



Code of Practice Cyber Security for Ports and Port Systems

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FOREWORD

Cyber-attacks on port systems are no longer considered hypothetical or simply the stuff of fictional narrative. In October 2013 drug traffickers mounted a sophisticated cyber-attack on the port systems in the port of Antwerp, Belgium. The traffickers employed hackers to break into the systems controlling the movement of containers through the port. It is believed that the initial breach occurred in June 2011 and for over two years the breach in the security of the container management system went undetected. Through their access to the system the traffickers were able to hide drugs in containers shipped from South America and then arrange for them to be removed from the port before the owner or shipper of any legitimate goods arrived to collect the container. In other cyber security incidents, port assets have been infected with malware and there has been unintentional jamming or interference with wireless networks.

Do you own, operate or occupy a port or port facility that has electronic or computer based systems?

If the port systems were to fail, malfunction or were misused would this result in economic, operational, physical or reputational loss or damage, or disrupt operations?

Do you own an information asset that includes information about your strategy and/or commercial operations, the construction and/or operation of your port or port facility, including any port systems?

If this information asset were compromised could this result in economic, operational, physical or reputational loss or damage?

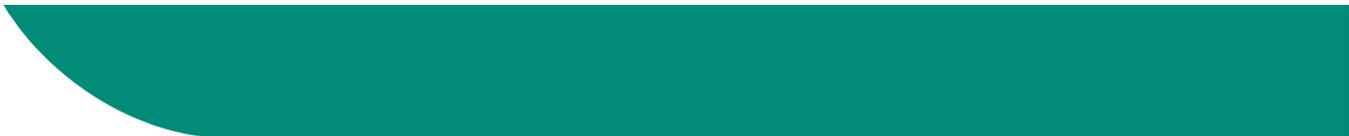
If your answer to any of the above questions is yes, you should carry on reading this Code of Practice and decide who in your organisation needs to take action.

Cyber security is not just about preventing hackers gaining access to systems and information. It also addresses the maintenance of integrity and availability of information and systems, ensuring business continuity and the continuing utility of cyber assets. To achieve this, consideration needs to be given to protecting systems from physical attack, force majeure events, etc. and designing port systems and supporting processes to be resilient. Personnel security aspects are also important, as the insider threat from staff or contractors who decide to behave in a malicious way cannot be ignored.

Failure to address security risks could lead to serious injury or fatality, disruption or damage to port systems, loss of use of buildings, impact upon business operations, reputational damage, loss of revenue, financial penalties or litigation. Port owners, operators and port facility occupiers need to understand cyber security and promote awareness of this subject to their stakeholders. This should include provision of appropriate briefings to the design, construction and operations teams, and their supporting supply chains.

Port facilities are becoming increasingly complex and dependent on the extensive use of information and communications technologies at all stages of their lifecycles. Some of this technology is embedded in the fixed and mobile assets used to operate the port; other elements may be remotely located such as the systems used to schedule vessel and cargo movements. This Code of Practice explains why it is essential that cyber security be considered as part of a holistic approach throughout an asset's lifecycle, as well as setting out the potential financial, reputational and safety consequences that may arise if threats are ignored.

It is intended that this Code of Practice be used as an integral part of an organisation's overall risk management system and subsequent business planning, so as to ensure that the cyber security of port systems is managed cost effectively as part of mainstream business.



This Code of Practice was developed following visits to a number of UK ports by the authors and Defence Science and Technology Laboratory (Dstl) personnel and reflects information gathered during these visits.

Some UK ports and port facilities are designated part of the Critical National Infrastructure and will receive further advice from the Department for Transport and the National Cyber Security Centre. Whilst not a mandatory requirement the aim should be to integrate cyber security into the overall security planning for a port/port facility.

SECTION 1

Introduction

This Code of Practice considers the cyber security requirement at both ports and port facilities, advocating a coherent, port-wide based approach. It is intended to complement the port security standards and their respective requirements by providing additional guidance on the cyber-related aspects of the security measures set out. It therefore makes extensive reference to, and assumes knowledge of, the definitions and concepts contained within those regulations.

This Code of Practice uses principles rather than national legislation or specific standards to help promote good practice. However, the specific cyber security measures implemented should depend upon the profile of the port and its facilities, its use and the nature of the cargos handled.

The rapid evolution in the use of, and reliance upon, information and communication technologies, as well as the advances in automation and the potential for integration of multiple electronic systems supporting management functions and business applications, increases the importance of addressing inherent vulnerabilities. It is therefore vital that port operators understand and implement appropriate and proportionate measures to address the resilience and cyber security issues that arise. Only by doing so can they fully meet their responsibilities for the secure operation of their facilities.

While this Code of Practice is concerned solely with the cyber security of ports and port systems, it recognises that, with a large proportion of security breaches caused by people and poor processes, it is essential that personnel, process and physical aspects directly related to these technological systems are also considered and appropriate measures put in place. Recommendations relating to those aspects are therefore detailed throughout this Code of Practice where relevant.

With the exception of any ship-to-shore interface, it is not the purpose of this Code of Practice to consider the cyber security of the ships to which the ISPS Code applies.

1.1 Who should use this Code of Practice?

This Code of Practice is intended for use by those with responsibility for protecting: the port/port facility and ships (when docked or berthed), persons, cargo, cargo transport units and ship's stores within the port from the risks of a security incident. It will also be of interest and relevance to those individuals involved in:

- (a) the financial and operational management of the port/port facility;
- (b) contractual arrangements with third parties;
- (c) determining policies relating to acceptable staff behaviour;
- (d) the specification, design, construction and maintenance of ports;
- (e) the specification, design, development, integration, commissioning, operation and maintenance of port systems, including associated software and technologies; and
- (f) management of specific security tasks, including incident response and the handling of security breaches.

1.2 Maritime Security Regulations in the UK

In December 2002 the International Maritime Organisation (IMO) adopted a new international instrument called the International Ship and Port Facility Security (ISPS) Code, which was incorporated by the European Commission (EC) into EC Regulation 725/2004.

For convenience the ISPS Code, EC Regulation and the EC Directive, along with maritime security regulatory material published by the UK Department for Transport, are collectively referred to in this Code of Practice as the 'port security standards'.

1.3 Terms and definitions

Definitions used in this Code of Practice are, to the extent practicable, in keeping with those contained in the International Convention for the Safety of Life at Sea, 1974, as amended. For ease of reference, certain terms used in this Code of Practice are defined in Section 7.

SECTION 2

Cyber security

2.1 What is cyber security?

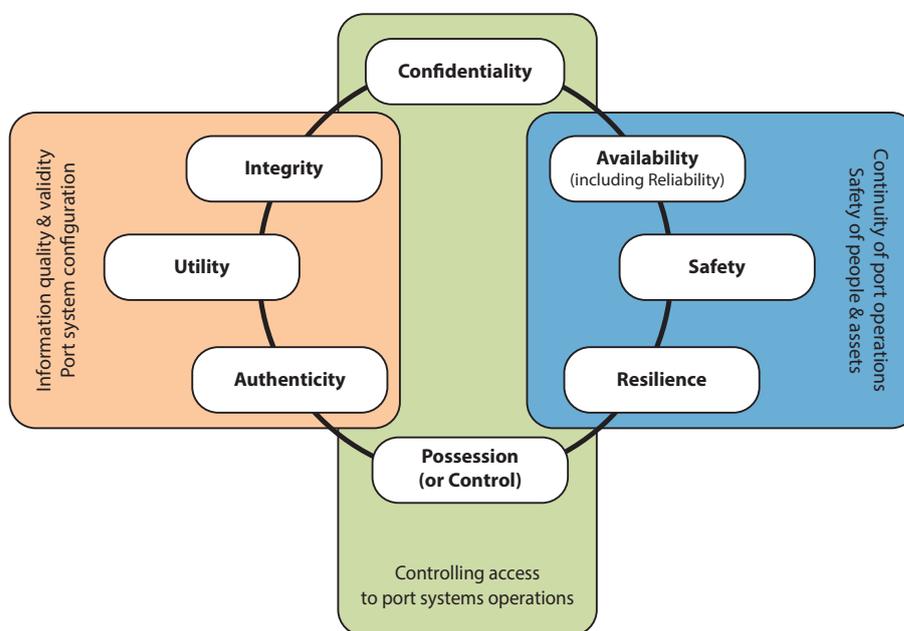
Cyber security can be defined as "the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment and organisation and user's assets."¹

Within this definition, 'cyber environment' comprises the interconnected networks of both information and cyber physical systems that use electronic, computer-based and wireless systems, including information, services and social and business functions that exist only in cyberspace.

The 'organisation and user's assets' includes connected computing devices, personnel, infrastructure, applications, services, telecommunication systems, and the totality of transmitted, processed and/or stored data and information in the cyber environment.

Cyber security strives to attain and maintain eight general security objectives, shown in Figure 2.1 and described in Appendix A.

▼ **Figure 2.1** Cyber security attributes²



- 1 International Telecommunications Union, "Overview of cyber security", ITU-T X.1205, 2008, Geneva, Switzerland
- 2 Adapted from Figure 2 of Boyes, H (2015) 'Cybersecurity and Cyber- Resilient Supply Chains'. Technology Innovation Management Review, 5 (4): 28-34

The varied nature of cyber security threats means that there is no single approach that is capable of addressing all the resultant risks. The rate of change of technology and the steady flow of serious vulnerabilities in operating systems, software libraries and applications means that any strategy needs to be kept under regular review.

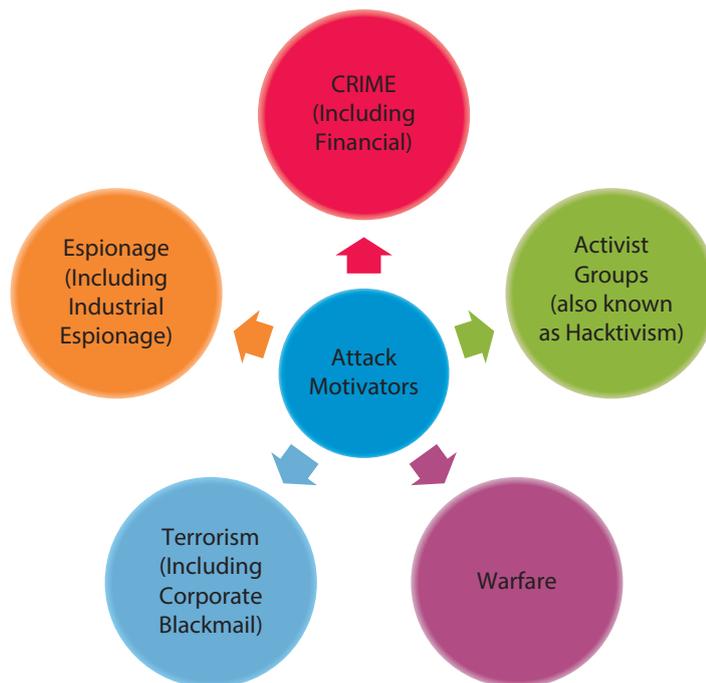
Business change also has a significant impact on cyber security, for example, the introduction of bring-your-own-device (BYOD) and the trend to deliver some assets as services, for example, the provision of back-up or standby power supplies under the management and control of a third party.

