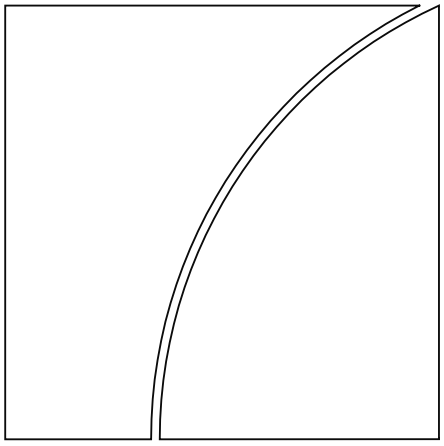
Committee on Payments and Market Infrastructures

Board of the International Organization of Securities Commissions



Framework for supervisory stress testing of central counterparties (CCPs)

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1. Introduction

1.1 Background

1. In the years following the financial crisis, central counterparties (CCPs) have become increasingly global, interconnected and critical segments of the financial system. The rise and pace of central clearing accelerated following the 2009 commitment by the G20 Leaders to implement reforms to ensure that all standardised OTC derivatives contracts are cleared through CCPs.[1] The increased use of central clearing of derivatives was 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. In achieving this objective, however, CCPs have become more interconnected with their participants and other financial institutions on which they rely for key services, such as liquidity providers and custodians. The continued growth in central clearing and the resulting networks have further heightened the need for CCPs to have effective governance arrangements and risk controls to achieve the risk reduction benefits of central clearing. 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.

2. Due to the increasing importance of CCPs in recent years, ongoing efforts have been made at both the domestic and international level to strengthen their individual financial resilience and to ensure that they support financial stability in the markets in which they operate. In 2012, the CPMI and the Technical Committee of the IOSCO (the Committees) published the *Principles for financial market infrastructures* (PFMI), which strengthened and harmonised the three pre-existing sets of international standards for financial market infrastructures (FMIs) by raising minimum standards, providing more detailed guidance and broadening the scope of the standards to cover new risk management areas. Among other things, the PFMI set expectations that CCPs would maintain a higher level of financial resources to address credit and liquidity risks.[2] 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.[3]

3. Following on from this work, in April 2015, 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.[4] The chairs of the relevant committees agreed on such a workplan (known as the "CCP workplan") and launched workstreams under their respective committees to address the substantive priorities related to CCP resilience, recovery planning and resolvability.[5]

1 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.

2 The *Principles for financial market infrastructures* are available on the CPMI and IOSCO websites: www.bis.org/cpmi/publ/d101a.pdf and 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 and www.iosco.org/library/pubdocs/pdf/IOSCOPD396.pdf.

3 The CPMI-IOSCO Implementation Monitoring Standing Group conducts this implementation monitoring programme. For more information, please see www.bis.org/cpmi/info_mios.htm.

4 See Communiqué from February 2015 G20 Finance Ministers and Central Bank Governors meeting at www.g20.utoronto.ca/2015/150210-finance.html.

5 See www.bis.org/cpmi/publ/d134b.pdf.

4. As part of the CCP workplan, the chairs also asked the Committees to "evaluate the existing stress-testing policies and practices of CCPs, and consider the need for, and develop as appropriate, a framework for consistent and comparable stress tests of the adequacy of CCPs' financial resources (including capital) and liquidity arrangements, which could involve supervisory stress tests". Accordingly, CPMI-IOSCO has developed more granular guidance on certain principles and key considerations in the PFMI regarding CCPs' financial risk management, including stress-testing frameworks and margining practices.[6] To complement these efforts, the Committees decided to develop a framework to support the design and execution of supervisory stress tests (SSTs) that would help authorities better understand the macroprudential risks that could materialise if multiple CCPs were to face a common stress event.

5. As discussed in more detail below, the framework is designed to support SSTs conducted for the purpose of evaluating broad, macro-level impacts across multiple CCPs rather than assessing the adequacy of resources at specific CCPs, which is typically an objective of microprudential stress tests. The focus of macro-oriented multi-CCP SSTs may also be informed by other relevant work on central clearing interdependencies carried out by a joint study group of the committees as part of the CCP workplan.[7]

6. The framework reflects work by the Policy Standing Group (PSG), a working-level group established by the CPMI-IOSCO Steering Group. The guidance in this report was informed by comments received during the public consultation as well as feedback provided by authorities and industry participants during informal, targeted engagements and formal workshops held in September 2017.

1.2 Supervisory stress tests

7. Supervisory stress tests (SST) broadly refer to stress-testing exercises designed and executed by authorities, with or without the direct participation of CCPs. SSTs can be designed to achieve different objectives. For example, one objective would be to use an SST to assess the resilience of a particular CCP under a specific stress scenario(s), evaluating micro-level impacts. Another objective would be to assess the potential systemic effects associated with multiple CCPs responding to the same stress event(s) (multi-CCP SST), evaluating macro-level impacts.[8] In considering these objectives and experience to date, CPMI-IOSCO developed a supervisory stress-testing framework focused on macroprudentially oriented multi-CCP SSTs. These exercises would evaluate the collective response of a set of CCPs to one or more common stress events, from a credit risk perspective, a liquidity risk perspective, or both. The macroprudentially oriented SSTs contemplated under this framework would neither supersede internal stress testing conducted by CCPs nor assess the resilience of individual CCPs.

8. In particular, conducting a multi-CCP SST could help authorities better understand the scope and magnitude of the interdependencies between markets, CCPs and other entities such as participants, liquidity providers and custodians. For instance, a multi-CCP SST could be designed to analyse concentrations of exposures to common participants, common risk factors or common dependencies on particular liquidity providers or other service providers. Furthermore, information generated by multi-CCP exercises could facilitate dialogue among CCP supervisors and overseers, banking supervisors and macroprudential authorities. Equally important, the risk management decisions and frameworks of CCPs, clearing participants, buy-side firms and other CCP stakeholders could be informed by the results of SST exercises.

9. Multi-CCP exercises could also provide valuable information on the potential impact of shocks, such as market price impacts due to the liquidation of similar or common assets across multiple CCPs that are managing one or more defaults. Although extremely relevant for financial stability, CPMI-IOSCO recognise the complexity, and the current incipient state, of techniques to model these feedbacks or

[6] See https://www.bis.org/cpmi/publ/d163.pdf or http://www.iosco.org/library/pubdocs/pdf/IOSCOPD568.pdf.

[7] The Study Group on Central Clearing Interdependencies has conducted analysis on this topic.

[8] SST and multi-CCP SST are used interchangeably throughout the framework.

second-round effects. Accordingly, the SST framework does not elaborate on these potential effects. That said, it is acknowledged that illuminating the nature and magnitude of interdependencies and common exposures through SSTs could provide valuable information that could serve as a starting point for additional focused analysis by relevant authorities.

10. To achieve this macroprudential objective, authorities would need to apply a common (set of) stress scenario(s) to a set of CCPs (referred to as "in-scope CCPs").[9] As CCPs have diverse organisational structures, functions and designs, commonly supporting specific, heterogeneous markets, and employ different business models, it is likely such a scenario(s) would impact CCPs differently. Consequently, any given scenario is unlikely to be equally stressful across all cleared markets. Although multi-CCP exercises could help to identify gaps, inconsistencies or implementation issues regarding existing risk-management standards or practices in CCPs, the tests are not specifically designed to establish minimum requirements for individual CCPs, and would not be a sound basis for direct comparisons of resilience across CCPs.

11. The types of information that could be provided through a multi-CCP test are not available through micro-level tools, such as individual CCPs' internal stress tests, an SST assessing the resilience of a single-CCP or other exercises designed to identify particular aspects of cross-CCP interdependencies (eg joint CCP default-management fire drills). Individual stress tests run by CCPs assess if each CCP has sufficient total prefunded financial resources to cover potential losses or test whether each CCP has sufficient liquid resources to cover its liquidity outflows under a wide range of extreme but plausible stress events. These tests result in a natural pass/fail metric and allow the authorities and others to determine whether each CCP is sufficiently resilient. In contrast, the multi-CCP SST described in this framework would evaluate the impact of a set of stress events on all in-scope CCPs without applying a pass/fail metric to individual CCPs. To the extent that metrics for sufficiency of financial or liquid resources were considered in analysing the outcome of a multi-CCP SST, they would be considered for the purpose of drawing conclusions on the collective drawdown of resources across in-scope CCPs and the dispersion or concentration of losses or liquidity shortfalls.

1.3 Use of the framework

12. The supervisory stress-testing framework is intended to serve as a guide for one or more authorities to design and run a multi-CCP SST with a macroprudential orientation.[10] The framework can accommodate SSTs that are conducted by a single authority or several authorities from the same jurisdiction or multiple jurisdictions, and that assess impacts on CCPs clearing any type of product. It can also support recurring SSTs involving the same authority or authorities and *ad hoc* tests by one or more authorities.

13. As noted above, CPMI-IOSCO considers that there is a policy benefit in conducting multi-CCP SSTs and has also identified a potential benefit to CCPs and other stakeholders. The framework purposely applies a non-prescriptive approach, as authorities may have different priorities for and constraints related to conducting an SST. It is likely that each authority implementing an SST exercise will need to develop its own tailored approach given applicable legal and regulatory frameworks as well as other relevant factors. However, authorities may benefit from sharing perspectives or communicating on their respective exercises or particular aspects of those exercises. Additionally, voluntary and flexible application of the framework allows authorities to develop the approach most appropriate given their circumstances. Authorities are therefore encouraged, but not required, to use the framework as they deem appropriate.

[9] See Element 1.ii, paragraphs 29-31, on "scope" of CCPs.

[10] While the framework has been designed for use by authorities conducting a multi-CCP SST with a macroprudential orientation, this does not preclude its use, suitably adapted, as a resource for the design of tests with other objectives, including SSTs designed to analyse the individual financial resilience of CCPs in either single- or multi-CCP tests.

14. Indeed, as each supervisory stress-testing exercise may involve different authorities with varying responsibilities, legal frameworks, expertise and resources, the discussion lays out a flexible and high-level approach for designing and running a test. Given the number of variables at play, this guidance is intended to help authorities think through various issues, decision points and potential options, while recognising that each issue or option may not be applicable uniformly across all authorities or jurisdictions. Authorities will need to consider each of these issues in light of their particular mandates and design their tests accordingly.

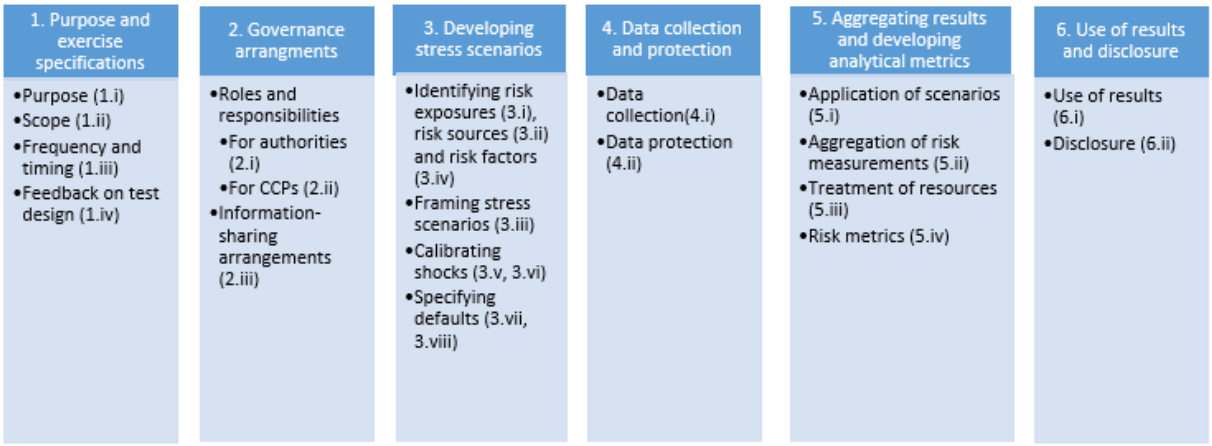
15. Finally, it should be noted that, while the framework could be used by any authority conducting an SST, it may be more useful to those authorities that have not yet conducted an SST. To help decision-makers work through the decision points described in the framework, Annex A includes a practical design tool. Following the same structure as the framework, this tool specifies some questions that a decision-maker is likely to need to consider in the design and running of an SST, and provides some illustrative design choices.

1.4 Structure of framework

16. The framework sets out six components with underlying elements that describe the steps authorities would likely follow when designing and running a multi-CCP SST, including: setting the purpose and exercise specifications (Component 1); establishing governance arrangements (Component 2); developing stress scenarios (Component 3); data collection and protection (Component 4); aggregating results and developing analytical metrics (Component 5); and determining the use of results and disclosure (Component 6). The components are intentionally broad in order to accommodate any multi-CCP SST.

17. Under each component is a set of elements that provide a more granular expression of the specific issues that authorities may need to consider when deciding how to implement that component.[11] These elements provide authorities with guidance on the substantive aspects of SSTs by describing the associated challenges and trade-offs as well as potential approaches to addressing them. To this end, the framework includes examples and alternative methodological approaches which are provided for illustrative purposes. These examples are not intended to be exhaustive and do not preclude authorities from exploring and implementing other approaches.

Figure 1: Overview of the SST framework



This diagram illustrates a number of interrelated steps associated with designing and running an SST. The framework discusses each of the six components and related elements. As noted in the guidance, when designing or planning an SST, these components and elements will likely need to be considered in parallel as well as in an iterative manner.

[11] Figure 1 provides an overview of the components and elements discussed in the framework.

18. As discussed in the guidance, there is considerable interplay between the components and elements, which can generate a range of choices for authorities to make when designing an SST. While it is not strictly necessary for authorities to apply all these components and elements when designing and running an SST, it may be useful to consider how they can be implemented as interrelated steps. For example, the choice of approach for any single element has the potential both to influence, and to be influenced by, choices of approach for other elements. There is a significant degree of optionality in the particular approaches authorities may select in applying each element, depending on the specific purpose of the test, the prevailing circumstances, and how the authorities view any trade-offs between them. Accordingly, the framework has been designed to facilitate various approaches rather than impose a rigid, and thus more limiting, structure.

19. In considering how to proceed on a particular element, authorities may find it helpful to consider the following: (i) how the approach will *add value* to the SST, such as supporting the purpose, producing stress scenario(s) that are sufficiently severe while remaining plausible and internally consistent so as to yield credible results (that is, risk factor shocks should be plausible both individually and collectively), or informing policymakers' understanding of cross-CCP interdependencies in times of stress; (ii) whether the method chosen will facilitate interpretability, transparency and consistency, such that the SST will be analytically tractable, feasible and credible; (iii) how best to achieve appropriate independence while benefiting from expertise where CCPs or other market participants may be involved in aspects of the SST's design and the development of stress-testing scenarios, such as by applying tools to consider and balance the interests of those involved; and (iv) the anticipated resource costs associated with running the SST, whether those costs can be appropriately balanced between participating authorities and the in-scope CCPs, and any other market participants involved in the SST, and whether the SST strikes the right balance between resource costs and the added value from the exercise.

20. In addition to the guidance in this framework, authorities should have regard to the PFMI and associated further guidance on CCP resilience when designing their SSTs and should ensure consistency with the guidance in these documents, as appropriate. As noted above, a multi-CCP SST with a macroprudential orientation is inherently different from a CCP's internal stress tests. Notwithstanding their different objectives, the basic approach to designing SSTs and the assumptions underpinning scenario development should be consistent across the two types of stress tests. Authorities should therefore consider the definitions and assumptions in the PFMI and associated guidance to inform the development of extreme but plausible scenarios. That said, given the macroprudential focus of the SST supported by this framework, authorities should not be constrained by the expectations set for CCPs for internal stress testing. For instance, authorities should select the risk sources and stress scenarios relevant to the specific SST's purpose rather than unnecessarily employ a "wide range of relevant stress scenarios" as expected of CCPs when evaluating credit risk.

2. Components of the framework

2.1 Purpose and exercise specifications (Component 1)

2.1.1 Description of component

21. Before executing an SST, authorities should consider a number of high-level questions. These include what the purpose of the test will be (Element 1.i), which CCPs will be involved in the test (scope; Element 1.ii), and the frequency and timing of the test (Element 1.iii). Further, authorities may also seek to establish a mechanism for soliciting feedback on aspects of test design (Element 1.iv). As there are a number of ways to approach each of these elements, authorities should carefully consider this component as it provides the foundation for the entire SST exercise.

2.1.2 Discussion

Purpose (Element 1.i)

22. One of the most important supervisory stress-testing decisions that authorities will make is to establish the specific purpose of the stress test. The purpose of the stress test will serve as the foundation upon which many design and execution decisions will rest. The SST's purpose can be defined in terms of the objectives that the test is trying to achieve or, alternatively, as the set of specific questions that the SST will attempt to answer. Many different purposes can be considered for a multi-CCP SST. The authorities may choose a single or multiple purposes for their SST. When identifying several purposes, authorities should consider whether the SST can feasibly achieve all of the stated purposes.

23. A clearly articulated purpose is important, not only for authorities as they design and execute an SST, but also so that CCPs, clearing participants, non-participating authorities and other stakeholders (including the public) fully understand the results and conclusions that can be drawn from the test.

