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## **Cover note to the CPMI-IOSCO report on the *Resilience of central counterparties (CCPs): Further guidance on the PFMI***

### **Background**

The Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO) (together, the “Committees”) are today publishing further guidance on the principles and key considerations in the *Principles for financial market infrastructures (PFMI)* regarding financial risk management for CCPs. This builds on a consultative report that was published on 16 August 2016.

### **Scope and purpose of the guidance**

Consistent with the priorities regarding CCP resilience identified in the joint CCP workplan of the Financial Stability Board (FSB), the CPMI, IOSCO and the Basel Committee on Banking Supervision,<sup>1</sup> this report is intended to improve the resilience of CCPs by providing guidance on the principles and key considerations in the PFMI regarding financial risk management for CCPs.<sup>2</sup> The report focuses on five key aspects of a CCP’s financial risk management framework: governance, stress testing for both credit and liquidity exposures, coverage, margin, and a CCP’s contribution of its financial resources to losses.

A CCP’s governance arrangements play an important role in ensuring its overall resilience, and the report further elaborates on the responsibility of the board in this process. The report also outlines guidance on the rigour of the credit and liquidity stress tests expected in the PFMI, as appropriate to the systemic importance of CCPs. The guidance on coverage is intended to strengthen a CCP’s observance of Principles 4 and 7 of the PFMI in setting and maintaining on an ongoing basis the required level of resources through its credit and liquidity risk stress testing practices. The guidance on margin systems is intended to assist CCPs in their ongoing efforts to implement and maintain margin systems that are effective in addressing the risks and particular attributes of each product, portfolio and market served. Finally, the report provides further guidance for CCPs on determining an appropriate contribution of own resources towards losses resulting from a participant default and custody and investment of participant assets.

The CPMI and IOSCO note that the detail and granularity of the guidance should be understood in the context of the principles-based approach reflected in the PFMI, which recognises CCPs’ differing organisations, functions and designs, and the different ways to achieve a particular result.<sup>3</sup> This report should be read in conjunction with the relevant

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<sup>1</sup> Available at [www.bis.org/cpmi/publ/d134b.pdf](http://www.bis.org/cpmi/publ/d134b.pdf).

<sup>2</sup> While the guidance included in this report is intended explicitly for use by CCPs, some of it may be relevant and useful to other types of FMIs.

<sup>3</sup> See paragraph 1.2 of the PFMI.



principles, key considerations and explanatory notes in the PFMI.<sup>4</sup> The guidance provides clarity on an acceptable way – although it does not prescribe what is necessarily the only way – of observing the PFMI. Each CCP, in conjunction with the authorities responsible for its regulation, supervision and oversight, should carefully take into account the guidance in this report when developing its approach to observing the PFMI.

## Inputs to the report

In developing this guidance, the CPMI and IOSCO considered input from:

1. Industry workshops (conducted both before and during the consultation).
2. Papers submitted by industry groups.
3. A stocktake of current CCP risk management practices in place at over 30 CCPs clearing securities and derivatives products in exchange-traded and OTC markets, representing a wide range of geographic locations, sizes, organisational structures, ownership structures and markets and covering: (i) credit and liquidity stress testing; (ii) margin practices; (iii) prefunded loss absorption capacity or coverage; (iv) CCPs' contribution of financial resources to losses due to participant default as well as to non-default-related losses; and (v) recovery planning. While a separate survey on governance practices was not conducted, governance issues emerged as a common theme in the responses to the surveys as well as in the workshops.
4. Findings from the Committees' Level 3 assessment of financial risk management practices for a selected group of CCPs.
5. Comments submitted in response to the consultative report on resilience and recovery of central counterparties ([www.bis.org/cpmi/publ/comments/d149/overview.htm](http://www.bis.org/cpmi/publ/comments/d149/overview.htm) and [http://www.iosco.org/publications/?subsection=public\\_comment\\_letters](http://www.iosco.org/publications/?subsection=public_comment_letters)).

The Committees would like to express appreciation to the industry participants in this process, who responded to the Committees' CCP surveys and provided detailed and thoughtful comments, on schedules that were particularly demanding.

## Main changes of the report in response to the public consultation

Some of the main issues raised with regard the consultative report, which have been clarified/revised in the report are outlined below.

### Governance

In response to comments, the report clarifies that, while the board of directors has ultimate responsibility for establishing a risk management framework and for the effectiveness of its implementation, the board is not expected to itself implement the risk management framework or to carry out the day-to-day management of risks. Rather, in discharging its ultimate responsibility over risk management matters, the board should work closely with the CCP's

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<sup>4</sup> See paragraph 1.36 of the PFMI.



management. More specifically, the board is itself responsible for: (i) carefully overseeing, monitoring and evaluating management's implementation of the risk management framework; (ii) taking appropriate steps to ensure that management is performing risk management tasks properly and effectively; (iii) ensuring that processes are in place for effective and timely communication, reporting and information flow between management and the board; (iv) communicating with management about risk management processes; and (v) when assessing the risk-management framework, appropriately challenging management to demonstrate the effectiveness of risk management processes.

Also in response to extensive comments from stakeholders, the report provides some additional clarity on the mechanisms for feedback. Regarding disclosure for feedback purposes, the approach followed in the report is to focus on desirable outcomes from disclosure and to provide some additional – non-exhaustive – examples of specific aspects of the risk management framework that would benefit from additional transparency, subject to certain safeguards. For example, the guidance calls upon CCPs to provide sufficient detailed information on the CCP's margin system and stress testing framework to participants and other relevant stakeholders to permit them to understand these aspects of the CCPs' risk management framework and provide effective feedback and challenge. This includes information on the supporting rationale for key decisions and sufficient information to support the replicability of margin requirements.

### **Stress testing**

A number of commenters called for a definition of "extreme but plausible". The report emphasises that the aim of the guidance is to elaborate on key matters that CCPs should take into account in establishing their stress testing frameworks, and not to provide a definition. Moreover, additional clarification has been provided in a number of areas; for instance, additional detail has been provided on setting the stressed period of risk (SPOR), including to note that a CCP should consider extending the SPOR or applying other methods to take account of the potential cost of liquidating portfolios that have concentrated positions. The final guidance also provides alternative techniques for analysing stress testing scenarios, models and underlying parameters and assumptions.

### **Margin**

The guidance on margin was also revised in a number of areas in the light of feedback from the consultation. For instance, the report elaborates on the need to clearly articulate the basis of and rationale for a CCP's policy in respect of margin add-ons and the need for appropriate governance and review of the conceptual soundness of its framework for setting add-on charges. The final report also clarifies expectations for CCPs' valuation models and procedures for addressing circumstances in which pricing data are not readily available and reliable, and provides some additional granularity on model backtesting. Finally, the report clarifies that CCPs should consider the potential effect on participants' liquidity positions and market liquidity in designing their operational arrangements for collecting variation margin intraday.

### **Implementation timeline**

Although this guidance does not impose additional standards on CCPs or authorities beyond those in the PFMI, a CCP may need to make changes to its rules, procedures, governance



arrangements and risk management framework in order for its practices to be consistent with the guidance. The relevant authority may also determine that it is necessary to make changes to its regulatory framework. As already noted in the consultative report, CCPs should promptly identify any areas where changes are necessary, and address them as expeditiously as practicable, so that implementation of the necessary changes is completed no later than the end of 2017.<sup>5</sup>

## Further work

This report does not address recovery planning, which was included in the consultative report. Recovery planning is addressed separately via revisions to the 2014 report on *Recovery of financial market infrastructures* (the 2014 recovery guidance<sup>6</sup>).<sup>7</sup> The recovery-related comments received on the consultative report on CCP resilience and recovery were carefully considered in the process of revising the 2014 recovery guidance. It remains important that CCPs maintain recovery plans consistent with the PFMI and the 2014 recovery guidance.

Another useful complement to this guidance is supervisory stress testing, particularly in considering the collective response of multiple CCPs to the same stress event or events. The CPMI and IOSCO are currently developing a framework for supervisory stress testing.<sup>8</sup>

During the market consultation, many conflicting comments were received on the need for additional and more detailed disclosure to support participants and other entities in understanding and managing their risks vis-à-vis CCPs. Although it is acknowledged that further guidance on disclosures to facilitate effective feedback on the CCP risk management framework included in this report may also enhance the information available to participants and other entities for due diligence purposes, the CPMI and IOSCO intend to assess the need for further work on disclosure-related aspects of the PFMI.

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<sup>5</sup> The consultative report also noted that a number of gaps and shortcomings had been identified in at least some CCPs' implementation measures through the stocktaking exercise and through the Level 3 assessment. In two areas in particular, the consultative report noted that the CCP and its supervisors, regulators and overseers should consider these gaps and shortcomings to be serious issues of concern that warrant immediate action and that should be addressed with the highest priority. One area was recovery planning, where a number of CCPs had not yet put in place the full set of recovery rules and procedures as required under the PFMI. The other area was credit and liquidity risk coverage, where a number of CCPs had not yet put in place policies and procedures sufficient to ensure that they maintain the required level of financial resources on an ongoing basis. In addition, some CCPs did not include sufficient liquidity-specific scenarios in their stress-testing frameworks. Consistent with the consultative report, the Committees are currently conducting a supplementary Level 3 assessment of progress in these areas as of 31 December 2016.

<sup>6</sup> See [www.bis.org/cpmi/publ/d121.pdf](http://www.bis.org/cpmi/publ/d121.pdf) and [www.iosco.org/library/pubdocs/pdf/IOSCOPD455.pdf](http://www.iosco.org/library/pubdocs/pdf/IOSCOPD455.pdf).

<sup>7</sup> The CPMI and IOSCO published on 5 July 2017 a revised report on [Recovery of financial market infrastructures](http://www.iosco.org/library/pubdocs/pdf/IOSCOPD455.pdf). In addition, the FSB published on 5 July 2017 the final guidance on CCP Resolution. See <http://www.fsb.org/2017/07/guidance-on-central-counterparty-resolution-and-resolution-planning-2/>.

<sup>8</sup> A consultative report on supervisory stress testing was published by CPMI-IOSCO on 28 June 2017. See [www.bis.org/cpmi/publ/d161.htm](http://www.bis.org/cpmi/publ/d161.htm) and [www.iosco.org/library/pubdocs/pdf/IOSCOPD566.pdf](http://www.iosco.org/library/pubdocs/pdf/IOSCOPD566.pdf).

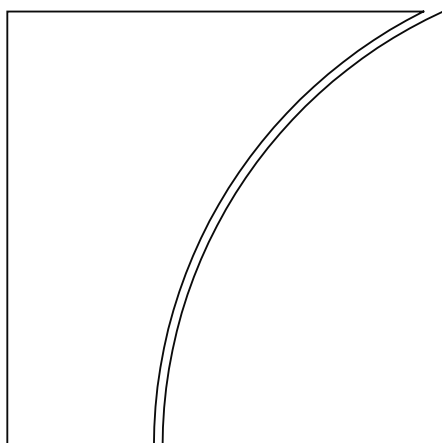
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## Executive summary

The purpose of this report is to provide guidance for use by central counterparties (CCPs) on certain principles and key considerations relating to CCP financial risk management in the *Principles for financial market infrastructures* (PFMI), published by the Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO). This guidance is also intended for use by regulatory, supervisory and oversight authorities as they carry out their respective responsibilities for CCPs. While numerous principles of the PFMI are referenced throughout the report, it should be noted that much of the guidance relates to governance (Principle 2), credit risk (Principle 4), margin (Principle 6), and liquidity risk (Principle 7). Other principles addressed include general business risk (Principle 15) and custody and investment risks (Principle 16).

CCPs have become increasingly critical components of the financial system in recent years, due in part to the introduction of mandatory central clearing for standardised over-the-counter (OTC) derivatives in some jurisdictions. It is imperative that each CCP is sufficiently resilient to withstand participant failures and other stress events to a very high probability.

To improve the resilience of CCPs, this report provides guidance on five key aspects of a CCP's financial risk-management framework: governance, stress testing for both credit and liquidity exposures, coverage, margin, and the contribution of its financial resources to losses.

As strong governance is a necessary component of an effective financial risk-management framework, Section 2 (governance) sets out the responsibilities of a CCP's board in its oversight of the risk-management tools and requirements discussed in other sections of the report. Sections 3 to 6 (stress testing for both credit and liquidity exposures, coverage, margin, and the contribution of CCP financial resources to losses) build on this governance framework and seek to assist CCPs in designing and implementing these key aspects of risk management, adding increased clarity and granularity relating to certain principles and key considerations of the PFMI.

The guidance topics in this report are interrelated. The guidance in this report is not intended to impose additional standards beyond those set out in the PFMI. This report should be read in conjunction with the relevant principles, key considerations and explanatory notes in the PFMI. The guidance provides clarity on an acceptable way – although it does not prescribe what is necessarily the only way – of observing the PFMI. Each CCP, in conjunction with the authorities responsible for its regulation, supervision and oversight, should carefully take into account the guidance in this report when developing its approach to observing the PFMI.

# 1. Introduction

## 1.1 Background

1.1.1. In 2009, the G20 Leaders committed themselves to ensuring that all standardised OTC derivatives contracts are cleared through CCPs.<sup>1</sup> Increased use of central clearing of derivatives is intended to enhance financial stability by simplifying the network of counterparty exposures between financial institutions and reducing the aggregate size of these exposures through multilateral netting by a CCP. The effectiveness of a CCP's governance arrangements and risk controls and the adequacy of its financial resources are critical to achieving these risk reduction benefits. Specifically, if CCPs are not properly managed, they can transmit financial shocks, such as liquidity dislocations and credit losses, across domestic and international financial markets.

1.1.2. In 2012, the CPMI and the Technical Committee of IOSCO (the Committees) published the PFMI, which significantly strengthened the international standards for risk management by financial market infrastructures (FMIs).<sup>2</sup> These standards (principles) were designed to make FMIs more resilient to financial crises and, in particular, participant defaults. For example, the principles require that certain FMIs should maintain a level of financial resources to address credit, liquidity and general business risk higher than their pre-2012 level. In addition, the principles introduced a requirement for all FMIs to comprehensively manage risks and develop plans for recovery or orderly wind-down.

1.1.3. The PFMI outline 24 principles for FMIs and five responsibilities for authorities, and provide “[f]or each standard ... a list of key considerations that further explain the headline standard. An accompanying explanatory note discusses the objective and rationale of the standard and provides guidance on how the standard can be implemented.”<sup>3</sup> With a few exceptions, the principles do not prescribe a specific tool or arrangement to achieve their requirements, instead allowing for different means to satisfy a particular principle. In some cases, the principles also incorporate a specific minimum requirement to ensure a common base level of risk management across FMIs and jurisdictions. The principles are designed to be applied holistically because of the significant interaction between principles; it is expected that the principles would be applied as a set and not on a standalone basis.

1.1.4. Since the publication of the PFMI, the Committees have been promoting full, timely and consistent implementation of the principles and responsibilities through their implementation monitoring programme. The Committees agreed to monitor implementation in 28 jurisdictions with authorities that are members of the Financial Stability Board (FSB), CPMI or IOSCO.<sup>4</sup> To this end, the CPMI-IOSCO Steering

<sup>1</sup> In September 2009, the G20 Leaders agreed in Pittsburgh that: “All standardised OTC derivative contracts should be traded on exchanges or electronic trading platforms, where appropriate, and cleared through central counterparties by end-2012 at the latest. OTC derivative contracts should be reported to trade repositories. Non-centrally cleared contracts should be subject to higher capital requirements. We ask the FSB and its relevant members to assess regularly implementation and whether it is sufficient to improve transparency in the derivatives markets, mitigate systemic risk, and protect against market abuse”. Full statement available at [www.fsb.org/wp-content/uploads/g20\\_leaders\\_declaration\\_pittsburgh\\_2009.pdf](http://www.fsb.org/wp-content/uploads/g20_leaders_declaration_pittsburgh_2009.pdf).

<sup>2</sup> The *Principles for financial market infrastructures* are available on the CPMI and IOSCO websites: [www.bis.org/cpmi/publ/d101a.pdf](http://www.bis.org/cpmi/publ/d101a.pdf) and [www.iosco.org/library/pubdocs/pdf/IOSCOPD377-PFMI.pdf](http://www.iosco.org/library/pubdocs/pdf/IOSCOPD377-PFMI.pdf). In December 2012, CPMI-IOSCO published a disclosure framework and assessment methodology to promote consistent disclosures of information by FMIs and consistent assessments by international financial institutions and national authorities. This report is available on the CPMI and IOSCO websites at [www.bis.org/cpmi/publ/d106.pdf](http://www.bis.org/cpmi/publ/d106.pdf) and [www.iosco.org/library/pubdocs/pdf/IOSCOPD396.pdf](http://www.iosco.org/library/pubdocs/pdf/IOSCOPD396.pdf).

<sup>3</sup> Paragraph 1.36 of the PFMI.

<sup>4</sup> The 28 jurisdictions that are participating in the PFMI implementation monitoring exercise are Argentina, Australia, Belgium, Brazil, Canada, Chile, China, the European Union, France, Germany, Hong Kong SAR, India, Indonesia, Italy, Japan, Korea, Mexico, the Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

Group<sup>5</sup> established a standing working-level group, the Implementation Monitoring Standing Group (IMSG), to design, organise and carry out the implementation monitoring assessments.<sup>6</sup> The monitoring work is being carried out at three levels: Level 1 assessments of the status of the implementation process by each jurisdiction, Level 2 assessments of the completeness of a particular jurisdiction's framework and its consistency with the PFMI, and Level 3 assessments of the consistency in outcomes of such frameworks by considering practices of certain FMIs or authorities.<sup>7</sup> The findings from these assessments inform the Committees on whether further guidance is needed to facilitate implementation of the PFMI.

1.1.5. Given the increasing importance of CCPs in recent years, catalysed in part by the introduction of mandatory clearing in some jurisdictions, the G20 Finance Ministers and Central Bank Governors asked the FSB to work with the CPMI, IOSCO and the Basel Committee on Banking Supervision to develop and report back on a workplan for identifying and addressing any remaining gaps and potential financial stability risks relating to CCPs that are systemic across multiple jurisdictions and for helping to enhance their resolvability.<sup>8</sup> The chairs of the relevant committees agreed on such a workplan (known as the "CCP workplan") in April 2015, and launched workstreams under their respective committees to address the substantive priorities related to CCP resilience, recovery planning and resolvability.<sup>9</sup>

1.1.6. CPMI-IOSCO is the primary forum for the priorities identified under CCP resilience and recovery. Such work is carried out by another standing working-level group, the Policy Standing Group (PSG), established by the CPMI-IOSCO Steering Group. Consistent with the CCP workplan on CCP resilience, the Committees evaluated the adequacy of several existing standards on CCP stress-testing practices, loss absorption capacity (including coverage requirements), liquidity and initial margin methodologies, taking into account the implementation of the PFMI. In considering these findings, and those of the IMSG Level 3 assessment, the Committees concluded that certain standards in the PFMI would benefit from more granular guidance in order to further advance implementation by CCPs and improve their overall resilience.

