Instructions for filling the NMRF SSRM data template

EBA non-modellable risk factor stress scenario risk measure data collection exercise

Version: 27 June 2019

Contents

Abbreviations

BCBS	Basel Committee on Banking Supervision
CRR2	Capital Requirements Regulation as amended[1]
EBA	European Banking Authority
ES	Expected Shortfall
FRTB	Fundamental Review of Trading Book
NCA	National Competent Authority
NMRF	Non-modellable risk factor
SSRM	Stress scenario risk measure

[1] Regulation (EU) 2019/876 of the European Parliament and of the Council of 20 May 2019 amending Regulation (EU) No 575/2013 as regards the leverage ratio, the net stable funding ratio, requirements for own funds and eligible liabilities, counterparty credit risk, market risk, exposures to central counterparties, exposures to collective investment undertakings, large exposures, reporting and disclosure requirements, and Regulation (EU) No 648/2012 (Text with EEA relevance.), http://data.europa.eu/eli/reg/2019/876/oj

1 Introduction

1. In January 2019, the Basel Committee on Banking Supervision (BCBS) published the finalised standards on Minimum capital requirement for market risk [2] (herein "(revised) FRTB standards"). One of the novelties of the (revised) FRTB standards for the Internal Model Approach (IMA) is the non-modellable risk factor (NMRF) requirement for market risk factors with limited observable market data, which are deemed not suitable for modelling within the Expected Shortfall.

2. Capital requirements for each non-modellable risk factor (NMRF) are to be determined using a stress scenario risk measure (SSRM). The stress scenario risk measure captures the potential loss that is incurred in all the trading book positions of the portfolio which depend on that non-modellable risk factor. It is derived through applying an extreme scenario of future shock to that risk factor.

3. Article 325bk(3) of the CRR2 mandates the EBA to develop draft regulatory technical standards to develop the methodology to derive the SSRM.

4. The present EBA NMRF SSRM data collection exercise was field tested by some pilot banks, whose feedback was of great value for the refinement of the templates and instructions.

5. Initial industry feedback in the pilot phase indicated that for many non-modellable risk factors, daily data was in fact available. The SSRM calculation methodology was therefore extended, proposing several SSRM calculation method variants, some of which may be more suitable when daily data is available.

6. The purpose of the data collection is to apply the EBA NMRF methodology proposals in practice and gather data for ensuring an appropriate calibration of the NMRF SSRM.

7. The EBA will treat all individual institution's data collected in this exercise as strictly confidential and will not attribute them to individual institution.

8. This document describes the template data fields and gives instructions on how to fill them in.

9. This document and the specifications are without any prejudice to the formulation of pertaining requirements in applicable regulation.

[2] https://www.bis.org/bcbs/publ/d457.htm

2 General information

2.1 Scope of the exercise

10. Participation in the EBA NMRF Stress Scenario Risk Measure (SSRM) data collection is voluntary. The exercise is targeted at institutions that currently use an internal model approach for market risk.

2.2 Filling in the data

11. Institutions should fill in all worksheets on a best effort basis. It is important to note that any modification to the worksheets might render the workbook unusable and may trigger the exclusion from the analysis or a request for re-submission.

12. Where information is not available or not applicable, the corresponding cell should preferably be filled with “NA” or left empty. Also, institutions must not fill in any arbitrary numbers to avoid error messages or warnings which may be provided by their competent authorities. Please do not leave a cell empty if the respective item is required, as doing so could trigger the exclusion from the analysis or a request for re-submission.

13. The template data should fulfil referential integrity, e.g. the ID of a risk factor time series reported in tab “RF_timeseries” must first be defined in the tab “Risk_factors”. To this end, some integrity conditions to adhere to for the data components are provided. Referential integrity and the layout of the tabs for the different components of the data should facilitate data extraction by SQL queries from databases.

14. Please adhere to the following general data field conventions:

    a. Dates should be provided in the ISO 8601 extended date format as **YYYY-MM-DD.**

    b. Decimal numbers should use a decimal point (i.e. a dot (.)) as the decimal separator, and should <u>not</u> use any thousands separator.[3] In the automatic processing, thousands separators cause severe problems (because they are falsely interpreted as field delimiters and filtering them is difficult). Percentages should be reported as decimal numbers using a dot (.) as the decimal separator. For example, 1% should be entered as 0.01. A comma (,) should <u>not</u> be used as a decimal separator.

    c. Present values (PVs) data should be provided with two decimals as a convention. If for some fields this is insufficient precision, please use more decimals; conversely, for very large values, the number of decimals could be reduced.