2.2 What are the motivations behind a cyber-attack?

The motivations (or 'actors') for a cyber-attack on a port system, as illustrated in Figure 2.2, can be for one of the following five purposes:

- (a) espionage – seeking unauthorised access to sensitive information (intellectual property, commercial information, corporate strategies, personal data, pattern of life) and disruption for state or commercial purposes.
- (b) activist groups (also known as 'hacktivism') – seeking publicity or creating pressure on behalf of a specific objective or cause, for example, to prevent the handling of specific cargos or to disrupt construction of a new port facility. The target may be the port itself, the operator of a port facility or a third party such as the supplier or recipient of the cargo.
- (c) criminal – largely driven by financial gain, this can include criminal damage, theft of cargo, smuggling of goods and people, and attempts to evade taxes and excise duties.
- (d) terrorism – use of the port to instil fear and cause physical and economic disruption.
- (e) warfare – conflict between nation states, where the aim is disruption of transport systems/infrastructure to deny operational use or disable specific port facilities, such as bulk terminals.

▼ **Figure 2.2** Cyber security threat actors



The threat actors may be classified into one of seven categories, which are detailed further in Appendix A:

- (a) individuals;
- (b) activist groups;
- (c) competitors;
- (d) cyber criminals;
- (e) terrorists;
- (f) proxy terror threat actors; and
- (g) nation states.

Any of these threat actors are equally relevant to elements of the port systems located beyond its perimeter, port information/data stored on external servers, services delivered by third parties and the port's supply chain.

When considering the potential threats from the hostile groups listed above, it is important to recognise that there may be some convergence between the aims and objectives of individual groups. For example, some of the malware developed by cyber-criminal gangs includes sophisticated command and control functionality, allowing secure exfiltration of information and updating of modular components to deliver new or varied exploits over time. Thus a machine or device that was compromised initially for financial crime could be used in future to access sensitive data or to provide a backdoor to allow attacks on port facilities or systems.

2.3 Resilience of port infrastructure

In addition to the human threat actors, there are resilience threats to port systems arising from natural causes, including solar events, weather, animals and insects. Their effects can result in damage, failure or significant impairment to utilities and port systems. In the case of the latter, port data may be lost or corrupted.



An example of the impact of natural causes on port operations was the tidal surge of 5 December 2013 that affected the port at Immingham, resulting in millions of tonnes of seawater surging over the lock gates into the port. Immingham, the UK's busiest port, was under water for weeks. The port had a network of over 40 electricity substations, of which nearly half had a degree of water damage and ten were seriously impaired. These substations supplied electricity to port systems and as a result of the flooding the port could not be operated due to the damage to the port's power supply infrastructure. The impounding pumps, used to maintain the water level in the docks, were located underground; they were completely inundated. The motors and equipment had to be stripped down to be repaired or replaced.

Although port operations were severely disrupted, business continuity plans allowed some port operations to be restored within a few days, with the port operating on a tidal basis with many operations diverted to Grimsby.

SECTION 3

Cyber security in ports

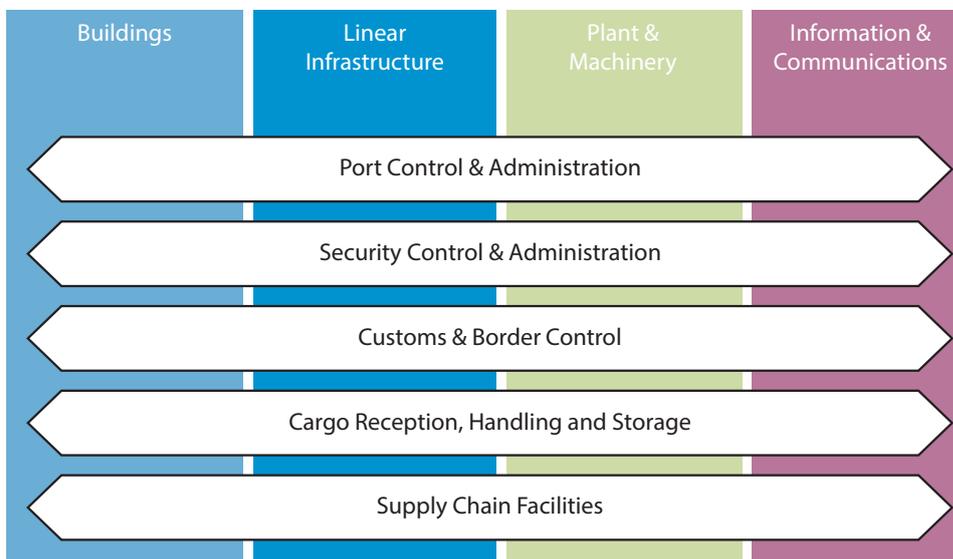
3.1 Why is cyber security important to ports?

A port is a complex cyber environment that encompasses both land and waterside activities and systems. As illustrated in Figure 3.1, and examined in more detail in Appendix A, a port comprises four main asset types (i.e. buildings, linear infrastructure, plant and machinery, and information and communications systems) that are used to provide a range of operational services and where technology plays an increasingly important role.

The loss, or compromise, of one or more of these assets has the potential to impact upon:

- (a) the speed and efficiency at which the port can operate;
- (b) the ability of the port to be able to safely carry out particular operations; and
- (c) the health and safety of staff and other people impacted upon by the work activities being undertaken and to whom a duty of care is owed.

▼ **Figure 3.1** Port assets affected by cyber security



Further, the failure of an organisation to appreciate the structure and operation of its assets, systems and associated business processes can result in a number of undesirable situations, including:

- (a) accidental or inadvertent exposure of sensitive systems, applications or data to unauthorised users;
- (b) loss of resilience or system redundancy; and

- (c) emergent failure modes that result in the cascade or catastrophic failure of critical systems or processes.

Any of the types of failure described can also have significant financial and reputational consequences.

3.2 Cyber security standards, guidance and good practice

There is a wide range of security-related standards and best practice guidance available that apply to IT and industrial control systems. The Bibliography at Appendix H lists a broad range of such documents. Much of the material is written from an information systems security perspective and needs to be carefully interpreted when applying it to systems in the port environment. For example, the application of some security techniques to safety critical systems may hinder their operation in an emergency situation.

A complexity that is increasingly occurring in the port environment is the integration of safety critical alarm and/or control systems with conventional enterprise and office IT systems. This integration requires careful management by the port operator as the office elements may operate under security policies and procedures originating from the ISO 27000¹ series of documents, whereas control and safety systems are more likely to operate under regimes determined by the IEC 61508² and ISA/IEC 62443³ standards.

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- 1** See Appendix H for further information.
 - 2** See IEC website for further details, <http://www.iec.ch/functionalsafety/>
 - 3** See Appendix H for further information.

SECTION 4

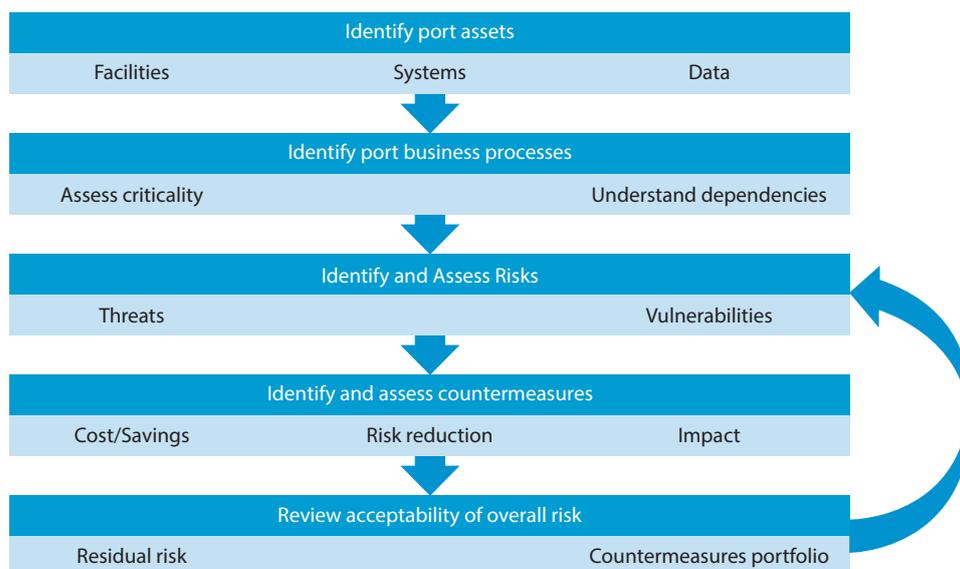
Developing a cyber security assessment (CSA)

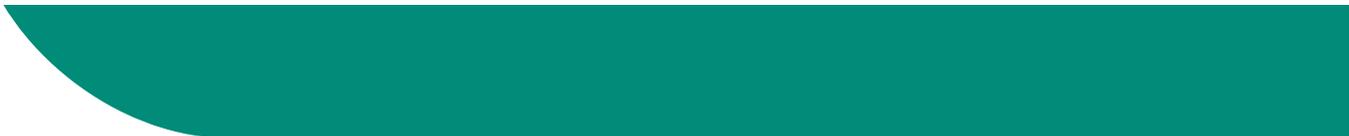
In compliance with the port security standards, security assessments are conducted for ports and port facilities. The purpose of these assessments is to identify vulnerabilities in physical structures, personnel protection systems and business processes that may lead to a security incident. It is intended that wherever appropriate the CSA should build upon the existing security assessments.

As set out in the port security standards and illustrated in Figure 4.1, these assessments should include the:

- (a) identification and evaluation of important assets and infrastructure (for example, facilities, systems and data) considered important to protect, and the external infrastructure systems upon which they depend;
- (b) identification of the port business processes using the assets and infrastructure, so as to assess criticality of assets and understand any internal and external dependencies;
- (c) identification and assessment of risks arising from possible threats to the assets and infrastructure, vulnerabilities and the likelihood of their occurrence, in order to establish the need for and to prioritise security measures;
- (d) identification, assessment, selection and prioritisation of countermeasures and procedural changes, based on their costs, the level of effectiveness in reducing the risk and any impact upon the port's operations; and
- (e) identification of the acceptability of the overall residual risk, including human factors, and weaknesses in the infrastructure, policies and procedures, based on the portfolio of countermeasures that have been selected.

▼ **Figure 4.1** Overview of CSA process





Where these assessments do not cover the full range of potential cyber security threats, the port and/or port facility should produce a CSA that includes each of the aspects listed.