24. Almost every component in the remainder of this framework will be influenced by the chosen purpose. Decisions about which CCPs to include in the SST, the data to be collected, the design of the stress scenarios, the clearing participants chosen to default, the information-sharing arrangements between CCPs and authorities that may be needed, the extent to which results or other information are disclosed, the metrics chosen to summarise the stress test results, and the possible actions taken by authorities in response to the results are all influenced by the test's purpose. Failure to clearly state the purpose of the stress test, or specifying too broad a purpose, may therefore cause difficulties at other points in the process of designing and running the test.[12]

25. Although a multi-CCP SST can serve many different purposes, this framework focuses on the high-level purposes of analysing credit risk and liquidity risk. Purposes that focus on credit risk pose questions on the potential losses that the set of CCPs may face in a stressed event, the amount of resources available to the in-scope CCPs, and mutualised losses that may need to be covered by clearing participants. In contrast, purposes that focus on liquidity risk will test the liquidity outflows of the in-scope CCPs, the liquidity resources available to the CCPs, and the liquidity calls made to clearing participants or other third parties during a stressed event.[13] Authorities may choose to design and execute a single SST with both

[12] For instance, an ill-defined purpose could cause difficulties in determining the high-level specifications necessary to implement the stress test, such as information-sharing arrangements, disclosure requirements and the scope of CCPs to be included in the test; the design of stress scenarios that are not consistent or appropriate for the desired purpose; and difficulties, on the part of authorities, CCPs or other stakeholders, in drawing effective conclusions from the test.

[13] An SST with a purpose focused on liquidity risk will likely have to focus on liquidity outflows and resources by currency and at specific points in time during the stress scenario, which may be default or non-default related.

credit and liquidity purposes, but should recognise the differences in design and execution associated with each type of purpose.

26. In addition to classifying possible purposes as focusing on either credit or liquidity risk, the authorities may specify more granular purposes for a multi-CCP SST. One possibility is to define purposes for an SST in relation to the type of information to be extracted from the tests, such as the collective drawdown of resources across in-scope CCPs, diversification of stressed losses or outflows across CCPs and CCP participants, and diversification of stressed losses or outflows across stress scenarios.

27. The purpose may also be defined in terms of the nature of the potential vulnerability being analysed. For instance, an SST may be focused on identifying vulnerabilities that could create financial losses or large, unexpected liquidity outflows at CCPs, non-defaulting clearing participants or other third-parties. Examples of such vulnerabilities include clearing participants whose default would generate the largest financial losses or liquidity shortfalls across the CCPs, the liquidity providers on which there is the greatest reliance and whose failure to perform as expected to meet a liquidity outflow could leave the CCPs with a liquidity shortfall, or stress scenarios that might generate large-scale financial losses or liquidity shortfalls across multiple CCPs simultaneously (which could potentially also give rise to amplified financial stress due to concentrated liquidation of both positions and collateral). Equally, an SST may be designed to examine the potential credit or liquidity impact of a suspected specific vulnerability or dependency that has been identified under another process. Examples of specific areas of focus for an SST might be the default or failure of common participants, common liquidity service providers, custodians, investment counterparties or collateral issuers, or extreme market conditions in a specific asset class.

28. Finally, it is important to note that the purpose of the test may have to be modified due to legal, technical, or resource constraints. It is possible that determining the purpose of the test may be an iterative process that starts with one desired purpose but changes as authorities consider and make decisions regarding the other components identified in this framework. Authorities conducting recurring exercises may choose to vary or alter the SST's purpose in subsequent tests. For example, authorities may wish to build upon the purpose of an initial SST or focus on different potential vulnerabilities through each iteration. However, it is important that, as authorities modify the SST's purpose, the modified purpose remains clearly articulated and well understood by the authorities, the CCPs and other relevant parties.

Scope (Element 1.ii)

29. Setting the scope of CCPs, including the clearing services, to be included in the SST is an important decision for authorities to determine and agree on early in the process of designing the exercise. Authorities should be clear in how they selected the CCPs for a particular SST and ensure that the scope aligns with the purpose of the test. For example, if an SST's purpose is to assess the impact of a shock on certain markets, the test should include CCPs that clear products in those markets. The scope of CCPs that authorities choose to include in an SST will also likely be driven by the jurisdiction, including the legal framework, and supervisory powers and mandates of the authorities conducting the test. Along with the purpose, the scope may also influence the composition of authorities involved in an SST. For example, an authority may seek to coordinate with other authorities to broaden the scope of CCPs included to achieve the purpose of the test. Additionally, authorities may need to limit the scope due to legal, resource capacity and information-sharing constraints.

30. One approach is to include all CCPs in a particular jurisdiction regardless of the products cleared, market share, or systemic importance. Proceeding in this way could, for instance, give the authorities a more complete perspective on the scope of interconnections between the CCPs, or evaluate the CCPs' collective response from a liquidity perspective. This approach could be implemented by one authority testing all CCPs it supervises or by multiple authorities testing all CCPs in a single jurisdiction, potentially leveraging existing information-sharing arrangements. While this approach would likely be feasible from a legal or jurisdictional standpoint, it may increase the complexity of the test design to account for multiple types of CCPs and markets. Additionally, where the scope of CCPs spans multiple authorities or multiple

jurisdictions, it will have a direct impact on the governance arrangements necessary to support the design and running of the test itself (see Component 2). When defining the scope, authorities should also keep in mind that, for any given scenario, the specified risk factor shocks are unlikely to be equally severe for all in-scope CCPs. Depending on the test's purpose, the authorities may need to include a number of diverse scenarios (see Element 3.iii).

31. Another approach is to target a set of CCPs based on particular factors, which could, for instance, include: (i) the systemic importance of the CCPs;[14] (ii) the particular markets or products cleared; (iii) the currencies in which cleared products are denominated; (iv) the number of common participants (in particular, where one or more of those participants account(s) for the largest credit exposures at one or more of the CCPs); or (v) other relevant interdependencies between CCPs, such as common liquidity providers. Authorities may also wish to target certain service lines of the in-scope CCPs, selected for instance according to the product characteristics most relevant to the purpose of the test, or the magnitude of exposures (perhaps measured by total initial margin).[15] For example, depending on the test's purpose, authorities could consider including only significant markets cleared by the CCPs in the test's scope. The authorities may wish to use one or more factors when determining the scope of CCPs to include or apply different criteria for subsequent iterations of a supervisory stress testing programme.

Frequency and timing (Element 1.iii)

32. Authorities may conduct an SST once, repeatedly on an ad hoc basis, or at regular intervals. In some jurisdictions, the frequency of tests may be set by law while, in others, authorities may elect a particular frequency. In the latter case, authorities may determine that a single SST is sufficient to meet the purpose of the exercise or that changes in the structure and composition of the participant base, changing market conditions, and resource constraints necessitate that tests are conducted on an ad hoc basis. Authorities should consider these varying approaches, among other factors, when specifying an appropriate interval between tests.

33. In establishing the appropriate frequency of SSTs, authorities should take into account both the resource demands on authorities and other relevant contributors and the potential incremental benefits associated with the test's purpose. Particularly, since an SST may take several months to conduct due to the complexities associated with the design of a test, authorities may wish to run a single exercise examining the same scenarios over multiple reference dates to obtain more representative results. While this could increase the end-to-end duration of the process and the resource burden on in-scope CCPs, it might also increase the information content of a given exercise. Authorities should consider these trade-offs as well as the complexity of the scenarios when deciding to use one or multiple reference dates.

34. Authorities could consider running subsequent tests annually or in alternating years. Additionally, when authorities plan to conduct recurring tests, they should consider the potential resource demands on authorities and other relevant contributors. For example, if the scenarios used in each test vary substantially or if the test makes significant data processing or analysis demands on CCPs, authorities may need to allow for increased time between tests. Conversely, an SST could be run at an increased frequency if there is no direct participation by CCPs, if major design aspects remain unchanged or if most parts of the SST process are automated, so as to manage the resource burden on authorities, CCPs and other market participants. When setting the frequency, authorities should also take into account other SSTs that in-scope CCPs are involved in and the level of CCP participation expected by the authorities conducting those tests.

[14] Certain jurisdictions may have frameworks or statutory provisions for determining the systemic importance of CCPs. Authorities may look to those or other relevant factors when targeting the inclusion of those CCPs in an SST.

[15] For a given purpose, the selection of scenarios may drive the scope of clearing services to be included in the test. Once the scenarios have been developed, it may be useful to review the scope of clearing services to ensure it will highlight concentrations of exposures to the risk factors most impacted under the scenarios.

35. Authorities should give sufficient notice of requests they intend to make for an SST. They should also provide appropriate lead time for CCPs or other market participants to produce deliverables as it may take time to respond to requests. For example, where a CCP will need to establish automated processes to support an SST, such processes will take time and resources to create. Additionally, deadlines should take into account other expectations and constraints on CCPs' resources. An authority should also consider coordinating with other relevant authorities to avoid overlapping or simultaneous demands from multiple, concurrent SSTs. Authorities may also wish to take into account certain dates that typically give rise to increased market activity, such as key settlement dates, year-end, or end-of-quarter, or known events, such as market implementation dates or national elections, when specifying deadlines or deliverables for market participants involved in an SST.

Feedback on test design (Element 1.iv)

36. Feedback from CCPs, market participants, and other relevant parties on the design of an SST may improve the overall effectiveness and credibility of the test. Authorities, therefore, could consider establishing mechanisms for receiving feedback on various design decisions. It is important that any feedback mechanism facilitates the collection of targeted and constructive comments. Additionally, when evaluating feedback, authorities should be aware of the varying interests and perspectives of those providing input. In particular, authorities should account for and seek to balance the interests that those consulted may have in order to maintain the SST's independence.

37. As authorities can solicit feedback before, during or after a test is run, they should ideally first determine at what points in the supervisory stress-testing process to seek comment, as the timing could shape the topics included for consideration. Seeking feedback early in the SST process may help authorities identify potential challenges or constraints in advance and improve the overall usefulness and efficiency of test. For example, authorities may want to receive feedback on the purpose and scope of the test before developing stress scenarios. Additionally, authorities may wish to consult relevant parties after designing a test, but before running it, to refine their approach to certain elements. If authorities plan to conduct additional tests in the future, they may also choose to solicit feedback after test completion to inform subsequent iterations. Such feedback could help inform future decisions regarding the test's purpose, scope, scenarios, and data templates. There are numerous formats that authorities can employ to collect input informally or formally, including bilateral meetings, workshops, conferences and requests for comment. Authorities might consider using one or more approaches in order to solicit a range of views in a manner that encourages open feedback.

38. Authorities may seek feedback from a number of sources and could consider consulting groups that have particular perspectives or expertise that could inform the design of a specific test or programme. In particular, there are several specific subject areas on which authorities could consider consulting CCPs, clearing participants and other relevant parties. These include frequency, data collection and protection, scenario selection and development, and the identification of risk sources and core risk factors. Additionally, when CCPs are asked to provide data for the test, authorities could consider seeking feedback on detailed data instructions and any templates used for data submissions. Feedback on these areas could help to ensure a common understanding and interpretation of data requirements; promote the accuracy and consistency of information supplied; and mitigate the resource burden associated with the test (see Element 4.i). Related to data collection and protection, authorities may also want to seek feedback on topics related to confidentiality as such input may enhance confidence among market participants regarding the security of any data provided and ensure that authorities adopt a comprehensive approach to data protection.

39. As relevant for a particular test, authorities may also wish to collect input from and in relation to other market participants, including clearing participants, customers, liquidity providers and custodians. Each of these groups has a unique perspective to offer given its respective relationship to in-scope CCPs which can be of value to authorities. Further, seeking input from a variety of sources and types of market

participants may promote the independence of the exercise. For example, seeking diverse views on scenario design not only from CCPs but also from clearing participants and customers may be an effective tool for creating balance among the views expressed.

40. In addition to CCPs and other market participants, authorities may also choose to consult non-participating authorities. Authorities that have previously conducted an SST for CCPs or banks (with the same or a different objective) may have "lessons learned" that could be valuable inputs for those authorities conducting a particular SST. In addition, authorities may choose to create a consultative group of non-participating authorities to provide input on high-level decisions related to purpose, scope, or scenario design. Further, academics may also offer novel and helpful approaches for test design.

2.2 Governance arrangements (Component 2)

2.2.1 Description of component

41. Governance arrangements should be considered and determined in advance of running the exercise. Clearly defined roles and responsibilities for all relevant parties should facilitate the SST's design and improve the likelihood that the exercise will be run efficiently, effectively and consistently with its stated purpose (Element 2.i; 2.ii). Similarly, information-sharing is key to executing an SST (Element 2.iii). Authorities should ensure that arrangements are in place to exchange and use the necessary data as well as other relevant information. Such information-sharing arrangements should take into account a number of considerations, including the mandates of authorities, the test's purpose, data sources, the governance arrangements of the test, the potential frequency of tests to be conducted (one-time or on a recurring basis), and the expected use and disclosure of the results. In particular, the legal framework in certain jurisdictions may influence authorities' (or CCPs') ability to share or disclose particular information and these limitations should be taken into account.

42. These governance arrangements will have a significant impact on the development of other components and, therefore, authorities may need to consider them when making decisions on other components in the framework.

2.2.2 Discussion

43. Authorities could approach the governance arrangements for an SST in several ways. In particular, the following discussion lays out considerations for identifying and setting roles and responsibilities related to conducting the test and the involvement of CCPs. Roles should be assigned to authorities at the beginning of the SST process, so that it is clear which authorities are responsible for certain actions or decisions that will arise over the course of the exercise. In doing so, the authorities can promote consistent application of the SST across all of the in-scope CCPs. Authorities should assign roles to organisations, groups of staff, or individuals, as appropriate. The respective roles and responsibilities may differ depending on the particular stage of the exercise, availability of resources, and level of institutional commitment required for a particular decision point.

44. SSTs require access to sensitive, non-public data and other relevant information by one or more authorities. The primary sources of this information are likely to be particular authorities who collect and maintain CCP-related data on an ongoing basis and CCPs within the scope of the exercise. The recipients of the data, which may be in raw or aggregated form, will generally be the authorities conducting the SST. However, the subsequent analysis of test results in varying levels of detail, as appropriate, may be shared among a broader group of stakeholders, including other relevant non-participating authorities, clearing participants and their customers and the public (see Element 6.ii).

45. The legal basis and ability to collect and share or use information may be derived from different sources. For instance, a CCP's rulebook and contractual relationships with third parties (such as custodians and liquidity providers) may enable or place limits on the CCP's ability to share data and information with its supervisor(s) and other authorities. In some jurisdictions, authorities have legal powers to collect information; however, they also may be limited as to whether and with whom they can share such information or otherwise use such information. As authorities design their SSTs and determine the various roles and responsibilities of the organisations involved, they will need to take steps to ensure the appropriate use and handling of the information, including when, for what purpose, and with whom it is shared and disclosed.

Roles and responsibilities for authorities (Element 2.i)

Roles and responsibilities: purpose and exercise specifications

46. Determining the purpose of the test and the exercise specifications is essential to the entire exercise; these decisions will have wide-ranging design and resource implications. Accordingly, it may be appropriate to subject these decisions to extensive discussion. Authorities could consider consulting a broad group with appropriate levels of responsibility, potentially including agency principals, on these elements to ensure that the SST complements and advances their respective policy objectives and supervisory or oversight mandates. Further, in making these decisions, authorities may choose to delegate responsibility for certain areas to one or a subset of authorities (especially when multiple authorities are conducting a test) based on resource availability or specific expertise.

Roles and responsibilities: developing stress scenarios

47. After determining governance arrangements for the purpose and exercise specifications of an SST, the authorities conducting the test could then determine roles and responsibilities for developing stress scenarios. This work would require contributions from staff with technical expertise across a range of topics, depending, in part, on the scope and purpose of the exercise. When multiple authorities are conducting a test, certain authorities may have greater technical capabilities or knowledge of specific products and markets and, therefore, could be better positioned to assume a key role in the design of this component.

48. Additionally, the authorities conducting the test may wish to draw upon expertise from various internal and external sources. For example, if an authority conducting a test is also a supervisor of clearing participants, it may be helpful for that supervisor to contribute to the SST's design in ways such as identifying key risk drivers or sources of emerging or potential risks that may influence the severity or specifications of the scenario(s) applied. Additionally, if appropriate and applicable, authorities could consider utilising in-house or external experts (see Element 1.iv) to select appropriately severe macro variables and quantitative parameters for the scenarios.

Roles and responsibilities: data collection and protection

49. Authorities conducting an SST will also need to define arrangements and procedures for accessing, collecting, and using data and other relevant information. Due to the confidential nature of these data sets and potential legal considerations, this is one of the most challenging aspects of supervisory stress-testing governance arrangements. Authorities can seek to overcome these challenges in different ways.

50. The scope of authorities involved and their respective legal mandates will likely shape data-related roles and responsibilities as well as any necessary information-sharing arrangements (see Element 2.iii). In some jurisdictions, authorities routinely collect detailed data from CCPs, which is then maintained and made accessible by staff in those particular organisations. While these authorities may not necessarily need to collect further information from the in-scope CCPs, they may still need to establish procedures to ensure proper handling and use of the data within their individual organisations and to facilitate sharing with other authorities.

51. One approach that authorities could employ is tasking a small group of staff, each of whom has requisite permissions, such as supervisory frameworks or any applicable consent from involved CCPs, to access and validate the raw data and perform the initial analysis. The composition of this group may be selected with reference to a number of factors, including technical expertise related to scenario design or particular knowledge of certain markets and products. In particular, validation and quality assurance of the data will require sufficient familiarity with the business of the in-scope CCPs and the markets they serve.

52. Once the small group has validated and conducted its analysis of the raw data, highly sensitive information, such as specific clearing participant names, customer positions, or other third party data,

could be anonymised or removed from any subsequent distribution of the analysis to a broader group of staff (see Element 4.ii). While the members of the small group would be obliged to maintain the confidentiality of that underlying sensitive information, the resulting anonymised and refined (and therefore less sensitive) analysis could potentially be shared with various groups, such as CCP supervisors or overseers, policy-focused staff and clearing participant supervisors within the authorities conducting the test.

