



European Association of CCP Clearing Houses

**Paper on
Best Practices for CCP Stress Testing**

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1. Introduction

The European Association of CCP Clearing Houses (“EACH”) has been actively involved in developing risk standards for CCPs since 1991.

As part of the development of the proposed CPSS-IOSCO principles for FMI and the recent focus on CCP risk management, there has been a demand for EACH to reflect on CCP stress testing practices.

The main aim of this paper is to make the appropriate distinction between stress testing performed by CCPs and those by banking institutions. In addition to this, the paper attempts to provide a compilation of existing best practices of stress testing within the community of CCPs. Furthermore it also sets some boundaries on the possibilities and feasibility of CCP stress testing by providing examples and detailed explanations. Please note that the relevance, appropriateness and feasibility of all elements mentioned in this paper may differ per CCP and cleared market.

Therefore EACH would like to clarify, that these practices shall not be considered as a set of minimum requirements for CCPs for regulations or principles. Furthermore it shall not be seen as a clearly defined process for stress-testing. In fact EACH rather believes that diverse stress testing methods are extremely important in order to ensure safer markets.

2. Definition and objective of CCP stress testing

In general a CCP has financial resources which are a combination of margin (loss coverage by defaulting member), Default Fund¹ (loss coverage by surviving members) and CCP capital (loss coverage by CCP).

Stress testing is performed to verify the adequacy of these financial resources and specifically the resources available in excess of initial margin. Such an activity is at the core of CCP activity as the event of a clearing member default may in many cases coincide with extreme market conditions.

The following elements are part of a typical stress test performed by a CCP:

- Selection of a particular market event (historical or theoretical)
- Number of clearing members will default at the same time considering potential (group) dependencies, timing, industry concentration, etc.
- How will the portfolio of the member(s) be handled (hedge/liquidation) and period required to close out the risk/portfolio of these clearing member
- The specific market movements of the instruments under a particular market event are translated into specific price changes considering the time period required for the closing out of the position/risk.
- These price changes are applied on the cleared portfolio of all clearing members as to establish the potential result of a defaulting clearing member or members under the applicable scenario.
- The stress results, in the form of a profit or loss arising from portfolio liquidation at the stressed prices, from all assumed defaulting members are compared with the available resources.
- These resources are placed in a 'waterfall' which determines the order in which they are applied successively to the member or member's stress losses

CCPs may perform multiple stress tests which may have different objectives and underlying assumptions.

Stress testing can be performed on the basis of fixed assumptions and stress scenarios. The scenarios and assumptions used must fulfil the "extreme but plausible" criterion. The objective is to determine the required level of financial resources, notably the level of the default fund or other resources (such as CCP capital) a CCP can reliably draw on.

Additional stress testing can be performed as to meet other objectives namely:

- A) Perform a stress test on the underlying assumptions for the Default Fund in order to verify the continuing adequacy of scenarios and assumptions used in stress testing, for example considering other possible correlations and movements.
- B) Stress testing can also be performed on scenarios on the basis of very extreme market conditions - scenarios which are currently considered implausible. They

¹ Including replenishment and Power of Assessment

provide the risk management of the CCP with a view on the impact on the CCP and member if the unthinkable would happen.

This additional stress testing is intended to provide informational value for CCP risk management. In the banking world this type of stress testing is often referred to as “reverse stress testing” or “stress to destruction”, but this wording is confusing in a CCP context as resources are already set at levels equal to potential losses under extreme market conditions.

In this context it should be remembered that stress testing in a banking context is different to a CCP context. For a banking institution the levels of capital are set based upon the Basel Committee CAD rules and stress testing is used in support of these rules while for a CCP its financial resources are directly related to the outcome of stress testing. Other distinct elements which distinguish both are

- The fact that banks have many different activities and risk types while a CCP is usually a mono purpose company for which market risk is the most important factor in stress testing
- A CCP is non risk taking entity and therefore does not hold portfolios for trading purposes
- The relevant period necessary to close out the portfolio for a CCP is considerably shorter than a banking entity (i.e. several days compared to years for a credit portfolio).