For further details of a process to create a CSA see Appendix B.

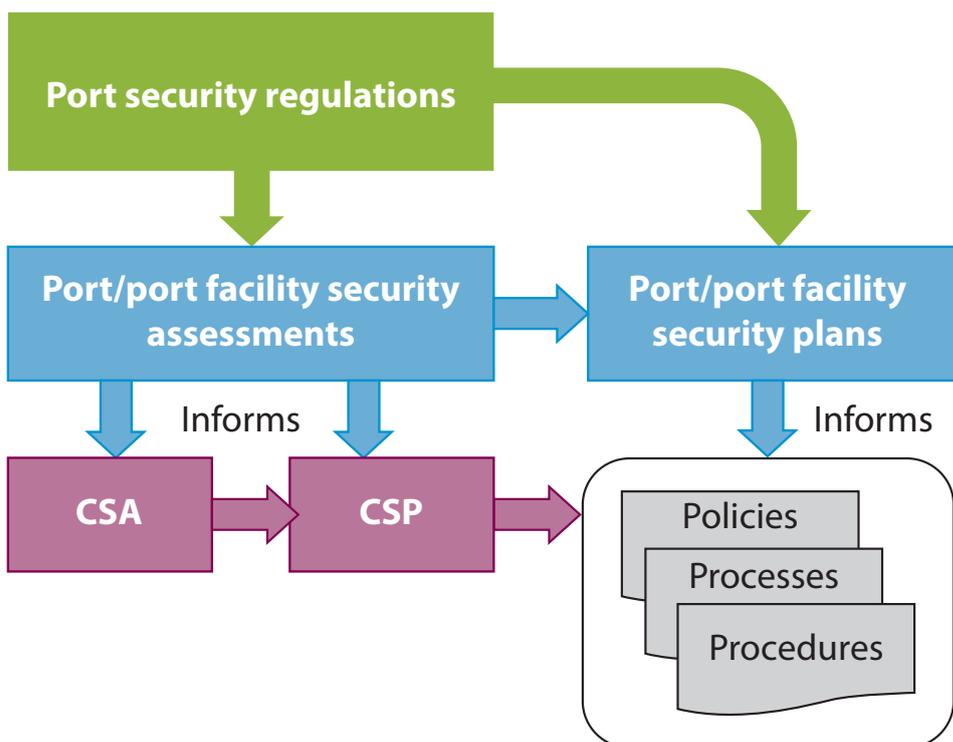
SECTION 5

Developing a cyber security plan (CSP)

The security assessments form the basis of the security plans for the port and port facilities. These plans should address the issues identified in the relevant assessment through the establishment of appropriate security measures designed to minimise the likelihood of a breach of security and the consequences of potential risks. It is intended that wherever appropriate the CSP will build upon the existing port facility security plan (PFSP).

A CSP should perform the same function for the issues identified in the CSA, also taking into consideration the impact of measures set out in the security plan for the port/port facility. Its relationship to other key documents is illustrated in Figure 5.1. The recommended contents of a CSP are set out in Appendix C.

▼ **Figure 5.1** Relationship of CSP to other documents



When developing the CSP it is essential that a holistic approach be adopted, covering the people, process, physical, and technological aspects of the port assets. From a cyber security perspective, the CSP should contain or reference:

- (a) the policies that set out the security-related business rules derived from the relevant CSP;
- (b) the processes that are derived from the security policies and that provide guidance on their consistent implementation throughout the lifecycle and use of the port assets; and

- (c) the procedures that comprise the detailed work instructions relating to repeatable and consistent mechanisms for the implementation and operational delivery of the processes.

With a large proportion of security breaches caused by people and poor processes, it is essential that personnel, processes and physical aspects directly related to the technological systems for which cyber security measures are required are also considered and appropriate measures put into place.

The measures required in each of the aspects will also depend upon the level of resilience that the port/port facility can call upon. Appendix D provides guidance on how to develop appropriate mitigation measures, which should inform the development of the CSP and the supporting policies, processes and procedures.

The completed CSP for the port and/or port facility should be protected from unauthorised access or disclosure and should form an annex to the PSP or PFSP respectively.

5.1 Review of the CSP

The CSP should include a suitable mechanism for performing periodic, at least annual, reviews of the CSP to verify that it remains fit for purpose. Where necessary, the CSP should be updated to reflect any identified gaps, shortcomings or organizational changes, or changes that have arisen for political, economic, social, technological, legal or environmental reasons, and which impact upon the port or port assets.

The CSP should establish a suitable mechanism for performing ad-hoc risk reviews to identify and assess the impact of any changes on port assets and to update the CSA as described in Appendix B.

5.2 Monitoring and auditing of the CSP

The CSP should set out the appropriate and proportionate monitoring and auditing measures that will take place across the lifecycle of all port assets, and are aligned where applicable with the business risk strategy. This monitoring or auditing will be in addition to any actions that may result from an incident or breach. The CSP should require that only those suitably qualified and experienced would undertake this monitoring and auditing work.

Measures should include assessing:

- (a) the implementation of all security policies, processes and procedures affecting the port assets, including the handling or storage arrangements implemented for security-sensitive and other sensitive information;
- (b) the compliance of its supply chain with the security policies, processes and procedures specified in the CSP as a minimum on a risk-based sampling approach; and
- (c) the management of security controls that operate throughout the operational lifecycle of the port assets.

Monitoring should continue through an event that causes the failure or interruption of one or more systems. An extreme weather event or other such occurrence does



not remove the need for effective security and how the systems perform will inform subsequent development and loss exposure.

Whilst the port/port facility operator may delegate some responsibility for compliance verification to a supplier, it should retain accountability for the overall effectiveness of security controls.

SECTION 6

Managing cyber security

Having established the cyber security management framework through the creation of the CSA and CSP, it is important that appropriate management and operational arrangements are in place, including:

- (a) the identification of the individual(s) responsible for the cyber security of the port and port facilities, with individuals fulfilling these roles being designated as a cyber security officer (CSO).
- (b) the possible formation, if one does not already exist, of a port security committee (PSC). Many PSCs have now been superseded by port security authorities (PSAs) established under the Port Security Regulations 2009. Where a PSC does not exist it may be appropriate to discuss cyber security matters at meetings of the PSA.
- (c) the establishment of a security operations centre (SOC).
- (d) the arrangements for providing information to third parties.
- (e) the arrangements for managing security incidents or breaches.

6.1 Role of the CSO

Where a CSP is also in place, a CSO should be responsible for:

- (a) ensuring the development and maintenance of the CSP; and
- (b) implementing and exercising the CSP.

Where the CSO has insufficient knowledge of cyber security issues and solutions, they should seek specialist cyber security advice from an appropriate professional source.

The CSO should maintain awareness of legal and regulatory changes that could affect the cyber security of port assets and, where necessary, make adjustments in policies, processes and procedures to comply with those changes.

For the CSP and associated security policies, processes and procedures to be effective, it is essential that there is a top-down flow of responsibility within both the organization and the contracts/supply chain. Responsibility for cyber security may be shared by the CSO with other managers and service providers, although ultimate responsibility should be retained by the CSO.

The CSP should detail the:

- (a) maintenance of security accountability within the port/port facility operator's organisation; and
- (b) management of security responsibilities within the supply chain, including the requirement for security to be retained at senior levels within the supply chain, with responsibility delegated appropriately, in order that it can be effectively and efficiently managed.

Where the port and/or port facility operator makes extensive use of contract personnel, the CSO should ensure that appropriate measures are used for the secure procurement

of contracting personnel, which includes appropriate screening or background checks. These checks should also be in place for staff employed through other mechanisms.

6.2 Port security committee (PSC)

Where a port has established a PSC, the scope of the committee should include cyber security. Model terms of reference for a PSC that addresses all aspects of security are provided in Appendix E.

Where a port does not have a PSC because a PSA has been established the PSA can consider cyber security.

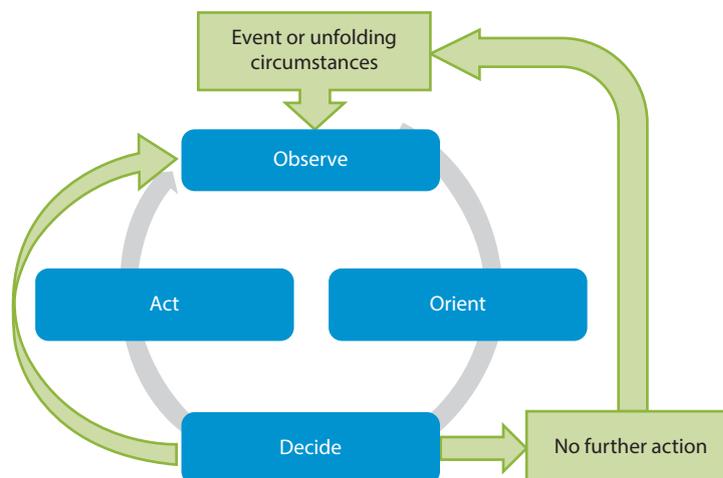
6.3 Security operations centre (SOC)

A SOC acts as a centralised unit dealing with security issues that affect a port/port facility, including those relating to cyber security, and may form part of an operations centre supervising the port, controlling access and managing business continuity and disaster recovery activities.

The key functions of a SOC as illustrated in Figure 6.1 are to:

- (a) observe, by maintaining situational awareness, i.e. understand potential, emerging and actual threats to the port/port facility operations. Observation includes detection of unauthorised changes to port systems or port data, non-secure modes of operation and unauthorised access to port assets.
- (b) orient, by analysing the risk to operations from new or changed threats and determine whether proactive measures are required to reduce the risk to an acceptable level.
- (c) decide what action may be appropriate either to deny further access to the port asset or to respond to the event by identifying suitable countermeasures.
- (d) act, by implementing the decision(s).

▼ **Figure 6.1** Key functions of a SOC



When observing the operating environment SOC personnel should maintain situational awareness of the general threat environment. From a cyber security perspective, this

may involve accessing threat intelligence information from both public¹ and private sector sources.

6.4 Provision of information to third parties

The port and port facility operators need to take appropriate measures to reduce the risk of sensitive information being released publicly or provided to unauthorised third parties. This can occur through public presentations, conference papers, marketing and publicity material, or by the use of social media both by their organisation and their staff, contractors and supply chain. The implementation of an appropriate data loss prevention solution should also be considered. For further information see Appendix F.

6.5 Handling security breaches and incidents

The CSA should detail the arrangements for handling security breaches and incidents, whether they occur accidentally or deliberately. A cyber security incident is likely to arise from unauthorised access to, misuse or fraudulent use of, port systems or related assets and may result in:

- (a) loss or theft of assets, including documents and storage media;
- (b) unauthorised access to data or information;
- (c) loss, compromise, unauthorised manipulation or change of data or information;
- (d) loss or compromise of port assets connected to its systems;
- (e) planting of bugs or other surveillance devices; and
- (f) insertion of malicious software.