[3] For example, thousand separators such as a comma (,), dot (.) or a space should not be used.

d. Currencies should be provided in the ISO 4217 currency code with three letters, e.g. USD, EUR, etc.

e. For Boolean flags, only the single capital letters “Y” and “N” should be used.

2.3 Process

15. The data collection exercise will follow the usual two-stage process:

- 1st submissions to NCAs and data quality checks by EBA;
- 2nd submissions to NCAs and data analysis by EBA.

16. Institutions should direct all questions related to this exercise to the contacts provided in the tab “Front_Page”.

2.4 Timeline

17. Institutions need to submit the completed templates to their national competent authority no later than <u>4 September 2019</u>. Please find below the proposed timeline:

- June 2019: Publication of templates and instructions on EBA webpage
- <u>4 September 2019</u>: First submissions from banks to their NCA
- 9 September 2019: First submissions from NCAs to EBA
- 9 to 20 September 2019: Data quality checks and resubmission to banks if needed
- <u>9 October 2019</u>: Second submissions from banks to their NCA
- 14 October 2019: Second submissions from NCAs to EBA
- 14 to 25 October 2019: Data quality checks
- 28 October to 20 November 2019: Data analysis, production of tables and graphs for the impact assessment of the CP RTS, recommendation to SGMR on calibration
- December 2019/February 2020: Finalisation of CP RTS on NMRF SSRM and development of an EU specific template for BM194 Basel monitoring exercise to assess overall impact
- February 2020: Publication for consultation
- June 2020 to December 2020: Review of industry feedback and finalisation
- Early 2021: Publication of final RTS on NMRF SSRM.

3 Specific instructions

3.1 Front_page

18. This tab contains general information, contact information and instructions for the submission of the template. The number reporting unit of PV and SSRM values (1, 1000, 1E06) should be used consistently throughout the template.

3.2 Comments

19. This tab is for free-form comments relating to the different components of the template. Institutions should provide information for any instance where an explanation would be helpful to better understand the data submitted or for any other observation.

20. By definition, non-modellable risk factors have less observable data. In the pilot phase it was pointed out by participants that in fact, for many NMRF daily data would be available. While it is clear that the modellability assessment is not the same as the usage of risk factor data in risk modelling, this aspect is nevertheless interesting. Thus, in case daily data is provided for non-modellable risk factors, please explain in the tab "Comments", what the nature of this risk factor data is.

21. The calculation of the nearest to 10 (business) days returns depends, strictly speaking, on the business day calendar for the risk factors. Please provide an explanation how this aspect was treated in the return calculations for the SSRM and what business day calendar was used. It is acceptable to assume all weekdays are business days for the purpose of this exercise.

3.3 Portfolios

22. This tab contains the list of portfolios relevant for the exercise.

23. For the purpose of this exercise, the term "portfolio" in the template refers to a set of risk positions for which a combined analysis in terms of the present value (PV) dependency and the different contributions to the SSRM is performed. In that sense, a "portfolio" in the template refers to desks, instruments, and EBA benchmarking portfolios. For the EBA benchmarking portfolios please refer to the EBA website[4].

24. The template should include at minimum the following portfolios of the 2019 EBA market risk benchmarking exercise:

- EBA Benchmarking 2019 ALL_IN no CTP
- EBA Benchmarking 2019 EQUITY Cumulative
- EBA Benchmarking 2019 IR Cumulative
- EBA Benchmarking 2019 FX Cumulative

[4] http://www.eba.europa.eu/-/eba-publishes-updated-its-package-for-2019-benchmarking-exercise

- EBA Benchmarking 2019 Commodity Cumulative
- EBA Benchmarking 2019 Credit Spread Cumulative

25. Please include in addition to the EBA benchmarking portfolios:

- ideally, the top of the house portfolio envisaged to be included in IMA scope under the FRTB (where available)
- some prospective FRTB desks (at minimum three, more at your discretion) that are relevant for your institution.
- some instruments with non-linear loss profiles depending on non-modellable risk factors that are relevant for the trading activities of your institution.
- some instruments or portfolios with non-monotonic loss profiles depending on non-modellable risk factors that are relevant for the trading activities of your institution.
- some portfolios (e.g. desks) that depend on a curve, surface or cube. The EBA considers that a detailed understanding of the SSRM for portfolios (desks) depending on curves, surfaces and cubes would be beneficial.