## 1.2 Purpose of the report

1.2.1. The purpose of this report is to provide guidance on the principles and key considerations in the PFMI regarding financial risk management for CCPs.<sup>10</sup> The guidance reflects a more detailed and granular expression of how CCPs should approach implementation of several key aspects of the PFMI to further improve CCP resilience. These are governance, stress testing for both credit and liquidity exposures, coverage, margin, and a CCP's contribution of its financial resources to losses. The Committees note that the detail and granularity of the guidance should be understood in the context of the principles-based approach reflected in the PFMI, which recognises CCPs' differing organisations, functions and designs, and the different ways to achieve a particular result.<sup>11</sup> This report should be read in conjunction with the

<sup>5</sup> The Steering Group comprises a subset of the members of the CPMI and the IOSCO Board, and is responsible for providing operational guidance on behalf of the parent committees on joint CPMI-IOSCO work.

<sup>6</sup> The IMSG comprises representatives from 18 jurisdictions that reflect a balance of CPMI and IOSCO members and geographical dispersion, as well as a range of domestic and global FMI supervisors and overseers.

<sup>7</sup> To date, four Level 1 assessments, four Level 2 assessments, one Level 3 assessment and an assessment of the responsibilities of authorities have been carried out. These assessments each addressed one or more jurisdictions or CCPs. All implementation monitoring reports are available on the CPMI and IOSCO websites at [www.bis.org/cpmi/info\\_mios.htm?m=3|16|599](http://www.bis.org/cpmi/info_mios.htm?m=3|16|599) and [www.iosco.org/publications/?subsection=public\\_reports](http://www.iosco.org/publications/?subsection=public_reports).

<sup>8</sup> See Communiqué from February 2015 G20 Finance Ministers and Central Bank Governors meeting at [www.g20.utoronto.ca/2015/150210-finance.html](http://www.g20.utoronto.ca/2015/150210-finance.html).

<sup>9</sup> See [www.bis.org/cpmi/publ/d134b.pdf](http://www.bis.org/cpmi/publ/d134b.pdf).

<sup>10</sup> While the guidance included in this report is intended explicitly for use by CCPs, some of the guidance may be potentially relevant and useful to other types of FMIs.

<sup>11</sup> See paragraph 1.2 of the PFMI.

relevant principles, key considerations and explanatory notes in the PFMI.<sup>12</sup> The guidance provides clarity on an acceptable way – although it does not prescribe what is necessarily the only way – of observing the PFMI. Each CCP, in conjunction with the authorities responsible for its regulation, supervision and oversight, should carefully take into account the guidance in this report when developing its approach to observing the PFMI.

### 1.3 Key inputs into the report

1.3.1. There were five main inputs to the development of further guidance in this report: (i) industry workshops (conducted both before and during the consultation) with participation by CCPs, direct participants and indirect participants; (ii) the stocktake of current financial risk-management and recovery practices in place at over 30 CCPs clearing securities and derivatives products in exchange-traded and OTC markets; (iii) papers submitted by industry groups; (iv) the findings from the Committees' Level 3 implementation monitoring assessment of financial risk-management practices for a selected group of CCPs; and (v) comments submitted in response to the consultative report.<sup>13</sup>

### 1.4 Organisation of the report

1.4.1. This report is organised by topic area. Each topic begins with context followed by guidance on specific principles and key considerations in the PFMI. Where applicable, examples illustrate possible ways to implement the guidance. These examples are not meant to be prescriptive or exhaustive.

1.4.2. The report is organised in sections as follows: governance (Section 2), credit and liquidity stress testing (Section 3), coverage (Section 4), margin (Section 5) and CCPs' contributions of financial resources to losses (Section 6).

### 1.5 Implementation

1.5.1. Although this guidance is not intended to impose additional standards on CCPs or authorities beyond those in the PFMI, a CCP may need to make changes to its rules, procedures, governance arrangements and risk-management framework in order for its practices to be consistent with the guidance.

1.5.2. Accordingly, a CCP should promptly identify any areas where changes are necessary and develop a course of action to address them as expeditiously as practicable, taking into consideration the relevant timelines for any necessary regulatory approvals. The implementation of such changes should be completed no later than the end of 2017.

1.5.3. Relevant authorities should perform their own assessments of a CCP's observance of the PFMI and determine whether any further action by the CCP based on this guidance is needed<sup>14</sup> and whether regulatory changes are required to ensure CCPs apply the principles and address any gaps.

<sup>12</sup> See paragraph 1.36 of the PFMI.

<sup>13</sup> Resilience and recovery of central counterparties (CCPs): Further guidance on the PFMI – consultative report. <http://www.iosco.org/library/pubdocs/pdf/IOSCOPD539.pdf>

<sup>14</sup> See paragraph 1.32 of the PFMI.

## 2. Governance

### 2.1 Context

2.1.1. Principle 2 of the PFMI sets forth governance standards for a CCP. Specifically, the principle requires a CCP to have documented governance arrangements that provide clear and direct lines of responsibility and accountability and clearly specified roles and responsibilities for the CCP's board of directors (or equivalent) and the CCP's management.<sup>15</sup> The principle also sets forth the ultimate responsibility of a CCP's board<sup>16</sup> to establish a clear, documented risk-management framework that includes the CCP's risk-tolerance policy, and to ensure that the CCP's design, rules, overall strategy and major decisions reflect appropriately the legitimate interests of its direct and indirect participants and other relevant stakeholders.<sup>17</sup> Accordingly, a CCP's board should have ultimate responsibility to ensure that the CCP's margin system and stress-testing framework, as key elements of the CCP's overall risk-management framework, are designed: (i) to set and to maintain on an ongoing basis the required level of financial resources; (ii) to determine the amount of a CCP's own financial resources and the characteristics of those resources to absorb certain losses; and (iii) to assess and limit the effects of procyclicality. The board should also have ultimate responsibility for establishing a comprehensive disclosure and feedback mechanism for engaging with direct and indirect participants and other relevant stakeholders on the above areas of its risk management. This guidance is intended to provide further direction for the board in carrying out the responsibilities discussed in this section.

### 2.2 Guidance

#### *Responsibility of the board*

2.2.1. The board has ultimate responsibility for establishing a risk-management framework and for the effectiveness of its implementation.<sup>18</sup> In carrying out this responsibility, the board is not expected to itself implement the risk-management framework or to carry out the day-to-day management of risks. Rather, the board, in discharging its ultimate responsibility over risk-management matters, should work closely with the CCP's management. More specifically, the board is itself responsible for: (i) carefully overseeing, monitoring and evaluating management's implementation of the risk-management framework; (ii) taking appropriate steps to ensure that management is performing risk-management tasks properly and effectively; (iii) ensuring that processes are in place for effective and timely communication, reporting and information flow between management and the board; (iv) communicating with management about risk-management processes; and (v) when assessing the risk-management framework, appropriately challenging management to demonstrate the effectiveness of risk-management processes. While a board may not delegate its ultimate responsibilities regarding risk management, it may assign certain tasks, so long as the board clearly defines the assigned tasks and retains ultimate responsibility over such tasks.

2.2.2. To assist the board in discharging its ultimate responsibility as described above (in paragraph 2.2.1), the board may assign tasks to a board committee. In such assignments, the board retains ultimate responsibility for the CCP's risk-management framework, and should oversee and, as appropriate, challenge decisions made by the committee. To the extent the board assigns certain tasks to a board committee, the board should ensure that: (i) such committee is composed of suitable members (including members of the board) with an appropriate mix of skills, experience and knowledge of the CCP; (ii)

<sup>15</sup> See Key Considerations 2 and 3 of Principle 2 of the PFMI.

<sup>16</sup> References to 'board' in this report should be taken to mean the board of directors (or equivalent).

<sup>17</sup> Other relevant stakeholders may include but are not limited to other CCPs, central securities depositories, securities settlement systems and payment systems. See Key Considerations 6 and 7 of Principle 2 of the PFMI.

<sup>18</sup> See paragraphs 3.2.8 and 3.2.12 of the PFMI.

members of such committee have a clear understanding of their roles in corporate governance, are able to devote sufficient time to their roles, ensure that their skills remain up-to-date, and have appropriate incentives to fulfil their roles; (iii) such committee is independent from the CCP's management; and (iv) such committee is of a size sufficient to ensure that its members have a range of experience and abilities to consider the issues assigned to them.

### *Design and objectives of the margin system and stress-testing framework*

2.2.3. The board should have the ultimate responsibility for ensuring that the margin system and stress-testing framework are designed to set and maintain on an ongoing basis the CCP's required level of financial resources, which includes (i) the required level of total prefunded financial resources to cover credit exposures, and (ii) the required level of qualifying liquid resources in each currency to cover liquidity exposures. These should each be consistent with the CCP's risk tolerance and subject to the minimum coverage requirements for credit and liquidity risk, respectively, as set forth in the PFMI.<sup>19</sup> In determining the risk tolerance of the CCP, including whether, and if so by how much, to set the CCP's required level of financial resources above the minimum coverage standards specified in Principle 4, Key Consideration 4 of the PFMI, the board should take into account the CCP's risk profile (as described in paragraph 4.2.1), as well as the stability of the broader financial system and other relevant public interest considerations.<sup>20</sup>

2.2.4. As part of this responsibility, the board should ensure that the CCP undertakes periodic reviews<sup>21</sup> to assess (i) how material changes to the CCP's products, services, policies, or practices, and how changes to market conditions or structures, may affect its risk profile or risk tolerance, and (ii) how these changes should be incorporated into the CCP's risk-management practices, including, in particular, the CCP's margin system and stress-testing framework.

2.2.5. For the purpose of using stress testing to establish the required level of financial resources, the board should ensure that the stress-testing framework includes proper risk identification, scenario selection, risk measurement and appropriate analyses of stress-testing scenarios, models, and underlying parameters and assumptions. In this regard, the board has ultimate responsibility for ensuring that the criteria for and the selection of all relevant extreme but plausible scenarios and market conditions are clearly defined, justified and documented.

2.2.6. For purposes of the design of the margin system, the board should have ultimate responsibility for identifying, clarifying and evaluating the choices and trade-offs present in the design of the overall risk-management framework, including the target degree of credit and liquidity risk mutualisation. As discussed in more detail in Section 5, part of this process entails evaluation of various models and approaches, and selection of those most appropriate for the product(s) cleared.

2.2.7. Notably, the board should be ultimately responsible for any material change to the margin system and stress-testing framework (eg changing margin models and changing the composition of total prefunded financial resources). In such cases, the board should properly assess, challenge, and require management to explain the need for, such a change, particularly where such changes are being driven by the CCP's evolving risk profile. For example, if a CCP's management recommends removing any historical event from the margin assumptions or stress-testing scenarios, then the board should require management to perform a comprehensive, rigorous analysis. Historical scenarios carry an initial presumption of plausibility because they are based on events that have, in fact, occurred; however, factors may change that may render such historical events implausible. As noted below in paragraph 3.2.34, such a determination is expected to be rare. Thus, in the event management recommends deletion of a historical scenario, the board should provide an effective challenge to management's analysis, and the board should

<sup>19</sup> For the purposes of this report, risk tolerance refers to the types and aggregate level of risk that a firm is willing to accept in order to meet its strategic and business objectives, as defined by the board in the CCP's risk-tolerance policy.

<sup>20</sup> See Principle 2, Key Consideration 1 of the PFMI.

<sup>21</sup> The appropriate frequency of such reviews is discussed in paragraph 3.2.57 of this report (for stress testing) and in paragraphs 3.6.15-17 of the PFMI (for margin).

retain responsibility for any decision to remove such historical scenario. Additionally, the board should ensure that any material change made to the margin system or stress-testing framework is documented and reported to the CCP's participants and other relevant stakeholders for review as part of the CCP's disclosure and feedback process, as discussed in paragraphs 2.2.18–27.

### *Ongoing maintenance of required financial resources*

2.2.8. The board should have ultimate responsibility for ensuring that the CCP maintains the required levels of financial resources on an ongoing basis, and for ensuring that prompt corrective action is taken if the CCP is not, or is at material risk of not, doing so. The board should ensure that the CCP's policies and procedures clearly delineate the respective roles, responsibilities and authorities of management and the board for taking such action.

2.2.9. The board should be equipped with necessary information to carry out its responsibilities referred to in paragraph 2.2.8. For instance, the results of daily and, as relevant, intraday margin coverage analysis and stress testing should be reported to the board, the chief risk officer (or other responsible individual) and the relevant management committee with sufficient frequency to allow each party to fulfil its responsibilities. The board may assign to management the authority to take prompt corrective action based on these margin coverage and stress-testing results. Furthermore, the CCP's policies and procedures should clearly stipulate the thresholds, escalation criteria and breaches that should trigger an automatic and, where appropriate, same-day contribution from direct participants. In addition, such policies and procedures should clearly articulate the form of the contribution (eg additional margin or default fund contributions), the method of calculating the contribution and the relevant payment deadline.

2.2.10. The board should review the CCP's relevant policies and procedures at least annually to ensure that the CCP is effective in identifying and taking prompt action if the CCP is not, or is at material risk of not, maintaining its required financial resources, based on margin coverage and stress-testing results. The board also should ensure that a review of relevant aspects of the CCP's risk-management framework is initiated immediately after a breach of either the required level of total prefunded financial resources to cover credit exposures, or the required level of qualifying liquid resources in each currency to cover liquidity exposures. The board should provide appropriate challenge to the review and ensure that the risk-management framework is amended as appropriate so as to avoid the reoccurrence of such breaches.

### *Determining the amount and characteristics of a CCP's own financial resources to absorb losses*

2.2.11. The board should have ultimate responsibility for determining and exposing an amount of the CCP's own financial resources to certain losses that would enhance confidence in the CCP's risk management. In particular, as discussed further in Section 6, the amount and characteristics (eg form, composition, segregation and seniority in a loss "waterfall") of a CCP's own contribution to absorb potential losses resulting from a participant default and the custody and investment of participant assets can enhance confidence that the CCP's risk-management design, rules, overall strategy and major decisions reflect appropriately the legitimate interests of its participants and other relevant stakeholders.<sup>22</sup> When the board determines the amount and the characteristics of the CCP's own contribution, the board should employ mechanisms to seek and consider the views of direct and indirect participants and other relevant stakeholders. Such engagement should be designed to ensure that the board considers, accounts for and reflects stakeholders' legitimate interests in the CCP's risk management. Moreover, exposing a

<sup>22</sup> Prefunded financial resources used to cover losses caused by participant defaults are commonly referred to as a "waterfall" and may include the defaulter's initial margin, the defaulter's contribution to a prefunded default arrangement, a specified portion of the CCP's own funds and other participants' contributions to a prefunded default arrangement. See paragraph 3.4.17 of the PFMI. In addition, in the case of some CCPs for cash markets, the CCP may require each participant to provide collateral to cover credit exposures; they may call these requirements margin, or they may hold this collateral in a pool known as a clearing fund. See paragraph 3.6.2 of the PFMI. Prefunded default arrangements are often referred to as a "default fund," "guarantee fund" or "clearing fund."

CCP's owners to losses can provide appropriate incentives to owners to ensure that the CCP is properly risk-managed.<sup>23</sup> However, without adequate governance arrangements and stakeholder engagement, these risk-management incentives may be less effective.

2.2.12. The board should periodically review and approve the amount and characteristics of the CCP's own financial resources that the CCP exposes to losses. To support this process, the board should ensure there are mechanisms to seek and consider the views of direct and indirect participants and other relevant stakeholders and, if necessary, revise accordingly the amount and characteristics of the CCP's contribution. The CCP should also be transparent in its decision-making and clearly communicate the outcome of the review to its direct and indirect participants and other relevant stakeholders.<sup>24</sup>

### *Limiting destabilising, procyclical changes*

2.2.13. The board should have ultimate responsibility to assess and limit – to the extent practicable and prudent – destabilising, procyclical changes in the overall quantity of financial resources collected from direct participants, including initial margins, margin add-on charges, and default fund contributions as well as in collateral haircuts. The approach established by the board for assessing and limiting procyclicality should be clearly defined, justified and documented with clear roles and responsibilities established for management and the board. In addition, the approach should be reviewed and approved by the board at least annually, supported by analysis performed by management and in consultation with participants, linked CCPs and other relevant stakeholders. For example, in the context of charges assessed under a CCP's margin system, re-sizing of prefunded default arrangements, or collateral haircut regime, a CCP could have in place policies and procedures that are designed to limit the probability of large, unpredictable charges.

2.2.14. As discussed in greater detail in Section 5, the board should ensure that the CCP considers establishing quantitative and qualitative criteria that assist it in evaluating procyclical effects. For example, a CCP could use these criteria to assess whether changes in the overall quantity and composition of financial resources collected at the participant level, from linked CCPs or in the aggregate by the CCP would have a destabilising, procyclical impact. Such criteria could also be used to assist the CCP in conducting periodic assessments of observed destabilising, procyclical changes, and the results could then be reported to the chief risk officer, the relevant management committee and the board.

2.2.15. The board should also ensure that the CCP conducts regular and rigorous due diligence of its participants' understanding of, and their ability to predict and manage, potential changes in margin, contributions to prefunded default resources, cash calls and collateral haircuts in times of market stress. This due diligence helps ensure that participants understand and have taken the necessary steps to be prepared to meet such requirements while the CCP also looks to implement and maintain its framework for addressing procyclicality.

### *Review and validation of margin system and stress-testing framework*

2.2.16. The board should have ultimate responsibility for ensuring that the validation of the CCP's margin system and stress-testing framework for both credit and liquidity risks is conducted at least annually and in a manner that is independent of the development, implementation and operation of the models and their methodologies. In addition, the board should have ultimate responsibility for ensuring that the adequacy and effectiveness of the validation process is subjected to an independent review.<sup>25</sup> This responsibility, in turn, requires the board to be informed of the findings of all such validations and reviews as well as to approve the CCP's response to these findings.

<sup>23</sup> See paragraph 3.3.9 of the CPMI-IOSCO report on *Recovery of financial market infrastructures*.  
<http://www.iosco.org/library/pubdocs/pdf/IOSCOPD455.pdf>

<sup>24</sup> See Key Consideration 7 of Principle 2 and paragraph 3.4.24 of the PFMI.

<sup>25</sup> See also paragraph 3.2.16 of the PFMI.



2.2.17. For example, any validations and reviews of the margin system and stress-testing framework (eg methodology, parameters, assumptions, changes and improvements) could be provided to the CCP's risk committee. Any advice provided to the CCP on such validations and reviews by a risk committee, or any feedback provided by a risk advisory or risk working group or any other mechanism (see paragraph 2.2.24), should be provided to and considered by the board.