53. Depending on the purpose of the test and existing information-sharing arrangements, in many cases authorities will need to collect additional data from CCPs. Certain authorities may have the legal power to compel CCPs to provide the necessary data, whereas others may rely on CCPs to voluntarily supply it. When collecting data from CCPs, the authorities may need to assign roles and responsibilities depending on their legal mandates. In an SST involving CCPs under different supervisory regimes, the authorities may choose, for example, to leverage their supervisory mandates and assign data collection responsibilities based on their respective supervisory relationships. As it is likely that each of the groups would need to have access to all of the data to ensure comparability, authorities could then establish appropriate permissions to share information within a single authority or a memorandum of understanding to facilitate information-sharing between multiple authorities (to the extent supported by their respective legal frameworks). They may still need to employ the "small group" approach described above for the handling and analysis of the raw data and decisions would need to be made on which data could be shared amongst the small groups.

Roles and responsibilities: aggregating results and developing analytical metrics

54. Authorities will also need to define responsibilities for consolidating and analysing test results. There are a variety of groups that authorities should consider including in this analysis. However, care should be taken to balance the confidentiality of data collected from and in relation to CCPs, clearing participants, and other relevant third parties with the need for input from a broad and diverse group of personnel. Authorities may consider involving a small supervisory stress-testing working group in the consolidation and analysis of results, perhaps comprising individuals with both policy and technical expertise, representatives of the supervisory or oversight teams of in-scope CCPs, and supervisors of clearing participants who are key to the test.

55. When analysing test results, authorities will likely apply methodologies and metrics that appropriately reflect the SST's purpose to ensure that the results are sufficiently informative. To facilitate this analysis, the authorities conducting an SST should consider establishing responsibilities for identifying relevant criteria before running the test. Defining these roles in advance may be of particular importance when several authorities are conducting a test as this could ensure that results are consistently analysed across the various authorities involved. Authorities should also consider assigning responsibilities to facilitate the internal and, potentially, external review of assessment methodologies and metrics to ensure appropriate calibration of such criteria.

Roles and responsibilities: use and disclosure of test results

56. An SST's governance arrangements should address the use of test results (see also Element 6.i). It is likely that the supervisory or oversight powers and jurisdiction of each authority will greatly influence how the results may be used and authorities should take care to ensure that the anticipated use of results is consistent with their mandates and applicable legal framework, as well as with relevant information-sharing arrangements with other authorities. In a multi-authority test, the various supervisory or oversight powers of the authorities will dictate if coordination in relation to the use of test results is possible or necessary. In particular, it may be helpful for authorities to consider in advance an appropriate approach for addressing any system-wide vulnerability that may be identified through the exercise, to the extent further action is appropriate. This may include establishing arrangements to share information to facilitate further assessment or actions by non-participating authorities who have the authority to take potential remediation measures. Further, there may be instances where the collective response of a set of CCPs to

a common shock indicates the need for supervisory engagement with individual firms, such as CCPs, clearing participants, liquidity providers or custodians. In this case, authorities conducting an SST should determine who will communicate such views to individual firms to ensure a coordinated and consistent approach.

57. Authorities conducting a test will also need to consider how the potential disclosure of test results will shape governance arrangements, roles and responsibilities. In particular, when multiple authorities are conducting an SST, they will need to determine collectively a strategy for any disclosure of the test methodology and results. If these authorities decide to disclose information regarding the test, they will need to determine how to do so. For example, one authority could be responsible for disclosing test methodology and results on behalf of all authorities. Alternatively, each authority could disclose information separately, all authorities could issue a joint statement, or another approach could be used.

58. As discussed in Component 6, the authorities conducting a test may implement different levels of disclosure for different stakeholders (eg CCPs, clearing participants, other authorities, and the public). In instances where multiple authorities are conducting a test, they may choose to assign roles specifying the authorities responsible for disclosing information to certain audiences. For example, each authority may be tasked with sharing the test results with the CCPs for which it has supervisory responsibility. Establishing these arrangements will help facilitate, to the extent possible and desired, consistent disclosure across all relevant jurisdictions and increase the likelihood that a test's disclosure mechanism supports the purposes of the test.

Roles and responsibilities for CCPs in the test (Element 2.ii)

59. As discussed further in the guidance (Components 3, 4, and 5), authorities may decide to invite CCPs to play a role in running the test.[16] Certain authorities may have the legal authority to compel CCP participation in an SST, while others may rely on voluntary participation. There are several important considerations associated with including CCPs in conducting a test that should be taken into account when authorities design the test and its corresponding governance arrangements. While CCP involvement can enhance the quality of outputs, balance the resource burden of the exercise, and leverage the expertise and operational capabilities of in-scope CCPs, authorities should take care to preserve the impartiality and validity of the exercise. In particular, when assigning certain roles and responsibilities to CCPs, authorities should consider establishing governance arrangements that ensure the independence of the exercise and its results. While authorities may seek input on specific topics intrinsic to test design from in-scope CCPs to add value to the exercise, they should retain control of the exercise and avoid relying exclusively on CCPs for such input.

60. The CCPs participating in the exercise could be helpful in a number of different areas, ranging from scenario development (Component 3) and data collection (Component 4) to the aggregation of results (Component 5). For example, authorities could initially develop the framing parameters and core risk factor shocks used for an SST, and CCPs could subsequently provide feedback to refine those scenarios. It may also be helpful for CCPs to provide input at other points in the development of scenarios, such as identifying core risk factors and extrapolating shocks to non-core risk factors. Where such input is provided, authorities should take appropriate steps to review the models used and outputs provided by CCPs (as discussed further in in Components 3, 4 and 5).

[16] For example, CCPs may be asked to submit data or other necessary information to authorities, which may require coordination with other relevant parties such as clearing participants. Components 3, 4, and 5 provide further examples of how CCPs could be involved in conducting a test.

Information-sharing arrangements (Element 2.iii)

Utilising pre-existing information-sharing arrangements

61. Authorities could leverage any existing information-sharing arrangements as appropriate to achieve the SST's purpose and data needs (eg memorandum of understanding supported by the legal framework). In pursuing this approach, authorities would need to evaluate whether pre-existing information-sharing arrangements cover the relevant CCPs, products, and data needed to conduct one-time or recurring SSTs. Furthermore, the authorities may need to consider whether these arrangements support participation by all relevant authorities in carrying out their respective roles and responsibilities in the exercise.

62. Roles and responsibilities may need to be revised to be consistent with existing information-sharing arrangement(s). For example, situations may arise where a single authority has an existing legal framework applicable to information obtained from particular CCPs that may define what data may be shared, with whom, and how it may be used. As a consequence of relying on these existing legal powers, such an authority may be constrained in sharing data with some or all of the other authorities. Accordingly, unless additional arrangements are established, that authority may be solely responsible for conducting the initial analysis on confidential raw data and be unable to share key outputs with other authorities. While leveraging pre-existing arrangements could improve the pace at which the authorities could commence work on the SST, it may materially change the manner in which it is conducted and the resource demands on certain authorities.

Developing new information-sharing arrangements

63. If pre-existing arrangements do not exist or cannot be used to conduct an SST, authorities will need to construct new arrangements that allow for information-sharing between authorities and others, as appropriate. As legal frameworks across jurisdictions differ, it is unlikely that any single construct would be universally applicable to all authorities seeking to conduct an SST. There are, however, some baseline considerations authorities should take into account when designing a new arrangement: (1) the legal mandates and supervisory or oversight frameworks of the authorities; (2) the SST's purpose; (3) the scope and granularity of data required as well as the envisioned flow of data throughout the exercise (for example, who is expected to access data, analyse them and formulate the results, from among the authorities and the CCPs); (4) the range of entities involved in the exercise; (5) whether the arrangement is intended to cover an ad hoc one-time test or recurring tests; (6) how authorities intend to use the data (eg the authorities may need to specify any limitations on the data's use beyond the SST); and (7) expected use of results and anticipated disclosure.

64. If authorities intend to rely on CCPs to provide necessary data, they should consult with the in-scope CCPs early on in the SST process to determine if information-sharing permissions or arrangements with various market participants are necessary. When designing such information-sharing arrangements, authorities should endeavor to construct arrangements that minimize multiple, overlapping data requests to the in-scope CCPs or other relevant contributors. Authorities should also consider any possible obstacles or restrictions when designing arrangements with CCPs or other market participants and the effect this may have on the SST's design. For instance, some CCPs may have legal restrictions placed on whether and how they may share data and may need to receive specific details on the purpose of the test, the data's intended use, and who the information will be shared with in advance of providing information to authorities. Providing this information in advance may also facilitate willingness to participate and allay confidentiality concerns among CCPs and other market participants. CCPs may also need to seek permission from clearing participants or customers prior to sharing position-level information or other relevant data with authorities. In the case of recurring SSTs, it would be helpful for such permissions to cover further iterations of the programme.

2.3 Developing stress scenarios (Component 3)

2.3.1 Description of component

65. This component presents the key elements of the process of developing stress scenarios for the SST. First, it describes the role that risk exposures and risk sources play in an SST's design. The component also discusses how authorities could select which risk exposures and risk sources to include in the SST and the factors that authorities may wish to consider when making this choice (Element 3.i; 3.ii). For instance, depending on the SST's specific purpose, the authorities may wish to include a number of risk sources beyond the mid-market price moves in cleared positions, increasing the severity of the stress scenarios.

66. Appropriately designed extreme but plausible stress scenarios are a necessary component of any stress test. Designing such scenarios will include a number of discrete elements: (3.iii) framing the stress-testing scenarios; (3.iv) identifying core risk factors; (3.v) calibrating the shock for core risk factors; (3.vi) extrapolating the shock to other (non-core) risk factors; (3.vii) specifying defaults or failures; and (3.viii) specifying the timing of defaults or failures. These elements correspond to steps in the design of an SST's stress scenario and apply equally to tests focused on credit and liquidity risks.

67. The guidance draws out a number of important considerations for authorities to take into account when developing stress scenarios. These include, for instance:

- Authorities should ensure that the scenarios are internally consistent when applied to multiple CCPs clearing multiple products or located across multiple jurisdictions. In developing scenarios, authorities should be cognisant of their complexity and the costs associated with implementing them. Depending on the SST's purpose (see Element 1.i), it is possible that the authorities will wish to develop more than one scenario to potentially increase the information that can be gained from the SST.
- Since CCPs may have exposures to a very large number of risk factors, it may not be feasible for authorities to directly calibrate shocks to all risk factors to be considered in the test. In such circumstances, it may be necessary to identify a subset of representative "core" risk factors for which shocks would be calibrated directly by authorities using either a historical or forward-looking approach or a combination of both. Shocks to other risk factors would then be extrapolated under a separate process, either based on a common methodological approach specified by the authorities or based on the in-scope CCPs' proprietary models.
- In specifying which participants or other obligors or service providers would be assumed either to default or to fail to perform in the stress scenarios, authorities might consider selecting those which under the relevant risk factor shock scenarios would generate the largest credit losses or liquidity shortfalls for the CCPs. Alternatively, the authorities might select defaults or failures on either a targeted basis or according to specified objective market indicators, reflecting the specific purposes of the SST and the framing parameters of the exercise.
- Specification of the timing of such defaults or failures – ie whether they occur simultaneously or sequentially – represents an important reference point for the sequence of events over time.

2.3.2 Discussion

Identification of risk exposures (Element 3.i)

68. This element represents the initial step in developing SST scenarios. It describes risk exposures, the role that risk exposures play in an SST, and the factors that authorities may consider when selecting the set of risk exposures to include in an SST. Risk exposures include, but are not limited to, the positions, collateral, investments and other financial products or liquidity arrangements that may be impacted by the stress scenarios provided by the authorities.

69. The key factors to be considered in choosing the set of risk exposures for inclusion are: the type of risk to be tested, ie credit or liquidity risk; the purposes of the SST within each of these categories; and an assessment of the benefits and costs that would accrue if the scope of the SST's set of risk exposures was expanded. For instance, SSTs focusing on analysing the diversification of the largest credit exposures among the participants of in-scope CCPs may restrict the scope only to the larger cleared markets and exclude positions in secondary ones. Similarly, for an exercise with such a purpose, authorities may exclude risk exposures to investments.

70. In identifying risk exposures, consideration should be given not only to the potential set of products to be tested, but also to the CCP participants responsible for generating the exposures. In particular, authorities could consider whether all CCP participants need to be included in the tests or if only a subset would suffice. For instance, when performing an SST focused on liquidity risk, interest may focus not only on participants with the largest settlement obligations, but also on a subset of those that provide multiple services for the CCP (eg secured lines of credit). Equally important when selecting participants is the size of their risk exposures. In some cases, depending on the circumstances, in targeted credit SSTs testing the collective drawdown on financial resources for a small number of defaults, the inclusion of the whole set of clearing participants may not add much more information while increasing the resource cost of the exercise. The type of participant and the size of their exposures are only two examples of attributes which could be varied to refine the set of risk exposures, but others may also be relevant for SSTs with different purposes (eg when country- or region-specific shocks are the focus of the tests, the domicile of the participant may be an important attribute to consider).

Risk exposures based on CCPs' internal stress-testing procedures

71. CCPs are required to conduct daily stress tests to evaluate both their credit and liquidity risks under a wide variety of extreme but plausible market conditions.[17] To perform these stress tests, CCPs should have already identified the risk exposures that comprehensively cover the range of their potential exposures.

72. In developing an SST, one approach authorities could take, for example, would be to choose the set of risk exposures already identified by the internal stress testing procedures at each CCP. Under this approach, the set of risk exposures considered in the test will likely be comprehensive and, presumably, familiar to the relevant supervisory authorities, and may help minimize the burden on the in-scope CCPs. However, computational costs may be high if some included risk exposures are deemed unnecessary in the light of the SST's purpose and authorities would likely have to spend resources verifying that the set of risk exposures used by each CCP is both sufficiently consistent across CCPs included in the SST and capable of meeting the SST's purposes.

Risk exposures specified by authorities

73. Alternatively, authorities could attempt to evaluate all of the candidate risk exposures at the in-scope CCPs and explicitly choose those risk exposures to best fit the SST's purpose. Such an approach would allow authorities to focus attention on only those risk exposures deemed necessary to meet the SST's purpose. However, this might entail an additional resource burden on CCPs if they are asked to perform calculations on a set of risk exposures other than the set used for their internal stress testing. In particular, there may be a need for CCPs to adjust their internal systems and procedures to tailor the risk exposure coverage of the exercise.

74. If authorities include only a subset of possible risk exposures in their stress tests, the authorities may wish to provide the rationale for their choice and demonstrate that the chosen subset still meets the SST's overall purpose. Such a rationale may help avoid the perception that the SST is missing material risk exposures, which could erode confidence in the conclusions drawn from the exercise.

[17] See Principle 4, Key Consideration 5 and Principle 7, Key Consideration 9 of the PFMI.

Identification of risk sources (Element 3.ii)

75. Once authorities have chosen the set of risk exposures that will be included in the SST, authorities then need to determine the risk sources that will be considered. For this purpose, a risk source is anything that may impact the profits and losses or liquidity inflows and outflows incurred by the CCP, or the financial or liquidity resources available to the CCP when managing a response to a stress event (eg the close-out of a defaulting clearing participant's portfolio).[18] The risk sources applicable to an SST focused on credit risk may differ from those of an SST focused on liquidity risk.[19]

76. The choice of risk sources will have important implications for the SST's design, the complexity of the modelling necessary to implement it, the conclusions that can be drawn, and how the results are viewed by the intended audience.

77. There are several ways that authorities could choose the set of risk sources to include in the SST. Authorities should consider how the particular choice of risk sources will support the purpose and impact the design, value proposition, and SST's costs. Table 1 presents examples of risk sources that authorities should consider. While some of these are challenging to implement, they nevertheless reflect risk sources that CCPs are expected to consider in their internal stress tests and may be integral to certain test purposes.

[18] Risk sources may also impact the liquidity inflows, outflows, and resources for a CCP in the absence of a clearing participant default and some SST exercises may explore stress scenarios that do not involve a clearing participant default.

[19] Risk sources in this element do not include the potential failure to perform or default of other counterparties to the CCP including liquidity providers, investment counterparties, or settlement banks. Element 3.vii discusses how authorities can incorporate these additional risks into an SST.