For further information see Appendix G.

¹ In the UK, the National Cyber Security Centre (NCSC) operates a joint industry and government Cyber-security Information Sharing Partnership (CISP) to share cyber threat and vulnerability information

SECTION 7

Terms and definitions

Definitions used in this Code of Practice are, as far as practicable, in keeping with those contained in the International Convention for the Safety of Life at Sea, 1974, as amended. For ease of reference, certain terms used are defined below.

7.1 Terms

Asset

Item, thing or entity that has potential or actual value to an organization. [BS ISO 55000:2014, 3.2.1]

Asset information

Data or information relating to the specification, design, construction, acquisition, operation or maintenance of an item, thing or entity that has potential, or actual, value to an organization. This also includes its disposal or decommissioning. It can include design information and models, documents, images, software, spatial information and task or activity-related information.

Cyber-physical system (CPS)

A system designed as an entity, or set of entities, with a specific purpose, or to meet a capability objective. A CPS should include a computational aspect (cyber) and a physical aspect working together to accomplish a task or function. The cyber aspect has a controlling or influencing role over the physical parts of the system, for example, a complex environmental conditioning system for a port or pressure and flow control systems in a utility network.

Cyber security officer (CS officer)

The person or persons tasked to manage and coordinate the cyber security in a port/port facility. For larger ports the CS officer is likely to report to the chief information security officer (CISO). For smaller ports the role is likely to report to the Head of Security.

High risk position

A position that has access to the details of the CSS, PSS, PFSP and/or information relating to sensitive assets, or a position that fulfils an IT system administration or information management role.

Personnel

Individuals employed by an organization, including contractors or temporary staff used to fulfil roles that may be undertaken by that organization.

Port

The geographical area defined by the Member State or the designated authority, including port facilities as defined in the ISPS Code, in which maritime and other activities occur.

Note: *Whilst this definition applies to an area, which may be enclosed within a physical boundary for the purposes of physical security, from a cyber security perspective the port will include the port systems wherever they may be located, for example, hosted in a remote data centre.*

Port assets

All port data, port facilities and port systems.

Port data

Any data, information, models and processes associated with the ownership, design and operation of a port.

Port facility

A location, as determined by the contracting government or by the designated authority, where the ship/port interface takes place. This includes areas such as anchorages, awaiting berths and approaches seaward, as appropriate [International Convention on the Safety of Life at Sea, 1974, Chapter XI-2].

Port systems

Systems that are used to manage or control the cyber–physical systems in a port, which may include: access control systems; port facility management systems; goods handling systems; energy management systems; port fire, communications, safety and security systems; and those used to manage the port business.

Risk appetite

A function of an organization's capacity to bear risk.

Security-sensitive information

Information, the disclosure of which would compromise the security of the port, including, but not limited to, information contained in any personnel-related file or privileged or confidential information that would compromise any person or organisation.

Sensitive asset

An asset, as a whole or in part, that may be of interest to a threat actor for hostile, malicious, fraudulent and/or criminal behaviours or activities.

Sensitive information

Information, the loss, misuse or modification of which, or unauthorized access to, could: adversely affect the privacy, welfare or safety of an individual or individuals; compromise intellectual property or trade secrets of an organization; cause commercial or economic harm to an organization or country; and/or jeopardize the security, internal and foreign affairs of a nation, depending on the level of sensitivity and nature of the information.

Threat

A potential cause of an incident that may result in harm to a system or organization.

Vulnerability

A weakness of an asset, or group of assets, that can be exploited by one or more threats.

7.2 Acronyms

ANPR	Automatic number plate recognition
CCTV	Closed circuit television
CERT-UK	UK national computer emergency response team
CoP	Code of Practice
CPS	Cyber–physical system
CSA	Cyber security assessment
CSP	Cyber security plan
DDoS	Distributed denial of service
DfT	Department for Transport



Dstl	Defence Science & Technology Laboratory
EDi	Electronic data interchange
GNSS	Global navigation satellite system
GPS	Global positioning system
IET	Institution of Engineering and Technology
ILO	International Labour Organization
IMO	International Maritime Organization
ITU	International Telecommunications Union
ISPS	International ship and port facility security
PMR	Personal mobile radios
PSC	Port security committee
SCADA	Supervisory control and data acquisition
SOC	Security operations centre
SOLAS	International Convention on the Safety of Life at Sea

Understanding cyber security

A.1 Cyber security attributes

The port environment involves a variety of technologies, existing and emerging, and the cyber security approach adopted will vary from building to building or system to system, depending on the complexity, ownership, use and the supply chain supporting the design, construction, operation and occupation of the building. In the port environment, cyber security is therefore best addressed by considering a set of security attributes, thus allowing appropriate solutions to be adopted, based on the nature of the building, facility or system and potential threats.

The key attributes of cyber security as applied to cyber–physical systems are outlined below. When considering these attributes, a risk management approach should be adopted, which will inform the degree to which any preventative or protective measures are implemented and the degree to which any residual risk is accepted.

- (a) **Confidentiality** – the control of access and prevention of unauthorized access to port data, which might be sensitive in isolation or in aggregate. The port systems and associated processes should be designed, implemented, operated and maintained so as to prevent unauthorised access to, for example, sensitive financial, security, commercial or personal data. All personal data should be handled in accordance with the Data Protection Act and additional measures may be required to protect privacy due to the aggregation of data, information or metadata.
- (b) **Possession and/or control** – the design, implementation, operation and maintenance of port systems and associated processes so as to prevent unauthorized control, manipulation or interference. The port systems and associated processes should be designed, implemented, operated and maintained so as to prevent unauthorised control, manipulation or interference. An example would be the loss of an encrypted storage device: there is no loss of confidentiality as the information is inaccessible without the encryption key, but the owner or user is deprived of its contents.
- (c) **Integrity** – maintaining the consistency, coherence and configuration of information and systems, and preventing unauthorized changes to them. The port systems and associated processes should be designed, implemented, operated and maintained so as to prevent unauthorised changes being made to assets, processes, system state or the configuration of the system itself. A loss of system integrity could occur through physical changes to a system, such as the unauthorised connection of a Wi-Fi access point to a secure network, or through a fault such as the corruption of a database or file due to media storage errors.
- (d) **Authenticity** – ensuring that inputs to, and outputs from, port systems, the state of the systems and any associated processes and port data, are genuine and have not been tampered with or modified. It should also be possible to verify the authenticity of components, software and data within the systems and any associated processes. Authenticity issues could relate to data such as a forged security certificate or to hardware such as a cloned device.

- (e) **Availability (including reliability)** – ensuring that the asset information, systems, and associated processes are consistently accessible and usable in an appropriate and timely fashion. To achieve the required availability may require each of these to have an appropriate and proportionate level of resilience. A loss of availability could occur through the failure of a system component, such as a disk crash, or from a malicious act such as a denial of service attack that prevents the use of a system connected to the Internet.
- (f) **Utility** – ensuring that asset information and systems remain usable and useful across the lifecycle of the port asset. The port systems and associated processes should be designed, implemented, operated and maintained so that the use of port assets is maintained throughout their lifecycle. An example of loss of utility would be a situation where a port system has been changed or upgraded and the file format of historic data is no longer intelligible to the system. There has been no loss of availability but the data is unusable.
- (g) **Safety** – the design, implementation, operation and maintenance of port systems and related processes so as to prevent the creation of harmful states that may lead to injury or loss of life, or unintentional physical or environmental damage. A safety issue could arise through malware causing a failure to display or communicate port systems alarm states. For example, the failure of a motion or proximity detector or other sensors could result in damage to property or loss of life.
- (h) **Resilience** – the ability of the asset information and systems to transform, renew and recover in a timely way in response to adverse events. The design, implementation, operation and maintenance of port systems and associated processes should be such that cascade failures are avoided. In the event that either a system or associated process suffers disruption, impairment or an outage occurs, it should be possible to recover a normal operating state, or acceptable business continuity state, in a timely manner.

A.2 Threat actor groups

A.2.1 An individual

The severity and sophistication of the threat will be determined by the individual's capabilities, for example:

- (a) a negligent, careless or ignorant employee or contractor fails to follow acceptable use or other security policies, or through error or omission compromises system security.
- (b) "friendly" individuals who are not seeking to harm systems or data, but may access the systems without the permission or knowledge of the owner and may cause accidental damage. The motivation of such agents is generally to investigate weaknesses and vulnerabilities in systems.
- (c) a disaffected employee or contractor with limited IT skills – motivations will vary; the intent may be to steal or leak sensitive information, to sabotage or disrupt port occupancy or operations, etc. The amount of damage they can inflict will depend on their role, system access rights and the efficacy of cyber security measures related to the port systems and data.
- (d) disaffected employee or contractor with significant IT skills, including system administrators – these individuals can do significant damage, particularly if they have wide-ranging systems access with administrative privileges. They may have sufficient knowledge and ability to bypass controls and protective measures, and may be adept at removing evidence of their activities, for example, deleting or modifying entries in system logs. For sensitive roles there is a need to consider

aftercare of disaffected individuals leaving the organisation, based on an assessment of risk and monitoring of social media feeds.

- (e) script kiddies – individual hackers with limited knowledge who use techniques and tools devised and developed by other people. The ready availability of hacking and denial-of-service tools on the Internet (in some cases distributed with technical magazines) means that the level of technical understanding required to launch an attack has been significantly reduced.
- (f) cyber vandals – such individuals can be very knowledgeable and may develop or further expand their own tools. Their motives are neither financial nor ideological – they carry out hacks or develop malware because they can and want to show what they can do. They may, for example, deface a website or break into a server to steal user credentials, which are then posted on a public website to demonstrate their ability.
- (g) lone wolf – an individual outside of the organisation possessing advanced technical knowledge. Such an individual may be adept at removing evidence of their activities, for example, deleting or modifying entries in system logs. They may also have sufficient knowledge and ability to bypass controls and protective measures. The number of such individuals is currently small, but may expand as a result of increased awareness of technical systems amongst the general population, or as members of nation state groups leave government service.

A.2.2 Activist groups

Often referred to as hacktivists, these groups comprise ideologically motivated individuals that may form dynamic groups or sub-groups. Their actions are effectively online protests, which may have the aim of disrupting systems or acquiring confidential or sensitive information for publication or dissemination so as to embarrass their target(s). The impact of small activist groups can be significantly magnified when, as some groups have demonstrated, they recruit or persuade naïve third parties to join in by allowing the installation of malicious software on the recruits' computers, thus creating botnets¹ and magnifying the effect of any distributed denial of service (DDoS) attacks.