CCPs should regularly re-evaluate their current set of scenarios and the adequacy of financial resources but also have a view on the sensitivity of these resources (for example changes in implied volatilities, rates, correlations, CDS spreads etc.) and the impact of new events which may exceed those recorded in the past.

CCPs, because they act as systemic risk managers, should manage their risks pro-actively; stress testing can be a valuable tool providing information on the impact of potential future market events.

3. Coverage of market events

The performance of stress testing requires both qualitative and quantitative analysis; due to changes in products, market structure, pricing, etc. historical data cannot be translated immediately to current situation but have to be fitted to the current products and portfolios.

The possible market scenarios which the CCP should take into account in its stress testing can be determined in different ways.

Extreme historic events experienced in the markets cleared by the CCP should be used for developing stress test scenarios. However, we cannot assume reoccurrence of past events thus theoretical scenarios should be developed in order to capture a wider range of extreme but plausible events.

As an example a \$10 move in the price of oil at the time of the Gulf War in 1990 was extreme at a price of \$30. A different scenario would result at the current price of \$100. The exit of the Pound from the ERM in 1992 was a considerable stress event where short term interest rates moved up to 1800bp but it can be questioned how useful such a scenario is in the current context.

There are different ways to arrive at a theoretical scenario, for example; (1) by taking historical scenarios and making changes to the observed correlations so to produce an Amended Historical Scenario, (2) by developing hypothetical economic “story-lines” and attach quantitative consequences to them and (3) by using statistical methods such as extreme value theory to determine possible price moves.

(1) Amended historical stress events

A typical approach in this type of theoretical scenario is to amend or reverse correlations and price/volatility movements during observed during a historical scenario. For example, many events involving a fall in equity markets have coincided with an increase in high quality government bonds - a flight to quality. If there is a plausible economic scenario whereby some bonds could decrease in price at the same time of a fall on the equity market, this could also be considered in performed stress testing

(2) Economic story lines

In many cases the economic “story lines” (e.g. sovereign default or recession) do not happen overnight and a CCP would increase its margin rates based upon the market conditions. These future actions should be considered when looking at the outcome of these stress tests. In many cases having continuity planning and running fire drills of potential future stress events could prove to be more effective than simply applying price shifts. Furthermore, scenarios involving sudden very extreme movements can be useful as ‘stresses to destruction’, evaluating the results against risk frameworks that would have kicked in and boosted the CCP’s resources. Equally, the lack of such specific risk frameworks may be identified through such an analysis.

(3) Statistical methods such as Extreme Value Theory

This methodology applies statistical analysis to define an extreme scenario based on the shape of the distribution of the worst moves experienced by each market or product over an appropriate time horizon. This might be the worst movement itself or a more complex function of the n worst. The resulting stress shift on prices is applied without being based upon a particular scenario.

(4) Other considerations in building stress scenarios

- a) Different events should be used for developing stress scenarios for different markets and/or products. For example, an event which has a significant impact on equity prices and bonds may be irrelevant for electricity. This principle applies to both the historic and the theoretical scenarios.
- b) The specific risks and complexity of especially OTC products should be considered in the stress testing scenarios, for example recognizing credit events happening simultaneously with a clearing member default. In addition any wrong way risks should be addressed in the relevant stress testing; some CCPs are currently considering the wrong way risk between a position in a sovereign bond and the clearing member domiciled in the same country. However, taking into consideration the credit standing of both the sovereign and applicable clearing member.
- c) Theoretical scenarios should focus on hypothetical price variations (and the risk factors which drive these price variations, such as – for example – changes in implied volatilities, rates, correlations, CDS spreads etc.).
- d) When building a stress scenario, the combination of the variations assumed for the different risk factors should be consistent with the economic “story-line” underlying the stress scenario as well as with available empirical evidence on how these risk factors behave in relation to each other in times of market stress.
- e) Include multiple changes in risk factors during a crisis (interest rate, equity movement, etc.)
- f) Evaluation of historical correlations in relevant stress testing scenarios as to accurately capture basis risk between different instruments and underlying values.
- g) Consider the impact of distressed market conditions on the liquidation process.
- h) Hypothetical position movements should not be taken into account. A CCP’s stress test scenarios are intended to calculate the risk buffers (and hence the collateral required) to cover the risk the CCP runs on the positions actually guaranteed. It would therefore be inappropriate to ask for collateral for hypothetical potential future positions. Moreover, it would be extremely difficult, if not impossible to determine what should be considered as “plausible” in terms of future changes in positions.
- i) The liquidation period to be taken into account should be based on a well founded estimation of the time the CCP will require between the last valuation of the position of the defaulter on which margin has been collected and the actual close out of the position by the CCP. In many cases the close out period used for stress testing mirrors that of the margin calculation as both will follow the assumed liquidation plan. For informational purposes a longer period could be considered.
- j) The liquidation period may differ by market, by CCP and by product depending on differences in the markets where the products are traded in terms of transparency and liquidity and applicable default management procedures. This should also be taken into account when the products are not fungible across these markets, i.e. when the CCP is limited in its possibilities to hedge or close out (quickly) in the most