#### *Disclosure and feedback mechanism for reviewing the margin system and stress-testing framework*

2.2.18. As a general matter, the board has ultimate responsibility for establishing a comprehensive disclosure and feedback mechanism for soliciting views from direct participants, indirect participants and other relevant stakeholders to inform the board's decision-making regarding the CCP's risk-management framework. Consistent with paragraph 1.2.1, this guidance relates to disclosure and feedback for reviewing the margin system, the stress-testing methodology, the appropriate sizing of prefunded financial resources and a CCP's contribution of its financial resources to losses.

2.2.19. Instituting a feedback mechanism ensures that the board is informed of, and considers for the purposes of internal review, any concerns expressed by direct participants, indirect participants and other relevant stakeholders with respect to the CCP's risk-management framework. To achieve these objectives, the board should take steps to ensure that the feedback mechanism employed is properly implemented and is carried out on an ongoing basis. In establishing such a mechanism, the board should specifically contemplate an appropriate predetermined frequency of communication with participants and any other relevant stakeholders. In addition, the mechanism should be designed to enable the CCP to draw upon the relevant expertise and perspectives of all relevant stakeholders.

2.2.20. An effective disclosure and feedback mechanism for reviewing the CCP's margin system and stress-testing framework should include: (i) categories of recipients, including the related level of detail and frequency of disclosure to such recipients (the level of detail and frequency of such disclosure may vary depending on the type of stakeholder); (ii) identification of the disclosure methods appropriate for each category of recipient; (iii) implementation of controls to ensure that disclosure is consistent over time; (iv) identification of explicit and effective channels for receiving and considering feedback from relevant stakeholders as part of the board's decision-making process relating to reviewing the CCP's margin system and stress-testing framework; and (v) processes for addressing, explaining and documenting actions taken in response to stakeholder feedback, including cases in which such action is not taken.

2.2.21. A CCP should disclose information in such a way that does not: (i) reveal the positions of individual participants, direct or indirect; (ii) confer commercial advantage on any individual stakeholder or groups of stakeholders; or (iii) put the safety and soundness of the CCP at risk. The CCP should make available such information in a consistent manner and over an appropriate and, if necessary, secure channel that facilitates timely access. In the case of confidential information, for example, this could be achieved through a secure connectivity between a participant and a CCP or through direct engagement of the chief risk officer of the participant institution during due diligence processes.

2.2.22. In order to solicit useful feedback on its margin system and stress-testing framework, a CCP will need to disclose information to participants and other relevant stakeholders to facilitate their review.<sup>26</sup> Subject to the safeguards set forth in paragraph 2.2.21, sufficiently detailed, accurate, reliable and timely information on the CCP's margin system and stress-testing framework should be provided to participants and other relevant stakeholders to permit them to understand and provide effective feedback and challenge concerning the rigour of the CCP's approach, methodologies, parameters, assumptions, scenarios and model performance. This information should cover, at a minimum:

- Methodologies, parameters, assumptions (eg market liquidity and closeout costs implicit in the CCP's assumed margin periods of risk (MPORs) and closeout periods), stress-testing scenarios

<sup>26</sup> See Key Consideration 7 of Principle 2 of the PFMI.

and summary results of stress tests and margin coverage tests, along with relevant sensitivity analyses and reverse stress-testing results.

- The supporting rationale for the CCP's financial and liquidity resource sizing decisions (paragraph 4.2.1), and for other key aspects of its risk modelling, including its choice of MPORs (paragraph 5.2.4), stressed periods of risk (SPORs) (paragraph 3.2.45) and its criteria for applying portfolio margining (paragraphs 5.2.53–55).
- Sufficiently granular details on the CCP's margin system to support its participants' ability to understand, to assess and to provide feedback on the predictability of margin requirements, including the likelihood of large or unexpected margin calls in times of market stress.
- The CCP's approach to add-on charges (paragraph 5.2.11-16), as well as its approach to assessing and limiting destabilising, procyclical changes of all financial resources collected, including the supporting rationale for these approaches.

2.2.23. More generally, the CCP should provide sufficient information, in a manner consistent with the safeguards in paragraph 2.2.21, to support the replicability of margin requirements (including, to the extent practicable, add-on charges) such that participants can understand how the margin model behaves and how their individual margin requirements can change over time and under changing market conditions.

2.2.24. To ensure that the CCP obtains a range of perspectives from relevant stakeholders, it should consider a variety of channels for feedback. These could, for example, include formal groups or committee structures established by the CCP, such as risk advisory or risk working groups (including, as appropriate, risk committees) involving participants and other relevant stakeholders who represent the views of either their respective institution or their peers (for example, a category of CCP participant). Other channels might include formal and/or informal dialogue with relevant stakeholders, either in bilateral or multilateral forums, or comment periods on proposed changes to a CCP's rules, procedures or operations. A CCP should also consider obtaining external, expert feedback.

2.2.25. In determining the combination of feedback mechanisms it uses, the CCP should aim to ensure that the range of perspectives it obtains adequately reflects the breadth and complexity of its business (eg its product scope). Where the CCP uses for this purpose one or more groups referred to in paragraph 2.2.24, it should consider whether the breadth of skills and expertise in such groups, in the aggregate, spans the full range of the CCP's services and its risk-management framework. The CCP should also take into account in whose interests (under any applicable terms of reference) the representatives on such groups are acting.

2.2.26. Feedback should be reported to the CCP's chief risk officer, relevant risk committee and the board. A CCP's board should therefore ensure that there is a process by which the feedback received reliably reaches the board. The CCP should also keep records reflecting the feedback provided when participants and other relevant stakeholders are consulted, regardless of the forum.

2.2.27. The disclosures described in the preceding paragraphs may serve a function beyond that of facilitating the CCP's solicitation of views from direct participants, indirect participants and other relevant stakeholders to inform the board's decision-making regarding the CCP's risk-management framework. As an additional potential benefit, such disclosures may also enhance the CCP's ability to provide to its participants and other stakeholders information that such parties can use to assess, manage and contain their risks vis-à-vis the CCP.<sup>27</sup>

<sup>27</sup> See paragraph 3.3.1 and Principle 23 of the PFMI. Potential vehicles available to a CCP to implement these disclosures include the *Disclosure Framework* and the *Public Quantitative Disclosure Standards for Central Counterparties*, which together form the minimum disclosure requirements for CCPs under Principle 23. See: [www.bis.org/cpmi/publ/d106.pdf](http://www.bis.org/cpmi/publ/d106.pdf) and [www.bis.org/cpmi/publ/d125.pdf](http://www.bis.org/cpmi/publ/d125.pdf).

## 3. Stress testing

### 3.1 Context

3.1.1. Stress testing is fundamental to the risk-management framework of a CCP. Credit and liquidity stress tests help the CCP determine whether it is maintaining sufficient prefunded financial resources pursuant to Key Consideration 4 of Principle 4 and sufficient qualifying liquid resources pursuant to Key Consideration 4 of Principle 7.<sup>28</sup> Furthermore, as described in Section 4 (coverage), the results of these stress tests inform the CCP, including the board, when it is deciding whether additional prefunded financial resources should be maintained beyond the minimum standards in the PFMI. The PFMI also set certain expectations for the scope and frequency of stress testing for both credit and liquidity exposures by a CCP.

3.1.2. For credit stress tests, Key Consideration 5 of Principle 4 calls for a CCP to “determine the amount and regularly test the sufficiency of its total financial resources available ... through rigorous stress testing”, while Key Consideration 6 of Principle 4 notes that “[i]n conducting [credit risk] stress testing, a CCP should consider the effect of a wide range of relevant stress scenarios in terms of both defaulters’ positions and possible price changes in liquidation periods. Scenarios should include relevant peak historic price volatilities, shifts in other market factors such as price determinants and yield curves, multiple defaults over various time horizons, simultaneous pressures in funding and asset markets, and a spectrum of forward-looking stress scenarios in a variety of extreme but plausible market conditions.”

3.1.3. For liquidity stress tests, Key Consideration 9 of Principle 7 establishes an expectation for a CCP to conduct such tests, recognising that stress scenarios should encompass the characteristics listed above for credit stress tests and “should also take into account the design and operation of the FMI, include all entities that might pose material liquidity risks to the FMI (such as settlement banks, nostro agents, custodian banks, liquidity providers, and linked FMIs), and where appropriate, cover a multiday period”.

3.1.4. Designing an effective stress-testing framework involves: identifying the credit and liquidity risks to which a CCP could be exposed; constructing a range of stress scenarios that adequately capture potential future extreme but plausible market conditions; using these scenarios to derive suitable measures of the CCP’s aggregate credit and liquidity exposures and the financial resources and liquid resources available to absorb these exposures; and evaluating the adequacy of the CCP’s financial resources and liquid resources. Accordingly, this section sets out guidance with respect to stress testing on: the structure of credit and liquidity stress-testing frameworks; the identification of risks; the development of extreme but plausible scenarios; and the calculation and aggregation of stress test results. Further guidance is provided on a CCP’s analysis of stress-testing scenarios, models, and underlying parameters and assumptions.

3.1.5. The guidance below is intended to set clear expectations for the rigour of the credit and liquidity stress tests called for in the PFMI, as appropriate to the systemic importance of CCPs. It does not set prescriptive requirements, or aim to provide a definition of terms such as “extreme but plausible”. Rather, it aims to elaborate on the key matters for consideration identified in the PFMI that CCPs should take into account in establishing their stress-testing frameworks.

<sup>28</sup> Specifically, Principle 4, Key Consideration 4 states that a CCP should “maintain ... financial resources to cover a wide range of potential stress scenarios that should include ... the default of the [one or two participants, including their affiliates] that would potentially cause the largest aggregate credit exposure for the CCP in extreme but plausible market conditions”. Similarly, Principle 7, Key Consideration 4 explains that a CCP should “maintain sufficient liquid resources in all relevant currencies to ... meet ... payment obligations on time with a high degree of confidence under a wide range of potential stress scenarios that should include ... the default of the participant and its affiliates that would generate the largest aggregate payment obligation to the CCP in extreme but plausible market conditions”. See Principle 7, Key Consideration 5 for discussion of qualifying liquid resources.

## 3.2 Guidance

### Structure of credit and liquidity stress-testing frameworks

3.2.1. Principles 4 and 7 of the PFMI establish similar, but subtly distinct, standards on how a CCP should conduct credit and liquidity stress tests for the purposes of verifying the adequacy of financial and liquid resources, respectively. In particular, Principle 7 of the PFMI establishes a requirement for a CCP to capture in liquidity stress tests exposures to entities other than its participants.<sup>29</sup>

3.2.2. A CCP should conduct distinct but consistent stress tests for credit risk and liquidity risk. A CCP's role as a central counterparty creates both credit and liquidity exposures, which should be covered by prefunded available financial resources and qualifying liquid resources, respectively. In conducting stress testing for both credit and liquidity exposures, CCPs should ensure that these exposures are adequately covered, taking into account the likely availability and value of these resources in stressed market conditions.

3.2.3. It will often be the case that there is some overlap between credit and liquidity stress-testing scenarios, for example in the way in which potential changes in the value of cleared positions (and resulting variation margin payments) are incorporated into the tests. However, a default by a participant or other counterparty can create a liquidity exposure in excess of, or even in the absence of, any credit exposure, as the CCP may be required to convert eligible collateral (including currencies other than the currency of settlement) into the currency required to meet its payment obligations when due.<sup>30</sup>

3.2.4. A CCP should ensure that its credit and liquidity stress tests are structured in a way that is consistent with the rules and procedures that govern, respectively, how credit and liquidity risk is managed day-to-day and following a participant default. This may include performing credit and liquidity stress tests over different time horizons, recognising the importance of intraday liquidity in particular.

3.2.5. In addition, some CCPs operate multiple clearing services, each clearing a distinct set of products.<sup>31</sup> Some of these CCPs manage their credit risk by maintaining separate default waterfalls to support each distinct service such that losses incurred in one service line cannot be covered by resources maintained to support another service line. A CCP employing this structure should conduct separate credit risk stress tests for each clearing service and the corresponding default waterfall. Similarly, if a CCP manages its liquidity risk on a service line basis, it should conduct separate liquidity stress tests for each clearing service and corresponding default waterfall. For other CCPs, a portion of credit or liquidity resources may be shared between service lines, and in still other cases, all credit or liquidity resources may be shared. A CCP should structure its credit and liquidity stress tests accordingly for each service line and for all relevant combinations, consistent with its particular arrangements. In the context of such combinations, the CCP should be attentive to the challenges associated with modelling stress scenarios that span multiple asset classes.

3.2.6. Even where credit and liquidity exposures derive from the same external event, a CCP may require additional liquid resources or arrangements to the extent that the prefunded financial resources available to meet the credit exposure are not sufficiently liquid. For example, a CCP may require a prearranged and

<sup>29</sup> See Key Consideration 9 of Principle 7 of the PFMI.

<sup>30</sup> A CCP's credit exposure in the event of a participant default is the net adverse movement in the value of the defaulter's portfolio over the period the CCP holds the position (ie until the position is closed out). However, during that period the CCP will need sufficient cash in each requisite currency to fund payment and settlement obligations as they fall due, and differences in the timing may mean that the CCP's liquidity exposure is larger than its credit exposure. This is especially the case for cash market CCPs, which may face relatively modest net credit exposures but may need to fulfil a significant amount of gross settlement obligations over that period.

<sup>31</sup> Although precise structures vary, in general a clearing service is characterised by a common set of rules and related arrangements to mutualise losses (in excess of margin) across participants in the service.

highly reliable funding arrangement for the highly marketable collateral it uses to cover credit risk to qualify as liquid resources.

3.2.7. Similarly, since a CCP may have obligations to make payments in a range of currencies, it should maintain sufficient liquid resources in each currency for which it has an obligation. Again, this may result in a situation in which the CCP requires additional arrangements to convert promptly available prefunded financial resources denominated in one currency into the required currency (ie the currency in which the CCP has the obligation).

3.2.8. Risks from entities other than participants can also affect the size of, or timeliness of access to, a CCP's resources. A CCP should recognise other potential sources of liquidity risk – arising, for example, from the failure of a liquidity provider, settlement bank, nostro agent or investment counterparty – and ensure that its sources of risk are properly captured in bespoke liquidity stress tests.

### Identification of risks

3.2.9. As set forth in Key Consideration 1 of Principle 3, a CCP should “have risk-management policies, procedures, and systems that enable it to identify, measure, monitor, and manage the range of risks that arise in or are borne by the [CCP].” Key Consideration 2 of Principle 4 provides that the CCP “should identify sources of credit risk” and Key Consideration 1 of Principle 4 notes that credit exposures and risks may arise to and from participants, payment, clearing and settlement processes, and that these exposures may arise from “current exposures, potential future exposures, or both”. Similarly, Key Consideration 1 of Principle 7 states that a CCP should “have a robust framework to manage its liquidity risks from its participants, settlement banks, nostro agents, custodian banks, liquidity providers, and other entities.” The guidance below is intended to cover the full range of risks, both credit and liquidity, that should be captured in stress testing.

#### *Identification of all sources of credit risk*

3.2.10. A CCP should identify all sources of credit risk to which it could be exposed in extreme but plausible market conditions, and ensure that each source of risk is appropriately captured in credit stress tests. These risk sources should include exposures related to the market value of cleared positions as well as the market value of the collateral and any other financial resources available to cover these exposures. Certain risks could affect both exposures and resources, and a CCP should ensure that it accounts for these risks consistently and accurately. A CCP should also identify credit exposures on both an end-of-day and intraday basis, recognising the potential for the composition of participants' positions and the collateral they provide to vary materially during the business day.

#### *Risks related to credit exposures*

3.2.11. A CCP should identify all sources of risk that affect the market value of cleared portfolios. These risk sources should include, as appropriate, price movements for all cleared products over the liquidation period (including, where appropriate, intraday exposures) as well as potential changes in the size and composition of cleared portfolios after the last collection of prefunded financial resources. Transaction costs or bid-ask spreads associated with liquidating or hedging the portfolio of cleared products in extreme but plausible market conditions should also be considered.<sup>32</sup> A CCP should also consider potential wrong-way risks arising, for example, from correlation between the market value of cleared products and the creditworthiness of participants. Additional risk sources may include risks addressed in the margin system (including those related to add-on charges), foreign exchange risk, risks associated with linked FMIs and risks posed by both end-of-day and intraday settlement processes (including the relevant standard settlement cycle generally), recognising in particular the impact on the composition – and

<sup>32</sup> These costs may be higher for concentrated positions or large portfolios and can also vary depending on the manner in which the CCP liquidates a portfolio.

therefore the market value – of cleared portfolios.

3.2.12. For the purposes of conducting credit stress tests, a CCP should ensure that all identified sources of risk are appropriately captured in a discrete set of measurable risk factors that form the basis of stress scenarios. Some risk sources are directly observable by the CCP, while other risk factors will need to be estimated or modelled by the CCP, including, for example, potential future changes in market prices (in extreme but plausible market conditions) and other non-observable, portfolio-specific risks such as wrong-way risk, jump-to-default risk, stressed bid-ask spreads or other costs.<sup>33</sup>

#### *Risks related to credit resources (ie financial resources)*

3.2.13. A CCP should identify all sources of risk related to collateral and other financial resources held to cover credit exposures.<sup>34</sup> Sources of risk that affect CCP credit resources include risks that affect the value of resources (eg market value of collateral). A CCP should also consider the interaction between exposures and resources by incorporating a specific assessment of wrong-way risks in determining potential losses, including the effect on collateral held by the CCP. The sources of risk considered by a CCP should include changes in collateral and investment values that may be experienced during extreme but plausible market conditions as well as potential credit losses arising from the default of a custodian used by the CCP.

#### *Identification of all sources of liquidity risk*

3.2.14. A CCP should identify, by currency, all sources of liquidity risk to which it could be exposed in extreme but plausible market conditions, recognising that liquidity exposures can arise even in the absence of a participant default or when there is no uncovered credit exposure. Sources of risk include the failure of participants (or their nostro agents) to settle payment obligations on time and in the required currency, such as payment obligations associated with variation margin calls or the delivery of securities, foreign exchange or physical assets. Sources of liquidity risk also include risks that affect the value of liquidity resources (eg collateral value) or the ability of the CCP to promptly access those resources (eg due to non-performance of a custodian, settlement agent or credit provider).

3.2.15. A CCP should also identify liquidity risks, by currency, on both an end-of-day and intraday basis, at every point during the assumed liquidation period where a payment may be necessary, taking account of, for instance, intraday price movements, changes in intraday participant positions and intraday settlement processes that are used within and across a CCP's service lines, if applicable. Similarly, a CCP should also consider other relevant sources of liquidity risk such as collateral-related defaults, foreign exchange risks and intraday settlement processes that may involve or depend upon other relevant entities such as settlement banks, nostro agents, custodian banks, liquidity providers and linked FMIs.