26. The figure dates (i.e. the date for which the reported data is calculated as opposed to the date the data were produced or submitted) of the data provided should be a date convenient for the institution, e.g. an end of month before the submission date. Figure dates could be the same for all portfolios, but could also be different for different portfolios if deemed convenient (e.g. in case of different portfolios being processed at different times).

27. The different total own funds requirement values will inform the calibration of the SSRM. For the totals of the SSRM, the use of regulatory buckets is considered relevant as this is assumed to correspond best to the future setup at institutions, although the implementation of risk factor buckets may not be fully available. Please provide any comment regarding the totals and the use of regulatory buckets in tab “Comments”.

28. In calculating the total SSRM charge field “Pof_SSRM_total_Waterfall”, a waterfall approach is applied for the individual contributions to the total:

    (i) If a regulatory bucketing approach is applied to a set of risk factors in a curve surface or cube, use the respective stress scenario risk measure $SS_{D^*}^{method,Bucket}$ for the bucket;
    (ii) else use the respective individual stress scenario risk measure $SS_{D^*}^{method,risk\ factor}$ for the risk factor

    For each bucket or individual risk factor, the following waterfall should be used:

    (iii) If the number of nearest 10 days returns N ≥ 250,

        (a) if the stress scenario risk measures in the direct method is available, use $SS_{D^*}^{\mathrm{direct},j}$;

        (b) else, use the return historical method $SS_{D^*}^{\mathrm{historical},j}$;

(iv) else if (N < 250 AND N ≥ 12), use the sigma method measure $SS_{D^*}^{\mathrm{sigma},j}$

(v) else apply the fallback method measure $SS_{D^*}^{\mathrm{fallback},j}$

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	Pof_ID	Unique ID of the "portfolio" (instrument, desk, portfolio, in the meaning of this exercise)	String [a-zA-Z0-9._-#]+ (no commas, no space)
C	Pof_description	A description of the portfolio in English, also explaining which kind of instruments it contains	String
D	Pof_figure_date	The figure date (data per date) of the values provided for this portfolio for the ES total, the SSRM total, and the SSRM components. The figure date can be different per portfolio.	YYYY-MM-DD
E	Pof_PV	The present value of the portfolio at the figure date	Float, 2 decimals
F	Pof_PV_CCY	Currency of the portfolio's PV, SSRM measure and ES measure.	ISO three letter code
G	Pof_ES_total	ES_t as specified in Art. 325bb(1) of the CRR2. The provided ES_t value should be calculated by considering all risk factors as modellable, i.e. by simulating values for all the RF listed in the tab "Map_portfolios_to_RF" for this portfolio. Other than that, the value should be calculated based on the same methodology and model assumptions as planned for the FRTB IMA on a best-effort basis. If no ES_t value is available, please put "NA" or leave blank.	Float or NA or blank
H	Pof_UES_total	$\mathrm{UES_t}$ as specified in Art. 325bb(1) of the CRR2. The provided $\mathrm{UES_t}$ value should be calculated by considering all risk factors as modellable, i.e. by simulating values for all the RF listed in the tab "Map_portfolios_to_RF" for this portfolio. Other than that, the value should be calculated based on the same methodology and model assumptions as planned for the FRTB IMA on a best-effort basis. If no UES_t value is available, please put "NA" or leave blank.	Float or NA or blank

Column	Field	Description and instructions	Format
I	Pof_FRTB_SA_total	The result of the alternative standardized approach (SA) of the FRTB as specified in Title IV, Part three, chapter 1a of the CRR2.	Float, 2 decimals
J	Pof_SSRM_total_Waterfall	The SSRM as calculated with the Consolidated SSRM methodology for the purpose of this exercise, and assuming that *all* risk factors are non-modellable, and applying the direct method optionally, the return historical method, return sigma method and fallback method in a waterfall in this order according to data availability of the NMRF. SSRM values for regulatory buckets should be used where applicable in the total, instead of the individual risk factors within the bucket.	Float, 2 decimals
K	Pof_SSRM_total_Return_sigma	The SSRM as calculated with the Consolidated SSRM methodology for the purpose of this exercise, and assuming that *all* risk factors are non-modellable, and applying only the return sigma method and fallback method in a waterfall in this order according to data availability . SSRM values for buckets should be used where applicable in the total	Float, 2 decimals
L	Pof_SSRM_total_fallback	The SSRM as calculated with the Consolidated SSRM methodology for the purpose of this exercise, and assuming that *all* risk factors are non-modellable, and applying fallback method only. SSRM values for buckets should be used where applicable in the total	Float, 2 decimals

