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Beyond Compliance: Preventing the Diversion of Sensitive Vacuum
Measuring Equipment - The “Controlled Delivery Model”

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Cover Image

MKS capacitance manometer visible (small cylinder with red band) on Iranian centrifuge cascade at the Natanz enrichment plant during inspection by President Ahmadinejad.

—Office of the President of Iran

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About Alpha

Project Alpha is a government-sponsored initiative that was established to support the private sector in implementing export controls and countering the illicit trade that maintains the prohibited nuclear and missile programs of countries such as Iran and North Korea.

The private sector has an important role to play in countering proliferation; while governments can adopt export controls and sanctions into law, it is individual firms that must exercise vigilance to avoid illicit trade on a daily basis.

Project Alpha has two main strands:

- Encouraging Antiproliferation practices through supply chains; working toward the goal of all firms having in place a proliferation resistant export compliance system
- Assisting exporters in implementing best-practice compliance systems which both meet legal requirements and counter the risk of illicit trade.

Project Alpha promotes a partnership model with the private sector. While the Project's information and guidance are made available to all, individual firms are encouraged to publically-embrace best-practice compliance standards by becoming a Partner Against Proliferation.

About the Authors

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Note: any views expressed in this paper are those of the authors and are not necessarily shared by any organisation with which the authors are affiliated.

Abstract

This paper describes a logistical technique referred to by MKS as the “Controlled Delivery Model” (or Direct Factory Shipment Program, DFSP) for reducing the systemic risk of sensitive dual-use technologies being diverted to WMD programmes of concern through illicit trade. The adoption of this voluntary approach by MKS is an example of “Anti-proliferation” in practice – the concept of resilience to proliferation in companies’ supply chains.

Introduction

Most countries lack the capability to manufacture all prerequisite technologies required for the production of fissile materials, nuclear weapons and their means of delivery. Those countries pursuing the acquisition of nuclear weapons are therefore reliant on goods imported from the international marketplace. While trade explicitly destined for proliferation would be blocked by export controls in almost every state, proliferators work actively to evade controls. As such blocking proliferation-related trade often depends as much on the actions of companies that manufacture or control technology as on the laws adopted by governments and the international community. The experience of MKS provides a prime example. As a leading manufacturer of capacitance manometers, an item used to measure near-vacuum pressures in semiconductor, pharmaceutical or advanced coating processes, MKS products are perhaps the best example of a dual-use 'chokepoint technology' - an item without which some forms of gaseous uranium enrichment could falter or even be set back. This paper describes one logistical technique referred to by MKS as the "Controlled Delivery" model (or Direct Factory Shipment Program, DFSP) for reducing the systemic risk of sensitive dual-use technologies being diverted to proliferation programmes of concern through illicit trade. The adoption of this voluntary approach by MKS is an example of "Anti-proliferation" in practice – the concept of resilience to proliferation in companies' supply chains.

History

Capacitance manometers manufactured by MKS became sensitive in the 1960s when the items were specified for use by URENCO for use in uranium enrichment centrifuges. Several years later AQ Khan would steal the design for these very centrifuges, utilizing them to jump start Pakistan's own nuclear weapons program. In doing so, Khan sought components and materials from the supply chain established by URENCO. Khan used his network to sell centrifuge technology to at least three additional countries – Iran, North Korea, and Libya. While the Khan network has long since been disbanded, the proliferation risks associated with capacitance manometers have not lessened, with the Iranian nuclear program and others continuing to seek such goods from a handful of existing international suppliers.

Products

Highly accurate, corrosion-resistant vacuum measurement equipment is perhaps the best example of a 'chokepoint technology' – a technology without which proliferation can be greatly constrained. Uranium enrichment – one of the two routes for producing fissile material for use in nuclear weapons – can be undertaken using a number of different processes. One commonality across most methods is that the enrichment process occurs under vacuum. This is true for enrichment using centrifuges as pursued in Iran and North Korea, in the gaseous diffusion plants pursued by many of the early nuclear weapons states, in electromagnetic separation pursued by the US and Iraq, and also in the emerging field of laser isotope separation. In many of these processes the optimum form of uranium for enrichment is uranium hexafluoride (UF_6). Hydrogen Fluoride—a common industrial but highly corrosive gas that most metals cannot withstand—is always present in the UF_6 gas stream - . Certain metals, alloys, and certain other materials are, however, resistant to these gases. Capacitance manometers and similar vacuum equipment made from such alloys are therefore sought by proliferators.