A.2.3 Competitors

This group is typically made up of large corporations seeking to create a competitive advantage. They may act directly or through third parties, with the aim of harming a rival by collecting business intelligence, stealing intellectual property, gathering competitive intelligence on bids or disrupting operations to cause financial or reputational loss. Depending on size, sector, geographic location and the sophistication of a large corporation's cyber capabilities they may be able to perform sophisticated malicious activities to target and infiltrate their competitors.

A.2.4 Cyber criminals

These are sophisticated criminal groups perpetrating a wide range of illegal IT-enabled crime. The motivation is to profit from illegal activities, and their focus has mainly been on fraud, thefts from accounts and theft of intellectual property. However, cyber-criminal activities also include blackmail and extortion through the use of malware to encrypt data or threats of DDoS attacks on corporate websites. In respect of ports, cyber criminals may seek to intercept or access information related to cargo shipments or to security

1 A botnet is a network of computers infected with malicious software (malware) and controlled as a group without the users' and/or owners' knowledge; they may be used to send spam or in DDoS attacks.

arrangements as a precursor to criminal activities or a physical attack on these premises. The sophistication of the malware used by these groups is increasing and there is evidence of a cyber-crime market, where developers, providers and operators create, supply and operate sophisticated malware and cyber-crime tools on a commercial basis, making their tools available to third parties.

A.2.5 Terrorists

Terrorists are becoming increasingly IT aware, and already make extensive use of the Internet to distribute propaganda and for communications purposes. Well-funded groups could take advantage of the service offered by cyber criminals, seek support from a nation state or encourage internal members to adopt these methods of attack. With the widespread use of electronic- and computer-based technologies in the port environment, terrorist groups could rely on the various toolkits available for download to disrupt or damage ports by attacking port systems. Terrorists may also exploit poorly secured port data to enable remote hostile reconnaissance of targets, thus reducing the time they need to spend in or near their target.

A.2.6 Proxy terror threat actor with nation state support

This is effectively state-sponsored terrorism, where the proxy party is used to provide deniability. This type of group effectively has the capacity and sophisticated technical support available to a nation state made available by the sponsoring nation. This group could include cyber fighters, i.e. groups of nationally motivated individuals who threaten or attack other groups, businesses and the infrastructure of other nation states. The cyber fighters may be seen as a type of hacktivist, but their interest is the support of a nation state and as such they may enjoy significant sophisticated technical support from that nation state.

A.2.7 Nation states

It is acknowledged that some nation states are actively involved in cyber-attacks on a wide range of organisations to acquire state secrets or sensitive commercial information and intellectual property. They may also threaten the availability of critical infrastructure in other nation states. During periods of heightened international tension and conflict, these activities may include more widespread attacks as evidenced by malware such as Stuxnet², Duqu³ and Flame⁴.

A.3 Port assets and cyber security

For the purposes of developing appropriate and proportionate cyber security measures, each of the technical systems in place can be considered as largely located in, or directly related to:

- (a) buildings;
- (b) linear infrastructure;
- (c) plant and machinery; or
- (d) information and communication systems.

² For further information see <http://spectrum.ieee.org/telecom/security/the-real-story-of-stuxnet>

³ For further information see <http://resources.infosecinstitute.com/duqu-2-0-the-most-sophisticated-malware-ever-seen/>

⁴ For further information see <http://www.wired.com/2012/05/flame/>

A.3.1 Buildings and linear infrastructure

Port facilities will include a variety of buildings, requiring security, access control and varying levels of technical infrastructure. Specialist buildings that may be found on a port include:

- (a) maritime control centres hosting the systems, terminals and displays used to manage vessel traffic both within the port and along the approaches to it;
- (b) data centres;
- (c) maintenance sheds or workshops;
- (d) warehouse and other storage accommodation, some of which may require specific environmental control, for example, cold stores; and
- (e) administrative accommodation for port staff and any government services operating within the port.

These buildings are typically serviced by IT-based building management systems and may have wired or wireless networking installed.

A.3.2 Linear infrastructure

Port facilities will include a variety of types of linear infrastructure, requiring control systems, security monitoring and access control. Types of infrastructure that may be found in a port include:

- (a) roads;
- (b) rail systems;
- (c) utilities;
- (d) cargo handling systems such as pipelines and conveyer systems; and
- (e) dockside linear infrastructure.

A.3.3 Plant and machinery

Ports utilise a diverse range of plant and machinery for the management of the port and cargo handling, and may include:

- (a) tidal locks and any associated pumps that are used to permit access from tidal waters and to maintain water levels within the docks;
- (b) automatic barriers/gates to control vehicular and pedestrian access to areas within the port;
- (c) cranes and conveyer systems used for the handling of dry bulk cargos;
- (d) vehicles or non-fixed cranes that move containers and cargo; and
- (e) gauges, pumps and valves used to control the flow of wet bulk cargos.

A common feature of this plant and machinery is the use of industrial control systems and supervisory control and data acquisition (SCADA). Some of these systems may be standalone, but increasingly they are connected to the port's enterprise network.

A.3.4 Information and communication systems

Within a port there will be a range of data, including information used to support decision-making and data that is used to effect a physical outcome (for example, to control movement of cargo and containers). The sensitivity of individual systems will depend on whether they create, process, store or provide access to security-sensitive or other sensitive information.

Within cargo operations, information technology is an essential part of the rapid and accurate transfer and processing of significant data volumes, relating to shipments, customs clearance, vessel itineraries and crew information, processed by international transport firms and port organisations. This applies both to container traffic and to other cargos including vehicles, bulk material, ferry and cruise traffic, etc.

Operations require significant levels of planning and coordination, encompassing:

- (a)** scheduling of land-side container arrival and collection at the port, which, along with the cargo information, includes data about the delivery vehicle, driver, container number, container size and scheduled arrival window;
- (b)** planning and organising container locations in the stacking area, including tracking any moves;
- (c)** planning and scheduling container loading onto vessels, with the aim being that a container's position in the on-board stacks minimises the amount of temporary off-loading at the destination port; and
- (d)** providing information to customs authorities to enable payment of any duties and grant of customs clearance.

They are managed using an asset management system, potentially in combination with a yard management or container traffic management system. Together they may include:

- (a)** real-time information terminals at:
 - (i)** entry gates for booking containers into the port; and
 - (ii)** container loading/unloading bays;
- (b)** automatic number plate recognition (ANPR) for lorries entering and leaving the container terminal, including:
 - (i)** CCTV; and
 - (ii)** video analytics;
- (c)** automatic container number reading and optical inspection for damage and presence of seals both on arrival and departure from the port;
- (d)** detailed position tracking of containers when placed/moved in the dockside storage areas;
- (e)** provision of movement and loading instructions to handling systems (for example, gantry cranes, straddle carriers, rubber tyre gantry units, etc.); and
- (f)** records of receipt of customs clearance to authorise the land-side release of imported containers.

The communications medium(s) used for exchanging the necessary data includes voice, email, electronic data interchange (EDI) and web portals. The level of sophistication of these exchanges will vary considerably depending on the degree of automation of any cargo handling and the IT capabilities of the relevant shipping community. The communications systems associated with control systems may use a variety of communications technologies, including IP and non-IP based networking, wireless and wired media and protocols.

Whatever the means of communication, the integrity of the asset database and the associated transactions is critical for the smooth operation of the container terminal.

Similar operations and systems are required for the handling of non-container cargos, for example, vehicles, bulk material, ferry and cruise traffic, etc. These will be handled within specific port facilities, with systems tailored to the management, movement, handling and storage or marshalling of the cargo and/or passengers, and include:

- (a)** security control – the port and cyber–physical systems that may be used to:
 - (i)** provide access control for staff, contractors and visitors;
 - (ii)** secure the port and/or the port facility perimeter;
 - (iii)** control access by vehicles and pedestrians; and
 - (iv)** prevent or deter theft of goods and/or damage to port facilities.
- (b)** port control and administration – facilities used to manage the day-to-day operations of the port, including:
 - (i)** scheduling of cargo;
 - (ii)** movement and storage of cargo;
 - (iii)** vehicle and passenger movements through the port; and
 - (iv)** potentially managing vessels in the approach to the port.
- (c)** police, customs and border control – while these systems may largely operate independently, some access is generally required to the port's facilities (for example, warehouses) and systems (for example, read access to the operations database and access to CCTV feeds and telemetry).
- (d)** supply chain facilities – while some may act independently of the port's information and communications infrastructure, with very limited access granted in relation to information about vessel movements, others may be integrated into the operation of the port or one of its port facilities.
- (e)** cargo reception, storage and handling, although the precise nature of these systems will vary according to the nature of the cargo being handled.

APPENDIX B

Process for developing a cyber security assessment (CSA)

The port and port facility should first assess each of the vulnerability and countermeasures identified in the respective final port/port facility assessment reports to establish whether there are cyber security implications arising from them. For example, the deployment of technology-based security systems as countermeasures to specific security threats or vulnerabilities may introduce or increase cyber security vulnerabilities.

The port and port facility should then review their overall business to assess the level of exposure and whether there are any additional potential cyber-related threats and vulnerabilities across the full range of port systems and data (for example, cargo handling systems, security systems, industrial control systems, etc.) not identified in the security assessments for a port/port facility, but which nevertheless impact upon the cyber security of each or both.

Where the security assessments for a port/port facility do not cover the full range of potential cyber security threats, the port and/or port facility should produce a CSA. This CSA should cover and document the same aspects as the security assessments for a port/port facility as described in Section 4.

The completed CSA for the port and/or port facility may form an annex to the security assessments for a port/port facility respectively.

B.1 Identification and evaluation of important assets and infrastructure

It will first be necessary to have an understanding of:

- (a) how the different assets support the port's operational use;
- (b) the criticality of different areas within the port/port facility; and
- (c) the systems that support or protect these critical assets or areas.