3.4 Map_portfolios_to_RF

29. This tab contains the mapping between the portfolios listed in the tab "Portfolios" and their respective relevant risk factors, meaning that they capture all risks for the portfolio in question. All risk factors needed to obtain the ES for a portfolio up to a small remainder should be reported (thus called the "relevant" risk factors). Both modellable and non-modellable relevant risk factors should be reported.

30. It is acceptable to leave out non-material risk positions from the portfolios to reduce the number of relevant risk factors.

31. A risk factor is a variable which drives the change in value of a financial market transaction and which is used for the quantification of market risk in a risk measurement model. For a simulation-based risk measurement model the set of risk factors are the variables for which historical time series are needed.

32. Implicitly this tab can be used to infer information about the relevant risk factor buckets for each portfolio via the information in tab “Risk_factors” and tab “Risk_factor_buckets”.

33. For the relevant combinations of portfolios and risk factors, resp. portfolios and regulatory buckets, SSRM related data needs to be provided. The mapping of the portfolios to their relevant risk factors provided in tab “Map_portfolios_to_RF” must therefore be consistent with the tabs “NMRF_figures_per_PofxRF”, and “NMRF_figures_per_PofxRegBucket”. For tabs “PV_functions_per_PofxRF” and “PV_functions_per_PofxRegBbucket”, the (Pof, RF_ID) combinations have to be subsets of the ones specified in tab “Map_portfolios_to_RF”.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	Pof_ID	Unique ID of the “portfolio” (instrument, desk, portfolio, in the meaning of this exercise) as defined in tab “Portfolios”	String
C	RF_ID	Unique ID of the risk factor (as defined in tab “Risk_factors”) relevant for the portfolio with the particular Pof_ID	String

Integrity conditions:

- All Pof_IDs must be contained in the tab “Portfolios”
- All RF_IDs must be contained in the tab “Risk_factors”

3.5 Risk_factors

34. This tab provides a list of relevant risk factors for all portfolios listed in tab “Portfolios”. More technically, tab “Risk_factors” contains the union of the risk factor IDs in tab “Map_portfolios_to_RF”, but each risk factors is reported only once in tab “Risk_factors”. The Risk factors ID (RF_ID) is the primary key in the table and must be unique. Conversely, this ensures that all risk factors are provided, which are needed to analyse the ES and SSRM total values and SSRM contributions for all portfolios in tab “Portfolios”.

35. Note the set of (i) “relevant” risk factors here, (ii) the set of risk factors for which time series should be provided, and (iii) the risk factors for which PV functions should be provided are not the same: (ii) and (iii) are subsets of (i).

36. With regard to the provision of time series, it is not needed to provide time series data for all relevant risk factors, but only for those identified according to section 3.7 (subsection “Determination of which time series of risk factors should be provided”) in order to reduce the amount of time series data. The flag RF_timeseries_is_provided in tab “Risk_factors” should be set accordingly.

37. In the pilot phase it was pointed out that decomposition of a non-modellable risk factor into a modellable basis and a non-modellable spread is important for NMRF. In order to better assess this aspect, data on such setups would be helpful. It would be helpful to receive in the risk factor description (column “RF_description”) an indication for such decompositions and some brief description in tab “Comments”.

38. The revised Basel FRTB standard issued in January 2019 (BCBS_d457[5]) introduces the notion of “bucketing” for the risk factor eligibility test (RFET) for curves, surfaces and cubes. For the purposes of this data collection exercise, the RFET should be performed as specified in this standard (BCBS_d457, MAR31.12 et seq, “Model eligibility of risk factors”) on a best effort basis.

