U) **Neutron Moderator** - A material that slows neutrons. Examples include graphite and heavy water. Moderators are used in nuclear reactors to slow neutrons from fission energies to thermal energies to increase the probability that the neutrons will react with the nuclear fuel in the reactor.

(U) **Nickel (Ni)** - A chemical element that is used in many nuclear applications because of its chemical resistance to oxygen and fluorine. Nickel is also a component of many types of steels.

(U) **Nuclear Attribution** - The assignment of responsibility (people) for the intended or actual use of nuclear material.

(U) **Nuclear Characterization** - The description of the chemical, elemental, isotopic, and physical aspects of the nuclear material as well as the inferred historical (pedigree/process) origins of the nuclear material.

(U) **Nuclear Forensics** - The application of nuclear physics and analytical technologies to the study of nuclear material in forensic samples. As with conventional forensics, the goal is to link people, places, things, and events. Nuclear forensics also seeks to identify how nuclear materials were produced, their intended use, and where they were produced. The findings may be presented as technical evidence in a court of law or on a national security setting.

(U) **Nuclear Detonation** - A nuclear explosion resulting from fission or fusion reactions in nuclear materials, such as from a nuclear weapon.

(U) **Nuclear Energy** - The energy released when the nucleus of an atom splits or when two nuclei fuse. (See fission and fusion).

(U) **Nuclear Radiation** - Particle and electromagnetic radiation emitted from various nuclear processes in atomic nuclei. The important radiations, from the nuclear weapon effects standpoint, are alpha and beta particles, gamma rays, and neutrons.

O

(U) **Optical Microscopy** - A microscope that magnifies light. Features as small as about 1 micrometer (or micron) can be resolved by this technique. Two variants are reflected light microscopy, which images the sample surface by reflection of light shone on the sample, and transmitted light microscopy, which images the interior of the sample by light that passes through the sample.

P

(U) **Parent Isotope** - A radioactive isotope that decays to produce a daughter isotope. The concept of parent isotope and daughter isotope are crucial for age-dating.

(U) **Penetrating Radiation** - External radiations of such penetrating power that the absorbed dose from exposure is delivered in significant and damaging quantities to human tissue and other organs. It refers to most gamma radiation, x-ray radiation (excluding those with very low energy), and neutron radiation assembly, but not including safing material.

(U) **Pit** - A pit is the core of an implosion type nuclear weapon. It contains the fissile material and any reflector or tamper associated with it.

(U) **Plutonium (Pu)** - A transuranic element with a fissile isotope of mass number 239 (^{239}Pu).

(U) **Polonium-210 (^{210}Po)** - An alpha-emitting radioactive isotope with a 138 day half-life. ^{210}Po occurs in trace amounts in nature due to the decay of naturally occurring ^{238}U. ^{210}Po is produced in nuclear reactors by irradiation of ^{209}Bi (the sole stable isotope of bismuth) and is used commercially for a variety of purposes (such as in small, encapsulated sources to eliminate static electricity) and in nuclear weapons as part of a neutron initiator (when mixed with beryllium).

(U) **ppb** - Parts per billion; refers to the concentration of something in a material.

(U) **ppm** - Parts per million; refers to the concentration of something in a material.

(U) **ppt** - Parts per trillion; refers to the concentration of something in a material.

(U) **Process Signatures** - Process signatures generally arise from product specifications, which depend on how the material was produced and how the material will be used. An important point is that "process signatures can generally be interpreted without the need for extensive databases." To interpret process signatures one usually needs only knowledge of the process (i.e. final product specifications). See Material Signatures.

(U) **Proton** - The proton is a positively charged particle of nearly the same mass as the neutron. Protons are one of the three basic particles that make up the atom, the others being neutrons and electrons.

(U) **Pusher** - A shell made out of low density metal – such as aluminum, beryllium, or other metals – which is located between the explosive lens and the tamper in an implosion type nuclear weapon. It works by reflecting some of the shock wave backwards, having the effect of lengthening its duration.

Q

R

(FOUO) **Radiological Dispersal Device (RDD)** - A Radiological Dispersal Device (RDD) is defined by the US Department of Defense as, "any device, including any weapon or equipment, excluding a yield-producing nuclear device, designed to employ radioactive material to cause destruction, damage, or injury by means of radiation produced by decay of such materials." An RDD may cause mass disruption – possibly causing mass hysteria, fear, and significant cleanup costs – but is not considered a WMD

(U) **Radioactive Counting Techniques** - Each radioactive isotope emits radiation of known types and energies at a known rate. By measuring the radiation emitted by a sample, it is possible to quantify the amount of each measured isotope present. There are three types of radiation that are usually considered for measurement: alpha, beta and gamma radiation. Each type of radiation has its own properties and methods of detection.
(U) Silicon surface barrier detectors commonly detect alpha radiation.
(U) Scintillation techniques or gas ionization detectors are used to detect beta radiation.
(U) Germanium crystals are commonly used to detect gamma radiation.