- liquid market available. These differences in liquidity between markets should be taken into account in the liquidation period assumed when determining the price variation scenario.
- k) In addition, the liquidation period should take into account the tools which the CCP has at its disposal to liquidate positions as well as the actions (hedging, auction, brokers, etc.) and timelines which have been agreed and tested as part of the default management procedure. Also considering that in some cases CCP could elect to first close-out the risk in the portfolio by engaging in hedging transactions in the most liquid product instead of liquidating the portfolio itself.
 - l) Some members may hold concentrated positions which may, as a result, be difficult to liquidate within the liquidation assumptions on which the margin calculation is based. A concentrated position however is the result of the behaviour of an individual member and related additional close out costs of a large, complex portfolio. It seems therefore more appropriate to take these into account through the collection of additional margin from the clearing member holding the concentrated position rather than in a stress testing calculation. This concentration risk margin will be held as an additional resource in addition to other financial resources applicable to all members.
 - m) An important interdependency exists between a clearing member and the collateral deposited by that clearing member. Some Clearing members provide collateral in their local currency or in locally issued government debt securities. Currently some CCPs take this into account in their stress scenarios whereas others calculate their collateral haircuts by definition on the basis of stress parameters. CCPs may also apply concentration limits on such collateral in order to minimise liquidity issues during liquidation.
 - n) In the absence of sufficient historical data for new or illiquid products it is good practice to use price movements of that particular product in another market or of a product which can be considered as comparable. The use of simulated data without a basis in real price movements would by definition lack any demonstrable plausibility and should therefore be avoided.
 - o) Interdependencies between the margin setting approach and the stress test scenario definition should be handled with extreme care and awareness to avoid possible unrecognised “echoing” effects. That is: if the stress test scenario is defined for each instrument as a price movement 50% larger than the applicable margin interval, that each time margins are raised the stress test scenario is made more severe and each time the margins are reduced, the stress test scenario is relaxed. While there might be rational reasons for reducing/increasing simultaneously margins and stress, this should not happen without full awareness of the CCP due to some hidden (and long-forgotten) hypothesis
 - p) The suitability of the comparable information used should then be tested in the periodic review of the stress testing process whereby each CCP will verify if in face of market developments new stress test scenarios should be included or if parameters should be adjusted (as described in the paragraph 8).

As a minimum a CCP should apply historical and theoretical stress scenarios that are appropriate to the markets and products cleared by the CCP. At a minimum, the worst case (relevant) historical event observed in the available and relevant price history for the relevant product/market combination should be taken into account in the scenario set. It

would however be implausible to produce a worst case scenario simply by assuming all worst case scenarios of all products occur at the same time.

4. Default assumptions

The default assumptions relate to:

- the number of defaults assumed to be occurring simultaneously and/or consecutively,
- the treatment of affiliated clearing entities
- the timing of the consecutive defaults
- the selection of the defaulter(s)
- Applicable segregation of Client accounts
- the interdependencies to be taken into account for the selection of the defaulter(s)

A CCP performs stress testing at the regulatory minimum which is currently the single clearing member with the largest exposure; it is understood that this minimum number may increase under proposed legislation.

A CCP should also take into account the simultaneous default of affiliates. The basic assumption is that the failure of one of the group companies should be expected to have an impact on all clearing members which are part of the group.