39. To present the main criteria, as stipulated in BCBS_d457, MAR31.13, the risk factors modellability assessment should be based on real price[6] observations (with no more than one real price observation per day to be included in the counts). A risk factor is modellable, if either it has

    a. at least 24 real price observations in the one year period used to calibrate the current ES model, and over the previous 12 months there must be no 90-day period in which fewer than four real price observations are identified for the risk facto ; or

    b. at least 100 real price observations over the previous 12 months.

else, the risk factor is non-modellable.

40. In addition, the EBA consultation paper on the draft regulatory technical standards to specify the criteria to assess the modellability of risk factors (CP on the RTS on modellability) as mandated in Article 325be(3) of the CRR2 provides more detailed information.

41. Function parameters of a mathematical function to represent a curve, surface or cube that are by themselves risk factors of the risk measurement model are a particular set of risk factors. To identify those, a flag “RF_is_curve_or_surface_parameter” is used. In general, they are treated in the data collection like any other risk factor.

42. If participating institutions apply the derogation in Article 5(3)(c) of the CP on the RTS on modellability, they should provide the risk factors and SSRM data arising from it (parameter and parameter spread in Option 1, or data points re-defined as risk factors in Option 2).

Column	**Field**	**Description and instructions**	**Format**
A	Line_of_data	Line of data counter.	Integer
B	RF_ID	Unique ID of the risk factor.	String [a-zA-Z0-9._-#]+

[5] https://www.bis.org/bcbs/publ/d457.pdf

[6] As defined in BCBS_d457, MAR10.26

Column	Field	Description and instructions	Format
		Please note that for referential integrity, the list should also contain modellable risk factors relevant for the portfolios in tab "Portfolios".	(no commas, no space)
C	RF_description	A description of the risk factor in English	String
D	RF_is_NMRF	Flag whether the risk factor is classified as NMRF according to the revised FRTB definition (BCBS_d457, MAR31.12 et seq). The EBA is aware that institutions might not have fully implemented this risk factor eligibility test yet. In this case, it is sufficient to provide a best guess of the risk factor's modellability in this field. Please provide the criteria used in the tab "Comments".	"Y" or "N"
E	RF_is_in_bucket	Flag whether the risk factor is contained in a bucket as relevant for risk factors belonging to curves, surfaces or cubes.	"Y" or "N"
F	RF_bucket_ID	If the risk factor is contained in a bucket (i.e. if RF_is_in_bucket="Y"), the RF_bucket_ID of the respective bucket. Else, leave the field blank	String or blank
G	RF_is_RegBucket_representative	Flag whether the risk factor is the representative risk factor of the bucket. Only the usage of regulatory buckets needs dedicated consideration in this data collection.	"Y" or "N"
H	RF_is_idiosyncratic_CS	Flag whether the risk factor is considered to be an idiosyncratic credit spread risk factor. This information is determining the aggregation when computing the total SSRM.	"Y" or "N"
I	RF_is_idiosyncratic_ERF	Flag whether the risk factor is considered to be an idiosyncratic equity risk factor. This information is determining the aggregation when computing the total SSRM.	"Y" or "N"
J	RF_is_curve_or_surface_parameter	Flag whether the risk factor is a curve or surface (or cube) function parameter defining the shape of a whole curve surface (or cube). I.e. the parameter is a risk factor itself, as opposed to a point on the curve or surface. This helps to better understand the usage of such risk factors.	"Y" or "N"
K	RF_broad_risk_factor_category	Broad risk factor category as defined in Art. 325bd Table 2 of the CRR2	String from drop-down
L	RF_broad_risk_factor_subcategory	Broad risk factor subcategory as defined in Art. 325bd Table 2 of the CRR2	String from drop-down
M	RF_LH_in_days	The liquidity horizon assigned to the risk factor in days as per the Consolidated SSRM methodology for the purpose of this exercise (i.e. at minimum 20 days).	Integer

Column	Field	Description and instructions	Format
		This field is filled automatically with a look-up table.	
N	RF_unit_of_value	The unit of the risk factor	String from drop-down
O	RF_return_type	The type of return associated with the risk factor	String from drop-down
P	RF_return_type_explain	In case the return type is "other_*", please explain briefly. E.g. a mix between absolute and log-returns for interest rates.	
Q	RF_timeseries_is_provided	Flag whether the time series of the risk factor is provided	"Y" or "N"
R	RF_timeseries_start_date	The start date of the risk factor time series data if RF_timeseries_is_provided == "Y", else NA or blank	YYYY-MM-DD or NA or blank
S	RF_timeseries_end_date	The end date of the risk factor time series data if RF_timeseries_is_provided == "Y", else NA or blank	YYYY-MM-DD or NA or blank

Integrity conditions:

- All RF_bucket_ID must be contained in tab "Risk_factor_buckets", column RF_bucket_ID.