Examples of risk sources | Table 1

Risk source	*Applicable to credit SSTs, liquidity SSTs or both*	*Description*
Mid-market price moves of cleared positions	Both	The changes to mid-market prices of cleared positions at the CCPs during the stress scenario. This is the most commonly considered risk source in stress testing and will likely be an integral component of most SSTs. The modelling of this risk source usually involves historical price time series for both exchange-traded and OTC markets. Because this risk source considers all cleared positions, it will include risks such as basis risks, curve risks, and the relationships between different product classes. This risk source could also include potential intraday price changes of cleared positions, typically modelled using intraday peak variations (eg open-high-low-close metrics).
Mid-market price moves of collateral	Both	The changes to the mid-market prices of collateral held at the CCPs.
Price moves that result in an entity default (jump-to-default)	Both	The mid-market price moves that are equivalent to an entity default. For example, authorities might include the default of a specific corporate or sovereign entity. This would have a direct impact on the price of securities issued by the defaulting entity such as equity or debt, as well as the price of securities or derivatives that reference the entity such as a credit default swaps or equity options. Further, these price moves may impact the cleared positions or collateral held at CCPs.
Transaction costs	Both	Any costs in addition to the mid-market prices that a CCP would incur when liquidating the cleared positions or collateral of a defaulting clearing participant. Examples of these costs include any difference between executed prices and the mid-market prices such as bid/ask spreads or fees and commissions paid to third parties. These transaction costs are frequently a function of the size and composition of the portfolio or individual positions to be liquidated relative to the depth of the market, the type of liquidation (open market transactions versus auctions) and the assumed liquidation period.
Wrong-way risk – specific	Both	Any additional costs or liquidity outflows incurred by the CCP when the defaulting clearing participant's portfolio or collateral contains securities issued by the clearing participant or that directly reference the clearing participant. For example, if a defaulting clearing participant's portfolio contains a short equity put option written on the defaulting clearing participant, the CCP will likely incur losses on this position in excess of those modelled by the mid-market price moves alone. The modelling of these additional losses (or gains) is usually relatively straightforward given the clearing participant chosen to default.
Wrong-way risk – general	Both	Any additional costs or liquidity outflows incurred by the CCP when the default of the chosen clearing participant is correlated in some way with the prices of positions held by the defaulting clearing participant. In this case, the losses (or gains) incurred by the CCP will likely be higher than those modelled by mid-market price changes alone. Modelling this risk source is considerably more difficult than specific wrong-way risk and will likely require material simplifying assumptions.
Settlement-related liquidity outflows	Liquidity SSTs	Any liquidity obligations that the CCP has to meet to ensure payment obligations in each currency are completed on time upon the default of one or more clearing participants. These liquidity obligations include settlement payments, coupon payments, option premium payments, and payments relating to derivatives expiries, securities or physical deliveries, among others.
Changes in credit exposures and resources	Credit SSTs	Any changes in credit exposures and financial resources available to the CCP resulting from, for instance: • Unsuccessful porting • Changes in conditions of hedging markets • Inability of non-defaulting clearing members to meet unfunded commitments.

Changes in liquidity exposures and resources	Liquidity SSTs	Any changes in liquidity exposures and resources available to the CCP resulting from, for instance: • Changes in conditions of funding markets, such as the repo market • Changes in foreign exchange rates • Substitution of non-cash for cash collateral by clearing participants • Other actions by non-defaulting clearing participants (eg return of margin in the event that they close out positions or the withdrawal of cash collateral).

Choice of risk sources

78. Authorities will have to make decisions on which risk sources to include in the SST. Authorities may choose to include risk sources based on factors such as the complexity of implementation or model risk, the level of accuracy necessary to meet the purposes of the SST, or the amount of resources available at the authorities to design and implement the SST. Independent of the selection criteria, authorities should ascertain that the chosen risk sources generate a scenario that is plausible and internally consistent. Authorities should also consider checking for inconsistencies between the selected risk sources and the in-scope CCPs rulebooks and operating legal frameworks (eg segregation of accounts and porting rules).

79. The more risk sources included, the more likely it is that the risk profile of each CCP under the stressed scenario will be accurately modelled. Furthermore authorities and the intended SST audience may have increased confidence that significant losses or liquidity outflows have not been excluded from the SST, which may increase confidence in the conclusions drawn from the exercise. Including more risk sources will also increase consistency with the PFMI and associated further guidance that describes the risk sources that CCPs should consider in their own internal stress-testing programmes.

80. The inclusion of a larger set of risk sources may, however, lead to increased modelling complexity or model risk. Authorities would have to provide sufficient information to the CCPs, or conduct extensive modelling themselves, to estimate the impact of every risk source included. Additional resources may be required from the authorities or CCPs to implement the more complex SST. Finally, it may not be necessary to include each risk source, depending on the SST's purpose.

81. If authorities have the objective of ultimately assessing a full set of risk sources and working with only a subset is not a viable option, a phased approach could be introduced as a way of balancing the complexity of using multiple sources of risk. This approach would allow authorities to evaluate the relative importance (and need) of each risk source to the final outcome of the exercise, while, at the same time, enabling the realisation of the associated costs of adding them.

82. The SST's purposes and the resulting choice of risk sources may have an impact on whether authorities or CCPs perform the calculation of the potential losses or liquidity outflows, as described in Element 5.i. Similarly, the set of risk sources included can have an impact on the types of prefunded and unfunded resources that are considered by the SST. For example, for some purposes, if the authorities choose to exclude a particular risk source from the SST, they may also wish to exclude any prefunded financial resources that are collected by each CCP solely for the purpose of covering that risk source.[20] Irrespective of the number of risk sources included, authorities may wish to provide a justification for the choice of risk sources.

Framing the stress-testing scenarios (Element 3.iii)

83. This element describes how authorities may frame the stress-testing scenarios, describing the parameters within which authorities have chosen to approach the development of the scenarios, the

[20] For instance, a CCP may apply margin add-ons that are targeted at particular specified sources of risk. If those risk sources are not captured in the design of the SST, it may not be appropriate to include the resources arising from the application of such add-ons.

selection of core risk factors, and the calibration of shocks. This may also include assumptions on the behavioural response of CCPs or their participants. Setting out these parameters, perhaps by way of a short plain-language statement, could help to promote the calibration of sufficiently severe yet plausible and internally consistent shocks.

84. Framing the SST in a coherent and plausible way may also help stakeholders to understand the SST's context and to link the shocks derived from the scenario with the purpose of the test. It may also help to guide the process of extrapolating shocks from core risk factors to non-core risk factors and may assist the relevant authorities in interpreting results and developing policy views or actions. Moreover, a transparent scenario developed by the authorities within clear parameters may aid communication, enhance independence, and make the stress test results less open to challenge.

85. In any given scenario, the magnitude of the specified risk factor shocks will not necessarily be equally severe for all in-scope CCPs and their respective services included in the SST. This is consistent with the stated objective of SSTs under this framework, which is to analyse the collective response of a set of CCPs to a common stress event rather than an individual CCP's resilience. The number of scenarios chosen will therefore need to be large enough to meet the SST's purpose, but small enough to be manageable in terms of both data processing costs, and the analysis, interpretation and communication of the results.

86. While potentially desirable, it would be challenging to develop a scenario that also draws a clear link between the risk factor shock scenarios and the incidence of defaults. This is especially true in the case of a large, complex set of CCPs, products and clearing participants. A more feasible approach may be to select the defaulting participants in accordance with one of the methodologies described under Element 3.vii; for instance, a quantitative approach that identifies the participant(s) that, in the event of their default, would give rise to the largest losses or liquidity shortfalls for the CCPs. Authorities may, however, seek to verify that the selection of defaulting participants is consistent with the framing parameters for the SST (see Element 3.vii).

Specifying an event-based scenario

87. One means of framing the stress-testing scenarios may be to provide a short overview – a narrative – of the sequence of events – an "event-based scenario" – that supports internal consistency in the shocks used in the stress scenarios.

88. A narrative may achieve this by setting out the sequence of events at a high-level, covering for instance: a link to the purpose of the stress test; a high-level overview of the triggers for the sequence of events described in the narrative (an event-based scenario); a description of the core set of market shocks in the event-based scenario, as well as the transmission channels/types of impact (eg asset price reversal, forced liquidations etc); and some guidance on how the specified core market shocks might translate to other markets and prices.

89. Depending on the SST's purposes (see Element 1.i), authorities could develop a suite of event-based scenarios that span, for example, some subset of macroeconomic/financial developments; policy regime changes; (geo)political developments; operational shocks (eg cyber-attack, pandemic event); large-scale disruptions (eg natural disasters). Each event-based scenario could be developed either as an exogenous shock that affects multiple markets simultaneously (eg flight to quality), or an idiosyncratic shock to one market (eg a steep rise in the oil price) that propagates to other markets. The sequence of events in the narrative could equally be grounded in an assessment of conjunctural risks, known system vulnerabilities, or prominent systemic threats.

90. Note that, compared with stress tests on banks' loan books, which are typically grounded in multi-year macroeconomic scenarios, the horizon for CCP SST scenarios would likely be much shorter, covering only the (longest) liquidation period (or stressed period of risk, SPOR) for the products cleared by the in-

scope CCPs.[21] Accordingly, where applied in an SST for CCPs, a macroeconomic scenario would merely provide the context, or an anchor, for the trigger event that drives the selection and calibration of core market risk factors.

91. It may, however, be challenging to develop an event-based scenario that drives a coherent, plausible and internally consistent set of shocks. It may also be a data- and resource-intensive process. For instance, the development of a narrative is likely to be an iterative process, because the specification of the event-based scenario would be informed at least in part both by the analysis of core risk factors relevant to the CCPs (Element 3.iv) and the application of the techniques for calibrating shocks to these risk factors (Element 3.v). Furthermore, authorities may choose to develop stress scenarios based on multiple event-based scenarios in order to more fully understand the impact that common stress scenarios may have on the set of in-scope CCPs. This would clearly have implications for the resource cost of an SST exercise.

Specifying a high-level approach

92. An alternative approach involves setting out at a high level the approach taken and the criteria applied in selecting core risk factors and calibrating internally consistent shocks to these factors. Such a high-level approach may avoid some of the challenges and resource costs associated with specifying a fully coherent sequence of events.

93. For instance, the authorities could frame the SST by setting out a conceptual framework for specifying scenarios and associated framing parameters. This could involve outlining the approach to selecting core risk factors based on expert judgment or quantitative analysis, provide information on the suite of scenarios that directly and independently determine core risk factor shocks based on extreme but plausible historical or hypothetical shocks and describe the set of assumptions regarding the co-movement between these individual risk factors.

94. Should such an approach be used, the conceptual framework might derive directly from the purpose of the test and the methodologies under Elements 3.iv and 3.v. It may nevertheless be more challenging to demonstrate and communicate internal consistency and, therefore, to benchmark severity and gauge the plausibility of stress scenarios. Consequently, authorities may need to give deeper consideration as to how best to interpret the results and thereby determine the appropriate use.

95. In a similar vein, authorities could consider an approach that is built directly from in-scope CCPs' internal stress-testing scenarios. For instance, each CCP could be requested to submit to the authorities the details of a specified number of its most severe scenarios. These could form the basis for the common suite of scenarios to be applied across all of the in-scope CCPs, suitably extrapolated to capture risk factors relevant to each CCP's specific product set and exposures. Such an approach would not only frame the scenarios, but also inherently determine the approach to selecting core risk factors (Element 3.iv) and calibrating the shocks to these factors (Element 3.v). The extrapolation to other risk factors relevant to the CCP would then proceed in accordance with one of the approaches described under Element 3.vi. One challenge authorities may face in implementing this approach would be to ensure that the resulting SST stress scenarios, based on the internal stress scenarios of the CCPs, are internally consistent and plausible, recognising that shocks may have different levels of severity across in-scope CCPs.

Practical considerations

96. To frame the stress-testing scenarios with reference to the purpose of the test, authorities would typically need data on relevant empirically observed stress situations and historical dependencies between different relevant risk factors. With reference to these data, authorities would specify the broad nature and

[21] It should be noted that the SPOR does not necessarily equate to the liquidation period associated with a single default, since defaults may occur sequentially rather than simultaneously.

magnitude of shocks that will drive the SST. These data might also help to calibrate the shock for core risk factors (see Element 3.v).

97. A number of approaches may be taken to establishing the parameters within which the authorities would approach the framing of the scenarios. For instance, the scenarios may be grounded in (i) an empirically observed sequence of events and would explicitly refer to the nature and scale of observed shocks in one or more key markets; (ii) a sequence of events which, while hypothetical, has a historical parallel – perhaps a scenario that has been observed in another country or market; or (iii) a purely hypothetical set of parameters, developed based on expert judgment with reference to historically observed dependencies between product classes.

Identifying core risk factors (Element 3.iv)

98. The provision of central clearing services may expose a CCP to adverse moves in hundreds or even thousands of distinct risk factors in the event of the default or failure to perform of one or more of its participants, obligors or service providers. In this sense, an important element of the development of scenarios for an SST is to select the most relevant risk factors and include a description of (or scenarios for) how these risk factors will evolve over the horizon of the test. This will be the basis for quantifying CCPs' stressed credit or liquidity exposures. Indeed, although the relative importance of risk factors varies across CCPs, typically there is a specific subset of factors that represents the largest part of the risk exposure.

99. In such circumstances, a more practical option may be to identify a small number of representative core risk factors for which authorities would develop the scenarios for the SST. This approach would allow authorities not only to concentrate efforts on the most important risk factors across CCPs, but also to focus on those most relevant to the purposes of the exercise. Working with this reduced subset of risk factors would allow the authorities greater control over the calibration of stress scenarios. Depending on the purposes of the SST exercise, shocks to these non-core risk factors would either not be modelled at all, or alternatively a methodology would need to be developed for extrapolation from the core risk factor shocks to the remaining risk factors (Element 3.vi).

100. The identification of core risk factors will be informed by the purposes of the SST exercise and the framing of the stress scenarios (Element 3.iii). Framing the exercise in an internally consistent manner would be expected naturally to highlight the most relevant risk factors for the SST stress scenarios (Element 3.iv). Additionally, decisions made on how the shocks to the core risk factors will be calibrated (Element 3.v) may influence the identification of the set of core risk factors. For example, if authorities choose to calibrate the shocks to the core risk factors to directly replicate an historical event, the authorities may identify a large set of core risk factors, minimizing the amount of extrapolation that may be necessary to other non-core risk factors (Element 3.iv).

101. A variety of approaches could be considered by authorities to identify and select core risk factors. These alternative approaches would likely involve to varying degrees expert judgment or quantitative analysis. A number of relevant trade-offs have already been introduced, including between judgment-led and quantitative analysis, and between approaches that rely on inputs from the CCPs as opposed to the authorities.

102. An approach that relied heavily (or even exclusively) on expert judgment of authorities may be the simplest to implement, involving limited data requirements. Such an approach may also be the least resource-intensive. If the test was informed by a narrative (Element 3.iii), it should be relatively straightforward for authorities to ensure a close link between the narrative and the selection of the core risk factors that underpin the stress scenario.

103. Alternatively, the authorities could build upon on the expert judgment of each in-scope CCP, requesting that each propose a set of core market risk factors based on its own deep knowledge of the markets it clears. Many CCPs may have already identified a set of core risk factors as part of their internal

risk management modelling. As a result, this approach would leverage the expertise of in-scope CCPs in an easy-to-implement way.

104. As discussed under Element 2.ii, where CCPs play an integral role in the design of the SST, authorities should take care to balance resource demands and utilisation of CCPs' expertise and modelling capabilities, while preserving the impartiality and validity of the exercise. In the context of identification of core risk factors, to support the independence of the exercise, authorities could specify in advance how the identification process should be conducted by in-scope CCPs, so as to reduce CCPs' discretion; or introduce a validation or review step, whereby authorities challenge the proposed core risk factors put forward by each in-scope CCP in an iterative manner. However, constraining CCPs' discretion would have the disadvantage of diluting some of the benefits of drawing on in-scope CCPs' knowledge and expertise. And validation would necessarily entail a larger resource commitment by authorities.

105. That said, a purely or heavily judgment-led approach (relying on the expertise of either authorities or CCPs) in this step of the scenario development process might not identify the most significant risk factors in terms of overall exposure. Also, in a multi-authority, multi-CCP stress test, a coherent methodology would need to be developed for aggregating the expert views of each authority in respect of each CCP to develop a list of core risk factors that was relevant for the full set of in-scope CCPs.

106. Building into the approach a significant role for quantitative analysis could address some of the issues associated with basing the selection solely on expert judgment. For instance, authorities could use granular data on the in-scope CCPs' exposures to each risk factor as the basis for selection of the core risk factors most relevant to the set of CCPs included in the SST.

107. As an example, authorities could consider adopting a two-stage approach to identifying core risk factors.

- In the first stage, a long list of candidate core risk factors might be identified based on objective measures of the contribution of each risk factor to the total risk exposure of in-scope CCPs. These measures could include, for example, the relative contribution to initial margin or aggregate stress losses from in-scope CCPs' own internal stress tests. The necessary data may be available to authorities already as part of routine regulatory reporting arrangements or supervisory processes, or could be requested from in-scope CCPs relatively easily, at limited resource cost.[22]
- The second stage would entail the exercise of expert judgment by authorities, perhaps informed by dialogue with in-scope CCPs, to select from the long list a more manageable set of core risk factors. The filtered list would reflect the purpose of and (where appropriate) narrative for the test. Authorities might also aim to ensure that the selected core risk factors capture a given percentage of the in-scope CCPs' total risk exposure, based on the same metrics as used in stage one.

Calibrating the shocks to core risk factors (Element 3.v)

108. The next step in the process is for authorities to calibrate the shocks to the selected core risk factors (identified under Element 3.iv). An SST's credibility depends on the approach taken by authorities

[22] Authorities could potentially carry out this analysis entirely independently if they had adequate understanding of CCPs' risk exposures and access to data at a sufficiently granular level either by using routine regulatory reports or by way of a bespoke data request. Importantly, however, the data would need to be comparable across all authorities and CCPs, such that they could be aggregated across in-scope CCPs to identify core risk factors relevant to all CCPs included in the SST. If available data did not meet this requirement, bespoke requests to each in-scope CCP would be necessary (see Component 4). Alternatively, authorities may request that CCPs perform this analysis. This approach may be appropriate if the CCPs have more granular data on contributions to risk exposures and are able to provide a more reliable quantification of the contribution of a given risk factor to the total exposure. The authorities might need to specify an analytical methodology to be applied by the CCPs in this process to ensure that it is carried out in an appropriate and consistent way. This would, of course, entail resource costs.

in its calibration of shocks. This is true irrespective of the SST's purpose and whether its focus is to evaluate credit risk, liquidity risk or both. Accordingly, the methodology applied should ensure the shock is suitably extreme, and scenarios remain plausible and internally consistent.[23] Analytical tractability and feasibility will also be important considerations, not only to manage the resource cost of the exercise, but also to support communications to relevant stakeholders and the accessibility of the exercise. In particular, authorities should consider balancing the number of scenarios necessary to generate the information required for the purpose of the test against the costs associated with implementing them.