A CCP should also consider the handling of House and Client² position in the performance of stress testing, which implies that a house surplus after stress testing may cover a deficit on the client account but not vice versa. The applied segregation model will also have an important impact on the default assumptions.

For informational purposes a CCP could also perform stress testing assuming a wider range of clearing member defaults.

In case of simultaneous defaults, the CCP can in principle take the possible offsets between the positions of the defaulting members' House account into consideration (depending on the legal possibilities and constraints), although this is not possible for Client positions². In practice this means that a CCP handling the simultaneous default of more than one member, may close out offsetting positions rather than liquidating separately in the market.

Also in the case of simultaneous defaults, care should be taken not to 'mix' market scenarios, as no more than one can happen simultaneously this could lead to inconsistent results.

In case of sequential defaults, the CCP would not take the possible offsets into account, assuming that each clearing member would default after the position of the previous one had been transferred / hedged / auctioned. Also different market conditions could be applicable for the handling of the sequential defaults, which could be accounted for in the performed stress testing. The outcome of such a test can be compared with the total waterfall of resources available to the CCP (including powers of assessment, replenishment, etc.) and not just the default fund.

² In some jurisdiction non-segregated clients are included in the House account and therefore treated in the same manner.

A CCP might consider in its stress testing that defaults will happen in a sequential order as it is the most conservative scenario and netting of client positions across several clearing members in case of a default is not possible.

5. Frequency

A CCP performs daily regular stress testing using a suite of extreme but plausible scenarios.

Such daily stress testing can be included in daily calculating the amount of the required default fund assuming that the underlying calculations are in line with the considerations outlined in this document.

6. Follow up

A CCP should also take appropriate action based upon the result of stress testing for example requesting additional individual margin calls for the coverage of excess risk or increasing the default fund. The choice depends upon many factors, including the flexibility of the default fund and the degree of mutualisation in the CCP's default risk model.

Senior management, the Risk Committee and the Board should be fully informed of the performed stress testing, adequacy of financial resources and actions taken.

7. Documentation and systems

A CCP should have stress testing policy and procedures to support the stress testing process and describe the underlying assumptions. This procedure should also be disclosed in reasonable detail.

The outcomes of all stress testing will be stored and actions documented.

A CCP should have flexible and robust systems and infrastructure to perform stress testing, which can quickly be adapted to cover new events which become plausible.

8. Review of on-going adequacy of stress tests

The main tool to assure that stress tests are severe enough is a periodic, typically annual, review process whereby each CCP shall make an assessment of its stress testing methodology, and consider amending scenarios, introducing new ones or even deleting scenarios that are no longer applicable. Risk Management will usually perform the review, however, any amendment shall be submitted to the Board of Directors and to the Risk committee³ where applicable.

A review may take into account:

- A comparison of stress testing results over the past year with the actual price movements observed.
- The results of the stress sensitivity analyses performed over the past year.
- A general assessment of the economic and financial developments in general and in specific markets and their possible impact on the probability and severity of future stress events.

In addition to this review, an ad hoc review should be performed as soon as possible after a crisis has occurred or if a substantial change in market conditions is observed which identifies (for example) newly plausible events. Ad hoc reviews can be performed during a crisis; for example performing additional stress testing to verify the continued suitability of financial resources. Nonetheless it should be considered that implementing more severe stress test scenarios during a crisis to evaluate financial resources may have a strong pro-cyclical effect.

³ Subject to the implementation of EMIR which requires the establishment of such a Committee

9. Liquidity stress testing

The purpose of liquidity stress testing is to verify that a CCP will continue to meet its payment obligations and those of any defaulting clearing member under stress conditions.

The stress conditions for liquidity could be an operational event (failure of an infrastructure, disruption of margin call process) or an event of default.

For operational scenarios, a CCP should make an inventory of potential events which may have an impact on liquidity. Nonetheless it is difficult to make a quantitative assessment of the impact of such events. The main importance is an adequate continuity procedure as to circumvent the potential impact of such events.