From a cyber security perspective, the business critical and/or sensitive elements of a port are likely to include:

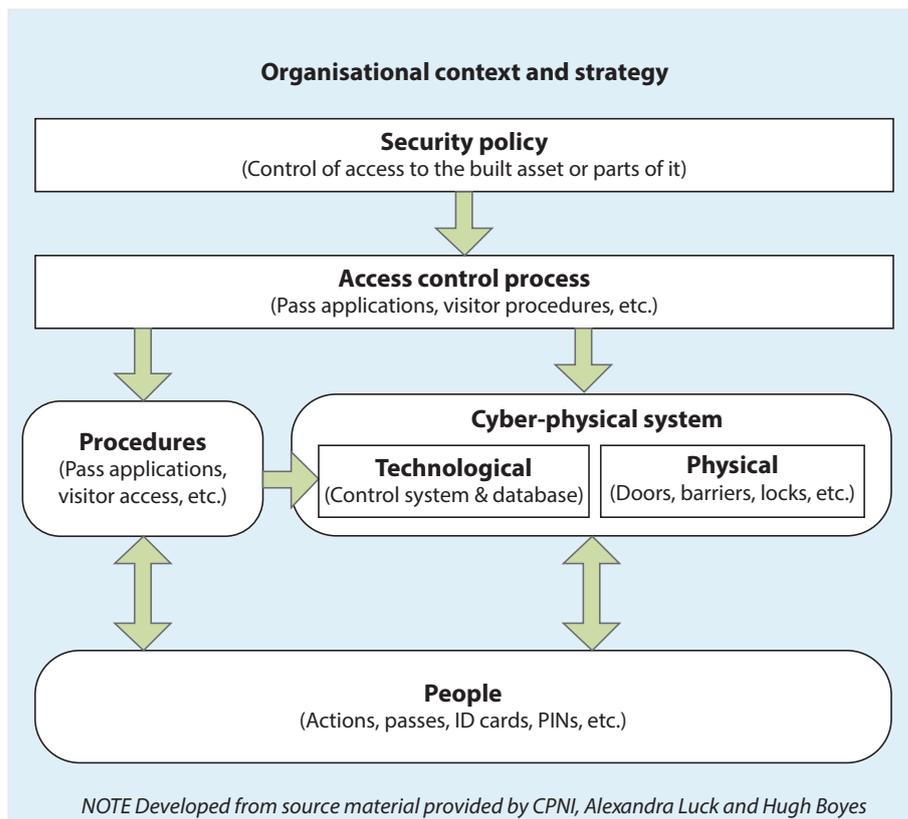
- (a) those assets that have been judged to have the potential to be used to significantly compromise the integrity of the port as a whole or the ability of a specific facility or system to function as required. Consideration should be given to:
 - (i) cabling routes and their containment (for example, ducts and trunking);
 - (ii) configuration, identification and use of control systems;
 - (iii) critical permanent plant or machinery;
 - (iv) security or other control rooms, including guarding;
 - (v) security, alarm and access control systems, CCTV and video processing.

- (b) key spaces and facilities used by law enforcement and security service personnel operating in, or visiting, the port.
- (c) port data relating to the location, identification, technical specification and operation of business critical and sensitive assets.
- (d) port systems, wherever they are hosted, used for planning, scheduling and receipt of ships and cargo.
- (e) assets or systems upon which the business critical and/or sensitive elements are dependent for their normal operation and resilience.

B.2 Identification of the port business processes

The operation of a port/port facility will depend upon a set of business processes that rely upon port data for the safe, secure and efficient movement of cargo through the port and enable supporting processes such as asset management, resource scheduling, financial and business planning, procurement, and the human resource processes. Having identified and assessed the important assets and infrastructure, the next step is to identify the port business processes that use the assets and infrastructure, as illustrated in Figure B.1.

▼ Figure B.1 Example of components supporting access control process, courtesy of BSI



This information should be used to assess the criticality of assets and to understand the interdependencies of the data and systems within the overall business processes of the port. By so doing, the real impact of failure or compromise of individual components can be understood.

B.3 Identification and assessment of risks arising from potential threats and vulnerabilities

The potential threats should have already been identified in the PSA and PFSA. However, it will be necessary to understand the degree to which individual threats and combinations of them may impact on the cyber security of the port and/or port facility.

When considering threat scenarios and types of undesired events, the port/port facility operator should include incidents such as:

- (a)** unauthorised access to sensitive port data (commercial, personal or security-related);
- (b)** theft of sensitive port data;
- (c)** deletion, unauthorised modification or corruption of port data;
- (d)** infection with malware;
- (e)** loss of service from systems due to loss of connectivity or power;
- (f)** loss of service from systems due to software and hardware failures;
- (g)** compromise of port security systems;
- (h)** denial of service – externally hosted systems;
- (i)** denial of service – port systems;
- (j)** jamming or interference with positioning systems (GNSS/GPS); and
- (k)** assessing efficacy of system operation (for example, coverage and performance of CCTV and intruder detection systems).

The identification of vulnerabilities should include consideration of:

- (a)** the relationships between systems;
- (b)** the technical composition of systems in terms of hardware and software components and the builds or revisions that are being used;
- (c)** physical robustness of enclosures (for example, cabinets, ducts, trunking, etc.);
- (d)** the relationships between systems and associated business processes;
- (e)** existing security measures and procedures, including the presence and permeability of any secure perimeter that prevents or limits access to the port, port facility and associated utilities, plant and machinery;
- (f)** reliance on automation of equipment;
- (g)** the level of resilience within the port/port facility, including the level of dependency of systems on infrastructure, for example, utilities;
- (h)** any conflicting policies between safety and security measures and procedures;
- (i)** any enforcement and personnel constraints; and
- (j)** any deficiencies identified during daily operation, following incidents or alerts, the report of security concerns, the exercise of control measures, audits etc.

The risk assessment should consider the nature of harm that could be caused to: personnel and other occupants or users of the port and its services; the port and port assets; and/or the benefits the port exists to deliver, be they societal, environmental and/or commercial.

The cyber security risk will depend on the likelihood that a threat actor can exploit one or more vulnerabilities and cause the nature of harm identified.

Throughout the process it will be essential for the port and port facility to liaise with each other to identify common risks, as well as where a risk in one may compromise the security of the other.

B.4 Identification, assessment, selection and prioritisation of countermeasures

For every cyber security vulnerability not already identified by the security assessments for a port/port facility, the port/port facility operator should identify and record possible mitigation or countermeasures.

The assessment of each countermeasure should identify and record:

- (a) the cost of the countermeasure and its implementation.
- (b) other impacts the countermeasure might have, for example, on asset or system usability and efficiency, business processes and port operations.
- (c) wherever possible, to support the business justification for investment in the countermeasure:
 - (i) the risk reduction that could be achieved; and
 - (ii) the predicted cost saving.
- (d) the potential for the countermeasure to create further vulnerabilities.
- (e) whether the countermeasure delivers any other business benefits, for example:
 - (i) reduction of overall business risk; and
 - (ii) aiding the development of efficient, robust and repeatable business processes.

The countermeasures that are chosen for implementation should be appropriate and proportionate to the risk that they are intended to mitigate. The selected measures should be listed in the CSA and should include a record of where co-operation is required between the port and/or port facilities for their successful implementation.

B.5 Review acceptability of overall risk

The assessment process should continue until a point is reached where the level of residual risk does not exceed the risk appetite of the port/port facility, i.e. repeat the steps outlined in Sections B.3 and B.4. The remaining residual risks should be listed in the CSA.

B.6 Review of the CSA

As with the security assessments for a port/port facility, the CSA should be periodically reviewed and updated, taking account of:

- (a) changes in previously identified risks;
- (b) new threats or vulnerabilities;
- (c) changes in the port and port facility;
- (d) the success of implemented countermeasures;
- (e) new and, potentially more effective, countermeasures.



The port/port facility operator should establish a suitable mechanism for performing ad-hoc risk reviews to identify and assess the impact of any changes on the port and port assets that should be reflected in the CSA. The triggers for initiating such a review and the timetable for its completion should be set out within the CSP. Triggers should include as a minimum the following events:

- (a)** a significant security incident at a port facility;
- (b)** a significant security incident affecting an externally hosted port system;
- (c)** a change in the shipping operations undertaken at the port;
- (d)** a change in the location, hosting or support of port systems;
- (e)** a project initiated to significantly change the port or its operations; and
- (f)** a change of port/port facility owner or operator.

Where the port contains a number of port facilities with different risk profiles, the CSA may need to be reviewed at a higher frequency in relation to any port assets that are deemed to be more sensitive. It is especially true of cyber security that any risk assessment represents a snapshot at a particular instance, which may change dramatically with the emergence of a new vulnerability.

APPENDIX C

Contents of a cyber security plan (CSP)

The port security standards define the term 'security level' to mean the degree of risk that a security incident will occur or be attempted. The CSP needs to be developed to cover the three levels of risk that are defined as:

- (a) security level 1 – the level for which minimum appropriate protective security measures shall be implemented at all times;
- (b) security level 2 – the level for which appropriate additional protective security measures shall be maintained for a period of time as a result of heightened risk of a security incident;
- (c) security level 3 – the level for which further specific protective security measures shall be maintained for a limited period of time when a security incident is probable or imminent, although it may not be possible to identify a specific target.

The recommended contents of the CSP should include, as a minimum:

- (a) information on cyber security responsibilities and links to organisations that will assist the port/port facility in the event of a cyber security incident.
- (b) how the cyber security of security and communications systems and equipment will be maintained.
- (c) the cyber security drills to be practiced to test the port's response to cyber security incidents.
- (d) the cyber security of communications, including those:
 - (i) between personnel with security responsibilities;
 - (ii) between those responsible for technical security and the wider security team; and
 - (iii) that provide information about the port and port assets to third parties.
- (e) cyber security measures required for any connection between ship systems and those of the port/port facility.
- (f) processes and procedures for approving the electronic or wireless connection of ship and port systems.
- (g) any changes to systems or system operations required at higher security levels, including any increased security measures required for admission of IT and systems maintenance contractors to the port and port facilities when the port is operating at security levels 2 and 3.
- (h) access control measures relating to cable ducts, trunking and cabins of equipment boxes located within the port, irrespective of whether they are in restricted or open areas.
- (i) access control measures to sensitive IT systems and accommodation, for example, networking, communications and server rooms.
- (j) cyber security measures pertinent to the protection and assurance of cargo-related data and the systems that process, store and transmit it. Where the port has automated systems handling cargo movement or storage, the plan should address the security measures required to protect the operational IT and cyber-physical systems.
- (k) cyber security measures pertinent to the protection and assurance of ships' stores and bunkering data and any systems that process, store and transmit it.
- (l) cyber security of port lighting, electronic access, security and monitoring systems,

and any specialist systems required to support security patrols or law enforcement authorities, for example, radiation detectors.

- (m)** response to cyber security threats, breaches and security incidents.
- (n)** arrangements for auditing of cyber security measures.
- (o)** contractual measures for the adoption of relevant cyber security measures within the supply chain to the port/port facility.
- (p)** cyber security awareness and training required by staff.

The section of the CSP that addresses security breaches and incidents should enable an effective and coordinated response. This will require an assessment of potential risks to the port/port facility, its function, port assets, personnel and third parties in the event of a security breach or incident. The section should include:

- (a)** the risk mitigation measures including:
 - (i)** the forensic readiness measures required to enable, when required, the capture of forensic information about an incident for use by law enforcement, and/or detailed analysis of the root causes of the incidents;
 - (ii)** the process to be followed on discovery of a breach/incident (including near misses, i.e. narrow avoidance of a security breach/incident);
 - (iii)** business continuity measures required in the event of port system failure, impairment or non-availability;
 - (iv)** the disaster/incident recovery actions required in the event of serious failure scenarios; and
 - (v)** steps to be taken to contain and recover from the event.
- (b)** the review process to be followed after a security breach or incident, including both an assessment of any ongoing risk and an evaluation of the response to the breach or incident by the port/port facility and, where appropriate, the supply chain.
- (c)** the need for contractual provisions to handle breaches/incidents caused by a third party connected to the port, for example, a professional advisor, contractor or supplier.
- (d)** the mechanisms for reviewing and updating the CSA, CSP and security procedures following a significant security breach or incident:
 - (i)** at the port or one of its port facilities; or
 - (ii)** at another port/port facility.
- (e)** the arrangements for conducting cyber security incident response exercises, which the port/port facility may handle in conjunction with existing business continuity planning and exercises.