(U) **Radioactivity** - The phenomenon, exhibited by and being a property of certain elements, of spontaneously emitting radiation resulting from changes in the nuclei of atoms of the element.

(U) **Radiochemistry** - Many samples are too complex for all the radioactive isotopes present to be measured directly. By utilizing the differences in chemical properties of the elements, it is possible to devise schemes of chemical reactions to separate and purify elements, or groups of elements, to allow measurement of the isotopes present by radioactive counting methods, or mass spectrometry. The isotopes measured are related back to the original sample by referencing to an internal isotopic standard called a "spike." The chemical separation and purification steps increase both the sensitivity and selectivity of the technique. Radiochemistry is especially important to allow measurement of isotopes that are present at low activity and are best measured by their alpha or beta emissions or by mass spectrometry. Radiochemistry in combination with radioactive counting techniques and mass spectrometry has the potential to measure down to 10^6 atoms or lower of certain isotopes.

S

(U) **Safing Arming Fuzing Firing (SAFF) system** - A SAFF system is crucial to the development of a militarily usable nuclear weapon. It consists of the following subsystems:
(U) Safing: Used to ensure that a nuclear weapon will not experience a nuclear detonation as it is being stored, handled, deployed, and employed. Safing usually involved multiple mechanical interruptions of both power sources and explosive firing trains. The nuclear components may be designed so that an accidental detonation of the high explosives is

intrinsically unable to produce a significant nuclear yield.
(U) Arming: Placing the nuclear warhead in a ready operational state, such that it can be initiated under specified firing conditions. Arming generally involves mechanical restoration of the safing interrupts in response to conditions that are unique to the launch or deployment of the system.
(U) Fuzing: Detecting that the desired conditions for warhead detonation have been met and providing an appropriate command signal to the firing set to initiate nuclear detonation.
(U) Firing: Delivering a precise level of precisely timed electrical or pyrotechnic energy to one or more warhead detonating devices.

T

(U) **Tamper** - A shell surrounding the fission core in an implosion type nuclear weapon which keeps the nuclear material confined during the implosion for a longer time, raising the yield of the weapon.

(U) **Thermal Ionization Mass Spectrometry (TIMS)** - In TIMS, a sample is deposited on a metal filament, which is heated in a high vacuum by passing a current through it. TIMS is capable of measuring isotopic ratios on picogram (10^{-12} g) to nanogram (10^{-9} g) samples, or down to tens of femtograms (1×10^{-15} g) using special pre-concentration techniques. TIMS routinely measures differences in isotope mass ratios of the order of 1 in a million.

(U) **Thorium (Th)** - A radioactive metallic element with atomic number 90. Thorium may be used as fuel for special types of nuclear reactors.

(U) **TNF** - Technical Nuclear Forensics.

U

(U) **Uranium (U)** - A radioactive element with various fissile isotopes. ^{235}U is used in nuclear weapons and as fuel for nuclear reactors.

(U) **Uranium Hexafluoride (UF_6)** - A compound used in the uranium enrichment process which produces fuel for nuclear reactors or highly enriched uranium for nuclear weapons. UF_6 is used as the feed material for gas centrifuges, gaseous diffusion, and MLIS enrichment methods. UF_6 is produced by reacting UF_4 with fluorine.

V

(U) **Visual Inspection and Photography** - Visual inspection of a sample can give an expert information as to its possible identity, especially in conjunction with data from NDA techniques such as gamma spectrometry and survey data. Size and shape can be sufficient to identify some items, especially if serial numbers or other identifying marks can be seen. For chemicals, the color and form of the material can be important clues.

W

X

(U) **X-ray** - A form of electromagnetic radiation, similar to visible light but of shorter wavelength (between 0.1 to 10 nm) and capable of penetrating solids and ionizing gasses.

(U) **X-ray Diffraction Analysis** (XRD) - XRD analysis is the standard method for identifying the chemical structure of inorganic and organic crystalline material. X-ray beams that impinge on regularly ordered lattices undergo constructive and destructive interference that depends on the spacing of the lattice, the wavelength of the X-rays, and the angle of incidence of the X-ray beam. By rotating the sample relative to a fixed X-ray source, variations in interference occur, leading to characteristic diffraction patterns. These diffraction patterns can be compared to reference spectra to identify the specific crystalline phase. XRD cannot generate diffraction patterns from amorphous (non-crystalline) material.