#### *Risks related to liquidity exposures*

3.2.16. A CCP should identify all sources of risk related to its liquidity exposures. Such sources of risk should include risks related to cleared positions and risks related to the default-management process to close out these exposures. At a minimum, a CCP should consider risks that will impact the amount of qualifying liquid resources needed to meet payment obligations on time and in all relevant currencies, such as variation margin, payment obligations related to settlement obligations or payment obligations related to derivatives expirations.

3.2.17. The phrase "relevant currencies" includes each and every currency in which a CCP or its

<sup>33</sup> For further detail, see paragraph 5.2.10 below.

<sup>34</sup> A CCP should consider stressing intraday measurements as well as those taken at the end-of-day, if intraday exposures tend to be larger because of specific features of the applicable markets and settlement processes or specific observable or historical events.

participants must meet a payment obligation arising from the CCP's clearing and settlement processes.

3.2.18. Liquidity exposures should, where applicable, include the following: (i) liquidity needed to satisfy variation and other margin payment obligations arising from the defaulter's portfolio; (ii) transaction costs or bid-ask spreads associated with liquidating or hedging the portfolio of cleared products in extreme but plausible market conditions;<sup>35</sup> (iii) liquidity needed to satisfy payment obligations including, but not limited to, settlement payments, coupon payments, option premium payments and payments relating to derivatives expirations or physical deliveries; (iv) liquidity needed to satisfy margin payment obligations to non-defaulting participants arising from their reducing the risk in their portfolio of positions or withdrawal of excess collateral; (v) an increase in the size of obligations due to specific wrong-way risk and, to the extent appropriate, general wrong-way risk;<sup>36</sup> (vi) exposures arising from foreign exchange risks in all currencies; and (vii) exposures associated with linked FMIs. A CCP should identify wrong-way risk and transaction costs in the construction of its liquidity stress tests. The modelling of liquidity exposures should be consistent with the stress scenarios developed for credit stress testing as discussed in paragraph 3.2.31 on consistency.

3.2.19. In identifying sources of liquidity risk, a CCP should determine which exposures are known ex ante by the CCP (eg pre-scheduled settlement obligations during the liquidation) and which exposures are not possible to determine ex ante and therefore must be modelled by the CCP when conducting its stress testing (eg future variation margin payments).

#### *Risks related to liquidity resources*

3.2.20. A CCP should identify risks related to the ability to promptly access its liquidity resources. The effects of the failure of certain service providers to the CCP (such as a settlement bank, securities settlement system or custodian) may prevent a CCP from accessing its liquidity resources in a stressed market and should be considered as sources of risk. Risks related to the performance of a liquidity provider (including the default of participants that act as liquidity providers) can also affect the ability of the CCP to quickly access the required amount of cash in the appropriate currency to meet its payment obligations when due.

3.2.21. Other risks related to liquidity resources could include the following: (i) changes in collateral and investment values (either in terms of their liquidation value or their haircut value when accessing collateralised liquidity from a liquidity provider) that may be experienced either on an intraday or end-of-day basis during extreme but plausible market conditions (particularly if the collateral or investments are concentrated);<sup>37</sup> (ii) inability to access committed liquidity facilities, such as repo arrangements, lines of credit or foreign exchange swaps, due to either the default of a liquidity or service provider or because of a market disruption; (iii) inability to access uncommitted liquidity resources, including market transactions, due to a market disruption or because of a lack of credit to the CCP;<sup>38</sup> (iv) the default of an issuer of collateral held by the CCP or a direct participant that is also a liquidity or service provider; and (v) failure of or delay in operations of a settlement bank, custodian, securities settlement system or payment system. In identifying these sources of risk, the CCP should also take into account the interaction between exposures and resources by incorporating a specific assessment of wrong-way risks in determining potential losses, including the effect on collateral used to access liquidity facilities.

<sup>35</sup> These costs may be higher for concentrated positions or large portfolios.

<sup>36</sup> For definitions of specific wrong-way risk and general wrong-way risk, see paragraph 5.2.50.

<sup>37</sup> A CCP should consider stressing intraday measurements as well as those taken at the end of the day, if intraday exposures tend to be larger because of specific features of the applicable markets and settlement processes or specific observable or historical events.

<sup>38</sup> This guidance is independent of the definition of qualifying liquid resources elaborated in Principle 7, Key Consideration 5, ie a CCP should always cover its minimum liquid resource requirement with a combination of cash and prearranged and highly reliable arrangements for converting highly marketable collateral into cash (in the appropriate currency).

3.2.22. As a part of its consideration of liquidity risks, a CCP should identify events that could affect the CCP's ability to make intraday payments, if applicable, in the appropriate form (eg domestic currency, foreign currency or securities) when due, such as events that impede the CCP's ability to convert non-cash resources to cash.

#### Development of extreme but plausible scenarios

3.2.23. Stress testing is designed to evaluate the credit and liquidity exposures a CCP could face in extreme but plausible market conditions. Constructing effective scenarios for stress testing involves designing scenarios that are sufficiently extreme to rigorously stress all identified sources of credit and liquidity risk, while retaining a level of plausibility that supports using the results for risk management. Establishing the plausibility of a scenario often involves subjective judgment by the CCP, and such judgment benefits from extensive expertise with respect to the behaviour of the underlying markets, the ecosystem of the markets cleared and the risk tolerance of the CCP.

3.2.24. It should be recognised that references to "extreme but plausible market conditions" are in the context of a participant default. Such a default, particularly for a large participant, may itself have second-order effects that amplify the stress while the CCP is closing out the defaulters' positions. Therefore, the determinations of which market conditions are extreme but plausible should be conditional on the default of the participant (or two participants) and their affiliates that would result in the largest aggregate credit and liquidity exposures, respectively. Indeed, where a CCP is modelling the default of two participants and their affiliates, the feedback effects from the default of the first participant are likely to amplify the extreme but plausible market conditions in which the second participant is assumed to default.

3.2.25. When constructing an appropriate set of scenarios, a CCP will also confront the difficulty that different positions or portfolios may have very different exposures to different movements in risk factors. A further challenge is the possibility that similarly-sized losses could be produced by different movements in risk factors for a single portfolio. Ultimately, the scenarios used in stress testing should be evaluated to determine whether they are, when considered collectively, comprehensive enough to determine reliably the exposures in cleared portfolios under any of the range of extreme market conditions that might plausibly develop.

3.2.26. One of the most direct ways to derive a set of extreme but plausible market conditions is to use historical scenarios. In order to generate sufficiently extreme tests, the PFMI expect a CCP to include relevant peak historical price volatilities.<sup>39</sup> Because different portfolios are exposed to underlying risk factors differently, the relevant peak historical volatility might differ for different portfolios, and therefore the use of multiple historical stress scenarios will be required. Nevertheless, because of challenges such as the limited frequency of extreme but plausible market conditions or limited historical data, historical stress scenarios alone are not sufficient. Moreover, extreme but plausible market conditions that a CCP could face in the future may not be captured in historical data.

3.2.27. Given the limitations of a purely historical approach, the PFMI, as discussed above in Section 3.1, call for the use of other techniques based on a forward-looking approach to derive stress scenarios, including hypothetical and theoretical methodologies (combinations of the methodologies are also encountered in practice). In particular, the theoretical approach uses primarily statistical modelling to derive the extreme but plausible scenarios using proxy data or by extrapolating historical data that do not contain sufficiently severe periods of market stress to observe directly extreme but plausible market conditions. In a complementary fashion, the hypothetical approach (sometimes referred to as a narrative or prospective approach) focuses on situations in which the stress event would not be captured by historical or theoretically based stress events. Deriving these scenarios involves both subjective judgment and imagination. As discussed further below, it is important that these are exercised by persons with expert knowledge of the particular markets involved, including the factors that might drive extreme price changes in those markets. For example, the shocks used by the CCP to model potential credit losses due to required

<sup>39</sup> See Key Consideration 6 of Principle 4 of the PFMI.



variation margin payments during the closeout period should be consistent with the shocks used by the CCP to model the potential liquidity needs due to required variation margin payments during the closeout period.

3.2.28. As a general matter, for any given scenario, the CCP should aim to ensure internal consistency in its modelled risk factor shocks. That is, within a particular scenario, modelled risk factor shocks should be plausible not only individually, but also when viewed in combination. Similarly, where a CCP's stress tests for credit and liquidity rely on similar underlying risk factors, the CCP should ensure that shocks to these risk factors are modelled in a consistent way (see paragraph 3.2.31).

### *Comprehensiveness of scenarios*

3.2.29. A CCP should model extreme but plausible market conditions in a manner that adequately captures all the risks identified (see paragraphs 3.2.9–22), using a mixture of historical and forward-looking scenarios. Scenario construction should also take into account the possibility that the failure of one or more participants will precipitate or exacerbate market volatility and recognise that exposures may be larger intraday than at the end of the day. In addition, for liquidity risk, a CCP should use forward-looking scenarios in its estimate of liquidity resources as well as in its estimate of liquidity needs (ie liquidity resources also need to be stressed).

3.2.30. The modelling framework needs to incorporate a set of risk factors that is flexible but sufficiently comprehensive to capture, under a wide range of extreme but plausible market conditions, both the material risks that currently impact cleared portfolios and risks that could plausibly emerge in the future. The set of risk factors used in constructing historical and forward-looking scenarios for stress testing for both credit and liquidity exposures should be justified using a combination of expert judgment and reliable statistical techniques that allow a CCP to identify – on an ongoing basis – the risk factors to which it is most exposed,<sup>40</sup> recognising in particular that different portfolios will be exposed to different risk factors. For example, while some directional portfolios (eg portfolios that are primarily exposed to an increase or decrease in the price of one product or related group of products) will be exposed mainly to outright price movements, other portfolios may reflect trading strategies that entail exposure to basis or curve risks (eg long and short positions at different points on a forward or yield curve which may be more sensitive to correlation shifts rather than general price movements). A CCP should ensure, as appropriate, that its stress scenarios adequately reflect the trading strategies employed by its direct and indirect participants.

3.2.31. The resulting set of extreme but plausible scenarios should be diverse enough to thoroughly stress all cleared current, historical and hypothetical portfolios (and other exposures where relevant).<sup>41</sup> Moreover, stress scenarios should cover comprehensively both credit and liquidity risks. The extreme but plausible scenarios used for liquidity stress testing should, in the aggregate, include all the scenarios used for credit stress testing and should additionally include bespoke scenarios that may affect the CCP's liquidity exposures but not its credit exposures, or affect the size of its liquidity resources but not its financial resources.

### *Development of scenarios using historical data*

3.2.32. A CCP should construct stress scenarios that are comprehensive, include potential effects on market liquidity and hedging costs, and take into account a wide variety of stressed market conditions. The PFMI expect a CCP to include relevant peak historic price volatilities in its scenarios,<sup>42</sup> and to ensure its scenarios are appropriate for determining the CCP's required level of default protection in the light of

<sup>40</sup> For example, using Principal Component Analysis or similar dimension-reduction techniques.

<sup>41</sup> When designing hypothetical scenarios, a CCP should consider how the participants' positions may change as a result of the particular stress event, for example by considering plausible changes in positions – and hence exposures – over the liquidation period.

<sup>42</sup> See Key Consideration 6 of Principle 4 and Key Consideration 9 of Principle 7 of the PFMI.

current and evolving market conditions.<sup>43</sup>

3.2.33. A CCP should consider the availability of reliable data and should maintain and implement procedures to verify the historical data set, including checks for erroneous data and missing values.<sup>44</sup> A CCP should regularly test and validate the methods used to verify data accuracy and select the risk factors used to construct stress scenarios.

3.2.34. In developing historical stress scenarios, a CCP should replicate as closely as possible historical stress events for which reliable price data are available. A CCP should include all of the most extreme scenarios observed unless the CCP determines, based on a comprehensive, rigorous analysis, that it is implausible that a particular historical scenario (eg a particular level of market volatility) can reoccur. Such a determination is expected to be rare. Historical stress scenarios should not be excluded purely on account of the passage of time. Decisions about the exclusion of observed historical scenarios on the basis that reoccurrence is implausible should be explicit and subject to a strong governance process (see paragraph 2.2.7). The procedures used for this analysis and any adjustments should be rigorously tested and validated at regular intervals, including in response to market developments. Where necessary, historical scenarios may need to be adjusted to ensure plausibility, for example by using relative rather than absolute price movements when asset prices are low.<sup>45</sup> This can be done in a variety of ways, but should preserve the intention that historical stress events are replicated as accurately as possible.

3.2.35. If the reliable historical data available are too limited to ensure that the observed scenarios are sufficiently extreme, for example for a new product or an illiquid product with limited historical data, a CCP should use reliable statistical methods to construct extreme but plausible scenarios that are subject to regular validation. There are a wide range of methods that could be used for this purpose. For example, a CCP could use proxies from similar asset classes to synthetically extend the historical data that are available, based on an analysis of the relationships between data from the new asset class and data from related asset classes with a longer history. Alternatively, a CCP could simulate stressed market events based on available historical data and using statistical tools such as extreme value theory.<sup>46</sup> Where statistical models are used to develop stress scenarios, a CCP should calibrate these models to the risk tolerance of the CCP and ensure that they are subject to regular validation and testing, especially as market conditions change.

#### *Development of forward-looking scenarios*

3.2.36. The PFMI state that a CCP should “consider the effect of a wide range of relevant stress scenarios ... includ[ing] relevant peak historic price volatilities ... and a spectrum of forward-looking stress scenarios in a variety of extreme but plausible market conditions.”<sup>47</sup> Accordingly, a CCP should complement stress scenarios based on historical data with stress tests based on a full spectrum of forward-looking scenarios for both credit and liquidity risk. These scenarios should aim to capture stress events that are plausible but have not occurred previously, or for which reliable price data are not available.

3.2.37. The development of forward-looking scenarios should be informed by the judgment of subject matter experts from within the CCP or the participant community. These experts should have knowledge of the underlying markets, including the relevant economic, physical, environmental or geopolitical factors

<sup>43</sup> See Key Consideration 5 of Principle 4 of the PFMI.

<sup>44</sup> This guidance would also be applicable to historical data used as the basis for constructing forward-looking scenarios.

<sup>45</sup> Other “filtering” methods (eg using shifted log returns) may also be used for this purpose, but should be subject to regular validation and testing wherever a modelling assumption is used.

<sup>46</sup> Extreme value theory is a statistical approach to modelling the distribution of extreme events, which by their nature are rare and indeed may never have been observed. Extreme value theory relies on the fact that many distributions have similar structures in the extremes or tails: for example, “fat-tailed” distributions used in finance feature such similarity. Methods based on the theory project from observed data to more extreme events in a statistically defensible way.

<sup>47</sup> Key Consideration 6 of Principle 4. See also Key Consideration 9 of Principle 7 of the PFMI.

that might affect those markets in the form of events that have not previously occurred and cannot be modelled directly. These should include scenarios constructed by considering a wide range of possible catalysts. For example, these catalysts may include geopolitical events, environmental disasters and past events that have occurred in different but related assets. For each catalyst, a CCP should construct multiple scenarios to account for different potential impacts on prices of cleared products, as a specific shock might generate a variety of plausible responses across various markets.

3.2.38. A CCP should also develop forward-looking stress scenarios that materially stress each of the liquidity risks faced by the CCP. These scenarios should incorporate all sources of liquidity risk mentioned in paragraphs 3.2.14–22. While the liquidity risk of certain CCPs, such as derivatives CCPs, may be driven predominantly by variation margin payments and are therefore stressed by changes in market prices, the liquidity exposures of other CCPs may be generated primarily by settlement processes. For example, a CCP clearing cash market products faces significant potential liquidity needs on the day of a participant default in the event that the CCP needs to pay for securities, currencies or physical assets that would otherwise have been delivered against payment to the defaulting participant. To the extent that the nature of the settlement process at certain types of CCPs causes additional liquidity risk, as can be the case for CCPs that clear cash securities and certain other products, such CCPs should develop scenarios that reflect the increased liquidity requirements arising from these processes (during the relevant settlement period).

#### *Use of end-of-day, intraday and intra-period price and intraday position movements*

3.2.39. Key Consideration 6 of Principle 4 provides that a CCP “should consider the effect of a wide range of relevant stress scenarios in terms of both defaulters’ positions and possible price changes in liquidation periods”.<sup>48</sup> A CCP should consider stressing intraday exposures as well as those taken at the end of the day, if intraday exposures tend to be larger because of specific features of the applicable markets and settlement processes or specific observable or historical events. In such cases, a CCP should consider how positions may change on an intraday basis when designing its stress scenarios, recognising that intraday position changes after the last collection of prefunded financial resources (eg due to day-trading activity or intraday settlement of positions) can generate additional risk exposures. In doing so, a CCP should consider the effects of historical and forward-looking stress scenarios that are based on relevant stressed intraday position changes after the last collection of prefunded financial resources.<sup>49</sup> Relevant scenarios (ie extreme but plausible) should be incorporated into a CCP’s stress-testing framework to assess the sufficiency of prefunded financial resources.

3.2.40. A CCP should incorporate historical and forward-looking stress scenarios that are based on peak intraday and intra-period price moves, in addition to stress scenarios using end-of-day changes.<sup>50</sup> For example, the CCP should consider incorporating scenarios using historical maximum price changes, including on an intraday basis, between two different points during the liquidation period (eg peak-to-trough price moves), recognising that the hedging and liquidation strategy that may actually be available to the CCP following a default in extreme but plausible market conditions may differ significantly from its planned strategy. In addition, the CCP should consider incorporating potential intraday price changes, as appropriate, including those that are larger than end-of-day price changes, and adapting historical stress scenarios accordingly. For example, in order to capture the most extreme price movements in its historical stress scenario based on the stock market crash of 1987, a CCP could consider using both end-of-day and intraday peak-to-trough equity and interest rate price changes to capture extreme movements on and during 19 and 20 October.

<sup>48</sup> See Key Consideration 6 of Principle 4. See also Key Consideration 9 of Principle 7 of the PFMI, which provides that a CCP “should consider a wide range of relevant scenarios”.

<sup>49</sup> A CCP could, for example, model the potential impact of changes in positions with reference to differences between participants’ intraday and end-of-day positions as observed over an appropriate look-back period that includes periods of stress.

<sup>50</sup> As discussed previously, risk exposures may be higher for concentrated positions or large portfolios.