Understanding the importance of accurate vacuum measurement, the Nuclear Suppliers Group (NSG) maintains controls on certain dual-use categories of vacuum pressure transducer made from materials resistant to UF_6 ¹. Specifically, these materials are defined as aluminium, aluminium alloys, nickel, and nickel alloys with 60%+ nickel content. But these controls are not comprehensive. First, it may be possible to utilise transducers with a lower corrosion resistance for a limited period of time, thus potentially allowing the procurement of uncontrolled transducers. Second, a competitor of MKS has introduced a product with parts made of aluminium oxide. Aluminium oxide is resistant to UF_6 so dual-use products made from this material are also of proliferation concern. However, pressure transducers made from these materials have only recently been added to the NSG's control lists and, therefore, will not automatically be included in UN lists of goods prohibited by sanctions for export to Iran or North Korea. It is also likely that it will be some time before the updated NSG lists are incorporated into national export control regulations. On the positive side from a non-proliferation perspective, capacitance manometers have a finite lifespan which varies according to use. This means that the enrichment capability of any country will slowly degrade over time unless additional units can be procured.

MKS Updates Their Approach: Taking the Profit Out of Proliferation

Trade compliance had been a high priority for MKS even before 2012. The control status of all products were recorded so that licenses could be sought when exporting any controlled item to a destination requiring a license. Customers and other parties to an export were screened against denied and designated entity lists. MKS management espoused a commitment to compliance and all staff were trained in compliance, red flag indicators and conducting due diligence. Local agents were also tasked with validating the credentials of potential customers.

Despite the operation of a trade compliance system, it became apparent to MKS in 2012 that some of the company's products were (allegedly) fraudulently being diverted to unauthorized end users via the company's distributor in China.² Indeed, a Chinese-based agent of MKS was arrested upon arrival in the US and currently awaits trial on charges of conspiracy to violate the Export Administration Regulations and the International Emergency Economic Powers Act. The complaint associated with that arrest alleges that Mr Qiang Hu caused thousands of MKS pressure transducers to be exported to unauthorised end users by falsifying details of the true customers.

In response, MKS rapidly implemented an approach to compliance based on supply-chain integrity herein referred to as "Controlled Delivery" or the "Direct Factory Shipment Program (DFSP)". This new system has been implemented by MKS since 2012 and has multiple, adjustable layers of protection designed to ensure legal compliance and to minimise the risks that goods will be systematically diverted. This updated approach increases supply chain transparency and is based upon the principles of simplification and directness. The founding principle of the new approach is to align the commercial interests of each element of the supply chain with the non-proliferation and compliance objectives of MKS.

Customers

The new approach allows sensitive capacitance manometers to be shipped only to the ultimate end user, or system manufacturers ("ultimate consignees"). The items are not shipped to resellers or distributors. Legally, shipment to intermediaries is permitted by most types of export authorization or licence provided that an undertaking is provided that the goods will not be supplied to WMD programmes. As such, the approach taken by MKS is an additional voluntary measure taken to prevent diversion to unauthorised end uses. MKS adopted this policy in recognition that in a market-based environment, an intermediary may be willing to bend the rules and could potentially seek profit from selling goods on the 'black market'. The decision to ship directly to authorised end users, therefore, negates any financial incentive and opportunity to misappropriate the goods on unauthorized parties, as resellers are never part of the transaction. As middlemen do not handle MKS products, their reliability and integrity cannot be challenged by the prospect of financial gain for facilitating diversion.

Nevertheless, proliferation can also occur if the declared end user itself poses an onward diversion risk. To counter this MKS has implemented an approach to due diligence based around the principle of "credible economic operators". End users with a legitimate need for MKS products are, by and large, well-established manufacturing companies which would stand to lose significantly from a reputational or economic process disruption if they became involved in the onward proliferation of MKS products. US-based MKS representatives therefore conduct site visits for all but the smallest orders, taking

photographs of the premises of end use and conducting other forms of due diligence to establish if the potential customer is a “credible economic operator”. MKS takes additional steps to verify their credentials, including utilising independent translators to verify the *bona fides* of potential customers.

In the case of system integrators, they are considered the ultimate consignee of the capacitance manometer but must also go through an economic justification process similar to any other end user. Even under such circumstances, however, this “ultimate consignee” is required to provide a list of those ultimate customers to whom the finished product will be sold – a list that is then included in the export licence application submitted by MKS to US regulators.