3.6 Risk_factor_buckets

43. This tab provides the list of relevant risk factor buckets that are used in determining the risk factor eligibility for curves, surfaces and cubes in the revised FRTB standard.[7] Please list buckets set up either under (i) the own bucketing approach, or (ii) the regulatory bucketing approach. For the purpose of calculating the SSRM for regulatory buckets, a "representative risk factor" for such buckets should be specified, according to the definition in section 4.4, paragraph 86. For regulatory buckets there are specific tabs to provide data on regulatory bucket level.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	RF_bucket_ID	Unique ID of the risk factor bucket. Please note that for referential integrity, the list should also contain modellable risk factors buckets that are relevant for the portfolios in tab "Portfolios"..	String [a-zA-Z0-9._-#]+ (no commas, no space)

[7] Cf. BCBS_d457, MAR31.16

Column	Field	Description and instructions	Format
C	RF_bucket_description	A description of the risk factor bucket in English. If there are several dimensions (for a surface or cube), please explain the dimensions.	String
D	RF_bucket_is_RegBucket	Flag whether the risk factor bucket is a regulatory risk factor bucket (which could contain several risk factors) (“Y”) or an institution specific one in the own bucketing approach (“N”).	“Y” or “N”
E	RF_RegBucket_representative_RF_ID	For regulatory buckets (RF_bucket_is_RegBucket == “Y”), the RF_ID of the representative risk factor, otherwise “NA” or blank. The definition is provided in the Consolidated SSRM methodology for the purpose of this exercise, paragraph 94.	String or NA or blank
F	RF_bucket_lower_bound_dim1	Lower bound of the risk factor bucket (first dimension if there are several)	Float
G	RF_bucket_upper_bound_dim1	Upper bound of the risk factor bucket (first dimension if there are several)	Float
H	RF_bucket_lower_bound_dim2	Lower bound of the risk factor bucket (second dimension if there are several, otherwise please put “NA” or leave blank.)	Float or NA or blank
I	RF_bucket_upper_bound_dim2	Upper bound of the risk factor bucket (second dimension if there are several, otherwise please put “NA” or leave blank.)	Float or NA or blank
J	RF_bucket_lower_bound_dim3	Lower bound of the risk factor bucket (third dimension if there are several, otherwise please put “NA” or leave blank.)	Float or NA or blank
K	RF_bucket_upper_bound_dim3	Upper bound of the risk factor bucket (third dimension if there are several, otherwise please put “NA” or leave blank.)	Float or NA or blank

Integrity conditions:

- All buckets for which RF_bucket_is_RegBucket == ”N” must have “NA” or blank in column RF_RegBucket_representative_RF_ID.
- All buckets for which RF_bucket_is_RegBucket == ”Y” must have a value for RF_RegBucket_representative_RF_ID contained in the set of values of tab “Risk_factors” for the same RF_bucket_ID.

3.7 RF_timeseries

Time series of risk factors to be provided in tab “RF_timeseries”

44. This tab contains the time series of the risk factors (both non-modellable and modellable) as identified based on materiality and completeness of curves, surfaces and cubes (see description below), which can be a subset of all relevant risk factors for all portfolios. Thus, time series of risk factors are required based on materiality conditions i.e. not for all risk factor IDs, RF_ID, of tab “Risk_factors” a time series needs to be provided. This is to reduce the effort for providing time series data. Note that these conditions are only relevant for the provision of risk factor time series.

45. Institutions should recognise only one value per day, and stale data should only be considered if it represents actual market data, otherwise no risk factor data should be provided for this date.

46. Please use only business days with risk factor values in the time series data.

47. In principle, the risk factor time series data period should start on 1 January 2007, in line with the minimum requirement for determining the ES stress period of BCBS_d457, MAR33.7 and should extend at minimum until the figure dates for the portfolio data, i.e. a date close to the submission date of the template.