### *Changes in relationships between different products or asset classes*

3.2.41. In developing a wide range of relevant scenarios, a CCP should not limit scenarios to stressing the effects of markets in isolation. Where a CCP clears different products or asset classes, the CCP should consider developing credit and liquidity stress-testing scenarios that capture the interrelationships among the markets for these cleared products (see paragraph 3.2.5). These scenarios should consider knock-on effects among financial markets, including propagating scenarios through extreme but plausible second-order (and, where appropriate, third-order or higher) effects on related markets.<sup>51</sup>

3.2.42. While appropriately incorporating relationships among different products or asset classes into stress testing is challenging, a CCP should consider how the relationships or dependence may behave under stressed market conditions.<sup>52</sup> In particular, the dependence among different products or asset classes in a scenario should be consistent with the financial conditions embodied in the scenario. For example, in propagating scenario shocks to price moves, the CCP should not limit itself to modelling dependencies among risk factors calculated under non-stressed market conditions. Instead, the CCP could use data from periods of market stress or model hypothetical correlations that capture potential market movement. As another example, a CCP may develop a scenario starting with an initial assumption of a sudden, sharp move in oil prices. The CCP could then construct knock-on effects in which related products, such as natural gas and equities, are consequently shocked. In contrast to adding together the most extreme shocks observed across products, this method of constructing scenarios can help to ensure that the resulting scenario is plausible.

3.2.43. Similarly, if a CCP constructs forward-looking scenarios by aggregating shocks across a number of risk factors across different time periods, the CCP should model the dependence between these risk factors under stressed conditions. Furthermore, a CCP should consider using dependence as a source of stress by developing forward-looking stress scenarios that contemplate the market prices of ordinarily uncorrelated products moving together or scenarios in which market prices of ordinarily correlated products diverge. When a CCP develops stress scenarios by shocking one risk factor and mapping the effect of this shock to other risk factors, for example using methods including a beta or regression-based approach, the CCP should model the dependence among these risk factors under a variety of extreme but plausible conditions.

### Calculation and aggregation of stress test results

3.2.44. In applying stress-testing scenarios to its exposures, a CCP will face challenges that include ensuring reliable valuation models, appropriate aggregation of results across services and product categories, and treatment of participant exposures in a manner consistent with applicable legal frameworks that also reflects the extreme but plausible market conditions that are required for stress testing.

### *Stressed period of risk*

3.2.45. In evaluating the risks that it incurs in stressed market conditions, a CCP should identify the appropriate length of time over which exposures could be realised.<sup>53</sup> A CCP should set this length of time, or liquidation period, known as the stressed period of risk (SPOR) to be at least as long as the MPOR. In

<sup>51</sup> It is important to note that this is not a steer towards simply concatenating extreme but plausible effects in multiple markets (eg to combine the most extreme but plausible move in energy prices with the most extreme but plausible move in equities and the most extreme but plausible move in interest rates).

<sup>52</sup> Dependence is a relationship among variables (eg risk factors, instruments, contracts), in which the movement of one variable tends to affect another. Dependence includes correlation or covariance, which capture linear dependence, but can be more complicated or non-linear: for example, assets may exhibit different dependence in extreme conditions, or in the tails. Dependence may also have a time dimension, for example prices might exhibit serial dependence and spikes in volatility might cluster together in time.

<sup>53</sup> Paragraph 3.4.22 in the PFMI notes that a CCP should consider a wide range of relevant stress scenarios in terms of both defaulters' positions and possible price changes in liquidation periods.

making a determination of the appropriate SPOR, a CCP should consider the specific characteristics of the products and markets cleared, recognising the potential challenges associated with liquidating or hedging a portfolio in extreme but plausible market conditions. It should also consider extending the SPOR, or using other methods, to take account of the potential cost of liquidating portfolios that have concentrated positions. A CCP should document transparently (see paragraph 2.2.22) the supporting rationale for its choice of SPOR. It should also consider the case for using different SPORs for credit and liquidity risk, recognising that these risks may crystallise over different horizons following a participant default.

### *Risk exposure calculation*

3.2.46. When evaluating its exposure to credit or liquidity risk in extreme but plausible market conditions, the CCP should fully revalue its exposures, where practicable, using sound valuation models to measure the impact of these market conditions on the (liquidity) value of positions, collateral and investments. These models should be documented, and regularly tested under stressed market conditions. Where approximation methods are used, the procedures used should be subject to ongoing validation and testing as part of the overall stress-testing framework. A CCP should ensure that it captures the foreign exchange risk that may arise from collateral and investments denominated in a currency different than the underlying exposure.

### *Aggregation of results across product categories*

3.2.47. The application of extreme but plausible scenarios to different products (eg equities, bonds, commodities, derivatives, etc) should be commensurate with the CCP's default-management procedures and its ability to implement them. A common or aligned stress scenario may be used where the CCP has a credible means of ensuring that the various products can be reliably default-managed jointly, resulting in a single stressed exposure metric for the portfolio. Where joint default management is not possible, separate stress scenarios for each specific product category should be considered, with no offsetting of gains and losses permitted across categories.

3.2.48. Consistent with Key Consideration 2 of Principle 5, which expects a CCP to set haircuts that take into account stressed market conditions, and as discussed in paragraph 3.2.13, a CCP should incorporate the stressed value of collateral (including cash collateral that has been invested by the CCP) into its stress testing. This can be achieved by stressing collateral and cleared positions separately and then aggregating losses, or by stressing both collateral and cleared positions simultaneously. Under either approach, the market conditions which are being used to value the collateral should be extreme but plausible, which may mean that the stressed value of collateral is less than the post-haircut value of collateral used by the CCP outside of stress testing. A CCP should ensure that its stress testing for collateral is consistent with the default-management procedures established by the CCP, such that collateral and cleared positions are stressed jointly only where they will be liquidated as a portfolio.

3.2.49. For CCPs with cross-margining agreements and, where relevant, for CCPs with links with other FMIs, aggregate stressed losses and liquidity needs should be measured based on the terms of the agreement. For instance, only amounts determined consistent with the terms of relevant cross-margining agreements are suitable for aggregation of stressed losses or liquidity needs.

### *Treatment of customer exposures*

3.2.50. The PFMI state that a CCP should "[o]n at least a monthly basis ... perform a comprehensive and thorough analysis of stress testing ... assumptions ... to ensure they are appropriate for determining the CCP's required level of default protection."<sup>54</sup> In designing stress tests, a CCP should structure its treatment of the use of customer collateral, including the availability of customer collateral held by the defaulting participant, in a manner consistent with the applicable legal framework.

<sup>54</sup> See Key Consideration 5 of Principle 4 of the PFMI.

3.2.51. While a CCP may often be allowed (where provided for in the CCP's rules) to apply collateral or gains in a participant's proprietary account to offset losses in customer accounts, legal frameworks will generally prohibit the use of collateral or gains with respect to customer accounts to be used to offset losses in proprietary accounts. Moreover, the permissible application of collateral and, separately, gains between customer accounts often varies based on the legal framework or the CCP's account structure.

3.2.52. For purposes of reflecting the extreme but plausible market conditions appropriate for stress testing, a CCP should assume that it will be unable to port customer positions. Since porting requires an able and willing transferee, during times of stress, it is plausible that no such transferee will be found.

3.2.53. A CCP should make the conservative assumption that no payments will be made on behalf of a defaulting participant's customers.<sup>55</sup> It is plausible that, upon the default of the direct participant, the CCP will not have access to any funds or other property that have not already been passed on to the CCP, regardless of whether such property has been or should be posted to the defaulting direct participant by its customers. It is, at the very least, plausible that the direct participant's management will not pass on any such property (because of potential personal liability) and that the direct participant's insolvency officer (eg a trustee, receiver, administrator or liquidator) will attempt to preserve all remaining assets. In particular, it is plausible that the CCP will not receive customer variation margin payments that were not already received by the CCP prior to the direct participant's default. The CCP may only be able to resume collecting customer margin if and when customer positions are ported to another direct participant.

#### Analysis of stress-testing scenarios, models, and underlying parameters and assumptions

3.2.54. The PFMI establishes expectations that a CCP has risk-management policies, procedures and systems that enable it to identify, measure, monitor and manage the range of risks that arise in or are borne by the CCP, and that these risk-management frameworks are subject to periodic review.<sup>56</sup> More specifically, Key Consideration 5 of Principle 4 of the PFMI states that a CCP should, "[o]n at least a monthly basis ... perform a comprehensive and thorough analysis of stress-testing scenarios, models, and underlying parameters and assumptions used to ensure they are appropriate for determining the CCP's required level of default protection in light of current and evolving market conditions."<sup>57</sup>

3.2.55. An important objective of the CCP's analysis should be to identify whether any stress scenarios previously considered implausible should now be considered plausible (or vice versa) and thus whether any changes to the set of extreme but plausible scenarios used in daily credit and liquidity stress tests are warranted – or whether any changes to the current models or underlying parameters and assumptions should be made. To this end, in conducting its analysis, a CCP should consider using some combination of the following techniques:

- (i) Analysis of scenarios to examine how a wide range of parameters and assumptions (eg liquidation periods, confidence levels, correlations, historical data periods, customer porting) that reflect possible market conditions might affect credit as well as liquidity stress test results. Using such analysis, the CCP can measure the impact of changes in parameters and assumptions on stress-testing outcomes to ensure that it understands how it should respond to evolving market conditions. By varying parameters and assumptions simultaneously, the CCP will be able to better

<sup>55</sup> An exception to this assumption may be appropriate in the narrow case where the CCP has an *ex ante* enforceable arrangement for the defaulting participant's customers to directly make payments to the CCP in settlement of the customers' outstanding trades with the CCP, and where the CCP has a strong basis to support and conclude that such arrangement will reliably result in timely direct payment (for example, this settlement arrangement with clients is provided for in the CCP rules and procedures).

<sup>56</sup> See Key Consideration 1 of Principle 3 of the PFMI.

<sup>57</sup> See Key Consideration 5 of Principle 4 of the PFMI.

- identify and understand interactions between these variables, especially where these interactions are complex and not necessarily intuitive.
- (ii) Reverse stress testing to help the CCP identify the extreme scenarios and market conditions (eg price volatilities, changes in the size and composition of cleared portfolios, shifts in other market factors such as price determinants and yield curves, multiple defaults over various time horizons, as well as simultaneous pressure in funding and asset markets, and variations in defaulters' positions) in which total prefunded financial or liquidity resources would not be sufficient, and to assess whether the break-even scenarios are plausible.<sup>58</sup> The CCP could also consider, given the number of simultaneous defaults that exhausts its prefunded financial or liquidity resources, whether these resources should be increased.
  - (iii) Incorporating additional "for-information-only" scenarios into its stress-testing framework. These scenarios should be implausible, rather than extreme but plausible, scenarios. For example, a "for-information-only" scenario may include a particular historical scenario which the CCP has determined is no longer plausible. As the determination of extreme but plausible stress scenarios is subject to interpretation by CCPs, in accordance with the PFMI and this guidance, "for-information-only" scenarios could help a CCP examine the boundary between plausible and implausible scenarios. For example, the plausibility of certain scenarios may vary based on current market conditions, and "for-information only" scenarios could inform the CCP on how its credit and liquidity risks may change as market conditions change.

3.2.56. However a CCP chooses to compose and execute its analysis of stress-testing scenarios, models, and underlying parameters and assumptions, such analysis should be undertaken at a frequency consistent with the frequencies indicated in paragraphs 3.4.21 and 3.4.23 of the PFMI<sup>59</sup> and, where relevant, before changes to the risk-management framework or when changes in the risk environment occur.

3.2.57. A CCP's analysis of its stress-testing scenarios, models, and underlying parameters and assumptions should be subject to appropriate governance arrangements.<sup>60</sup> In particular, a CCP should clearly identify the purpose of each type of analysis undertaken and any actions that the CCP will take based on the outcomes of such analysis.

<sup>58</sup> A break-even scenario is defined as a scenario, identified through reverse stress testing, which exactly exhausts the CCP's financial resources (based on participant positions at the time the analysis is conducted).

<sup>59</sup> For instance, paragraph 3.4.21 of the PFMI notes that a CCP should perform a comprehensive analysis of stress-testing scenarios, models, and underlying parameters and assumptions on a monthly basis, while paragraph 3.4.23 notes that reverse stress tests should be conducted "as appropriate". Paragraph 3.4.21 of the PFMI also notes that "[a] CCP should perform this analysis of stress testing more frequently when the products cleared or markets served display high volatility, become less liquid, or when the size or concentration of positions held by a CCP's participants increases significantly". In addition, more frequent analysis of stress-testing scenarios, models and underlying parameters and assumptions may be necessary when a CCP uses more complex models, or when other features of its stress-testing framework are more sensitive to assumptions or may be subject to more frequent change.

<sup>60</sup> See Section 2 of this report.

## 4. Coverage

### 4.1 Context

4.1.1. Principle 4 of the PFMI requires a CCP to maintain prefunded financial resources to cover its credit exposures on an ongoing basis. CCPs are expected to cover fully their current and potential future exposures to each participant with a high degree of confidence. All CCPs are also expected to maintain additional prefunded financial resources in an amount sufficient to cover a wide range of potential stress scenarios that should include, but not be limited to, the default of the one or two participants and their affiliates that would potentially cause the largest aggregate credit exposure to the CCP in extreme but plausible market conditions. These minimum coverage amounts are typically referred to as “Cover 1” or “Cover 2”. A CCP that is involved in activities with a more complex risk profile or that is systemically important in multiple jurisdictions is expected to, at least, meet the Cover 2 requirement. All other CCPs should at least meet the Cover 1 requirement.<sup>61</sup>

4.1.2. Similar to Principle 4 setting coverage standards for credit risk, Principle 7 requires a CCP to maintain on an ongoing basis sufficient liquid resources in all relevant currencies to cover its payment obligations.<sup>62</sup> All CCPs are expected to have sufficient liquid resources to meet all payment obligations in each currency on time, including sufficient liquidity to settle payment obligations associated with variation margin calls and the delivery of securities, foreign exchange and physical assets.<sup>63</sup> In order to do so, CCPs are required to conduct rigorous stress testing to determine the amount and to test the sufficiency of their liquidity resources. For liquidity risk, all CCPs are required to meet a Cover 1 minimum standard. CCPs that are involved in activities with a more complex risk profile or that are systemically important in more than one jurisdiction should consider maintaining additional liquidity resources that meet a wider range of stress scenarios, including Cover 2 stress scenarios.

4.1.3. The guidance in this section is intended to strengthen a CCP’s observance of Principle 4 and Principle 7 of the PFMI in setting and maintaining on an ongoing basis the required level of resources through its credit risk and liquidity risk stress-testing practices.<sup>64</sup> The Cover 1 and Cover 2 standards set out in Principle 4 and Principle 7 of the PFMI are minima, and a CCP should consider its risk profile in determining the resources it should maintain above these minimum standards. A CCP should regularly test the sufficiency of those resources through stress testing. To the extent the results indicate that the CCP is not, or is at material risk of not, maintaining the required amount of resources to cover its potential credit and liquidity exposures, the CCP is expected to take prompt corrective action.

<sup>61</sup> Key Consideration 4 of Principle 4 of the PFMI.

<sup>62</sup> See Principle 7, Key Consideration 4 of the PFMI. As discussed in paragraph 3.2.17, the phrase “relevant currencies” includes each and every currency in which a CCP or its participants must meet a payment obligation arising from the CCP’s clearing and settlement processes.

<sup>63</sup> On 5 February 2016, CPMI and IOSCO issued guidance on the “Clearing of deliverable FX instruments.” See [www.bis.org/cpmi/publ/d143.pdf](http://www.bis.org/cpmi/publ/d143.pdf). That guidance is incorporated by reference herein.

<sup>64</sup> The guidance in this section addresses only the setting and maintenance on an ongoing basis of the required level of resources, in accordance with a CCP’s credit and liquidity risk stress testing. This guidance does not relate to the potential depletion of the CCP’s financial resources following a default event. The expected timing of replenishment of financial resources in such circumstances is discussed in the CPMI-IOSCO report, *Recovery of financial market infrastructures*, October 2014, section 4.4, page 24.



## 4.2 Guidance

### *Cover 1 or Cover 2 is a minimum*

4.2.1. The Cover 1 and Cover 2 standards in the PFMI for credit and liquidity risk are minimum standards.<sup>65</sup> As discussed in Section 2, the board has ultimate responsibility for setting the required level of financial and liquidity resources commensurate with the CCP's risk tolerance and for maintaining that amount on an ongoing basis. In determining the required level of resources it should maintain, a CCP should consider its specific risk profile and the results of its stress testing under all relevant extreme but plausible scenarios and market conditions. This assessment should include analysing the number of simultaneous participant defaults that are extreme but plausible given the composition of its particular participant base, and also monitoring the composition and concentration of projected stress-testing losses across participants.

4.2.2. When considering its minimum coverage requirements, a CCP should clearly define how it identifies the participant(s) and affiliates whose default would cause the largest aggregate credit or liquidity exposure for the CCP in extreme but plausible market conditions.<sup>66</sup> In doing so, a CCP needs to recognise that both the underlying stress scenario and the defaulting participant(s) may be different for the purposes of credit risk and liquidity risk. In calculating stress-testing losses generated by a participant default, a CCP should consider a participant's initial margin and positions. A CCP should assume that a participant and all of its affiliates default simultaneously and only allow for offsetting to the extent the rules of the CCP and the applicable legal framework allow for such offsetting in the event of a default.

4.2.3. When assessing its ability to withstand the default of multiple participants, a CCP should be transparent about its approach to selecting the stress scenarios that drive this assessment. The aggregate of the largest two exposures under any particular stress scenario is consistent with assessing the CCP's ability to withstand the simultaneous default of those two participants in extreme but plausible market conditions. However, if a participant defaults while a CCP is still managing a previous default, the market conditions may change between the two defaults. Consequently, a CCP may consider sequential defaults to be better reflected by the use of unsynchronised stress-testing results (ie different stress scenarios). Since allowing the stress scenario to vary across participants may result in larger estimated exposures, the CCP should clearly explain its approach so that authorities, participants and other stakeholders are better able to interpret the stress-testing results.

### *Amount of collateral to be recognised*

4.2.4. When assessing the adequacy of its resources, a CCP should take into account only margin and other prefunded financial resources that it has received. That is, the CCP should not recognise any component of margin or other required prefunded resource that has been called but not yet paid by participants.

4.2.5. In addition, a CCP should ignore any voluntary, excess contributions from participants. Since the contributions are voluntary, a participant may withdraw or decrease any excess deposits during times of stress. Therefore, when conducting stress testing for both credit and liquidity exposures, a CCP should

<sup>65</sup> As previously noted, the minimum coverage requirement for credit is set out in Key Consideration 4 of Principle 4 of the PFMI. The analogous requirement for liquidity is contained in Key Consideration 4 of Principle 7 of the PFMI, which requires a CCP to maintain sufficient liquid resources in all relevant currencies to settle securities-related payments, make required variation margin payments, and meet other payment obligations on time with a high degree of confidence under a wide range of potential stress scenarios that should include, but not be limited to, the default of the participant and its affiliates that would generate the largest aggregate payment obligation to the CCP in extreme but plausible market conditions.