By focusing on customers that are “credible economic operators” MKS realises other business benefits. As capacitance manometers have a limited useful life, this approach to customer validation strengthens the relationship between MKS and customers, facilitating future sales. MKS staff build up personal connections with officials in the customer’s organization, thus gaining insights into customer needs. MKS recognise the opportunity cost associated with short-term business relationships, such as those that arise in proliferation-related trade. As such, the Controlled Delivery Model is seen as more sustainable business model for MKS in the long term.

Agents

To get goods to the market MKS has traditionally used a network of agents or distributors. Utilising agents and distributors is often attractive from a business perspective. For example, local agents will understand local market conditions and compliance requirements. However, it was one such agent that allegedly became involved in the unauthorised onward transfer of capacitance manometers noted above. In response, MKS has opted to replace its network of distributors with a single global trusted delivery agent. The use of a single agent minimizes the logistical burden on MKS because all of the company’s products can be tracked and monitored through the agent’s globalized tracking system.

In selecting an agent after the 2012 incident, MKS opted to utilize a firm with a strong reputational interest in maintaining compliance. As such, the firm selected was an agent which regularly serves consumer electronics and industrial product markets in the US and elsewhere. In part, this action was taken in recognition that the cost of involvement in proliferation for such a firm could be disproportionately high. Designation by the US, for example, would seriously damage the agent’s competitiveness by denying the agent access to the North American market. The agent was thus selected to ensure that compliance interests and economic motivations converged.

Distribution Channels: Can Free-Trade Zones be Non-proliferation Assets?

Free trade zones (FTZ) are areas where some financial assessments and admissibility regulations are deferred by the parent territory. As such, FTZs have traditionally been viewed with suspicion by authorities working to counter proliferation. MKS believes, however, that FTZs can prove to be non-proliferation assets if appropriately utilised. Specifically, as the authorities of the FTZs are strictly constructed to protect and collect revenue when items enter the parent territory, it is in the interests of the recipient government to ensure that the trade is conducted transparently and legitimately. Goods can be temporarily held in FTZs close to high-profit markets—thus facilitating responsive delivery to

customers. At the same time, MKS staff can utilise the agent's web-based inventory and delivery tracking tools to ensure that goods are not shipped to unauthorised end uses.

The Impact of Change

MKS implemented its revised approach to non-proliferation in mid-2012, with a global roll out occurring in January 2013. As such, the program continues to evolve to meet the specific challenges presented by the risks and the marketplace, although the fundamentals remain constant.

The MKS system focuses on minimizing complexity and assuring transparency with delivery custody over the controlled products. Export controlled capacitance manometers are now delivered only to verified end users in elevated risk countries. Profit driven proliferators can no longer expect to gain financially from intermediate resale if they never have possession or control of the goods in the first place. Proliferators could still opt to resort to more basic criminal activity such as theft, but with the profit motive and local government revenue protection lined up against them, such unprofitable inventory losses would be obvious to all concerned. The intermediate market appears therefore to be substantially closed off by the MKS Controlled Delivery program. MKS summarizes this approach as "taking the profit out of proliferation".

Effect on Proliferation

There continues to be a demand for proliferation-sensitive technologies. As whenever there is an increase in demand there is a corresponding increase in price, there are potentially lucrative profits to be made by any entity that succeeds in circumventing controls. Such market conditions can complement the personal "World Views" of those individuals involved in proliferation, thus providing both an incentive and a justification for them to facilitate the illicit procurement of proliferation-sensitive goods through whatever mechanism is deemed necessary, be it legitimate or otherwise, should the opportunity arise.

The targeting of supply chains by proliferators means that the implementation of an export control system which ensures legal compliance alone may be insufficient to prevent proliferation without a programme like "Controlled Delivery". Even when a company complies with export controls, proliferation can still occur through at least two channels. First, as described above, unsupervised delivery to resellers could provide the opportunity for the reseller to sell the items to the highest bidder, potentially evading and circumventing the controls in the process. Second, uncontrolled foreign inventory resales and transfers can obscure the path of true end use, potentially allowing diversion in the supply chain.