APPENDIX D

Devising mitigation measures

This Appendix provides a framework for the identification of mitigation measures to be applied to the people, physical, process and technological aspects of a port/port facility. When choosing mitigation measures, a balance will need to be struck on a case-by-case basis between optimum risk reduction and minimising the overall impact on the business of the port/port facility.

D.1 People

People are often the weakest element in any secure system or operation so the interaction of people with the port systems needs to be understood. It is therefore advised that the answers to the following questions are established as the first stage in the process of deciding upon the appropriate and proportionate mitigation measures:

- (a) who needs access to the port data and systems?
- (b) what types of access are required?
- (c) how is this access provided, and is remote access required?
- (d) what access controls will be required (for example, can an individual create, read, update or delete the port data, and what level of control does an individual have)?
- (e) what level of cyber security awareness and understanding of cyber security is required by individuals?
- (f) are contractors and temporary and agency staff provided with cyber security awareness training as part of their induction?
- (g) do individuals understand the port operator's policies, processes and procedures for the creation, use and maintenance of port data and the operation and maintenance of port systems?
- (h) are processes and procedures in place to update individuals about any changes in policies, processes and procedures?
- (i) are individuals briefed in a timely manner on changes in threats, risks and the required countermeasures?

The answers to the first four questions will also enable the port and port facility to identify high-risk positions. The individuals holding those positions should be subjected to appropriate pre-employment/pre-contract security screening and vetting checks, with appropriate ongoing monitoring.

High risk positions will include those with:

- (a) IT and/or operational system administration responsibilities;
- (b) security roles;
- (c) information management roles;
- (d) purchasing, finance and contract management roles; and
- (e) personnel managers (regarding handling of security-breach related disciplinary matters and management of the insider threat).

D.2 Physical

In order to enhance the achievable level of cyber security, it is necessary to have in place physical security that:

- (a) prevents unauthorised access to sensitive port systems, for example:
 - (i) IT equipment accessing, processing or storing sensitive information;
 - (ii) systems fulfilling critical port functions; and
 - (iii) port security and control systems.
- (b) prevents theft of, or damage to:
 - (i) IT equipment, storage media, cables, etc.; and
 - (ii) port data, in particular that pertaining to the safe and secure operation of the port.
- (c) protects network and communications infrastructure from:
 - (i) accidental damage;
 - (ii) deliberate/malicious damage; and
 - (iii) tampering and/or denial of service.
- (d) protects utilities, heating, ventilation and cooling systems required to:
 - (i) operate the sensitive port systems;
 - (ii) operate the network and communications infrastructure; and
 - (iii) maintain a safe and secure working environment.

Some port systems may need to be accorded the same level of physical protection as key operational spaces, with security perimeters defined and implemented to protect not only the systems but also their cabling and any associated plant and machinery.

It will therefore first be necessary to establish:

- (a) what physical and electronic infrastructure is used to create, access, process and store port data, including any communications and networking components;
- (b) the infrastructure that is critical to ensuring the ongoing operation of port systems and any processes or services they support;
- (c) the dependencies that parts of the infrastructure have on other critical services or infrastructure;
- (d) the extent to which this infrastructure is dedicated to port systems or shared with different activities;
- (e) the extent to which this infrastructure is shared with third parties; and
- (f) the availability of port personnel and external agencies for reaction and response and their ability to access the functional areas.

This information should then be used to decide where physical protective measures are required.

Where it is decided that secure perimeters are needed, these should be designed to prevent unauthorised access or tampering and, depending on the location and criticality, may need to be alarmed and monitored by CCTV systems. When considering the level and type of protection to be provided, a defence-in-depth approach is more reliable than a single protective barrier.

D.3 Process

The failure to develop and maintain appropriate policies and their supporting processes that reflect the operating culture of the organisation can result in them being ignored, or

lead to the adoption of informal local practices, resulting in the security or operation of the site or key port assets being undermined.

It is therefore important that processes specific to cyber security are in place, which, as a minimum, detail:

- (a) the use of externally hosted systems or business portals employing web-based interfaces;
- (b) communications and networking links, whether from externally hosted systems or services, or those hosted at the port;
- (c) wireless networking and communications technologies, for example, Bluetooth and Wi-Fi;
- (d) configuration of protective software, such as firewalls, anti-malware products and intrusion detection applications;
- (e) the connection of new computers, mobile devices or IT-controlled operational equipment to the port's IT infrastructure;
- (f) the use of personal mobile radios (PMR) within the port;
- (g) configuration and management of user and systems account privileges, including those of third party personnel with access to port systems, particularly those controlling power, heating, ventilation and cooling systems for accommodation containing on-site IT systems, or port security systems, for example, access control, security barrier control, CCTV, etc.;
- (h) connection of personal IT devices or removable media to port systems;
- (i) access to emails, instant messaging services, external websites or file sharing services from workstations on operational systems (control systems, security systems, etc.); and
- (j) mobile time-critical access to data during an emergency.

It will also be necessary to have processes in place for:

- (a) regularly reviewing access privileges to ensure that individuals' privileges are consistent with their job roles and functions; and
- (b) regularly reviewing systems logs and the investigation of anomalies.

D.4 Technological

In deciding upon technical mitigation measures that are needed to address cyber security risks, it will first be necessary to gain an understanding of:

- (a) the systems in use;
- (b) the channels used by systems, sensors and actuators to communicate; and
- (c) the information and data held.

Systems may operate across a whole port, within a single port facility or across several facilities. They may be located on-site or hosted remotely, for example, as a cloud service or within a data centre. In order to establish the nature of systems in use, the following questions will need to be answered:

- (a) what port systems are involved in the creation, use, maintenance, storage and transmission of port data?
- (b) to what extent are each of these systems dedicated to a single port/port facility?
- (c) are the port systems shared by different activities?

- (d) are the systems accessible by any third parties, either within or outside the port?
- (e) what is the typical operating life of each system?
- (f) when is it likely that each system will become unsupported, obsolete or need to be replaced for business and/or operational reasons?

The channels by which systems, sensors and actuators communicate can be vulnerable to attacks and interference. The answers to the following questions should therefore be sought:

- (a) what channels, technologies and parts of the overall spectrum are used to communicate and share port data between port systems and with any users who need to access or use it?
- (b) what channels, technologies and parts of the electro-magnetic spectrum are used to control and integrate port systems?
- (c) to what extent are the communications confined to the port/port facility, and will remote access to, or remote processing of, communications be required?

The information and data that is created, used and/or processed by the port systems needs to be understood. In order to do this, the answers to the following questions should be established:

- (a) what information and data, including sensor data, do the port systems require to function?
- (b) what other information and data is held, for example, personally identifiable information?
- (c) what legal requirements are there with regards to the information and data held?
- (d) how are information and data encoded?
- (e) how and where are information and data stored?
- (f) what will the consequences be if information and/or data was lost and therefore no longer available?
- (g) who owns the information and data?
- (h) how are information and data made available and what restrictions are there on their use?
- (i) how long do information and data need to be kept?
- (j) what information and data need to be securely removed when no longer required?

When designing, procuring, implementing and operating physical security systems that operate over IT, the port/port facility operator should consider how the systems will be protected from cyber security attacks or incidents. This is particularly important given the trend of convergence of physical security and IT infrastructure, for example, the use of a shared enterprise network and access to security systems from the corporate desktop environment.

Where such convergence occurs, or has occurred, the port/port facility operator should ensure that:

- (a) an appropriate architecture is employed;
- (b) appropriate management, support and maintenance is available from both the port's IT team and the system vendors, to maintain system security and performance;
- (c) appropriate protection is provided to prevent IT control and security systems becoming infected with malware; and
- (d) wherever possible the critical security systems operate over a segregated infrastructure.

D.5 Resilience

Resilience is the ability to adapt, respond and recover rapidly from disruptions and maintain continuity of business operations.

In the event of an incident it is vital, from a business perspective, that a port is able to operate without disruption or compromise of the services provided to its users.

A port should therefore have in place an incident management plan that is based upon an understanding of:

- (a)** the potential causes of disruption, both human and natural;
- (b)** the essential systems required to keep the port operating safely;
- (c)** the nature and practicality of alternative methods that can be employed in order to maintain operations in the event of an incident; and
- (d)** the capacity at which the port can realistically operate under such arrangements.

It will also be necessary for the port to have in place systems and processes that enable the timely detection of disruptive events in order to enable the correct response, as set out in the incident management plan, to be initiated as quickly as possible.

Emergency plans should be exercised on a regular basis to test communication, coordination, resource availability, procedures and response. The exercises may be:

- (a)** full-scale or live;
- (b)** table-top simulation or seminar; or
- (c)** combined with other exercises such as emergency response, etc.

APPENDIX E

Model terms of reference for a port security committee (PSC) or port security authority (PSA)

At the port level, there will be a need to establish clear communications between key stakeholders, including those responsible for operating both the port/port facilities and a number of external stakeholders. Such stakeholders may include government organisations operating within the port and local law enforcement agencies. By establishing a PSC/PSA those responsible for the development and implementation of security policies, processes and procedures will have a representative group who can review documents and advise on the practical aspects of their implementation.

The PSC/PSA should consist of representatives from the port/harbour authority, the port facilities within the port, government organisations operating within the port, local law enforcement agencies, those employed in the port and port users. This provides a mechanism for: aiding communications related to the flow of responsibility; sharing of security-related information; increasing overall accountability; and the embedding of security-minded behaviour into day-to-day operations.

The terms of reference for a port security committee could typically include:

- (a) promoting a security-minded culture throughout the port;
- (b) designing and evaluating security-awareness programmes;
- (c) identification of security threats – physical, people, process and technology related;
- (d) reporting and assessing recent security incidents at the port;
- (e) assessing the potential implications of security incidents at other ports;
- (f) enhancing coordination in the application of security procedures and countermeasures;
- (g) planning, coordinating participation in and evaluating security drills and exercises;
- (h) coordinating port and port facility security assessments;
- (i) coordinating, communicating and facilitating implementation of applicable security measures specified in the port security plan; and
- (j) sharing best practice and experiences in the implementation of security plans.

The Department for Transport's UK Maritime Security Measures includes further requirements relating to PSCs and PSAs.

APPENDIX F

Handling release of information to third parties

There are a number of situations where a port/port facility may be asked or required to publish information about its plans and operations. These can include provision of information to support a planning application, release of information to regulators, presentations about the port/port facility. The operator of the port and/or port facility need to be aware the public release of information can enable a party undertaking hostile reconnaissance to obtain sensitive information or through data aggregation to deduce sensitive information.