<sup>66</sup> This should be done as part of the process for documenting the CCP's supporting rationale for, and having appropriate governance arrangements relating to, the amount of total financial resources it maintains. See, for example, Key Consideration 4 of Principle 4 of the PFMI.

assume that no voluntary, excess collateral posted by a participant will be available to meet losses or to make payment obligations.

#### *Maintaining resources on an ongoing basis*

4.2.6. A CCP should maintain its required level of prefunded financial and liquid resources on an ongoing basis.<sup>67</sup> In order to assess observance of its coverage requirements, a CCP should conduct daily stress testing and daily (and, as necessary, intraday) margin coverage analysis, for both credit and liquidity risks. If stress testing indicates that the CCP is not, or is at material risk of not, maintaining its required levels of resources, the CCP should have policies and procedures in place that result in prompt corrective action. To observe the coverage requirement for credit or liquidity resources on an ongoing basis, a CCP should use a sizing methodology sufficiently conservative to minimise the likelihood of a shortfall.

4.2.7. The CCP should have clear procedures or rules in place that stipulate what steps the CCP will take to re-establish compliance promptly in the event that the CCP's stressed exposures/payment obligations breach the relevant minimum coverage requirement. The CCP's policies and procedures should clearly define the thresholds, escalation criteria and breaches that would trigger an automatic and, where appropriate, same-day contribution from a direct participant or direct participants. Such triggers could, for example, be based upon: (i) quantitative thresholds (eg proportion of identified actual or potential deficiencies in credit or liquidity resources) at the level of a participant, a participant and its affiliates, and/or aggregated across all participants; (ii) qualitative criteria (eg participant risk rating); or (iii) multiple thresholds established to monitor sufficiency of financial resources in various default scenarios, including defaults of multiple participants.

4.2.8. The CCP should clearly articulate the circumstances in which it will call for additional financial or liquidity resources from participants, the nature of the resources it will call (eg additional margin or additional contributions to the default fund), how the allocation of additional contributions will be determined, and the payment deadline. For example, a CCP could consider assessing stress-testing exposures to pre-established limits and monitoring daily usage of those limits. As a part of this process, a CCP could additionally compare stress losses to its available prefunded financial and qualifying liquid resources, and, in the event the amount used breaches certain thresholds, call for additional financial resources from a single participant or a number of participants. The CCP should engage regularly with participants to ensure that the participants understand their potential obligations and have taken appropriate steps to ensure that they would be able to meet such obligations.

<sup>67</sup> See Key Consideration 4 of Principle 4 and Key Consideration 4 of Principle 7 of the PFMI.

## 5. Margin

### 5.1 Context

5.1.1. Principle 6 of the PFMI states that a CCP should cover its credit exposures to its participants for all products through an effective margin system that is risk-based and regularly reviewed. This further guidance on margin systems is intended to assist a CCP in its ongoing efforts to implement and maintain margin systems that are effective in addressing the risks and particular attributes of each product, portfolio and market served. As discussed in greater detail below, a CCP should apply the PFMI to all components of its margin system.

5.1.2. This guidance builds on several key considerations, explanatory notes and concepts in the PFMI. For example, the guidance on margin system components and margin system design relates to Key Consideration 1 of Principle 6, which notes that CCP margin systems should “establish[] margin levels commensurate with the risks and particular attributes of each product, portfolio, and market” the CCP serves. The guidance on monitoring intraday exposure, backtesting, sensitivity analysis and wrong-way risk relates to portions of Key Consideration 3, which states that “[a] CCP should adopt initial margin models and parameters that ... generate margin requirements sufficient to cover its potential future exposure to participants in the interval between the last margin collection and the close out of positions following a participant default.” The guidance on the MPOR or closeout period, model assumptions, pricing data and procyclicality also relates to Key Consideration 3, which states, among other things, that models should “(a) use a conservative estimate of the time horizons for the effective hedging or close out of the particular types of products cleared by the CCP (including in stressed market conditions), (b) have an appropriate method for measuring credit exposure that accounts for relevant product risk factors and portfolio effects across products, and (c) to the extent practicable and prudent, limit the need for destabilising, procyclical changes.” Finally, in developing effective portfolio margining systems, Key Consideration 5 states that a CCP should explicitly consider and ensure consistency with potential default management of positions in a portfolio.

5.1.3. It should be noted that some of the margin guidance echoes, and is intended to supplement, guidance previously described in this report in Section 2 with respect to CCP governance, including disclosure mechanisms. Other margin guidance reflects themes previously highlighted in Section 3 of this report. A CCP, its participants and other parties are encouraged to analyse and consider the margin guidance in the overall, broader context of this report.

### 5.2 Guidance

#### *Margin system design*

5.2.1. The PFMI provide that a CCP should have a margin system that establishes margin levels commensurate with the risks and particular attributes of each product, portfolio and market it serves.<sup>68</sup> For this purpose, a CCP should implement a margin system (including margin and pricing models) that appropriately captures the characteristics and complexity of the products it clears.

5.2.2. In supporting the board’s responsibility as discussed in paragraph 2.2.6, the CCP should have processes to identify, clarify and evaluate the choices and trade-offs present in the design of the margin system. Part of this process should entail evaluation of various models and approaches, and selection of those most appropriate for the product(s) cleared. For example, a CCP could consider the following non-exhaustive list of system design factors: (i) the number and interdependence of risk factors; (ii) data availability, data reliability and the characteristics of such data (eg non-linearities, seasonality); (iii) model performance; (iv) model stability; (v) flexibility and scalability; (vi) independence of errors and breaches;

<sup>68</sup> See Key Consideration 1 of Principle 6 of the PFMI.

(vii) transparency and predictability; and (viii) correlation offsets. In addition, a CCP should take into account explicitly the relevant risks for its particular products and markets. For example, such risks may include: (i) the consequences of changes in underlying asset prices, rates, spreads, implied volatilities, correlations and bases; (ii) the presence of wrong-way risk; and (iii) the impact of market illiquidity. All of these risks may be further exacerbated for large portfolios or concentrated positions.

5.2.3. The PFMI provide that a CCP should regularly review and validate its margin system.<sup>69</sup> The CCP should review all of the relevant factors and risks it chooses to reflect in its margin system on an ongoing basis, and through a range of mechanisms. Examples of such mechanisms include practices already reflected in the PFMI such as validation, backtesting and sensitivity analysis, which take into account the characteristics of the products cleared and the reliability of the relevant price sources and other inputs. Other mechanisms a CCP should consider relate to the governance process as discussed in paragraphs 2.2.16–17.

### *Margin period of risk*

5.2.4. A CCP should identify and consider a number of elements when constructing an appropriate margin system that seeks to address risks that arise from the products cleared. One common conceptual building block is the MPOR or the closeout period that a CCP assumes in its margin model. The PFMI note that the appropriate closeout period may vary among products and markets, depending upon the product's liquidity, price and other characteristics, such as whether trading occurs on a multilateral trading platform or bilaterally.<sup>70</sup> Additional factors such as volume, open interest and the availability of market-makers or similar providers of market liquidity could be considered in establishing a closeout period for a given contract. As a general matter, the assumed MPOR or closeout period should incorporate the market depth and characteristics of the products cleared and should have a clear supporting rationale which is transparently documented by the CCP.<sup>71</sup> Where a CCP clears products with different market characteristics (eg interest rate swaps and credit default swaps), the CCP should consider multiple MPOR assumptions or seek to ensure that a single MPOR assumption is appropriate for all cleared products.

5.2.5. The PFMI indicate that the closeout period should account for the impact of a participant's default on prevailing market conditions.<sup>72</sup> In addition, a CCP should take into account a number of specific factors that may come into play in the event of a participant default. As a general starting point, the assumed MPOR or closeout period should be consistent with market conditions likely to be present upon the default of any of the CCP's participants. Such conditions may include the level of product standardisation in the market, whether the product is traded on an exchange or OTC, and general indications of the degree of market liquidity, such as the degree of concentration in market-makers.

5.2.6. A CCP should adopt a margin system and parameters that are risk-based and generate margin requirements that are sufficient to cover its potential future exposures to participants in the interval between the last margin collection and the closeout of positions following a participant default.<sup>73</sup> Furthermore, the assumed MPOR or closeout period should incorporate explicitly the time between the point at which the CCP will have collected the last margin payment and the point at which market risk will be neutralised, either through liquidation of the defaulted participant's portfolio or through hedging. Another relevant factor a CCP should consider is compatibility with its segregation and portability regime, including any assumed period in which closeout would be deferred pending consideration of the ability to port customer positions promptly. In justifying its choice of MPOR, therefore, the CCP should reference an evidence base that takes into account its operational and procedural default-management capabilities,

<sup>69</sup> See Key Consideration 7 of Principle 6 of the PFMI.

<sup>70</sup> See Key Consideration 1 of Principle 6 and paragraph 3.6.3 of the PFMI.

<sup>71</sup> See paragraph 2.2.22.

<sup>72</sup> See paragraph 3.6.7 of the PFMI.

<sup>73</sup> See Key Consideration 3 of Principle 6 of the PFMI.

any known interdependencies and the outcomes of the testing of its default-management procedures. As part of its ongoing review of margin system performance and model validations, a CCP should regularly test and assess the appropriateness and effectiveness of the length of the assumed MPOR or closeout period and seek periodic feedback from its participants, indirect participants and other relevant stakeholders to gauge the current assumed market liquidity and closeout costs.

5.2.7. The PFMI provide that a CCP should ensure that its rules, procedures and agreements allow it to gather basic information about indirect participation in order to identify, monitor and manage any material risks to the CCP arising from such tiered participant arrangements.<sup>74</sup> In order to properly evaluate whether the assumed MPOR or closeout period is consistent with these factors, a CCP should consider a number of governance-related measures, including regular assessments of the CCP's direct participants and the size, nature and distribution of their customer positions. For example, a CCP should consider whether its direct participants generally have: (i) few customers with large positions; (ii) customers that are typically in the same sector; or (iii) customers that typically have directional portfolios.

### *Model assumptions*

5.2.8. The PFMI provide that when setting margin requirements, a CCP should have a margin system that establishes margin levels commensurate with the risks and particular attributes of each product, portfolio and market it serves.<sup>75</sup> How a CCP determines and applies its model assumptions is important to meeting this expectation. As a general matter, a CCP should clearly identify explicit and implicit assumptions made in its margin model, and should develop and maintain clear, thorough justifications for such assumptions. Margin models require assumptions ranging from design choices to parameter estimation methods, and in order to ensure the overall effectiveness of the margin system, a CCP should manage and mitigate the impact of model risk associated with the margin system's assumptions. This approach may vary depending on the risks the margin system seeks to address. For risks that are more difficult to measure, or perhaps even to observe, because of a lack of reliable data or for other reasons, a CCP should make conservative assumptions to reduce model risk and to ensure that margin coverage is commensurate with risk exposure(s). For example, rather than relying on a single method to calculate volatility, a CCP might choose to use the highest estimate from different methods.

5.2.9. Another related approach might entail setting thresholds on margin parameters such that if margin is based on a measure of volatility, a CCP could apply a "volatility floor" below which no reduction in margin would be granted by the model. In addition, as with other aspects of a CCP's margin system, a CCP should monitor and analyse whether the assumptions in its margin model continue to be appropriate. In any event, sensitivity analyses should be used to identify assumptions that have a large impact on the model outputs and performance. In addition, a CCP should ensure that model validations address the specific assumptions and related justifications.

5.2.10. One particular area of consideration in margin model assumptions is the potential market liquidation costs that a CCP assumes it will incur when liquidating a participant's portfolio. Such costs are relevant to the assumed market conditions a CCP believes will be present upon the default of any of its participants. A CCP's margin model assumptions should incorporate estimates of market liquidation costs, including bid-ask spreads not otherwise modelled in the price returns or explicit fees paid to trading platforms or liquidation agents. These market liquidation costs should also reflect the market impact of liquidation activity, when applicable. When a portfolio liquidation requires the disposal of concentrated positions or portfolios that are otherwise significant in terms of anticipated impacts on market liquidity in the relevant product, a CCP should contemplate the possibility that assumed market liquidation costs,

<sup>74</sup> See Key Consideration 1 of Principle 19 of the PFMI.

<sup>75</sup> See Key Consideration 1 of Principle 6 of the PFMI.

such as bid-ask spreads or mid-market pricing, will not in fact be actionable or otherwise predictable in the face of an actual liquidation.

### *Margin system components*

5.2.11. The PFMI provide that an effective margining system is a key risk-management tool for CCPs in managing the credit exposures posed by its participants' open positions.<sup>76</sup> A CCP should collect margin to assure performance and mitigate its credit exposures, if a participant defaults, to all products that it clears. As described in the PFMI, margin systems differentiate between initial margin and variation margin.<sup>77</sup> Within that basic structure, initial margin models may comprise a number of components. These components frequently include a model, such as value-at-risk or other statistical model, designed to capture the price movements of cleared products. A CCP may also use a number of margin add-on charges. In some cases, these are used to capture risks that may not be captured in price histories or may be difficult to model accurately. In other cases, margin add-on charges may be used to modify the balance between defaulter-pays and mutualised default resources. This guidance references, as examples, certain components found in a CCP's margin system (eg add-on charges). However, the discussion is not exhaustive.

5.2.12. Initial margin is used by a CCP to require each participant to provide collateral to protect the CCP against a high percentile of the distribution of future exposure.<sup>78</sup> Add-on charges can be one of several components in a CCP's margin system designed to serve this purpose. As a general matter, add-on charges can be understood as components of a CCP's overall margin requirement that are typically calculated to supplement statistical models. These add-on charges may include additional charges based on market liquidity risk, wrong-way risk or correlation risk, position concentration, portfolio composition, participant concentration, momentum or volatility metrics, and activity or utilisation metrics. Furthermore, add-on charges can address risks that may be more challenging to model accurately, or are not readily discernible in the price histories of the products cleared. As a result, add-on charges may utilise a more qualitative approach or be calculated in an intentionally conservative fashion.

5.2.13. In addition, other margin add-on charges may be explicitly designed to increase the amount of defaulter-pay resources rather than increasing mutualised resources. Such add-on charges may include additional collections based on credit or counterparty concerns (eg charged to participants on a CCP's watch list), stressed scenarios or stressed market conditions.

5.2.14. A CCP should ensure that it observes the PFMI for all components of its margin system, including any add-on charges. In doing so, a CCP should refer to the guidance in this report, including Section 2 on governance and the discussion on procyclicality.<sup>79</sup> A CCP should ensure that expectations in Principles 4 and 6 are observed for add-on charges to the same extent as for the other margin system components. In particular, the add-on charges described in paragraphs 5.2.11 and 5.2.12 should be designed so that they observe Principle 6, and also so that they observe Principle 4.

5.2.15. A CCP should generally avoid applying add-on charges as a substitute approach in instances when the relevant risks may reasonably be addressed by other components of the margin system or other aspects of a CCP's risk-management framework. In addition, the application of add-on charges should be documented and disclosed with the same level of rigour and transparency that is applied to all other components of a CCP's margin system.<sup>80</sup> As part of this, a CCP should document and disclose why other

<sup>76</sup> See also Principle 4 of the PFMI.

<sup>77</sup> See paragraph 3.6.1 of the PFMI.

<sup>78</sup> See paragraph 3.6.2 of the PFMI.

<sup>79</sup> See, for example, paragraphs 5.2.42-47.

<sup>80</sup> See paragraph 5.2.39 below and paragraph 2.2.22 on disclosure.

components of the margin system or the CCP's risk-management framework do not or cannot address the same risks.

5.2.16. As a general matter, a CCP should articulate clearly and disclose to participants and other stakeholders the basis and rationale for its policy in respect of add-on charges,<sup>81</sup> and ensure that its add-on charges are subject to appropriate governance and review for conceptual soundness.<sup>82</sup>

### *Price data*

5.2.17. Another conceptual building block for the margin system is the incorporation of pricing data, including historical data, look-back periods and price estimates. The PFMI note that a CCP should base its determination of the closeout periods for its initial margin model on historical price and liquidity data, as well as on reasonably foreseeable events in a default scenario. When using historical prices in its margin model, a CCP should carefully evaluate the appropriate historical sample period. The choice of a historical sample period should be based on consideration of explicit factors relating to the specific characteristics of the relevant cleared products, including potentially (i) the need to accurately estimate model parameters or model outputs; (ii) the need to accurately model the potentially complex dependencies between cleared products; (iii) seasonality in the historical data; and (iv) the need to be representative of market conditions consistent with the default of a participant.

5.2.18. A CCP should conservatively model its margin requirements for products lacking sufficient periods of historical data (such as new products). The margin model also should reflect the market behaviour of the underlying or similar products, accounting for any differences. For this purpose, a CCP should adopt a sufficiently long historical sample period to capture several historical periods of market stress or otherwise consider a range of sample periods, with a view to adopting the most conservative margin requirement generated. For example, where appropriate and relevant, a CCP could implement a weighting or scaling methodology and incorporate a decay factor in order to ensure that the margin model is sufficiently responsive to current market conditions and quickly adapts to changes in market volatility. A CCP should also periodically review, recalibrate and validate decay factors, and should take into account risk factor types and respective holding periods.

5.2.19. A related concern is the degree of reliance a CCP may have on sources of price data.<sup>83</sup> The PFMI provide that a CCP should have a reliable source of timely price data for its margin system, recognising that such data are critical for a CCP's margin system to operate accurately and effectively.<sup>84</sup> In most cases, a CCP may be able to rely on market prices from continuous, transparent and liquid markets.<sup>85</sup>

5.2.20. The PFMI also provide that a CCP should have procedures and sound valuation models for addressing circumstances in which pricing data are not readily available and reliable.<sup>86</sup> As the PFMI note, even when quotes are available, bid-ask spreads may be volatile and widen during times of market stress, thereby constraining the CCP's ability to measure its exposure accurately and promptly.<sup>87</sup> A CCP should therefore evaluate the reliability and consistency of prices that it receives, to detect both stale and erroneous data. For example, a CCP could scrub price data by using outlier-detection algorithms to identify, investigate and potentially remove erroneous observations. A CCP should have procedures and sound valuation models for addressing circumstances in which pricing data are not readily available or

<sup>81</sup> See paragraph 2.2.22 of Section 2.

<sup>82</sup> As an example, this would include justifying add-on charges individually and in the context of the CCP's margin framework.

<sup>83</sup> See paragraphs 3.6.4 and 3.6.5 of the PFMI.

<sup>84</sup> See Key Consideration 2 of Principle 6 of the PFMI.

<sup>85</sup> See paragraph 3.6.4 of the PFMI.

<sup>86</sup> See Key Consideration 2 of Principle 6 of the PFMI.