Tackling these proliferation risks is a complex challenge even for the most committed firms. The challenge becomes how to manage the proliferation risks while also facilitating trade. The decision by MKS to use "Controlled Delivery" to authorised and licensed end users offsets substantial risks and their unpredictable costs, but simplicity and consolidation of logistics agents has allowed MKS to keep the costs manageable. It is a tailored solution which -- because of the MKS commitment to protect the supply chain for legitimate customers -- ensure both these customers and MKS profits are systematically protected from diversion risks.

Corruption, diversion and circumvention of legitimate users is always a risk, but leveraging the commercial interests of each part of the supply chain can produce an environment in which diversion is

an unlikely exception rather than a likely outcome.

Why Should Companies Care?

The reforms MKS has undertaken in recent months originated in the diversion of items in 2012. Nonetheless, these reforms build upon a well-established compliance culture in the firm which had previously developed around the need to counter known proliferation risks. As a result the company's leadership had a clear awareness of the risks involved. That diversion still occurred is as much down to the complexity of securing the supply-chain as it is to any specific legal failure by MKS. The internal bureaucratic and cost hurdles to implementing the "Controlled Delivery" approach described herein were minimal and the drivers were clear: failure to respond could leave the company susceptible to legal, financial, reputational and market-based penalties. Proactive mitigation on the other hand could largely counter these risks while also leading to more sustainable business relationships.

When engaging commercial enterprises on non-proliferation grounds national authorities cannot afford to rely upon initiating events such as that experienced by MKS in 2012. This is because firms often become aware of supply-chain risks only when it is too late. The focus should be on proactively engaging firms in implementing tailored and transparent trade compliance systems; simplification and transparency are an aid to compliance.

The concept of resilience to proliferation in the supply chain of firm's is termed "Anti-proliferation" herein.³ It is in firms' interests to be proactive in implementing Anti-proliferation measures. The MKS case demonstrates that the costs of deploying an effective proliferation-resistant supply-chain model can be affordable provided that the system is well-tailored to the needs of the business. Motivations for firms to be proactive include better management of risk and proactive demonstration of Corporate Social Responsibility credentials. These motives have real business benefits: for example, demonstrating a commitment to compliance can ease export license decisions even when exporting the most sensitive of goods.

The first step that a firm should take to implement an effective trade compliance system is to recruit or train an employee to become a compliance specialist. Having an employee who understands the proliferation risks associated with a company's products, the controls that affect a company's products and the company's supply chain is vital to managing proliferation risks in the long term. Trade compliance does not necessarily require a full time member of staff, but it is vital that the trade compliance function have the full support of senior management.

Governments must also do more to help firms. The "Controlled Delivery" system is well-suited to the MKS business model and may well prevent future diversion of MKS products, but it is not a system that suits other firms.

Outlook

Firms are often prepared to go beyond compliance when there is a clear rationale for doing so. Firms may be driven by a number of factors, such as avoiding legal penalties, protecting reputations and “doing the right thing”. Each of these drivers requires that senior management and those in a compliance role understand both how the firm’s technology could be misused and what measures the firm should take in order to counter supply-chain risks. Other staff in the organization must see that senior management take compliance obligations and non-proliferation objectives seriously. They must also understand both the rationale for controls and their own responsibilities in the process.

In the case of MKS, the “Controlled Delivery” programme is well-supported by the company’s top management and it is well resourced. This model leverages the economic interest of all parties in the legitimate supply chain to prevent diversion.

There is nonetheless no immediate prospect of a reduction in the demand for proliferation-sensitive technology. There will also continue to be a financial incentive for middlemen to circumvent the MKS control system. Perhaps because of this, MKS has noticed a shift in the nature of suspicious enquiries since introducing the programme: enquiries from China and other traditional diversion hubs have reduced, whereas, suspicious enquiries from individuals in more developed countries, including the US and Europe, appear to be rising. Continued vigilance is therefore vital if proliferation is to be stemmed.

Endnotes

1. INFCIRC 254 Rev 8 Part 2, Control list of the Nuclear Suppliers Group, available online at <http://www.nuclearsuppliersgroup.org/Leng/PDF/infcirc254r8p2.pdf> accessed 30 March 2012
2. US Department of Justice Press Release: Chinese National Charged With Illegal Export Of Sensitive Technology To China, 23 May 2012, available online at <http://www.bis.doc.gov/news/2012/doj05232012.htm> accessed 30 March 2013
3. For more information on the concept of antiproliferation see Stewart, Ian J. "Antiproliferation: Tackling Proliferation by Engaging the Private Sector." Discussion Paper 2012-15, [Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School](#), November 2012.

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