109. Authorities could develop shock scenarios for core risk factors using historical scenarios, forward-looking scenarios or a combination of both. Forward-looking scenarios in this context may be specified with reference to a historical parallel in another market, derived from statistical models or based on other types of qualitative assessments. Yet, these different scenarios could be formed of shocks that are either relative or absolute, incorporating distinct types of behaviour (eg parallel moves, curvature changes, etc), and authorities would need to assess the appropriateness of the parametrisation of these shocks to each selected core risk factor. Where practical, model outputs would ideally be subject to a rigorous process of challenge, checks for consistency, and validation by experts within the authorities.[24]

110. While the approaches to calibrating shock scenarios would generally be expected to be similar for both liquidity and credit stress tests, consideration should be given to assumptions that may have particular implications for each type of test. One such consideration in implementing an SST will be the choice of SPOR and, for liquidity stress tests, the assumption made regarding the timing of the risk factor shocks within this period (that is, what path does the shock take for each risk factor). A particular multi-day SPOR (eg three days, five days etc) may be deemed appropriate for calibrating shocks to the prices of cleared positions for credit tests, for example, but the appropriateness of applying the same shocks for liquidity stress tests will likely depend on the timing over which these shocks are assumed to occur. A relatively simple approach would be to assume that shocks occur instantaneously. Other more sophisticated methods may be considered, with different implications for the relative severity of the shocks. For instance, path-dependent shocks could be assumed whereby their size is specified for each day of the SPOR, or even on an intraday basis.

111. If authorities have chosen to incorporate transaction costs as an additional risk source, these additional costs need to be specified in addition to the mid-market shocks of the core risk factors. The transaction costs associated with liquidating a portfolio may depend upon many factors and there are likely to be many different ways that authorities could capture their effects. For example, in addition to specifying the magnitude of the mid-market shocks, authorities could develop a mapping of portfolio and position characteristics to additional shocks that model transaction costs.

112. If authorities have chosen to incorporate jump-to-default risk as a risk source, authorities may wish to augment their core risk factor shocks with idiosyncratic defaults of specific entities (eg a securities issuer or derivatives reference entity). For example, if authorities choose to frame their scenarios with a narrative, they may choose to include the default of an entity consistent with that narrative. In this case, the shocks of the defaulting entity would be calibrated consistent with its default (eg equity price of defaulting entity is zero or a default event is triggered for relevant credit default swaps). If authorities incorporate jump-to-default risk, they may wish to be careful when considering how shocks to core risk factors will be extrapolated to non-core risk factors to include any specific defaulting entities.

[23] In designing an SST, authorities may want to consider introducing different levels of severity for shocks in order to achieve the purpose of the exercise Nonetheless, it is important that these levels are coherent with assumptions made in other parts of the stress testing scenario design. For instance, stress scenarios that involve the default of the largest clearing members may have more adverse shocks than those which do not.

[24] For instance, for cleared positions with similar risk factors across different CCPs, authorities could assess whether the specified shocks are able to generate equivalent levels of stress.

Scenarios based on historical experience

113. Referencing historical experience – either in the context of a purely historical approach or a hypothetical approach that draws on a historical parallel – can help to achieve a plausible scenario. Such an approach may be grounded either in a single observed historical event or an event that has one or more historical parallels. In either case, the relevant historical experience may be adapted or combined to derive a suitable extreme but plausible scenario.

114. Using historical market events as the basis for establishing the shocks to core risk factors can help to promote plausibility and internal consistency in the combination of modelled risk factor shocks.[25] This approach is equally applicable to all types of market risk factor (spot prices, futures, yield curves, volatility surfaces etc) and could, in principle, be used to identify shocks individually or conjointly. Building a scenario with reference to historical experience may also help to link the calibration to the framing parameters for the scenario (Element 3.iii), to the extent that these are also grounded in historical experience. Indeed, as noted, there may be some iteration between the setting of framing parameters for the scenario and the calibration of shocks to core risk factors.

115. Statistical models can be used to ensure that any adjustments to an historical data series are made in a suitably rigorous and consistent way, for example by capturing the specific behaviour of individual risk factors, the historical relationship between risk factors, or both. Of course, where such methods are used, authorities would need to acknowledge the model risk in the derived outcomes.

116. To construct a set of shock scenarios that either replicate or are based on historical stress events, authorities could consider proceeding in three steps: (i) identify a relevant extreme historical stress event that can serve as the basis for the market shock scenario, or construct a hypothetical scenario that is nonetheless grounded in historical experience; (ii) should the historical scenario include one or more core risk factors that the authorities deem to be insufficiently stressed, adjustments may be made to such less extreme shocks, perhaps using one of a number of alternative statistical techniques; and (iii) once adjustments have been made, it is important that authorities assess whether the stresses to all core risk factors considered together respect plausibility conditions.

Forward-looking scenarios

117. Authorities may additionally or alternatively develop forward-looking scenarios informed by the judgment of experts and possibly combined with a statistical approach. This approach may still rely on historical experience or data over a defined look-back period and could inform the decision regarding joint distribution between core risk factors.

118. In addition to technical modelling considerations, the preferred method will depend on factors such as the purpose of the test, the range (and number) of core risk factors selected in Element 3.iv and the availability of reliable data to aid calibration. As in the case of scenarios based on historical experience, the ultimate aim would be to arrive at a calibration of final risk factor shocks that are suitably extreme but plausible. The shocks should be internally consistent and, where appropriate, should credibly reflect the framing parameters of the test.

119. It should be recognised, however, that, if a statistical approach is taken, elaborate multi-factor risk models may be resource-intensive to implement and will necessarily require some assumptions or methodological compromises to be made in order to maintain analytical tractability.

[25] For some product classes, the historical reference point will be relevant for the proportional (or relative) magnitude of shocks, rather than the absolute magnitude of shocks.

Extrapolating the shock to other (non-core) risk factors (Element 3.vi)

120. The approach to identifying core risk factors under Element 3.iv aims to capture a significant fraction of the in-scope CCPs' core risk factor exposures. To the extent that the scope of the SST extends beyond these risk factors, once the authorities have calibrated shocks to the core risk factors (as discussed under Element 3.v), they will need to consider the development of a methodology to extrapolate these shocks to other non-core risk factors.[26]

121. It is important that the approach to extrapolation contributes to the credibility of the SST by delivering coherent, sufficiently extreme but plausible and internally consistent outputs. Furthermore, both to support the quality of outputs and to balance the resource burden of the exercise, the chosen approach should recognise and leverage the relative expertise and operational capabilities of the authorities and the in-scope CCPs.

122. A spectrum of alternative approaches to this extrapolation exercise may be considered. These involve different trade-offs. In general, the chosen extrapolation approach should be equally applicable to SSTs focused on credit risk and to those for liquidity risk. In a liquidity context, the extrapolated shocks could be used to identify profits and losses on cleared positions (and collateral holdings, investments etc). As a result, the underlying methodology need not differ materially.

123. At one extreme, authorities could develop and implement (either directly or by assignment to the CCPs) a common methodology for extrapolating shocks to every non-core risk factor covered by the SST, thereby ensuring consistency in non-core risk factor shocks across all in-scope CCPs. Under this approach, authorities would ultimately specify the shocks for all risk factors: core risk factor shocks would be calibrated as described under Element 3.v, while non-core risk factor shocks would be calibrated using a more mechanical statistical methodology.

124. At the other extreme, the extrapolation task could be assigned to the in-scope CCPs, using their own proprietary models. Authorities would simply provide the CCPs with the details of the core risk factor shocks and the relevant parameters for framing the stress scenarios and place no other constraints on the process. Permitting CCPs to apply their proprietary models would recognise the CCPs' expertise in the markets they clear and acknowledge that the CCPs already have statistical models that can readily be applied for the purpose, as well as ready access to relevant granular data and the operational capability to carry out extensive computations. However, this benefit comes at the cost of a potential loss of consistency if CCPs' models produce materially different outputs. Further, the calculated shocks may prove inconsistent with the framing parameters of the SST.

125. In practice, therefore, if the extrapolation task was assigned to CCPs, their use of proprietary models may need to be subject to prior review, perhaps with reference to some documented criteria. In any event, the authorities could subject the outputs from the extrapolation exercise to some form of review (eg spot checks on the generated shocks, focusing in particular on risk factors that are common to multiple CCPs) to ensure that CCPs' calibrated shocks were: (i) sufficiently extreme; and (ii) in the case of common non-core risk factors, sufficiently similar.[27]

126. Intermediate options might involve the authorities specifying a principles-based methodology for the calibration of non-core risk factors. Indeed, the authorities could choose different approaches, depending on the risk factor, permitting CCPs to use proprietary models for some risk factors and

[26] When purely historical scenarios are selected by authorities, the need to extrapolate shocks to non-core risk factors may be reduced or even inexistent, given the historical events may contain realisations for all in-scope risk factors.

[27] As an example, each CCP could be asked to provide the output of its extrapolation to the authorities in a pre-defined format, alongside a technical document explaining its methodology. Whichever model was adopted, the calibrated shocks (for at least a subset of non-core risk factors) generated by the CCPs' models could be subject to *ex post* validation and consistency checks. If this process identified material inconsistencies in the calibrated shocks for common non-core risk factors, the authorities could impose an adjustment. A standardised data template, including *inter alia* a common naming convention for risk factors, could potentially be developed for this purpose.

specifying a more or less prescriptive methodology for others. If authorities decide to specify an extrapolation methodology to be implemented by the CCPs for all or a subset of the risk factors, then care must be taken to provide sufficiently granular and detailed instructions to minimize the cost to the CCPs and authorities, and the potential for errors and inconsistencies. Authorities might also give consideration to developing the fallback option of a "standardised" modelling approach if a CCP didn't have an acceptable model. A standardised approach might be a relatively simple model designed to be adaptable to multiple different risk factor types (eg statistical regression models).

127. Applying extensive constraints to CCPs' proprietary models could make them operationally cumbersome to apply. Other things equal, the more authorities intervene in either specifying or approving the CCPs' extrapolation methodologies, the less the need for extensive quality and consistency checks at the end of the process. The authorities' involvement in the extrapolation stage of an SST process could therefore be either front- or back-loaded, depending on the capabilities of the authorities (including availability of specialist resources) and other prevailing circumstances.

Specifying defaults or failures (Element 3.vii)

128. This element considers the specification of defaults or failures, which is fundamental to an SST, whether it focuses on credit risk or liquidity risk. In the case of an SST focused on credit risk, specifying the participants who default or other relevant entities (eg investment counterparty or collateral issuer) who fail to perform is an intrinsic part of the development of the stress scenarios. Combined with an adverse market shock, such a default may generate losses for the CCP. Liquidity risk may also crystallise in the event of a default or the failure to perform of a participant, obligor, liquidity provider, or other relevant service provider.[28] Further, concerns could arise where a solvency event was accompanied by a failure to perform, as might be the case where a clearing participant was also a liquidity or other service provider to the CCP, such as, for instance, a payment bank, a settlement facility, or a custodian.[29]

129. In developing extreme but plausible scenarios for defaults or failures, a number of supporting assumptions will need to be made, including for instance in respect of the treatment of the defaulting participant's customer positions and affiliated clearing members. These should be guided by the PFMI and associated further guidance on CCP resilience.[30]

130. In selecting which participants or other obligors or service providers would be assumed either to default or fail to perform in the stress scenarios, authorities might conservatively select defaults or failures that, given the market shock scenarios, would generate the largest credit losses or liquidity shortfalls for all the in-scope CCPs. Here, the authorities could use data on the size and distribution of the CCPs' credit or liquidity exposures to identify the entities that would give rise to the largest stressed losses (eg net of relevant prefunded resources) across the in-scope CCPs, or the largest liquidity shortfalls.[31]

[28] For instance, a settlement facility facing technical difficulties could impede pay-ins to the CCP; or a custodian that fails to deliver assets could delay the completion of a settlement session.

[29] For the purposes of this framework, a liquidity provider could be any third-party institution that will convert non-cash collateral into cash or exchange cash in one currency for another. Examples include banks offering lines of credit or committed repo providers.

[30] For instance, it should be assumed that the positions of all the clients of a defaulting participant were closed out, on the conservative assumption that client positions could not be ported to a non-defaulting clearing participant. Further, if a defaulting clearing participant was also a liquidity provider, the CCP should assume that it will not perform on any committed line of credit.

[31] For instance, the clearing participants that generate the largest cumulative losses net of relevant prefunded resources across all CCPs could be identified using the following procedure: (i) authorities would identify a set of clearing participants that they would like to consider in the stress test, which may be all or a subset of institutions; (ii) CCPs would calculate losses net of relevant prefunded resources for every clearing participant in the candidate set under the stressed scenarios provided by authorities (which may be zero in the event that the clearing participant has a gain in the stressed scenario or the loss is smaller

131. For an SST with a focus on liquidity risk, the authorities could also examine the implications of the failure of service providers such as liquidity providers, in particular when these are also clearing members or affiliates thereof. Authorities could, for instance, select the failing liquidity provider(s) that would generate the most severe liquidity shortfall across all the in-scope CCPs in a particular scenario.[32] The liquidity shortfalls could be calculated for every relevant currency and for each day of the liquidation period and then compared with the available cash in each currency for each day to determine each day's liquidity shortfall in each currency, if any. The authorities could then use expert judgment to determine which liquidity providers should be assumed to fail to perform.[33]

132. While this may be appealing as an objective and conservative approach, it should be acknowledged that this approach may place a higher computational burden on CCPs, since they must calculate stressed losses and outflows associated with the default or failure of all candidate entities, rather than only those specified by authorities in advance. With this approach it may also be difficult to account for any interdependencies either between default scenarios (eg due to wrong-way risk) or between default scenarios and the magnitude of the underlying risk factor shocks.

133. To address some of these concerns, depending on the purpose of a particular SST, a purely data-driven approach may be supplemented with some expert judgment though with care to uphold the transparency of the exercise and to avoid adding excessive complexity to the process. For instance, the authorities could select defaulting participants or obligors based on data on the size and distribution of the CCPs' credit or liquidity exposures, but select failing liquidity providers in a more judgment-based way perhaps by asking CCPs to provide a ranking of their reliance on particular liquidity providers and then using expert judgment to select from this list.

134. As an alternative, the authorities might select defaults or failures on either a targeted basis or according to specified objective market indicators, reflecting the SST's specific purposes and the framing parameters of the exercise.

135. For instance, the SST's focus may be on a particular aspect of the in-scope CCPs' design or operation (eg their reliance on particular arrangements for liquidity provision, perhaps in a particular currency), or their reliance on particular custodians or settlement banks. In such cases, a targeted, judgment-based approach may be taken to selecting which participants or service providers would be assumed either to default or fail to perform in the stress scenarios.

136. Alternatively, authorities may use market prices (eg credit default swap prices or corporate bond spreads) or analytical models (eg modelling the company's equity as an option on its assets) to gauge the plausibility of default or failure to perform under the specified risk factor shock scenarios.

than the relevant prefunded resources); (iii) authorities would calculate the sum of losses net of relevant prefunded resources for each clearing participant in the candidate set across all CCPs; and (iv) the authorities would choose the clearing participant(s) to default that would generate the largest cumulative losses net of relevant prefunded resources across all CCPs. Depending on the purpose of the test, an approach on these lines could be extended also to consider exposures to other obligors, such as investment counterparties or collateral issuers. In the case of an SST that aims to evaluate CCPs' resilience to liquidity risk, a similar approach may be taken to that set out above, but with a focus on the defaults that generate the largest cumulative liquidity shortfalls (eg taking into account variation margin and settlement obligations, operational liquidity requirements, as well as accompanying liquidity shortfalls arising due to the failure of liquidity providers) rather than losses (net of relevant prefunded resources).

[32] For example, this may be a scenario where the liquidity provider is also a clearing participant or a scenario where a failure of a liquidity provider to perform is accompanied by the default of another clearing participant.

[33] In addition to the default or failure of liquidity providers, authorities may also wish to consider specifying stressed assumptions regarding the CCP's ability to use uncommitted liquidity lines or open market transactions to raise liquid resources. For example, the authorities may specify that the CCPs should assume that it cannot obtain access to cash in the relevant currency on a same-day basis through the use of open market repo transactions of government securities, or that the spot foreign exchange market has a delayed settlement of one day for a specified group of currencies.

Specifying the timing of defaults or failures (Element 3.viii)

137. Specification of the timing of defaults or failures applies equally to exercises focused on credit and liquidity risk. It represents an important reference point for the sequence of events over time. The time horizon assumed for the stress scenarios forms an important aspect of the design of an SST. The incidence of the same set of shocks to a CCP in different time sequences would generate distinct outcomes. Not only would the amount of resources available to the CCP differ, but the options available to management may be more limited if events unfolded over a shorter timeframe. More specifically, the timing of the default or failure to perform is crucial in establishing the level of resources available to the CCPs and the market shifts that have taken place between the last margin call and the point of default, especially if defaulters are participants of CCPs operating in jurisdictions in different time zones. Timing is equally relevant to establish how other risk sources apart from defaults (eg failure to perform of a custodian, liquidity provider etc) could impact the CCPs during adverse market conditions, defining whether shocks are concentrated at one point in time or sequential, with knock-on effects.