(U) **X-ray Fluorescence Analysis (XRF)** - XRF analysis can be useful for the broad and non-destructive elemental quantification of a sample. An incident X-ray beam is used to excite characteristic secondary X-ray wavelengths and energies in a solid sample. These X-rays are counted using a solid state or proportional counter. The detection limits for XRF are in the range of 10 ppm. Analysis of the light elements is possible but more problematic due to the low characteristic X-ray energies involved. XRF is strictly an elemental analysis tool, while ICP-MS or GD-MS, which are more sensitive, are able to measure isotopic composition. XRF can be performed directly on solid samples, although dissolutions are often analyzed to provide homogenization of the sample.

(U) **Xenon (Xe)** - A chemical element of atomic number 54. Xe is a noble gas which occurs in the Earth's atmosphere in trace amounts. Naturally occurring Xe consists of 9 stable isotopes. Xe also has over 40 unstable isotopes that undergo radioactive decay. ^{135}Xe is produced as a result of nuclear fission.

Y

(U) **Yellowcake** - A processed oxide of uranium (U_3O_8) which is extracted and concentrated from uranium ore. It is used as the raw material for commercial nuclear materials.

Z

(U) APPENDIX C: Dynamic Analysis Process

(U//FOUO)Very hard to nearly intractable intelligence problems usually go through to an initial stab by a highly-focused special analytical team. Outputs from the team's efforts are used to update collection requirements, and sometimes result in the formation of a new entity to work the problem full-time. After a long period of little progress or no real intelligence production, the problem may fall below the day-to-day focus. If and when activities related to the concern about the issue remind consumers of the threat, then another focused look at the problem may be initiated.

(U//FOUO) For certain classes of issues, failure represents catastrophic consequences. Issues of this nature demand a level of focus that digs deep every day, even if the results are negative over long periods of time. In such situations, dedicating some resources to working the problem on a continuing basis is worth the effort.

(U//FOUO) A dynamic approach to analysis and collection for hard to nearly intractable issues is illustrated in the chart below (Dynamic Analysis and Collection Cycle Process). This approach has previously been recommended in several studies performed by the DNI's now defunct Intelligence Concepts Development Office (formerly under the ADCI/Collection as the Collection Concepts Development Center). The recommendations were generated by applying the process to developing analysis and collection recommendations on particular hard problems identified by the NICB.

(U//FOUO) The concept for dynamic analysis is straight forward. The first phase involves creating a notional series of phases that any entity would use to start and achieve a particular objective. The actual steps would be based on whatever is known about the ilk of the entity and real world activities that would have to take place to achieve their objective.

(U//FOUO) Under each phase or step, participants in the process brainstorm the manifestations of activities that must occur in order for an entity forward on their objective. In concert with this brainstorming, participants identify what might be collectable from any particular manifestation. (For example, there would be a number of areas where information and phenomena would be generated in the course of arranging for a safe-house to set up a covert meeting of the "group-who-hates-potatoes". Someone would have to make the arrangements for a room or house—leaving a trail of paper. Some attendees might rent cars—another trail of paper. Cars on the way to the meeting would cause a Doppler shift in any local radio frequency signals. An upswing in anti-potato rhetoric might show up in internet media.) Possible collectable information would be arrayed against the capabilities of existing collection resources.

(U//FOUO) If a collection resource had the access to and ability to collect the information, an appropriate requirement would be initiated. Alternatively, requirements already in place would be updated if necessary.

(U//FOUO) If collection was feasible but no capability yet existed, an associated gap-closing research objective might be initiated.

(U/FOUO) When conducted on a continuing basis, the dynamic analysis process would

(b) (1)

constantly iterate the issue's evolutionary steps and possible manifestations. These iterations would be based in any refinement in understanding the ilk of the target entity and specific intelligence information. (A simple analogy is the constant process of writing and rewriting scripts for a movie, as a movie director shoots and evaluates scenes or as the script writer does more research.)

(U//FOUO) Work on nuclear attribution is more than just picking up the pieces after an event takes place. Vigilance in working the issue before any harm takes place is a vital part of the job. Interdiction as early as possible should be the primary objective. Some resources should be dedicated to a achieve the objective of frequently revisiting what indications might emerge in LE, TNF and intelligence data from motivation to the aftermath of a terrorism-based nuclear event.

(U//FOUO) A dynamic analysis process could be part of the responsibilities of the dedicated working group proposed for the [redacted] CONOP.

(b)(1)
(b)(3)

(U/FOUO) **DYAMIC ANALYSIS AND COLLECTION CYCLE PROCESS**

(b) (3)
(b) (6)

(U) APPENDIX D: SHARP 2009 Nuclear Attribution Participants and Personnel

Participants

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