<sup>87</sup> See paragraph 3.6.5 of the PFMI.

reliable, even for data usually sourced from an exchange; such policies and procedures may include estimating prices or adjusting margin requirements if price data become unreliable or even unavailable. These valuation models and pricing procedures should be included in a CCP's model validation processes.

5.2.21. The PFMI note that, for some markets such as OTC markets, prices may not be reliable because of a lack of a continuous liquid market. In some cases, there may not be a steady stream of live transactions from which to determine current market prices. In some cases, participants may be an appropriate source of price data, as long as the CCP has a system which ensures that prices submitted by participants are reliable and accurately reflect the value of cleared products.<sup>88</sup> For products that are traded on OTC markets or where trading platforms are a recent market development, a CCP should ensure that quotes or other pricing models are reliable and accurately reflect the value of cleared products. For example, a CCP that clears OTC derivative products could use a pricing model, as necessary, to value positions or extract risk characteristics. A pricing model may also be needed to transform quotes from one convention to another, for example from spread to price for credit default swaps.

### *Monitoring intraday exposure*

5.2.22. One element a CCP should consider in its margin system is how intraday exposure is addressed. The PFMI provide that a CCP should have the authority and operational capacity to make intraday margin calls and payments, both scheduled and unscheduled, to participants.<sup>89</sup> A CCP faces the risk that its exposure to its participants can change rapidly as a result of intraday changes in prices, positions, or both; ie adverse price movements, as well as participants building larger positions through new trading (and settlement of maturing trades).<sup>90</sup> For the purposes of addressing these and other forms of risk that may arise intraday, a CCP should address and monitor on an ongoing basis how such risks affect all components of its margin system, including initial margin, variation margin and add-on charges.

5.2.23. In this vein, a CCP should identify, establish and implement clear triggers and thresholds to recalculate margin requirements on an intraday basis. This may be particularly relevant for a CCP that services markets and products where intraday exposures tend to be larger than end-of-day exposures because of specific features, such as the settlement process. For example, a CCP could recalculate its intraday margin requirements on an ongoing basis, taking into account new cleared positions and current market prices. A CCP could also establish and implement intraday margin triggers related to changes to exposure. If recalculation of margin intraday is not feasible, the CCP should take appropriate steps to ensure that the intraday risks are adequately covered, such as through more expansive MPOR (see paragraphs 5.2.4–7) or stress testing (see paragraphs 3.2.39 and 3.2.40), in order to ensure observance of the PFMI coverage standards via prefunded financial resources on an ongoing basis. In addition, and as appropriate, a CCP could consider implementing a backstop mechanism such as an intraday margin call conducted whenever the uncovered margin liability for a particular participant exceeds a specified risk-based measure.

5.2.24. The regular collection of margin prevents uncollateralised current exposures from accumulating. In addition, a CCP should be able to monitor, and perform intraday margin calculations for, regular or ad hoc intraday margin calls. For example, a CCP could implement such measures as it monitors erosion of the margin held in relation to the observed changes in intraday credit exposures to its participants' portfolios.

### *Variation margin*

5.2.25. In designing its governance and operational arrangements for intraday variation margin calls and payments, a CCP should take into account how these arrangements could have adverse implications for the liquidity positions of its participants and the relevant market, particularly when market conditions

<sup>88</sup> See paragraph 3.6.5 of the PFMI.

<sup>89</sup> See Key Consideration 4 of Principle 6 of the PFMI.

<sup>90</sup> See Key Consideration 4 of Principle 6 of the PFMI.



give rise to large and unexpected changes in current exposure. A CCP should take a holistic approach to structuring and applying its variation margin arrangements.

5.2.26. As part of this, a CCP should give consideration to how its intraday variation margin arrangements interact with other components of its margin system and how it can, to the extent practicable and prudent, limit the potential for liquidity implications, adverse to its participants or their customers, arising from its variation margin arrangements. A CCP should seek to increase the predictability of its variation margin calls and payments in order to enhance participants' operational readiness and financial capacity to make and receive such payments. For example, a CCP could use scheduled margin calculations and collections on an intraday basis, rather than relying on unscheduled calculations and collections. As a further example, where a CCP has collected additional collateral ex ante that mitigates the build-up of current exposure intraday, this can be a factor in reducing the need for unscheduled intraday variation margin calls.

5.2.27. A CCP should also address other aspects of its operational arrangements for variation margin. As part of this, to the extent permitted by a CCP's rules and supported by law, a CCP should net any gains against any losses. Furthermore, when determining the timing of the collection and payment of variation margin, a CCP should take into account the operational and liquidity implications for its participants.

5.2.28. A CCP's variation margin arrangements should be documented and disclosed with the same rigour and transparency as are applied to all other components of its margin system. As an additional related measure, a CCP should engage regularly with its participants (and, as appropriate and practicable, their customers) and linked FMIs as part of its consideration of how its variation margin arrangements, including operational arrangements, could potentially impact the liquidity positions of those constituencies. Such engagement can also potentially facilitate a better ex ante understanding by all such parties of how the CCP's variation margin arrangements could affect market liquidity.

### *Backtesting*

5.2.29. The PFMI provide that a CCP should conduct rigorous backtesting and sensitivity analysis as an integral part of the evaluation of its margin system. The PFMI also provide that a CCP should regularly conduct an assessment of the theoretical and empirical properties of its margin model for all products it clears.<sup>91</sup> A CCP should conduct backtesting of its margin system for two primary purposes: (i) to assess whether the CCP has collected sufficient margin to meet the coverage requirement, and (ii) to assess the statistical performance of the margin system.

5.2.30. When performing backtesting to assess whether the CCP has collected sufficient margin to meet its coverage requirement and whether there are any exceptions to its initial margin coverage, the CCP should:

- (i) Use actual portfolios of the participants that are guaranteed by the CCP but not yet settled.
- (ii) Assess margin that it has collected and ignore any voluntary, excess collateral posted by a participant
- (iii) Make explicit assumptions about the timing of the participant default and what actions the participant took before default, such as paying any intraday margin charges or meeting settlement obligations. These assumptions should conservatively reflect the timing and decisions likely to be made immediately before the default of a participant. In particular, a CCP should not assume that a participant will fully satisfy any outstanding margin or settlement obligations just prior to entering into default.

<sup>91</sup> See Key Consideration 6 of Principle 6 of the PFMI.

- (iv) Calculate the profit and loss consistent with the assumed MPOR or closeout period and include the period from the last margin payment calculation to the start of the default-management process.
- (v) Ensure that backtesting is based on valid comparisons by appropriately accounting for risks that are not included in the historical price data but that are meant to be covered by the margin components applied. These include, for example, market liquidation costs and specific wrong-way risk (many of these risks are typically dealt with by margin add-on charges). These additional exposures need to be either included in the historical P&L or excluded from the margin for the purposes of the test.

5.2.31. When performing backtesting to assess the statistical performance of the margin system, the CCP should include in a given test only the components of the model that can be directly measured and tested without the use of ad hoc assumptions. For example, margin charges, including certain add-on charges, that are not determined based on a statistical model, should be excluded from this type of backtesting. Components of the margin system that cannot be directly measured and tested in this way – for instance, components that reflect particular portfolio characteristics, such as liquidity or concentration – should nevertheless be subject to detailed validation for conceptual soundness (see paragraph 3.6.18 of the PFMI) as well as adequate and conservative consideration in stress testing.

5.2.32. The backtesting period should be sufficiently long to ensure reliable results, but should avoid in-sample testing. Also, when assessing the statistical performance of the margin system, the CCP should supplement backtesting of actual portfolios with a variety of additional tests. These may include backtesting or sensitivity analysis (see paragraphs 5.2.35 and 5.2.36) of how the margin model performs when using: (i) hypothetical portfolios that may contain particular concentrations of exposure (eg single contracts/products, yield curve exposures, or particular combinations of assets); (ii) portfolios with fixed and decaying time to maturity (ie rolling maturity versus fixed maturity); or (iii) different time windows of distinct lengths, including periods of stress.

5.2.33. A CCP should analyse the backtesting results to assess whether its margin methodology meets minimum standards. This analysis should include an assessment of the performance of the margin methodology on an overall basis as well as on a participant basis. As indicated in the PFMI, this assessment of margin coverage is required by Key Consideration 6 and should be considered an integral part of the evaluation of the model's performance.<sup>92</sup> These analyses can include assessing the number of exceedances and their size and clustering (eg over time or among certain participants) using statistical tests. Where backtesting exceedances are observed, the CCP should investigate and evaluate the source of those exceedances to determine what, if any, response is necessary. Such responses might include recalibration of current parameters, making adjustments to sampling periods, or addressing new or neglected risks more rigorously. In some cases, however, a more fundamental change to the margin methodology may be necessary.

5.2.34. Results of backtesting analyses, including documentation supporting the results of the investigation, should be reported through the CCP's governance structure, as appropriate, as discussed in paragraphs 2.2.6 and 2.2.7, and included as part of the disclosure of the results of margin coverage tests, as discussed in paragraph 2.2.22.

### *Sensitivity analysis*

5.2.35. The PFMI provide that a CCP should analyse and monitor its model performance and overall margin coverage by conducting a sensitivity analysis at least monthly, and more frequently where appropriate.<sup>93</sup> A CCP should conduct a sensitivity analysis monthly in order to assess the responsiveness of margin system parameters and determine which parameters and assumptions have the largest impact

<sup>92</sup> See paragraph 3.6.16 of the PFMI.

<sup>93</sup> See Key Consideration 6 of Principle 6 of the PFMI.

on margin outputs. This should include reviewing the procyclical properties of the margin system, for example, by simulating how the margin system would respond to a sharp increase in market volatility. When the sensitivity analysis results identify an issue, a CCP should undertake further investigation and present recommendations to change or maintain margin settings.

5.2.36. The PFMI note that such analysis should be applied to assess and monitor overall margin coverage.<sup>94</sup> For purposes of conducting a sensitivity analysis, each add-on charge should be analysed separately and the results of that analysis may then be considered in connection with the overall analysis of all components of the margin system. The PFMI note that the range of parameters and assumptions should capture a variety of historical and hypothetical conditions.<sup>95</sup> For key parameters, a CCP should use a range of confidence intervals to compare model output and assess longer-term model behaviour. With respect to testing model parameters and assumptions, a CCP could test the sample period, closeout period, and confidence levels. In addition, the CCP could use historical and hypothetical periods of stressed data.

### *Addressing procyclicality*

5.2.37. While a CCP should follow a holistic approach when taking procyclicality into account in its margin system, this section focuses specifically on addressing procyclicality in a CCP's initial margin arrangements, including margin add-on charges. The PFMI provide that, to the extent practicable and prudent, a CCP's margin model should limit the need for destabilising, procyclical changes.<sup>96</sup> In this context, procyclicality typically refers to changes in risk-management requirements or practices that are positively correlated with market, business or credit cycle fluctuations and may cause or exacerbate financial instability.<sup>97</sup> A CCP should evaluate the appropriateness of procyclicality-limiting tools in its margin models and develop clearly articulated frameworks for assessing, disclosing and addressing this particular risk (see paragraphs 5.2.42-47).

5.2.38. The PFMI acknowledge that procedures designed to limit the need for procyclical changes may create additional costs for a CCP and its participants in periods of low market volatility and/or no market stress, but these procedures may also result in additional protection and potentially less costly and disruptive adjustments in periods of high market volatility.<sup>98</sup> In devising a holistic approach to procyclicality in its margin models that is both practicable and prudent, a CCP should be cognisant of potential trade-offs in its approach that may emerge under certain market conditions. In considering such trade-offs, the CCP should seek to ensure that its approach to procyclicality is appropriately designed to target outcomes that result in additional protection and potentially less costly and disruptive adjustments in periods of high market volatility and/or market stress.

5.2.39. To the extent that add-on charges are typically calculated outside the CCP's initial margin model, a CCP should clearly and transparently document where such charges are applied (and why other components of the margin system do not, or perhaps cannot, address the same risks).<sup>99</sup> In this regard, some degree of detail is useful regarding how each add-on charge is calibrated and the consistency of its calibration with the CCP's holistic approach to managing procyclicality. This may be particularly important where a CCP applies add-on charges linked to counterparty credit risk.

5.2.40. A CCP should assess the procyclicality of add-on charges in order to reduce the risk that such charges could become destabilising in periods of increased market volatility or market stress. The

<sup>94</sup> See Key Consideration 6 of Principle 6 of the PFMI.

<sup>95</sup> See paragraph 3.6.17 of the PFMI.

<sup>96</sup> See Key Consideration 3 of Principle 6 of the PFMI.

<sup>97</sup> See paragraph 3.6.10 of the PFMI.

<sup>98</sup> See paragraph 3.6.10 of the PFMI.

<sup>99</sup> See paragraphs 5.2.15-16.

application of add-on charges should avoid large-step changes, to the extent that the resilience of the CCP is not undermined. For example, more frequent margin changes can be applied for the purpose of gradually smoothing out increases in participant margin requirements over time, while taking into account the need for a CCP to cover its exposures with a high degree of confidence, such that a potentially destabilising large-step change in margin requirements does not materialise.

5.2.41. Moreover, changes in margin add-on charges should, as far as practicable, be clearly related to metrics that would allow participants to predict changes in line with the margin system transparency provided by the CCP. This might enhance the ability of participants to predict possible add-on charges and to prepare accordingly.

#### *Measuring and addressing procyclicality in the CCP's margin system*

5.2.42. As provided in the PFMI, to the extent practicable and prudent, a CCP should appropriately address procyclicality in its margin arrangements, including through well documented policies and procedures. In this regard, a CCP could consider assessing procyclicality by using quantitative metrics to evaluate the procyclical properties of its margin components as part of the model validation process. Also, a CCP could examine procyclicality through regular sensitivity testing and review metrics, such as the variability of margin and peak-to-trough ratios or instances of sudden material increases in margin. In addition, a CCP could incorporate historical sample periods of various lengths into the sensitivity analysis in order to appropriately capture the risk of destabilising, procyclical changes. Relevant metrics could also be based upon an ex ante range of tolerances determined by the CCP's governance process that specifies acceptable large changes in the amount of resources collected from participants. In addition, a CCP should follow a holistic approach when measuring procyclicality in its approach to total prefunded financial resources. For example, a CCP could evaluate how the resizing of the prefunded default resources affects margin procyclicality.

5.2.43. Taking into account this metrics-based analysis to the extent practicable and prudent, a CCP should develop appropriate methods or tools for mitigating the potential for destabilising, procyclical changes arising from its margin system. As already reflected in the PFMI, a CCP should incorporate elements that mitigate procyclicality into its margin system, as appropriate, and tailor the specific approach to reflect the risk characteristics of the products and markets cleared. For instance, a CCP should consider installing buffers or floors on its margin requirements (eg a margin requirement that cannot fall below a certain percentage of notional value, tailored to the risk characteristics of each product cleared) in order to avoid margin requirements falling below a pre-defined threshold in times of low market volatility and no market stress.

5.2.44. A CCP should also recalibrate margin system parameters frequently and regularly to mitigate the potential risk that recalibration of margin system parameters results in a sudden jump in margin requirements. The predetermination of specific metrics referred to above (eg ex ante tolerances for acceptable large changes) can facilitate and enhance such an approach. In addition, a CCP should incorporate a historical period of high market volatility into its margin models so that the model can appropriately anticipate and mitigate destabilising reactions to risks associated with sudden increases in volatility.

5.2.45. As was noted in paragraph 5.2.22, the PFMI provide that a CCP should have the authority and operational capacity to make intraday margin calls and payments, both scheduled and unscheduled, to participants. A CCP should seek to ensure, however, that any application of intraday margin calls (i) appropriately takes into account, to the extent practicable and prudent, the need to limit destabilising, procyclical changes in margin requirements, and (ii) is consistent with the CCP's holistic approach to managing procyclicality (including any relevant internal governance processes or disclosure mechanisms).

5.2.46. When determining whether to recalibrate margin system parameters and collect resulting margin deficiencies on an intraday basis, a CCP should take into account the potential impact on the

liquidity positions of its participants.<sup>100</sup> The PFMI provide that transparency regarding the CCP's margin practices in the context of market volatility increases may help mitigate the effects of procyclicality.<sup>101</sup> A CCP should seek to increase the predictability of its intraday margin calls in order to enhance participants' operational readiness and financial capacity to meet such calls.

5.2.47. A CCP's arrangements for intraday collections based on recalibration of margin system parameters should be documented and disclosed with the same rigour and transparency as are applied to all other components of its margin system. As an additional related measure, a CCP should also regularly engage with its participants (and, as appropriate and practicable, its respective customers) and linked FMIs as part of its consideration of how its arrangements for intraday collections based on recalibration of margin system parameters may potentially impact the liquidity positions of those constituencies.<sup>102</sup> Such engagement can also potentially facilitate a better ex ante understanding by such parties of how the CCP's margin arrangements may relate to procyclicality concerns (see also paragraph 2.2.22).

#### *Addressing procyclicality in collateral haircuts*

5.2.48. As noted above, where practicable and prudent, a CCP should develop and implement an appropriate approach to procyclicality that is holistic and cuts across all aspects of its prefunded financial resources, as well as other related aspects of its default-management framework. A CCP should include forward-looking and conservative collateral haircuts among the tools used to manage procyclicality. The PFMI provide that, in order to reduce the need for procyclical adjustments, a CCP should also establish stable and conservative (collateral) haircuts that are calibrated to include periods of stressed market conditions, to the extent practicable and prudent.<sup>103</sup> For example, in a stressed market, a CCP may require the posting of additional collateral because of the decline of asset prices and an increase in haircut levels. Such actions could exacerbate market stress and help drive down asset prices further, resulting in additional collateral requirements.

#### *Other approaches to addressing procyclicality*

5.2.49. A CCP's approach to procyclicality need not be focused exclusively on the CCP's initial margin arrangements (including margin add-on charges). As mentioned in the PFMI, to limit the need for destabilising, procyclical changes, a CCP could consider increasing the size of its prefunded default arrangements to limit the need for and likelihood of large or unexpected margin calls in times of market stress.<sup>104</sup> One possible method of addressing procyclicality concerns in its margin system is for a CCP to incorporate elements into the sizing of its prefunded default arrangements resources (eg placing a floor on the total amount of such resources available in the prefunded default arrangements or installing a buffer above the stress losses observed) that limit the need for and likelihood of large or unexpected margin calls in times of high market volatility and/or market stress. However, in drawing these distinctions, a CCP should take care to consider the implications of changing the balance between the specific risks addressed by its margin system (which draws resources from a defaulter) and the differing risks addressed by its prefunded default arrangements resources (which draws resources significantly from surviving, non-defaulting direct participants).

#### *Wrong-way risk*

5.2.50. A CCP should ensure that the risks addressed by its margin system explicitly include specific wrong-way risk (SWWR). The PFMI define SWWR as a risk that arises where an exposure to a counterparty

<sup>100</sup> See paragraph 3.6.11 of the PFMI.