138. There are two broad options for specifying the timeframe over which defaults or failures to perform are assumed to occur:

- *Simultaneous defaults or failures*. It is assumed in calculating stressed losses and liquidity shortfalls that the participants and service providers selected for default or failure by the authorities default and fail simultaneously.
- *Sequential defaults or failures*. The authorities would specify a path for the default or failure of participants or service providers.

139. Assuming simultaneous defaults or failures has some advantages. First, it is relatively simple for both the authorities and the CCPs, because it does not require that the authorities determine the sequence of possible clearing participant and obligor defaults, or the time elapsed between defaults and failures. Similarly, simultaneous defaults or failures is typically the standard practice for CCPs' internal stress tests, which may minimize the burden of implementation for some or all of the in-scope CCPs. In addition, it does not require the modelling of management actions between the defaults of clearing participants or the failure of service providers. An example of a management action would be the calling of additional initial margin from non-defaulting clearing participants.

140. The assumption that defaults or failures unfold over a period of time (sequentially), rather than simultaneously, is likely more complicated to implement but may also be more plausible. Indeed, the particular path of defaults or failures may be especially important in the case of liquidity stress tests, where the order of events may create mismatches between inflows and outflows of funds. Conversely, for credit exercises, sufficiency of resources is typically assessed at the end of the default management period, with a focus on cumulative losses. Sequential events could also have implications for the SPOR and associated calibration of risk factor shocks, as closeout periods for different participants could only partially overlap.

141. No specific actions or data are required by authorities in order to implement the above methods but, given the implications for stress tests focused on liquidity, further consideration could be given to the precise timing of defaults (eg intraday or end-of-day) under the particular simultaneous or sequential option chosen. CCPs may also have to adjust their risk management systems to handle the default assumptions chosen by authorities. Assuming the simultaneous failure of liquidity providers, for instance, would translate into a single point-in-time assumed impact on the ability of the CCP to access cash, convert cash into alternative currencies, or convert non-cash assets into cash.

2.4 Data collection and protection (Component 4)

2.4.1 Description of component

142. Once the authorities have designed their SST stress scenarios, including the risk sources they wish to assess, the next component involves identifying the relevant data needs, establishing how the data will be validated (Element 4.i), and applying safeguards to protect the data (Element 4.ii).

143. Authorities should give careful consideration to this component in order to ensure that the collected data are of the highest quality, and that any data manipulation performed by authorities (Component 5) could be reliably implemented. Errors at this stage of the process can lead to significant delays and, if data quality is compromised, potentially reduce the integrity and information value of the SST's results. Furthermore, with access to information from CCPs (or other market participants) comes a responsibility for authorities to protect it and ensure that any applicable restrictions on disclosure are respected. Authorities should, therefore, establish comprehensive measures to ensure the confidentiality of data and other information used to conduct an SST. Further, authorities should be transparent regarding the approach they are taking in respect of data protection.

2.4.2 Discussion

Data collection (Element 4.i)

144. Once authorities have designed the set of stress scenarios to be used in the SST exercises, including risk factor shocks and defaults or failures, the next stage involves identifying the data required such that stress scenarios can be applied to risk exposures. Similarly, authorities will have to define the manner in which any external data used in the tests will be validated. The authorities should establish processes to ensure the collected data are of the highest quality since errors may delay the running of the SST and compromise the integrity and information value of the exercise.

145. During the various stages of an SST, data will circulate between authorities and CCPs, and, as appropriate, between participating and non-participating authorities (see also Elements 2.i and 2.iii). The guidance for this element focuses on the data collection procedures necessary to assess profits and losses (credit risk) or inflows and outflows (liquidity risk) that would result from the application of stress scenarios to risk exposures, as well as the financial resources available to the CCPs under those scenarios. Notwithstanding this, many of the matters considered under this element could be relevant when handling data for other purposes.

Required data

146. As an initial part of the data collection process, authorities will need to consider and subsequently define the specific data items required. The specific set of data required for any SST will be closely aligned to the purpose of the exercise and the types of risk the authorities wish to assess. For instance, a liquidity stress test should focus on the actual cash flows arising from the risk factor shocks. Similarly, data needs will vary according to the allocation of responsibilities between authorities and CCPs. As discussed in more detail in Component 5, if CCPs are expected to perform the bulk of the calculations when measuring stressed profits and losses or inflows and outflows, the required granularity of the data to be collected may be reduced. Additionally, authorities should take care to limit data requests to the information necessary to run the test.

Data collection process

147. Having defined the set of data the authorities wish to collect, it is important to consider the operational aspects of the data collection process (see also Component 2). Some authorities may already have access to the data necessary for the SST as a result of their authority or supervisory activities, while others may need to establish mechanisms for data collection. In the latter case, there are numerous ways for authorities to approach data collection depending on their legal frameworks and the test's purpose. One potential method is for CCPs to submit the necessary data to their primary supervisors and for those supervisors to then share that data onwards with other relevant authorities through information sharing arrangements, such as memorandums of understanding. Authorities could also, for example, choose to engage with an independent third party to manage the data collection process. This approach could be helpful in instances where legal or resource constraints prevent authorities from collecting the data themselves.

148. A well-constructed template can significantly improve the efficiency of the data collection process. Given that the CCPs themselves are often the holders of the data and responsible for its timely and accurate submission, authorities should seek their input into the design of a data template (see Component 1, Element 1.iv). In doing so, the authorities can mitigate the costs imposed on CCPs, and reduce the likelihood of delays with respect to problems delivering data in the specified format and errors in the final submission (eg if CCPs have to convert data from their usual format into a different format or style). Authorities could also leverage, where relevant, aspects of pre-existing data templates used for other, similar SSTs or routine data collections to inform the template's design.

149. The creation and dissemination of detailed instructions for CCPs can facilitate data collection and CCPs should have the opportunity to provide input on these instructions (see Element 1.iv). Such instructions might therefore include the reference date for data collection; the required currency denomination(s) and any relevant exchange rates to be used; the format requirements for the data (eg units; millions/billions etc); and detailed definitions of and explanations for each individual data item. Authorities may also wish to provide CCPs with information on the SST's methodology to help CCPs contextualize any data requests.

150. It may not be possible to identify all potential issues with the data template and its completion prior to its dissemination to CCPs. Consequently, it may be helpful to facilitate an ongoing dialogue with in-scope CCPs and provide a clear channel through which CCPs can submit questions to the relevant authorities (see also Component 1). Authorities should also endeavour to respond to inquiries in a timely manner.

Data validation process

151. To ensure submitted data are of high quality, it is important that the authorities devise a process through which the data can be reviewed and assessed. This should be undertaken solely by participating authorities and, if the exercise involves more than one, shared between them.

152. Prior to the execution of an SST, the authorities should clearly articulate the relevant steps required when validating submitted data. The granularity of this process and the length of time spent reviewing the data will depend on the capabilities of the authorities and resource availability. This is particularly the case when several CCPs, each with perhaps more than one clearing service, are participating in the exercise, which could result in the production of large volumes of granular data.

153. As noted, a carefully designed data template may limit the scope for errors. Indeed, it may be possible to develop a template structure that supports the identification of erroneous data at the point of entry. Another practical alternative is for authorities to conduct spot checks on the data submitted. This could give authorities an early indication of the quality of the data provided by CCPs, which could reveal whether a deeper quality assurance exercise is necessary.

Data protection (Element 4.ii)

154. With access to information from CCPs and other market participants comes a responsibility for authorities to protect it. Comprehensive data protection measures may, in some instances, also facilitate relevant CCP participation in the exercise by alleviating concerns regarding confidentiality. Authorities should, therefore, establish comprehensive and effective measures to ensure the confidentiality of data and other information used to conduct an SST.[34] These measures may vary depending on the specific nature of the data. For example, when collecting position-level information or other relevant data including institution-specific third-party data, authorities should consider, to the extent necessary, anonymising such data to ensure that they cannot be attributed to any particular clearing participant, customer or other third party.

155. When collecting data from CCPs, one possible approach could be to separate raw data from the identity of the institution to which they relate. For example, a segregated group of staff from the authorities could assign an alias to each clearing participant (or other counterparty) across the various sets of clearing participants (or other counterparties) included in the data received from in-scope CCPs. CCPs would then associate the raw data with these aliases, rather than the actual identities of individual participants or counterparties. A separately segregated group of staff conducting the initial analysis for test would subsequently receive the raw data associated with the corresponding aliases. This would ensure anonymity as no staff would have access to both the identities and the raw data.

156. When sending or receiving information between various jurisdictions, authorities should also take care to ensure that information-sharing requirements are met in each relevant legal regime (See Element 2.iii). This may require securely transmitting, storing, and disposing of the data used in each jurisdiction. Authorities should employ information security protections when handling sensitive data, such as by encrypting the data. Further, authorities should facilitate transparency in the approach they are taking in respect to data protection. This may include notifying, as applicable, CCPs, participants, their customers and other third parties of the approach before obtaining the data required for a test. Further, when CCPs are tasked with providing data to authorities, the latter should be transparent about which specific participant, customer or third-party data are shared, with whom they will be shared, and for what purpose. Information could also be provided to market participants on how the data will be used, stored, and disposed of.

[34] Authorities conducting recurring exercises should establish comprehensive data protection measures for each test.

2.5 Aggregating results and developing analytical metrics (Component 5)

2.5.1 Description of component

157. Having developed the stress testing scenarios and collected the necessary data, the risk factor shocks must be applied to CCPs' exposures and the results aggregated consistently. Ultimately, the final outputs should be summarised in a set of risk metrics designed to support the specific purpose of the exercise. One of the challenges is to promote sufficient consistency in valuation and data aggregation procedures across different CCPs, while at the same time remaining coherent with individual CCPs' rulebooks. This will ensure that the findings of the SST exercise are meaningful and sufficiently comparable across CCPs, and that they can be interpreted by the authorities and other stakeholders. While the guidance for this component generally applies equally to credit risk and liquidity risk, some levels of aggregation, resources, and metrics will be more relevant than others, depending on the specific purpose of the exercise. Four elements are discussed in this component: (5.i) application of scenarios to exposures; (5.ii) aggregation of risk measurements; (5.iii) treatment of resources; and (5.iv) specification of risk metrics.

2.5.2 Discussion

Application of scenarios to exposures (Element 5.i)

158. An SST's basic premise is to examine how CCPs' exposures evolve under the adverse market conditions captured by the stress scenarios and to assess the sufficiency of resources to address any losses or liquidity outflows in these circumstances. Independent of how risk exposures (Element 3.i) and risk sources (Element 3.ii) are combined in the SST, the initial output of the process is a series of gross profits and losses (credit risk) and gross payment inflows and outflows (liquidity risk) at the product level.

159. Accordingly, authorities should develop an approach to calculating these losses and outflows. In particular, authorities should consider estimating the change in value of each product that generates the risk exposures subject to the SST exercise (see Element 3.i). Each product will therefore need to be revalued under the stress conditions, most commonly performed under a full valuation approach. Specifically, under such an approach, stress scenarios would be applied to risk factor exposures to derive shocked risk factor values, which would subsequently be applied within closed pricing formulas to generate new prices for the products. Although potentially computationally intensive, this technique may be expected to generate sound estimates of the potential changes in value of each product; it can also capture higher-order effects and incorporate interactions between risk factors.[35]

160. When performing such revaluation, one initial aspect to consider is how losses or outflows may be expressed for different types of product. For risk exposures related to financial products that are marked to market on a periodic basis and cash settled with the respective collection of variation margin, losses or outflows are typically measured by assessing the change in value of the specific product. An example of this category of product is a futures contract. The credit risk for these products is simply equal to the change in value since the last successful mark-to-market (or variation margin collection); therefore, the focus is typically on assessing how much, in the event of one or more participant defaults, position values could potentially change from the last mark-to-market payment until exposures could be closed out.

[35] The approach of approximating the potential changes in value of a cleared product using the change in the value of its underlying risk factors, for example, by using delta or delta-gamma approximations may be relatively simple and may help to reduce the dimensionality of the problem. However, an important drawback of this approach is that it may provide misleading results when applied to non-linear financial products, or when used to approximate the risk from large shocks. If approximation methods are used, it is important authorities check the accuracy of generated results.

161. Conversely, products that do not involve the periodic exchange of variation margin may build market value over time, such that potential losses or outflows would be associated with the final value of the product. This is the case, for instance, for products that are collateralised using contingent variation margin (eg equity-style options and physically settled contracts). Similarly, assets held by the CCP in the form of collateral and investments, for example, would also have intrinsic value. Accordingly, the output from the valuation exercise is a set of stressed prices (or prices with haircuts).

162. In addition to aspects related to how contracts are marked to market and variation margin is paid, when assessing stressed losses and outflows at the product level authorities should also consider taking into account assumptions made regarding hedging and early liquidation cleared positions, collateral, etc. These types of management actions may alter not only the set of risk exposures to be revaluated, but also the amount and allocation of losses and outflows over the closeout horizon.

Practical considerations

163. A variety of approaches can be taken to perform the above calculations. For example, authorities could rely entirely on the CCPs' proprietary valuation methodologies, or they could specify a common valuation methodology to be implemented by the authorities themselves or by the CCPs. An intermediate possibility would involve some reliance on CCPs' proprietary methodologies, with authorities approving the models and validating the outputs as appropriate. These approaches are neither exhaustive nor mutually exclusive, and different alternatives may be considered.

164. The specific approach chosen would involve various trade-offs. For instance, if authorities develop a common methodology, this would likely ensure consistency in the valuation of product-level losses and outflows across all in-scope CCPs. On the other hand, CCPs should already have valuation models that could be readily applied for this purpose, and any need to implement new methodologies could imply substantial costs and operational burdens to the CCPs. To alleviate concerns regarding comparability, the use of proprietary models could be subject to *ex ante* review or high-level guidelines. However, CCPs may find it operationally cumbersome to apply any imposed restrictions on their existing models. Other potential alternatives could be for authorities to carry out an *ex post* review of the outputs (eg spot check on the re-valued product prices, with a particular focus on products that are common to multiple clearing services), or ask CCPs to provide documentation explaining their methodologies.

165. If authorities decided to calculate the losses and outflows themselves, one aspect to consider is the data necessary to support such implementation. In addition to detailed information on risk exposures (ie exposure at the product level), the calculations will also require extensive market data. In most cases, the stressed market quotes included in the stress scenarios alone will not suffice, and complementary data may also be necessary in order to compute returns (eg end-of-day prices). Other supporting information could also be required, including, for instance, maturity dates, settlement dates, and other attributes of the products.

166. Further, the market and supplementary data required may not be available in a ready-to-use format, and some data manipulation may therefore be necessary before positions can be re-valued. For instance, interpolations of zero-coupon curves, prices curves, volatility surfaces etc could be necessary, depending on the set of products assessed. Such processes inherently introduce some dependence on the particular modelling approaches used. Calendar functions may also be required to convert reference dates into variables to be inserted in the pricing formulae.

167. Finally, as discussed previously, the SST framework should not be considered as a set of independent elements. Consequently, any particular approach selected to assess losses and outflows at the product level would impact the available options in the subsequent stages of the exercise. As an example, consider the aggregation of the above figures into consolidated risk metrics for the CCP (Element 5.ii and iii). If authorities perform the product price calculations as described, it may be more efficient for the exercise if the authorities also implement subsequent stages of the aggregation process.

Aggregation of risk measurements (Element 5.ii)

168. This element describes the process of aggregation of stressed losses and outflows for cleared products, as generated under Element 5.i. The required level of aggregation for losses and outflows for a cleared portfolio is likely to differ according to the purpose of a given test.[36] In general, results may be aggregated at several levels of clearing operations: the product or product class, portfolio, the clearing service, the CCP, the full set of in-scope CCPs or across the clearing participants. Strong dependencies exist between the levels of aggregation because the output from one level of aggregation is typically an input for another, and the methodological approach adopted at one level may condition the range of possibilities at another. At all levels of aggregation, it is important to give due consideration to the appropriate degree of offsetting of profits and losses or inflows and outflows between different currencies, product classes, account types, affiliated clearing participants and clearing services. In determining the relevant levels of aggregation, authorities should also have regard to the granularity of data that would be required in order to calculate the desired risk metrics (Element 5.iv).

Generally, the various levels may be summarised as follows:

(i) *Stressed profits and losses or liquidity inflows and outflows by portfolio*. The first step is aggregating the gross profits and losses, or inflows and outflows, at the portfolio level. That is, taking the gross profit or loss for each product position and creating a final profit and loss for the clearing participant's cleared portfolio or payment inflows and outflows, in the case of liquidity stress testing. Authorities will need to determine what will be included in this aggregation, such as transaction costs, wrong-way risks and other risks. Authorities will also have to specify whether the aggregation will be performed in a single or multi-currencies basis. For example, for a liquidity stress test, it is important to see the results for each individual currency. For a credit stress test, it may be acceptable to have a single credit loss expressed in a single currency.

(ii) *Stressed profits and losses or liquidity inflows and outflows by clearing service*. At this level, the portfolio-level stressed profits and losses or inflows and outflows are further aggregated at the segregated clearing service.[37] Authorities should determine whether stressed profits and losses or liquidity inflows and outflows should be summarised by clearing participant, clearing participant group (eg multiple participants with the same parent company) or by account type (eg house and customer accounts).

(iii) *Stressed profits and losses or liquidity inflows and outflows by CCP*. At this higher level of aggregation, stressed profits and losses or liquidity inflows and outflows are aggregated by clearing participant (again, either by a participant and its affiliates, or separately by account type) across all the segregated clearing services offered by a given CCP. This may be particularly relevant where a CCP manages its liquidity exposure across several CCP service lines, but it may not be relevant where a CCP manages its credit risk at the service line level.