Where a port falls within the scope of regulations or legislation requiring public disclosure of information, for example, Planning Regulations, Environmental Information Regulations or Freedom of Information legislation, the CSO should ensure that the CSP details the approach to be taken to protect sensitive data or information. As a minimum, the approach should:

- (a) consider the impact of releasing data, including the potential issues arising from data aggregation;
- (b) prevent leakage of security-related information;
- (c) protect commercially sensitive data and intellectual property; and
- (d) safeguard personally identifiable information, taking into account the range of attributes that can be used to identify individuals.

Based on an assessment of the risk of disclosing detailed information about the port or a port asset, it might be necessary and appropriate to adopt measures to reduce the detail. Measures that might be necessary include, but are not limited to:

- (a) limiting access to particular types of port data;
- (b) redacting sensitive information, for example, description of the functions of individual port facilities or components of them; and
- (c) providing the information in an unstructured format¹.

1 Use of unstructured formats such as hard copy, images, and non-interactive PDF formats may reduce the risks associated with data aggregation, making it more difficult to search for specific terms or to develop associations between data items that relate to sensitive aspects of the port/port facility.

APPENDIX G

Handling security breaches and incidents

It will be necessary for the port and port facility to have in place appropriate measures that can be implemented in the event of an incident to reduce its impact on the port's operations and aid recovery. These are likely to include:

- (a) incident response plans, which include liaison, where appropriate, with NCSC;¹
- (b) communication plans to reassure and inform stakeholders, during and after any incident or breach, as well as handling any third party, regulator, media or public interest issues;
- (c) risk assessment and mitigation plans to enable the impact to be assessed over both the short and medium to longer terms; and
- (d) disaster recovery and business continuity plans which are able to afford the same level of security for the port data as the processes and systems in use on a day-to-day basis.

It will also be necessary for consideration to be given to when and how forensic evidence will be preserved to aid in any investigation into the cause of the event or the perpetrators. Where evidence collection is for law enforcement purposes it should be in accordance with the relevant national guidelines.^{2,3}

In the event of an incident involving the loss or theft of port data, unauthorised access to port data or systems, or interference with computer systems, the CSO should notify the relevant parties⁴ and law enforcement agencies.

When identifiable personal information is lost, stolen or compromised, the CSO should ensure that the relevant information commissioner or data protection authority⁵ and affected individuals are notified.

The CSO should ensure that discovery procedures are established in all appointment documents and contracts, including, where applicable, in non-disclosure agreements.

Following any security breach or incident, an important post-incident activity is the formal evaluation of the way that the event was handled, to determine lessons that can be learned and to review whether any changes are required to the security assessments, security plans or supporting policies, processes and procedures.

1 The NCSC, opening in late 2016, will bring together the capabilities already developed by CESG, CPNI, CERT-UK and CCA in protecting industry from cyber-attacks. The NCSC has four main responsibilities that flow from the National Cyber Security Strategy:

- to understand the cyber security environment, share knowledge and use that expertise to address systemic vulnerabilities;
- to reduce risks to the UK by working with public and private sector organisations to improve their cyber security;
- to respond to cyber incidents to reduce the harm they cause to the UK; and
- to nurture and grow our national cyber security capability, and provide leadership on critical national cyber security issues.

2 In the UK these are the ACPO Good Practice Guide for Digital Evidence (2012), which is available from http://www.7safe.com/electronic_evidence/ACPO_guidelines_computer_evidence.pdf

3 CESG Good Practice Guide Forensic Readiness, October 2015, Issue 1.2 [[https://www.cesg.gov.uk/content/files/guidance_files/Forensic%20Readiness%20\(Good%20Practice%20Guide%2018\)_1.2.pdf](https://www.cesg.gov.uk/content/files/guidance_files/Forensic%20Readiness%20(Good%20Practice%20Guide%2018)_1.2.pdf)]

4 In the UK incidents affecting ports covered by the ISPS Code or ILO/IMO CoP should in the first instance be notified to NCSC

5 In the UK incidents involving the loss or compromise of personally identifiable data should be notified to the Information Commissioner (<https://ico.org.uk/>)

APPENDIX H

Bibliography

This Appendix lists standards that are relevant to the design and operation of information and communications systems used in the management and operation of the port environment.

H.1 General IT and cyber security standards

Reference	Title/Description
ISO/IEC 13335	<i>IT Security Management – Information technology – Security techniques – Management of information and communications technology security</i>
ISO/IEC 15408	<i>Common Criteria for Information Technology Security Evaluation</i>
ISO/IEC 27000	<i>Information security management systems – Overview and vocabulary</i>
ISO/IEC 27001	<i>Information security management systems requirements</i>
ISO/IEC 27002	<i>A code of practice for information security management</i>
ISO/IEC 27003	<i>Information security management system implementation guidance</i>
ISO/IEC 27004	<i>Information security management – Measurement</i>
ISO/IEC 27005	<i>Information security risk management</i>
ISO/IEC 27006	<i>Requirements for bodies providing audit and certification of information security management systems</i>
ISO/IEC 27007	<i>Guidelines for information security management systems auditing</i>
ISO/IEC TR 27008	<i>Guidance for auditors on ISMS controls</i>
ISO/IEC 27010	<i>Information security management for inter-sector and inter-organizational communications</i>
ISO/IEC 27013	<i>Guideline on the integrated implementation of ISO/IEC 27001 and ISO/IEC 20000-1</i>
ISO/IEC 27014	<i>Information security governance</i>
ISO/IEC 27017	<i>Code of practice for information security controls based on ISO/IEC 27002 for cloud services</i>
ISO/IEC 27018	<i>Code of practice for protection of personally identifiable information (PII) in public clouds acting as PII processors</i>
ISO/IEC 27031	<i>Guidelines for information and communication technology readiness for business continuity</i>
ISO/IEC 27033-1	<i>Network security – Part 1: Overview and concepts</i>
ISO/IEC 27033-2	<i>Network security – Part 2: Guidelines for the design and implementation of network security</i>
ISO/IEC 27033-3	<i>Network security – Part 3: Reference networking scenarios – Threats, design techniques and control issues</i>

Reference	Title/Description
ISO/IEC 27033-5	<i>Network security – Part 5: Securing communications across networks using Virtual Private Networks (VPNs)</i>
ISO/IEC 27035	<i>Information security incident management</i>
ISO/IEC 27036-3	<i>Information security for supplier relationships – Part 3: Guidelines for information and communication technology supply chain security</i>
ISO/IEC 27037	<i>Guidelines for identification, collection, acquisition and preservation of digital evidence</i>
Critical Security Controls	<i>Critical Controls Version 5.0 – 27 February 2014</i>
Controls	A reference set of recommendations for methods to address risks to enterprise data and systems. Published by the Council on Cyber Security (for further information, see http://www.counciloncybersecurity.org).
HMG IA Standard No 1	Technical Risk Assessment – IA Standard for Risk Managers and IA Practitioners responsible for identifying, assessing and treating the technical risks to ICT systems and services handling HMG information.
Supplier Information Assurance Assessment Framework and Guidance	Guidance on how the Supplier Information Assurance Tool (SIAT) question sets and tool specification can be used by suppliers of key business services to HMG.
Supplier Information Assurance Tool (SIAT) – Summary	A brief summary of the Supplier Information Assurance Tool (SIAT) Community of Interest set up to drive development of a supplier Information Assurance model. ISAB Approved.
CESG IA Top Tips	2010/01 – DDoS – Distributed Denial of Service 2010/02 – Importing Data from External Networks 2010/03 – Basic Web Server Security 2011/01 – Trusted Platform Modules 2011/02 – Delivering Services Online 2011/03 – Mitigating Attacks to Online Services 2012/01 – Network Access Control
BIS/12/1120	<i>10 steps to cyber security: executive companion.</i> Provides guidance for business on how to make their networks more resilient and protect key information assets against cyber threats.
BIS/12/1121	<i>10 steps to cyber security: advice sheets.</i> Provides detailed cyber security information and advice on the 10 steps described in BIS/12/1120.

H.2 Security and safety of Industrial Control Systems (ICS & SCADA)

Reference	Title/Description
IEC 61508	
IECTS 62443-1-1	<i>Industrial communication networks – Network and system security – Part 1-1: Terminology, concepts and models</i>
IEC 62443-2-1	<i>Industrial communication networks – Network and system security – Part 2-1: Establishing an industrial automation and control system security program</i>
IECTR 62443-2-3	<i>Security for industrial automation and control systems – Part 2-3: Patch management in the IACS environment</i>
IEC 62443-2-4	<i>Security for industrial automation and control systems – Part 2-4: Security program requirements for IACS service providers</i>
IECTR 62443-3-1	<i>Industrial communication networks – Network and system security – Part 3-1: Security technologies for industrial automation and control systems</i>
IEC/TS 62443-3-2 Ed. 1.0	<i>Network and system security – Part 3-2: Technical requirements – Target security levels</i>
IEC 62443-3-3	<i>Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels</i>
ANSI/ISA-99.00.01	<i>Part 1: Terminology, Concepts, and Models</i>
NIST IR 7176	<i>System Protection Profile – Industrial Control Systems – V1.0</i> Incorporates industrial control systems into Common Criteria
NIST SP 800-82	Guide to Industrial Control Systems (ICS) Security
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

H.3 Business-related security guidance

Reference	Title/Description
BIS/12/1119	<i>Cyber risk management: a Board-level responsibility.</i> Explains the benefits of cyber risk management to senior executives.
ISO 20000 BS 15000	<i>IT Service Management Standards</i> based on ITIL.
BS 7858	<i>Code of Practice for Security Screening of Individuals Employed in a Security Environment</i>
COBIT 5	A Business Framework for the Governance and Management of Enterprise IT (Control objectives for information and related technology.)
PAS 555:2013	<i>Cyber security risk. Governance and management. Specification</i>

H.4 Other standards and guidance

Reference	Title/Description
PCI DSS	<i>Payment Card Industry Data Security Standard</i>
NIST SP 800-61	<i>Computer Security Incident Handling Guide</i>
PAS 1192-5:2015	<i>Specification for security-minded building information modelling, digital built environments and smart asset management</i>
PAS 754:2014	<i>Software Trustworthiness. Governance and management. Specification</i>
PAS 97:2012	<i>A specification for mail screening and security</i>
RFC 2196	<i>Site Security Handbook</i> From IETF (The Internet Engineering Task Force)
RFC 2350	<i>Expectations for Computer Security Incident Response</i> From IETF (The Internet Engineering Task Force)
BS ISO/IEC 42010	<i>Systems and software engineering – Architecture description</i>
	<i>EACOE Enterprise Framework</i>
	<i>IET Code of Practice for Cyber Security in the Built Environment</i>