<sup>101</sup> See paragraph 3.6.10 of the PFMI.

<sup>102</sup> This is analogous to the approach discussed in paragraph 5.2.28 above.

<sup>103</sup> See Key Consideration 3 of Principle 5 of the PFMI.

<sup>104</sup> See paragraph 3.6.10 of the PFMI.

is highly likely to increase when the creditworthiness of that counterparty is deteriorating.<sup>105</sup> As a general matter, the PFMI provide that a CCP should identify and mitigate any credit exposure that may give rise to SWWR, as well as review its portfolio regularly in order to identify, monitor and mitigate promptly any exposures that give rise to SWWR. The challenge of identifying and seeking to address SWWR varies depending on the particular exposures a CCP may encounter in its clearing activities. A CCP should have clear rules, policies and procedures in place to identify, assess and mitigate SWWR. General wrong-way risk arises at a CCP when the potential losses of either a participant's portfolio or a participant's collateral are correlated with the default probability of that participant. Examples of general wrong-way risk include situations where the equity or debt securities issued by one participant could lose significant value if another similar participant defaults to the CCP, or when a sovereign default could be strongly correlated with the default probability of a participant domiciled in the same country. Consistent with Principles 4 and 6, a CCP should cover its potential future exposures to general wrong-way risk when calculating its margin requirements.

5.2.51. In some instances, the risk of exposure to SWWR may be evident for certain cleared products. In the credit default swap context, SWWR may arise where a participant seeks to clear a product that references its own name or the name of an affiliate. Another related area where a CCP should be sensitive to exposures that may give rise to SWWR is the specific positions that participants or their customers may clear. As already discussed, this is an area where certain examples (ie clearing of products in the same name as a participant or customer) are well known. However, the ways in which a CCP can address SWWR in this context may vary depending on the circumstances. As a general matter, a CCP should have in place frameworks that identify, monitor and manage self-referencing or other highly correlated positions maintained by participants and their customers at the CCP. Such frameworks may include increased margin requirements for such positions, including through the application of add-on charges. Another potential approach could entail enhanced collateral requirements where, for example, the notional value of a cleared transaction that reflects a short position in the direct participant's equity or debt needs to be fully collateralised.

5.2.52. A CCP should also keep in mind how other aspects of its operations affect risk exposure. For example, all CCPs collect collateral from their participants based on specific margin system requirements and methodologies. In this context, a CCP should consider whether the type of collateral it accepts or other aspects of its margin systems create exposures to SWWR, and should use suitable, sufficient and transparent methods to identify risks arising from the interconnection between the creditworthiness of participants (and their customers, as applicable) and respective risk exposures. For example, a CCP could incorporate SWWR into its collateral acceptance policy through the imposition of collateral limits or constraints to mitigate SWWR, to the extent practicable. In addition, a CCP could prevent participants or their customers, as appropriate, from posting collateral where there is a correlation between the creditworthiness of a participant (or customer) and the value of the collateral it has posted to the CCP.

### *Portfolio margining*

5.2.53. A CCP that uses portfolio margining should identify, document and apply clear criteria when determining which products are correlated and, therefore, are potentially eligible for portfolio margining, including criteria to evaluate whether portfolios may reliably be liquidated and risk-managed on a consolidated basis in the event of a participant default. These criteria should be justified analytically, and the supporting rationale should be disclosed to participants.<sup>106</sup> Such a CCP should also continuously review and monitor the performance of its portfolio-margining system in order to ensure that the margin system of the CCP performs appropriately under both current market conditions and during periods of market volatility.

<sup>105</sup> See paragraph 3.6.9 of the PFMI.

<sup>106</sup> See paragraph 2.2.22.

5.2.54. In addition to the considerations discussed immediately above, a CCP should also evaluate and determine whether portfolio-margined positions can be reliably liquidated in the event of a participant's default over a range of market conditions. A CCP should factor into its conclusions regarding correlation of products specific assumptions regarding how those correlations perform when the portfolio has to be liquidated in a stressed market environment.<sup>107</sup>

5.2.55. The PFMI provide that, in calculating margin requirements, a CCP may allow offsets or reductions in required margin across products that it clears, if the risk of one product is significantly and reliably correlated with the risk of the other product.<sup>108</sup> In this regard, the PFMI specify a number of elements for a CCP to consider and apply. These elements include: (i) an economically meaningful methodology that reflects the degree of price dependence between products; (ii) ensuring that the resultant offset or reduced margin requirements continue to meet or exceed the single-tailed confidence level of at least 99% with respect to the estimated distribution of the future exposure of the portfolio; (iii) continuous review and testing of offsets among products; and (iv) testing the robustness of its portfolio method on both actual and appropriate hypothetical portfolios, with a particular focus on testing how correlations perform during periods of actual and simulated market stress to assess whether the correlations break down or otherwise behave erratically. Prudent assumptions informed by these tests should be made about product offsets.<sup>109</sup>

#### *Reliable statistical relationship*

5.2.56. A CCP should identify, document and apply clear criteria when determining what products are correlated and are therefore potentially eligible for portfolio margining. In analysing correlations in the context of portfolio margining, a CCP should determine: (i) whether a strong economic rationale for the correlation exists (eg the products are complements of or substitutes for each other, or one product serves as a significant input into the other product); (ii) whether a proven ability to risk-manage the products as a single portfolio already exists and, importantly, whether the CCP can close out its exposures to the products as a single portfolio in the event of a participant default, consistent with its default-management processes; and (iii) whether a reliable joint statistical relationship between the products in the portfolio exists, including during periods of market volatility or in times of stress. For example, in determining whether a strong economic rationale exists, a CCP could look to the similarity of product characteristics and features and the extent to which assets underlying those products overlap; this analysis could complement any price correlation observed between products.

5.2.57. While no specific approach or model for correlations is endorsed in the PFMI, as a general rule a CCP should identify and consider different aspects of correlation across products. For instance, stability of correlation is an important element and can be understood to mean stability of cross-product correlation and how changes in correlation are captured by the CCP's margin system. Under this approach, a CCP could apply portfolio margining to two products when price changes in the respective products exhibit a stable correlation over time, including in times of stress. In seeking to apply and understand these different but complementary aspects of correlation, a CCP should consider applying certain thresholds on the level and stability of correlation that must be met, as well as minimum thresholds regarding the period of time over which each historical correlation is measured and the confidence level. When thresholds are used, they should be applied in a manner that reflects the ability of the CCP's margin model to capture changes in correlation between products.

5.2.58. In seeking to implement its approach to identifying and addressing correlation, a CCP should have in place specific measures that address a variety of instances of correlation. For example, a CCP could seek to address instances when there are price differences between two contracts within the same product type through the application of hypothetical stress or correlation scenarios, or through the application of

<sup>107</sup> Consistent with the use of the term in the PFMI (footnote 72, page 51), correlation should not be understood to be limited to linear correlation, but rather to encompass a broad range of co-dependence or co-movement in relevant economic variables.

<sup>108</sup> See Key Consideration 5 of Principle 6 of the PFMI.

<sup>109</sup> See paragraph 3.6.12 of the PFMI.

multiple correlation parameters (eg Pearson, Kendall's tau, Spearman, etc). In any event, a CCP should ensure that it applies suitable and sufficiently prudent methods to identify and measure both present and future exposure at both the individual product and combined portfolio levels. As discussed in paragraph 5.2.59, specific consideration of default and other stressed scenarios can be useful in this regard.

#### *Monitoring of the portfolio-margining system*

5.2.59. A CCP should monitor the performance of its portfolio-margining system on an ongoing basis to ensure that the margin system of the CCP performs appropriately under both current market conditions and during periods of market volatility and stress. Such monitoring includes, for example, reviewing the performance of the portfolio margin model during periods of market volatility and stress, assessing the assumptions regarding the strength of the dependence among products, and observing how those offsets and assumptions impact the overall performance of the CCP's margin system. For example, sensitivity analysis could be performed on the set of correlations used for the offsets, and the results could then be considered as part of the CCP's wider sensitivity analysis of the margin system.

5.2.60. In considering these matters, a CCP should maintain strong internal controls on the extent and practice of its portfolio margining. In addition, a CCP should review the appropriateness of portfolio-margining treatment regularly and should include in its review an assessment of the economic rationale. A CCP should also implement and maintain controls and procedures that allow its risk-management process to override any offsetting of products that essentially reflect unstable correlations despite a high level of correlation in some periods. For this purpose, a CCP should explicitly consider how its approach to procyclicality relates to such controls and procedures.



## 6. CCP contributions to losses

### 6.1 Context

6.1.1. Principles 4 and 15 of the PFMI require a CCP to maintain financial resources to cover losses resulting from a participant default and general business risk, including custody and investment risk, respectively. The financial resources used to cover such losses may come from participants or the CCP itself, as specified by the CCP's rules. As participants are expected to contribute resources towards certain losses and entrust assets to the CCP for safeguarding, a CCP's contribution of its own resources to losses resulting from a participant default and the custody and investment of participant assets can improve confidence that the legitimate interests of participants and other relevant stakeholders are reflected in the CCP's risk management as expected under Key Consideration 7 of Principle 2.<sup>110</sup> This guidance is intended to provide further direction for a CCP when contributing its own resources towards these types of loss.

### 6.2 Guidance

6.2.1. In carrying out the responsibilities outlined in Key Consideration 7 of Principle 2, a CCP should determine and expose an amount of its own financial resources to absorb losses resulting from a participant default and the custody and investment of participant assets that would enhance confidence that the CCP's design, rules, overall strategy and major decisions reflect appropriately the legitimate interests of its participants and other relevant stakeholders.<sup>111</sup> In particular, the amount and characteristics (eg form, composition, segregation and seniority in a loss "waterfall") of a CCP's own contribution to absorb potential losses resulting from a participant default and the custody and investment of participant assets can enhance confidence among participants with respect to the risk management at the CCP and with respect to the alignment of interests between the CCP and its participants. In determining the amount and characteristics of its own contribution, the CCP should consider the results of engagement with direct and indirect participants and other relevant stakeholders. Further, to achieve these objectives, a CCP should identify the amount of its own financial resources to be applied prior to those of non-defaulting participants to absorb losses resulting from a participant default and prior to those of all participants to absorb losses resulting from the custody and investment of participant assets.

#### *Losses related to a participant's default*

6.2.2. A CCP typically uses a sequence of prefunded financial resources to manage its losses caused by a participant default. These prefunded financial resources are commonly referred to as a "waterfall" and may include the defaulter's initial margin, the defaulter's contribution to a prefunded default arrangement, a specified portion of the CCP's own funds, and other participants' contributions to a prefunded default arrangement.<sup>112</sup> When a CCP contributes a portion of its own resources to losses resulting from a participant default, these contributions can help to enhance participants' confidence in a CCP's management of risk since the CCP's own resources are exposed to some portion of the loss. A CCP, therefore, should identify the amount of its own financial resources to be applied towards losses resulting from a participant default; this amount may be in excess of any minimum amount required by law.<sup>113</sup>

<sup>110</sup> For the purposes of this guidance, references to "losses" collectively mean losses resulting from a participant default and the custody and investment of participant assets unless otherwise specified.

<sup>111</sup> See also paragraphs 2.2.11 and 2.2.12.

<sup>112</sup> See paragraph 2.2.11.

<sup>113</sup> See paragraphs 2.2.11 and 2.2.12.

### *Custody and investment losses*

6.2.3. A CCP is responsible for safeguarding the assets that its participants provide to the CCP and for minimising any risk of loss or delay in access to these assets.<sup>114</sup> Typically, a CCP will hold participants' assets (cash and securities) with custodians selected by the CCP and may invest these assets in accordance with its investment policy. In order to minimise the associated risks, a CCP is expected to use supervised and regulated custodians, and any invested assets should be in instruments with minimal credit, market and liquidity risks.<sup>115</sup> Despite these risk controls, participants could be exposed to potential losses that they are not in a position to manage or mitigate fully because the CCP has discretion over custody and investment decisions. Consequently, a CCP should identify the amount of its own resources to be applied towards losses arising from custody and investment risk, to bolster confidence that participants' assets are prudently safeguarded.

6.2.4. The CCP's own contribution related to custody and investment losses should reflect the degree of the involvement of the CCP in the decision-making process related to the custody and investment of participants' assets, including any margin and prefunded default arrangements posted to the CCP. Where the CCP has greater discretion in such process, it should consider contributing a relatively larger amount of its financial resources to absorb the losses. Where participants have full decision-making authority on the custody and investment of their assets, the associated risks will depend on the decisions made by those participants and not the CCP. In these cases, the CCP would not be expected to identify an amount of its own resources to apply towards losses arising from those custody and investment risks. If a CCP operates multiple clearing services that apply different models for safeguarding participant assets, the exception noted here would only apply to those service lines for which the CCP does not have any decision-making authority on how assets are held and invested.

### *Seniority of the CCP's own financial resources*

6.2.5. Participants' and stakeholders' confidence in the CCP's risk-management practices may depend, in part, on where the CCP positions its own resources that are exposed to losses vis-à-vis contributions from its participants. Applying a CCP's resources prior to those of non-defaulting participants in a participant default scenario and prior to those of all participants in the event of losses due to the custody and investment of participant assets ensures that the CCP is among the first to bear losses and thus may increase confidence in risk management at the CCP among its participants. Therefore, a CCP should apply the amount of its own resources determined necessary to enhance participant confidence prior to those of non-defaulting participants to absorb potential losses resulting from a participant default and prior to those of all participants to absorb losses resulting from the custody and investment of participant assets. In addition to this amount, a CCP may also choose to expose a separate amount of its own resources to remaining losses concurrently or after allocating a portion of such losses to its participants.

### *Form of a CCP's own resources exposed to losses*

6.2.6. A CCP's default rules and procedures should enable the CCP to take timely action to contain losses and promptly use any financial resources that it maintains to cover losses resulting from a participant default.<sup>116</sup> In order to achieve this outcome, any of a CCP's own financial resources exposed to losses resulting from a participant default as part of the waterfall should be of high quality and sufficiently liquid, such as cash, cash equivalents or liquid securities, to ensure that they can be used promptly and effectively in the event of a participant default, consistent with the expectations set forth in Principle 4 of the PFMI. In particular, a CCP would be expected to have rules and procedures on how it would replenish

<sup>114</sup> See Principle 16 of the PFMI.

<sup>115</sup> See Key Considerations 1 and 4 of Principle 16 of the PFMI.

<sup>116</sup> See paragraph 3.13.3 of the PFMI.

any of its financial resources that it may employ during a participant default.<sup>117</sup> Furthermore, a CCP should ensure that any financial resources it contributes to its “waterfall” are only available for this purpose and cannot be applied to any other type of loss.<sup>118</sup>

6.2.7. As set out in Principle 15, a CCP is expected to hold sufficient liquid net assets funded by equity to cover potential losses associated with its general business risk so that it can continue its operations and services as a going concern.<sup>119</sup> Custody and investment risk is considered a type of general business risk, and business-related losses may arise from custody and investment risk.<sup>120</sup> Nevertheless, a CCP should ensure that any financial resources it contributes to absorb potential losses resulting from the custody and the investment of participants’ assets are only available for this purpose and cannot be applied to any other type of loss; therefore, the amount of these resources should not be counted towards the amount of liquid net assets funded by equity required under Principle 15 of the PFMI.

6.2.8. When a CCP exposes some amount of its financial resources to custody and investment losses, those assets should be of high quality and sufficiently liquid, such as cash, cash equivalents or liquid securities, to ensure that they are readily available for use when needed.<sup>121</sup> Furthermore, assets held by a CCP to cover losses other than general business risk or to cover losses from other business lines that are unrelated to its activities as a CCP should not be included when accounting for liquid net assets available to cover general business risk, including custody and investment risk.<sup>122</sup> When developing its capital plan, a CCP should take into account any liquid net assets funded by equity that it expects to apply towards the potential materialisation of business risk, including custody and investment losses. The CCP should also specify how it would raise new capital if it were to use these assets to cover such losses.<sup>123</sup>

<sup>117</sup> See Key Consideration 7 of Principle 4 of the PFMI.

<sup>118</sup> See also paragraph 3.4.24 of the PFMI.

<sup>119</sup> See Principle 15 of the PFMI.

<sup>120</sup> See paragraph 3.15.1 of the PFMI.

<sup>121</sup> See paragraph 3.15.8 of the PFMI.

<sup>122</sup> See paragraph 3.15.7 of the PFMI.

<sup>123</sup> See paragraph 3.15.9 of the PFMI.

## 7. List of PSG members

### Co-Chairs:

European Central Bank	Daniela Russo
Commodity Futures Trading Commission, US	Robert Wasserman

### Members:

Reserve Bank of Australia	Jennifer Hancock (until December 2016) Louise Carter (since December 2016)
National Bank of Belgium	Steven Van Cauwenberge
Securities and Exchange Commission of Brazil	Sergio Schreiner
Bank of Canada	Eric Chouinard
Autorité des marchés financiers, Quebec	Derek West (until September 2016) Marc Stephens (since October 2016)
Ontario Securities Commission	Kevin Fine
Bank of France	Emmanuelle Assouan (until September 2016) Maud Abdelli (until March 2017) Valérie Fasquelle (since March 2017)
Autorité des marchés financiers, France	Patrice Aguesse
European Central Bank	Fiona Van Echelpoel
European Securities and Markets Authority	Giampiero Carlà
Deutsche Bundesbank	Roland Neuschwander
Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin)	Christian Schindler (until December 2015) Jürgen Oberfrank (since January 2016)
Hong Kong Monetary Authority	Esmond Lee
Securities and Futures Commission, Hong Kong	Ryan Ko
Securities and Exchange Board of India	Manoj Kumar
Bank of Italy	Claudio Impenna
Central Bank of Ireland	Giuseppe Insalaco
Bank of Japan	Shuji Kobayakawa
Financial Services Agency, Japan	Kazunari Mochizuki
National Banking and Securities Commission, Mexico	Luis Leyva
Netherlands Bank	Ron Berndsen (until November 2016) Jeannette Capel (since November 2016)
Central Bank of the Russian Federation	Elena Nenakhova
Monetary Authority of Singapore	Pui Hoon Loh
International Organization of Securities Commissions	Tajinder Singh Verinder Sharma (until May 2016) Patricia Sáenz de Maturana Pinedo (since May 2016)

Finansinspektionen	Manabu Kishimoto
Committee on Payments and Market Infrastructures	Jan Axelsson
	Klaus Löber (until May 2016)
	Morten Bech (since May 2016)
	Robert Lindley (until February 2016)
	Umar Faruqui
Swiss National Bank	Thomas Nellen
Bank of England	David Bailey (until September 2016)
	Mark Manning (since September 2016)
	Paul Bedford
Board of Governors of the Federal Reserve System	Jennifer Lucier
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Federal Reserve Bank of New York	Lawrence Sweet
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