(iv) *Stressed losses and liquidity outflows across CCPs*. At this yet higher level, aggregation of stressed losses or liquidity outflows occurs by clearing participant (again, either by clearing participant group, or separately by account type) across all in-scope CCPs. Cross-margining and other types of cross-CCP agreements could influence the way aggregation is performed across CCPs, and should be considered if appropriate to the exercise.

[36] Definitions of the types of resource (ie initial margin, default fund, default fund add-ons, CCP capital) and their amounts (ie available or required) to be included in the aggregation process are provided in the guidance to Element 5.ii.

[37] Although precise structures vary, in general a clearing service may be characterised by a common set of rules and related arrangements to mutualise losses (in excess of margin) across participants in the service.

(v) *Stressed losses and liquidity outflows across clearing participants*. Finally, this dimension captures the aggregation of stressed losses or liquidity outflows across different clearing participants or clearing participant groups for all in-scope CCPs, creating an aggregate metric for the "n-largest" participants or groups.

169. It is important to ensure that the aggregation process is consistent with the purpose of the SST and the risk sources included in the exercise. For example, if authorities have chosen to include specific wrong-way risk as a risk source to be modelled in the SST, special care needs to be taken when calculating the profits or losses of a clearing participant's portfolio. The calculation of profits or losses should reflect the additional losses (beyond the provided price shocks) that are consistent with the default of the chosen clearing participants. If the CCP clears equities of its clearing participants, then the equity prices of the chosen clearing participants to default should be zero (or equal to their recovery value) when calculating the stressed profits and losses at the portfolio level.

170. Similarly, if authorities have chosen to include general wrong-way risk as a risk source to be modelled in the SST, authorities need to consider how these additional losses should be accounted for in the profit and loss calculations. General wrong-way risk arises when the profits or losses of a clearing participant's portfolio is correlated with the default of the chosen clearing participants.

171. For SSTs focused on liquidity risk, the calculated liquidity outflows due to the specified stress event may include liquidity needs beyond those modelled by variation margin payments. These additional liquidity outflows include settlement payments, option premiums, coupon payments, payments related to physical deliveries, and operational flows (eg the withdrawal of cash collateral by non-defaulting clearing participants). Authorities should consider the appropriateness of including these types of outflows. Similarly, the aggregation process should also reflect any assumptions made about the changes in the liquidity exposures present in the stress scenarios (see Element 3.i). For example, if the actions of non-defaulting clearing participants are being considered as a source of risk, the stressed outflows should be adjusted accordingly. Finally, all these calculations may need to be performed separately by currency and at every point in time during the close-out period when a liquidity obligation is due.

172. At least for levels (i)–(iii), it may be preferable to rely as far as possible in this process on the existing aggregation methodologies of the in-scope CCPs, supported by very high-level guidelines from authorities. This would ensure that the aggregation process was carried out in a manner consistent with the CCPs' respective rulebooks, risk management frameworks and relevant legal framework. At the same time, however, a potential lack of consistency in methodology across CCPs could reduce transparency and comparability of the results. Furthermore, it may restrict the level of granularity available to the authorities.

173. Depending on the extent to which the calculation of stressed losses or outflows was also carried out by the CCPs, there may be efficiencies in having the CCPs perform further stages of the aggregation themselves if they are able to utilise existing systems and techniques, with no need to develop new tools or operational processes. However, CCPs may face a considerably higher burden in carrying out this aggregation if authorities were to specify more standardised methods of aggregation, or to include risks that were not commonly considered in the CCPs' respective processes.

174. To mitigate any transparency and comparability costs of relying on CCPs' proprietary methodologies, authorities could specify some minimum parameters and also request that each CCP document transparently the approach it has taken in respect of key dimensions such as offsetting and netting. Similarly to other elements of the SST framework (eg Element 3.vi), validation could be necessary. These checks could be performed by way of "spot checks" on a subset of the aggregation process and selected entities.

Treatment of resources (Element 5.iii)

175. This element considers how authorities could approach the specification of financial and liquidity resources available to the CCPs and the order in which they are used to offset losses or outflows in the

SST exercises. When assessing the aggregate measures of potential losses or outflows, the type and order in which available resources will be used plays an important role in determining the level of coverage at each CCP. Therefore, the treatment of financial resources might impact stress test results because it defines the actual level of resources that may be available to address credit losses or liquidity outflows following the default of one or more participants or some other service provider's failure to perform.

176. CCPs require participants to provide collateral to cover current and potential future exposures, typically accepting a range of different types of collateral. Participants may provide cash collateral, for example, which will typically be deposited by CCPs at central banks of issue, creditworthy commercial banks, or invested in highly marketable collateral. Alternatively, participants may provide non-cash collateral to CCPs, which will typically be held in custody. However, not all types of resources can be used for all situations. For instance, less liquid collateral may not be available to address temporary liquidity outflows arising from cash flow mismatches. In addition, CCPs' rulebooks may impose further restrictions on the use of certain resources, such as collateral posted in respect to a segregated client. Similarly, authorities should be cognisant that different jurisdictions, and associated legal frameworks, may have distinct definitions of availability of resources, and the order they would be used.

177. Authorities designing and implementing the SST could take different approaches to identifying the set of resources to be considered in the exercise, and also in which order they would be consumed under adverse market conditions.

178. In setting such approaches, the authorities should make assumptions consistent with the PFMI and associated further guidance on CCP resilience. For instance, in their treatment of available resources, the authorities should not take into account excess collateral posted by participants or collateral called but not yet received. Furthermore, the authorities should draw a distinction between committed and uncommitted resources. Yet, another aspect to consider is the valuation of resources. Since the value of available resources may vary rapidly under stressed market conditions, it is appropriate that authorities either apply a haircut to their market value or revalue them on the stress scenario (see Element 5.i). Although non-exhaustive, these aspects can directly influence the extent to which CCPs will be deemed able to withstand the shocks modelled in the stress scenarios.

179. With regard to the set of available resources considered, authorities should also be consistent with the purpose of the SST, the risk sources included in the SST, and any management actions permitted by the CCP's rulebook and internal procedures (eg default management procedures). For example, when the actions of non-defaulting clearing participants are also being considered as risk sources (eg withdrawal of cash collateral), the set of available resources should be sized accordingly. Similarly, if settlement-related flows are being included as a risk source in a liquidity stress test, authorities will need to determine how to treat any scheduled deliveries and receipts of physical securities. For example, if the CCP receives securities that were due to be delivered to a defaulting participant and the CCP has an arrangement to convert these into cash, authorities should determine whether these can be used as a resource to address any losses or liquidity outflows during the closeout period.

180. Likewise, if the SST is examining only losses due to mid-market price movements and is not examining losses due to transaction costs, then the authorities should consider, taking into account the purposes of exercise, whether any resources collected by the CCP specifically for the purposes of covering transaction costs should be incorporated in the test. By including resources collected to cover risk that were not included in the stress scenarios, authorities may be overestimating the CCPs' ability to withstand the given stress. Conversely, if the SST is specifically including specific wrong-way risk or general wrong-way risk, for example, then the authorities could consider including any resources collected by the CCPs to cover those risks.

181. The calculation of available resources should also be consistent with the corresponding level of aggregation of risk measurements (Element 5.ii). For example, when assessing a participant's stressed losses and outflows at the clearing service level, a simple aggregation of all collateral posted by that participant's house and client accounts may not be appropriate (eg if collateral posted in respect of one

client account is not available to address losses or outflows on other client or house accounts). Similar care should be taken when assessing the impact of a liquidity stress scenario at the CCP level, as some CCPs manage their liquidity exposures across several service lines, while others might have more segregated arrangements. In addition, if the authorities intend to assess the results of a liquidity stress test for each individual currency, they may wish to segregate the resources available to address liquidity outflows in each currency accordingly. The chosen levels of aggregation of both risk measurements and resources would have an impact on the authorities' ability to calculate risk metrics at the desired levels of granularity (Element 5.iv).

182. With regard to the order in which available resources will be used, CCPs' rulebooks typically define waterfall structures to absorb credit losses and detail contingent arrangements to withstand temporary liquidity mismatches. The sequence in which resources are used could reveal different points of pressure on the CCPs and in the clearing network. In particular, the sequence in which resources are used may reveal important information about how financial pressures evolve across CCP participants, providers of services to the CCP, and the CCPs themselves. This is particularly relevant when a time dimension is introduced into the SST exercises (see Element 3.viii), such that knock-on and propagation effects can be better analysed by the authorities. As an illustration, consider the case of clearing participants that are also (either themselves or via an affiliate) liquidity providers. Following a period of market volatility, clearing participants could be faced with substantial margin calls (ie variation and initial margin) such that their capacities to provide temporary funding to CCPs may be hampered. Therefore, when the CCPs need to access these liquidity lines with providers, additional pressures could build among participants. Similarly, some collateral and investments may take longer to liquidate, and should therefore not be used to address shorter-term shortfalls in liquidity stress tests. This may need to be reflected in the amount of resources deemed to be available at every point in time during the closeout period.

183. While authorities should aim for consistency with each CCP's rulebook and risk management framework, they should also remain cognisant that a CCP could maintain a range of options for addressing losses and liquidity outflows, and may have considerable discretion in exercising and sequencing these options. For example, a CCP might choose the order in which to liquidate certain types of collateral based on the assumed market scenario, and may select which of its available liquidity lines should be accessed at any point in time. A similar example relates to CCPs that operate multiple clearing services. The extent to which liquid resources from one service can be used to address cash outflows at another may directly influence the extent to which CCPs will draw on other unfunded resources. Since such decisions are likely to be complex and involve careful consideration of the specific circumstances surrounding the scenario, documented credit and liquidity risk management procedures may not be prescriptive. It may therefore be difficult for the authorities to accurately replicate the CCPs' procedures by relying on the rulebooks alone, and authorities should consider defining criteria to assess the appropriateness of such actions for the exercise. This would be particularly pertinent for liquidity stress testing.

Specification of risk metrics (Element 5.iv)

184. This element constitutes the last step in the analysis of test results and addresses considerations for defining metrics against which to assess the results of an SST. When designing risk metrics, it is important that the metrics used not only support the purpose of the exercise, but also reflect the intended use by the relevant authorities and other stakeholders (see Component 6). It is also key that such metrics are consistent with the framework's aim to assess the collective response of a set of CCPs to a stress scenario, rather than the performance of an individual CCP.

185. Further, authorities should ensure that the metrics used reflect a sufficiently rigorous, but plausible, measure. Poorly constructed and designed metrics may provide participating authorities, market participants and the public with misleading information on the performance of a set of CCPs and result in the test failing to achieve its stated purpose. Adequately calibrating assessment methodologies and

metrics through internal and, potentially, external review may help authorities set appropriate metrics (see Element 1.iv).

186. There are many ways of potentially evaluating the results of a test, including a range of quantitative and qualitative measures. In addition, it is likely that more than one metric can be selected by the authorities to evaluate the results of the SST, especially for more general SST purposes. In the context of multi-CCP exercises, for instance, metrics on concentration of exposure to particular clearing participants, and interconnectedness between them, could yield valuable information on the resilience of the clearing network and potential macro-vulnerabilities. A single participant could be responsible for substantial losses across multiple CCPs and, at the same time, be a liquidity provider to many other CCPs.

187. Several quantitative metrics could be considered to summarise the outcomes of an SST exercise, with each alternative offering a distinct perspective on the results. Although numerous, generally these metrics could be categorised according to:

- *Collective drawdown of resources*. Assessing the extent to which stressed losses or liquidity outflows lead to a drawdown (individually and collectively) of in-scope CCPs' financial and liquidity resources – in the form of pre-funded cash and non-cash collateral, CCP capital allocated to the default waterfall, liquidity arrangements and unfunded commitments.
- *Diversification of stressed losses/liquidity outflows/resources*. Assessing the amount of stressed losses or liquidity outflows arising at different nodes of the exercise (eg risk factor, type of account, clearing participant, CCP etc). These metrics could also assess the diversification of resources available to CCPs. For instance, the concentration of collateral per issuer (eg government bonds, equities etc), reliance on particular liquidity providers (eg liquidity lines, repo facilities etc), or reliance on particular funding markets. The interconnectedness of clearing participants and CCPs could also be considered under this category.
- *Scenario diversification*. Assessing the amount of stressed losses/liquidity outflows arising under different stress scenarios. When collateral is also re-priced under the stress scenarios, this could be included in the analysis.

188. In addition to the quantitative metrics discussed above, qualitative measures could also provide useful information when assessing the outcomes of an SST exercise. Such measures may be particularly relevant for tests that examine scenarios in which CCPs can exercise discretion in their risk management approach. For example, in liquidity stress tests where CCPs are expected to respond to stress outflows according to their own contingency arrangements (such as using the repo market to convert non-cash collateral into cash), authorities may deem it relevant to assess the reliability of these arrangements in the context that several of the in-scope CCPs may be performing the same management action.

189. In a more technical specification, there are perhaps three dimensions to be considered when defining a risk metric: (1) variables to be summarised, (2) qualifying attributes, and (3) the measures themselves. On the first dimension, stakeholders' interest may lie, for instance, in variables such as stressed losses and liquidity outflows. These variables could be calculated with reference to one or more of the following attributes: (1) type of resource; (2) clearing service; (3) CCP; (4) type of account (customer, house and affiliates); (5) clearing participant; (6) scenario; (7) currencies etc. Finally, different summary statistics could be used in the process, such as sums, range, percentage, dispersion etc.

190. Two additional and interrelated features to consider when specifying the risk metrics are the frequency of the measurements and presentation formats. The SST could be designed such that more than one reference date is used in the exercise, allowing a comparative analysis through time. Similarly, proposed metrics could be presented as a single measurement, or they could be assessed at many different points of the existing attributes, generating a distribution of possible outcomes. The presentation format may need to be tailored to account for the intended disclosure of the results (Component 6). For example, if the findings of the SST are presented to individual CCPs, care should be taken to ensure that the presented results do not reveal any sensitive information about the other in-scope CCPs. The ability to calculate risk metrics at different or lower levels of granularity will depend in part on the levels of

aggregation of risk measurements (Element 5.ii) and resources (Element 5.iii) that had been carried out by the authorities in the earlier stages of the exercise.

191. Most of the metrics will require that authorities perform calculations and assessments using the results and information that may be provided by the CCPs. Therefore, the metrics chosen will impact the degree of detail requested by the authorities regarding the data provided by the CCP (see Component 4). For example, if the authorities chose to evaluate the distribution of total resources losses by house and customer accounts separately, the CCPs would be required to provide losses by clearing participant sub-account and not just at the aggregated level of the clearing participant and its affiliates. The risk metrics will therefore be a key driver of earlier stages of the analysis. Accordingly, authorities should endeavour to define the risk metrics as early in the process as possible, to ensure that any data requests and initial analyses are sufficient to enable the calculation of the desired risk metrics.

2.6 Use of test results and disclosure (Component 6)

2.6.1 Description of component

192. Before running a test, authorities should carefully consider how they could potentially use the results of an SST (Element 6.i). However, through the various stages of conducting an SST, authorities may need to revisit and revise these initial views. Therefore, although authorities will only use test results at the end of the supervisory stress-testing process, they will likely need to employ an iterative approach to determining the use of results (though uses will always be bounded by the relevant legal regimes and respective mandates of the authorities participating in the SST).

193. Additionally, transparency of supervisory stress testing by authorities can advance the overall objective of a multi-CCP stress test by providing a range of stakeholders with a broader understanding of the macroprudential implications of an extreme but plausible credit or liquidity stress event. By disclosing the methodology used and the results observed, authorities can facilitate various stakeholders' understanding of how different stress scenarios will impact a group of CCPs and, potentially, the financial system more broadly (Element 6.ii). Authorities, therefore, should endeavor to develop a strategy for transparency and disclosure before running an SST. While this initial approach to disclosure should ideally be developed early on in the supervisory stress-testing process, authorities may need to refine and adapt their strategy at various stages of the exercise in the light of the exercise findings and other relevant developments.

194. A number of factors will influence authorities' strategy for disclosure as well as the degree and scope of transparency that can be achieved. In particular, all forms of disclosure would need to be designed to ensure consistency with the purpose of the test as well as compliance with each authority's legal mandates and information-sharing arrangements. It may also be necessary and appropriate for the authorities conducting the test to design varying levels of disclosure for different audiences, such as CCPs, clearing participants, customers, other relevant authorities and the public. Furthermore, authorities would likely need to consider how the scope and timing of the expected disclosure could impact the markets.

2.6.2 Discussion

Use of test results (Element 6.i)

195. Not only is it important for authorities to clearly articulate the stated purpose or purposes of the SST, it is also important that authorities carefully think about how they intend to use SST results. The possible uses of the SST results will be heavily influenced by the test's purpose (see Element 1.i).

196. Although authorities will use the results of an SST after the stress test has been conducted, it is important that authorities employ an iterative approach throughout the supervisory stress-testing process to determine how the SST's results will be used. Specifically, authorities should carefully decide how they would expect to respond if the results identify possible weaknesses or vulnerabilities across the in-scope CCPs or in the financial system more broadly. This may require revisiting and adapting any prior strategy for the use of results or communication with other relevant authorities who may not necessarily be participating in the test.

197. There are many possible uses of an SST and authorities should consider using the results to address any findings uncovered through the test to the extent appropriate and permissible under the relevant authority's legal regime. Examples of possible uses include informing authorities' expectations on risk management that apply categorically to CCPs, clearing participants or other third parties; specific supervisory actions focused on a subset of CCPs, clearing participants or other third parties; or monitoring broad systemic risks across the financial system with a view to identifying macroprudential risks and evaluating potential policy responses. As discussed in the introduction, this framework is designed to

support SSTs conducted for the purpose of evaluating broad, macro-level impacts across a set of CCPs as a whole. Accordingly, it is unlikely that the results from this type of SST would be used for the purpose of taking a policy action targeted towards a single CCP.