In general the largest liquidity stress will result from the handling of a defaulting clearing member. The liquidity impact differs per type of product:

- For some derivatives products (e.g. exchange traded futures) the cash flows in case of default are equal to the liquidation losses
- On other hand for cash settled products (equity, bonds and repos) the cash flow obligations arising from guaranteeing settlement may become substantial and much larger than the liquidation loss for which a CCP keeps margin collateral.

Most of the basic elements used to define a liquidity scenario are the same (market scenario, default assumption, handling of default etc.) as for normal stress testing. IN addition the CCP is required to make assumptions on its access to sources of liquidity under the applicable market conditions (as defined by the extreme scenario).

A CCP may have the following type of liquid resources to its disposal:

- Central bank credit lines
- Bilateral or tri party repo facilities
- Commercial bank lines
 - o Guaranteed or non-guaranteed
 - o Secured or unsecured

There is no absolute assurance of liquidity provision, even with guaranteed facilities, as it depends on the ability and willingness of commercial lenders to provide the available liquidity keeping into consideration possible hidden interdependencies, such as the same bank being liquidity provider for multiple CCPs, unbeknownst to each other. A CCP will have to make assumptions on the availability of different liquid resources; the most advanced scenario will model the impact of one or more of these liquidity resources being unavailable, either through the liquidity provider being the defaulter itself or an affiliate, or through general market dislocation with liquidity shortages.

The collateral used to support the above liquid resources consists of:

- The collateral of the defaulting member,
- Securities received by the CCP in the settlement process (originally to be delivered to the defaulting member)
- Other securities available to the CCP (collateral received in transfer of ownership or eligible papers resulting from Treasury investment).

The operational process of a CCP should support the quick transformation of these securities into available liquidity.

A CCP should perform stress testing to support the regulatory minimum as defined in EMIR using several assumptions with regards to the default scenario, actions necessary to handle a default and the actual availability of liquidity on the (distressed) money market.

Additionally a CCP should perform sensitivity testing as to test the impact of changes in different assumptions on the outcomes of liquidity stress testing.

Finally, a CCP should also have an emergency plan available and perform fire drills in order to assure that different actions necessary to create liquid resources can be performed in practice.

10. Participant involvement

Different possibilities exist for participant involvement:

Stress testing models and scenarios are reviewed regularly in the Risk Committee. In this committee, risk specialists can provide their experience to enhance the quality of the CCP's stress testing.

CCPs should publish their stress test approach and “headline” scenarios on their website, giving their participants the opportunity to bilaterally provide their feedback on the stress tests.

The adequacy of stress testing scenarios for specific markets and products can be discussed periodically with participant working groups which are made up of market specialists representing the participants although actual market movements and methods used could not be shared with third parties in all cases.

Some CCPs require members to participate in practice default fire drills. While not directly related to stress testing, these help to ensure that members who are required by the rules of the CCP to participate in managing a co-member default, e.g. through pricing, liquidation, auction, etc., are practiced in doing so.

11. About EACH

European central counterparty clearing houses (henceforth CCPs) formed EACH in 1991. EACH's participants are senior executives specialising in clearing and risk management from European CCPs, both EU and non-EU. Increasingly, clearing activities are not restricted exclusively to exchange-traded business. EACH has an interest in ensuring that the evolving discussions on clearing and settlement in Europe and globally, are fully informed by the expertise and opinions of those responsible for providing central counterparty clearing services.

EACH has 23 members:

CC&G (Cassa di Compensazione e Garanzia S.p.A.)	IRGiT S.A. (Warsaw Commodity Clearing House)
CCP Austria	KDPW_CCP S.A.
CME Clearing Europe	KELER CCP Ltd
CSD and CH of Serbia	LCH.Clearnet Ltd
ECC (European Commodity Clearing AG)	LCH.Clearnet SA
EMCF (European Multilateral Clearing Facility)	MEFF
Eurex Clearing AG	NASDAQOMX
EuroCCP (European Central Counterparty Ltd)	National Clearing Centre (NCC)
HELEX AS	NOS Clearing ASA
ICE Clear Europe	NYSE Liffe
	OMIClear
	Oslo Clearing ASA
	SIX x-clear AG

This document does not bind in any manner either the association or its members.

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