198. Authorities conducting the SST will have to consider the requirements and limits of the relevant legal regimes when deciding how to use the results of the test, and discretion should be exercised to ensure adherence to any existing practices or protocol. Further, if multiple authorities are involved in the design and execution of an SST, the authorities should have a common understanding of how the test results will be used and which authorities will implement any agreed actions. Authorities should also promote the consistency of any resulting actions across the various jurisdictions involved in the test. As permissible and relevant, the authorities conducting the test may also wish to coordinate with non-participating authorities when determining how to use results. Such cooperation among authorities may require the prior implementation of information-sharing arrangements with other relevant authorities (see Component 2).

Disclosure (Element 6.ii)

199. Authorities should develop a strategy for the disclosure of an SST's results, methodology, and, as relevant and appropriate, any planned follow-up engagement. The scope of these anticipated disclosures should be carefully considered and may vary depending on the audience and purpose. To manage the expectations of CCPs and other market participants, authorities may wish to provide CCPs and other relevant market participants with high-level information on how they intend to disclose and use test results to CCPs and other relevant market participants before running an SST. It should be acknowledged, however, that authorities may need to refine and adapt their strategy at various stages of the exercise in the light of their findings and other relevant developments.

200. In particular, as with all disclosures, authorities should protect non-public information and carefully consider the appropriate level of detail shared to prevent any unintended impact on the stress-tested entities, their customers or the financial markets. While authorities should endeavor to disclose some form of test results to the public, there may be instances where the potential impact on the financial markets or financial stability prevents or justifies a delay in publishing results. For example, in particular circumstances, authorities may choose to delay or not disclose results if doing so could exacerbate market stress. However, authorities should remain cognisant that not disclosing or delaying disclosure of results could also convey a signal to the market, especially when authorities have previously communicated anticipated timeframes for the completion of the exercise and publication of a report.

201. When determining an approach to disclosure, authorities should also consider including information on the test methodology used. As wide range of approaches can be taken for each element of the framework, disclosing all or certain aspects of the methodology can therefore provide important context for the SST and inform the manner in which test results are interpreted. It can also support comparability of the results of SSTs carried out by different subsets of authorities, or by the same authorities over time. In particular, to inform the reader's understanding of the SST, authorities should consider broad disclosure of the methodology's assumptions, limitations of the approach taken, information on framing parameters, as appropriate, and a description of the scenarios used. As relevant, authorities could also consider explaining the rationale for any design choices that differ from the expectations set forth in the PFMI. Such disclosure can also inform authorities designing SSTs in other jurisdictions.

202. Information on test methodology could be disclosed before the test is run or after it is complete. Such disclosure, however, should be designed to complement authorities' disclosure of test results and promote consistency with the overall disclosure strategy. In particular, authorities should remain aware that information disclosed before a test is run may impact the market's expectations regarding the disclosure of results.

Selected disclosure

203. When determining a strategy for disclosure, authorities should consider consulting relevant parties, such as CCPs or non-participating authorities that supervise in-scope CCPs or clearing members, before publicly releasing final results. This consultation can be a useful check and help alleviate any concerns among participating stakeholders. It could also shape the use of results and what is ultimately disclosed publicly, provided that the feedback is constructive and consistent with the SST's purpose, as opposed to feedback that is self-serving to a particular entity. For example, this outreach could be used to clarify any anomalies in the data and validate the results; to scrutinise further the analysis or results of the test by engaging with risk experts or other functional areas at one or more of the authorities; to provide more granular details to non-participating supervisors of in-scope CCPs or clearing members on the firms they supervise; or to discuss potential public sector responses (such as further policy work). To maximise these potential benefits, authorities should determine an approach for such a distribution in advance, including who will be consulted, the type of feedback desired, and how any comments will be incorporated.

204. In such cases, authorities should anticipate, with due regard to confidentiality, considerations surrounding any data that might be disclosed as part of this process. As a result, authorities may need to remove sensitive data or restrict which CCPs are privy to certain data. For example, authorities could share clearing participant or customer-level information or transaction data with the CCPs in which those firms participate, but may not be able to share the same level of detail with other CCPs, and possibly other authorities, that review the test results. The timing of any such consultation should also be carefully considered to avoid any front-running or inadvertent disclosure. To the extent that authorities identify any follow-up actions specific to the in-scope CCPs and, if relevant, clearing participants, these expectations should be disclosed to the affected parties before sharing with a broader audience, if at all.

Public disclosure

205. Authorities should aim to be as transparent as possible regarding their SST's design and results. Ideally, this would include public disclosure of the test objective and purpose, the scope of the exercise, the authorities who participated in the exercise, the methodology, the aggregated results, and, at a high level, any follow-up work envisioned.[38] SSTs will likely be of interest to a wide range of potential parties beyond those involved with the test. In addition to illustrating the implications of the scenarios for in-scope CCPs, transparency on all aspects of the SST could help other authorities design their own stress-testing programmes, facilitate the sharing of lessons learned, and promote the use of SSTs as a macroprudential tool. The results of an SST could also promote industry dialogue and inform risk management decisions and frameworks of CCPs, clearing participants, customers and other CCP stakeholders. Transparency of the results could provide clearing participants and their customers with another valuable data point as they utilise CCP clearing services or participate in CCP governance arrangements.

206. Since SSTs inherently involve firm-specific, non-public information, the benefits of broad disclosure must be balanced against the need to protect sensitive data and avoid market impacts, and to ensure consistency with each authority's legal mandate. For example, authorities should carefully consider the impact that disclosure could have on CCPs that are publicly traded or issue their own debt or equity and ensure that material non-public information is not revealed though the disclosure of test results. Authorities should review and, as appropriate, agree in advance the desired level of disclosure, as well as the allocation of responsibilities for disclosure and the appropriate timing. As the data are analysed and processed, authorities should avoid disclosing sensitive information. This may require that results are eventually aggregated or anonymised to reduce the potential for reverse engineering. In particular, care should be taken when disclosing results that relate to smaller or more concentrated markets with only a few major participants.

[38] Authorities may wish to refer to the list of metrics in 5.ii for examples of the types of information that could be disclosed.

207. Authorities should also consider how the expected timing of disclosure could impact CCPs, market participants and the financial markets more broadly. For example, to avoid undue market impact, authorities may want to avoid disclosing information on certain dates that typically have increased market activity, such as key settlement dates, the year-end, or end-of-quarter. When considering the timing of their disclosures, authorities should also take into account known events, such as market implementation dates or national elections, to avoid market disruption or volatility.

208. In addition to considering the timing of public disclosure, authorities should also consider whether and how they will disclose information on any vulnerabilities and weaknesses revealed by the test results. An approach for such results should be considered along with a broader strategy for the use of results and disclosure before a test is run. Developing such a strategy in advance would lessen the likelihood that delaying disclosure or failing to disclose inadvertently conveys a message about the results. In particular, authorities should weigh the pros and cons of publicly disclosing potential vulnerabilities and weaknesses.

Annex A: SST design tool

Questions for authorities to consider: illustrative design choices per component and element

Component/element	Questions	Illustrative design choices
1. Purpose and exercise specifications		
1.i – Purpose	What are the purposes of the exercise?	To examine stressed losses across CCPs; to examine liquidity shortfalls across CCPs; both
	What are the constraints that may impact the purposes of the exercise?	Participating authorities; legal powers; sharing arrangements; authorities' resources and operational capability; data limitations
1.ii – Scope	Which CCPs and clearing services will be included in the exercise?	All CCPs and clearing services supervised by participating authorities; a target set of CCPs based on systemic importance or other predetermined criteria
	What are the criteria used to select CCPs and clearing services?	Purpose of the exercise; systemic importance of CCPs; markets and products cleared; settlement currencies of cleared products
	What are the constraints that may impact the selection of CCPs and clearing services?	Jurisdiction; legal framework; supervisory powers of authorities
1.iii – Frequency and timing	What is the frequency of the exercise?	Annual; biannual; ad hoc
	What is the time frame for the exercise? (ie when does the exercise start? how long does the exercise cycle last for? what is the anticipated duration of each stage of the exercise)	Authorities start working on the exercise in March with the goal of completing all phases by October
	What reference date or dates will be used for the exercise?	Reference date is 02/11/2016
	What constraints may be considered when determining the timeframe for the exercise?	Resource constraints (authorities, CCPs and other market participants); legal requirements; market conditions; sensitive dates
1.iv – Feedback on test design	Which aspects of test design will authorities seek feedback on?	All aspects; purpose and scope; other particular subject areas (eg design and flow of data, scenario selection and development)
	When, during the exercise cycle, will feedback be collected?	During the design of the exercise; prior to the start of the stress scenario development or the aggregation of results; after completion of the exercise in order to inform future iterations
	From which parties will feedback be sought? What mechanisms will authorities use to collect feedback?	CCPs; market participants; selected non-participating authorities; other relevant parties with particular perspectives or expertise
	What considerations may impact the collection and use of feedback?	Possible conflicts of interest; confidentiality issues; efficiency issues

Component/element	Questions	Illustrative design choices
2. Governance arrangements		
2.i – Roles and responsibilities for authorities	What criteria will be used to determine the specific roles and responsibilities of the participating authorities for each element of the exercise?	Types of participating authority; mandates; resources; expertise; access to data
2.ii – Roles and responsibilities for CCPs in the test	What criteria will be used to determine the specific roles and responsibilities of the CCPs in the exercise and the related governance arrangements?	Expertise and ability of CCPs; resource burden; independence of the exercise and its results
	For which specific components of the exercise would input from CCPs be most useful?	Scenario extrapolation; calculation of P&L or liquidity outflows given market shocks provided by authorities
2.iii – Information-sharing arrangements	What existing information-sharing arrangements are in place between authorities and what additional arrangements are necessary to allow data-sharing for the purpose of the test?	Memorandum of understanding supported by the legal framework (also referred to as legal gateways)
3. Developing stress scenarios		
3.i – Identification of risk exposures	Which types of risk exposure are necessary to include in the exercise in order to meet the stated purpose(s)?	Clearing participants' cleared positions/portfolios; posted collateral; CCP investments; CCPs' own liquidity arrangements (eg non-performance of liquidity lines)
	What set of products will be considered in the SST?	All cleared positions at all CCPs; largest cleared markets; other subsets selected based upon total initial margin, average size of variation margin requirements, cleared product type (eg security vs derivative)
	What set of participants will be considered in the SST?	Cleared positions from all participants; participants with largest settlement obligations; other subsets selected based on each participant's level of (eg credit/liquidity) exposure, total initial margin
3.ii – Identification of risk sources	Which sources of risk should be considered given the purpose(s) of the SST?	Price moves for cleared positions or collateral (eg mid-market prices); transaction costs; any wrong-way risks; settlement-related liquidity needs
	What aspects should be considered when deciding which sources of risk to analyse?	The perceived plausibility of any desired stress scenarios; the complexity and resource cost of any required statistical modelling; whether the authorities or CCPs will be required to apply the scenarios to the exposures; financial stability considerations

Component/element	Questions	Illustrative design choices
3.iii – Framing the stress-testing scenarios	What approaches could be used to frame the stress-testing scenarios?	A fully coherent sequence of events (ie event-based scenario); a high-level approach applied mainly to the selection of risk factors and the calibration of internally consistent stress scenarios
	Which stress events (historical or hypothetical) could provide market context (corresponding to the purpose(s) of the SST) for framing stress scenario(s)?	Macroeconomic/financial developments; policy regime changes; geopolitical developments; operational shocks
3.iv – Identifying core risk factors	How will authorities identify the set of core risk factors required when defining the exercise's stress scenario(s)?	Authorities' expert judgment; in-scope CCPs' expert judgment; quantitative analysis based on the relative importance of each risk factor (eg initial margin, stressed losses); a combined approach of quantitative analysis and expert judgment
	What criteria could be used to ensure that identified core risk factors are adequate with respect to the purposes(s) of the SST?	Coherence of identified risk factors with selected risk sources; consistency with the framing of the stress-testing scenario
3.v – Calibrating the shocks to core risk factors	How will participating authorities calibrate shocks to core risk factors for the stress scenarios?	Historical stress scenarios; hypothetical stress scenarios; statistical scenarios
	What operational and technical considerations should the authorities take into account while calibrating shocks to the core risk factors?	The internal consistency of any chosen methodology; plausibility of joint movement of core risk factors
3.vi – Extrapolating the shock to other (non-core) risk factors	What operational and technical factors will be considered when determining whether the authorities or the CCPs will perform the extrapolation?	Resource costs for authorities and in-scope CCPs; availability of expertise and the operational capabilities of both authorities and in-scope CCPs
	If the extrapolation is performed by the CCPs, how will the authorities ensure consistency in the extrapolation procedures across CCPs and risk factors?	Specification of extrapolation techniques; spot checks against pre-defined benchmark; comparison across CCPs
	What criteria will be used by the authorities to ensure that the extrapolation is consistent with the purpose(s) of the SST?	Coherence of stressed risk factors with the framing of stress-testing scenarios; consistency of the extrapolated shocks with those calibrated by authorities
3.vii – Specifying defaults or failures	What criteria will be used by the authorities in order to specify the number and identity of defaults or failures?	Purpose of the exercise; size of stress losses over initial margin; size of liquidity shortfall; implied probability of default; expert judgment
	How can authorities ensure that the information used to set the criteria to specify defaults is reliable and consistent with the purpose(s) of the SST?	Comparison with CCP reports; comparison with other macro-prudential studies

Component/element	Questions	Illustrative design choices
3.viii – Specifying the timing of defaults or failures	What aspects can authorities use to define whether default(s)/failure(s) happen in a sequence or simultaneously?	Plausibility of stress scenario; complexity of modelling second-order effects
	What criteria will authorities use to ensure that the chosen timing is consistent with the purpose(s) of the SST?	Coherence of timings with identified risk sources; plausibility of stress scenarios
	If sequential defaults/failures are chosen, what criteria will be used to determine the time horizon of the SST?	Liquidation period or MPORs of the products; sequence of events during historical time periods
4. Data collection and protection		
4.i – Data collection	What mechanisms can be used to collect data from CCPs and to ensure its quality?	Data templates; validation checks; comparison across CCPs or against other appropriate sources of information (eg for prices, comparison with market vendors)
	What data need to be collected such that stress scenarios can be applied to credit risk exposures?	Exposures to risk factors; historical prices for cleared products
	What data need to be collected such that stress scenarios can be applied to liquidity exposures?	Clearing participants' outflows; cash collateral; size of liquidity lines
4.ii – Data protection	What arrangements would be necessary for authorities to protect the confidentiality of the data collected?	Data anonymisation (if possible given the overall test purpose); segregated working groups; limited access to raw data
5. Aggregating results and developing analytical metrics		
5.i – Application of scenarios to exposures	What criteria will be considered by authorities when developing the approach to calculating stressed losses and outflows?	Data, computational and modelling requirements; types of products; choice of risk sources; approach selected to the aggregation of risk metrics
	To what extent will authorities rely on CCPs' proprietary valuation methodologies for calculating stressed losses and outflows?	Full reliance; some reliance; no reliance
5.ii – Aggregation of risk measurements	What are the main aggregation levels of risk measurements that will be needed in order to generate the required risk metrics?	Product or product class; clearing service; CCP; all in scope CCPs; clearing participant
	What are the intermediate aggregation levels that may help identify issues related to netting/offset of stressed profits/losses or inflows/outflows?	Currency; type of account (house, client); clearing participant/participant group
	To what extent will authorities rely on CCPs' existing rules and procedures when conducting the aggregation?	All levels of aggregation performed by CCPs using existing systems and techniques; some levels of aggregation performed by CCPs supported by high-level guidance from authorities
	If authorities place reliance on CCPs' existing procedures, how will potential transparency and comparability issues be mitigated?	Specification of minimum parameters; validation; CCPs' documentation

Component/element	Questions	Illustrative design choices
5.iii – Treatment of resources	Which financial resources will authorities include for a credit (required and posted/available collateral) or liquidity stress test (committed/uncommitted resources)?	All pre-funded resources posted at the CCP; required resources only; committed liquidity arrangements
	How will authorities and, as appropriate, CCPs model the timing of availability of these financial resources when offsetting stressed losses or outflows?	Coherently with each CCP rulebook; same order across all CCPs
5.iv – Specification of risk metrics	What types of metric will be used to summarise the outcomes of the SST?	Collective drawdown of resources; diversification of stressed losses/liquidity outflows/resources; scenario diversification
	At what frequency will the metrics be measured?	Point-in-time measurement using a single reference date; comparative analysis over time
	How will the metrics be presented and tailored to suit the intended use of results?	One set of risk metrics produced for all audiences; attributes of metrics tailored to specific audience
6. Use of test results and disclosure		
6.i – Use of test results	What are the different uses for the results of the exercise, and how do these relate to the stated purpose(s) of the SST?	Identifying macroprudential risks and evaluating potential policy responses; informing authorities' expectations on risk management
	How will authorities coordinate when addressing SST results?	Steering group composed of staff from participating authorities; harmonised internal governance procedures in different authorities
6.ii – Disclosure	What interim consultation will be considered by authorities prior to releasing the final results?	Clarification of anomalies with CCPs; further scrutiny of results with risk experts at one or more authorities
	What other factors will be considered by authorities when developing the disclosure strategy?	Data sensitivity; legal constraints; market impact

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