48. In case the relevant stress period for one or several risk classes for the stress scenario risk measure calculation for NMRF (cf. BCBS_d457, MAR33.16) is before 2007, the data period should be extended backwards for the affected risk factors accordingly.

49. Information on the 12-month period of stress across NMRF should be provided in tab “SSRM_stress_periods”.

50. There are two main ideas to make a selection for which risk factors time series should be provided:

    a. If a risk factor is modelled as part of a curve, surface or cube, then the whole curve, surface, or cube risk factor set should be provided to ensure a meaningful and complete “**related risk factor set”**.

    b. The **most material** risk factors relevant for the portfolios in tab “Portfolios” should be identified for each risk factor sub-category at a minimum.

a. Related risk factor sets

51. For analysing curves, surfaces and cubes, it is more sensible to have the full curve, surface, or cube. Therefore, all pertaining risk factor time series should be provided.

52. We call “related risk factor set” a

- set constituted by a single risk factor that is not considered as part of a curve or surface parametrization (e.g. a single stock price)
- set of risk factors pertaining to a curve (e.g. the different tenors of a yield curve)
- set of risk factors pertaining to a surface (e.g. a volatility surface)
- set of risk factors pertaining to a cube (e.g. a volatility cube)

b. Determination of which time series of risk factors should be provided

53. In order to understand the relation between the total ES and total SSRM amounts for each portfolio, not only non-modellable, but also modellable risk factors should be provided.

54. Thus, please identify for each portfolio and **each risk factor sub-category** of Article 325bd, Table 2 of the CRR2 (cf. paragraph 130) that is relevant for the portfolio:

    - the 5 most material modellable related risk factor sets as measured with the SSRM return sigma method, and the fallback method, where there is insufficient data for the return sigma method.
    - the 5 most material **non**-modellable related risk factor set as measured with the same method.

    The rationale for the inclusion of modellable risk factors is threefold: First, it allows comparing the SSRM risk measure with the risk measure when modelling; second, to reduce reliance on the exact classification of non-modellable versus modellable risk factors; and third to understand the main risk characteristics of a portfolio where modellable risk factors are presumably relevant.

    Sampling all risk factor sub-categories serves to ensure a full coverage of all the sub-categories in the NMRF SSRM data collection exercise and consequently of the draft RTS for the SSRM methodology in the future.

55. For the purposes of this data collection exercise, the RFET should be performed as specified in the BCBS standard (BCBS_d457, MAR31.12 et seq,_"Model eligibility of risk factors") and the EBA consultation paper on the draft regulatory technical standards to specify the criteria to assess the modellability of risk factors (CP on the RTS on modellability) on a best effort basis in order to determine if a risk factor is considered modellable or non-modellable.

56. At minimum, the union of all of the related risk factor sets identified based on this materiality criterion for all portfolios of tab "Portfolios" should be provided in tab "RF_timeseries". More risk factor time series can be provided.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer

Column	Field	Description and instructions	Format
B	RF_ID	Unique ID of the risk factor.	String
C	RF_date	Risk factor date (on trading days of the relevant market representing actual market data) for which a value of the respective risk factor with the ID as specified in column “RF_ID” is provided.	YYYY-MM-DD
D	RF_value	Risk factor value of the risk factor with the ID as specified in column “RF_ID” on the date as specified in column “RF_date”.	Float, precision as needed

57. An example on how to fill the table is given below:

Line_of_data	RF_ID	RF_date	RF_value
1	UniqueRF_ID01	2007-01-02	5.3
2	UniqueRF_ID01	2007-01-03	5.42
3	UniqueRF_ID01	2007-01-04	5.90
4	UniqueRF_ID01	2007-01-05	6.02
5	UniqueRF_ID01	2007-01-06	6.14
6	UniqueRF_ID01	2007-01-07	6.26
7	UniqueRF_ID01	2007-01-08	6.86
8	…	…	…
9	UniqueRF_ID02	2007-01-02	534.87
10	UniqueRF_ID02	2007-01-03	668.9
11	UniqueRF_ID02	2007-01-04	576.74
12	…	…	…
13	UniqueRF_ID03	2007-01-02	…
(etc…)			

58. Excel 2010 can hold 1024^2 = 1048576 lines of data per tab. This may not be sufficient, as the following estimate shows: Assuming the figure date and the end date of the time series to be 31 March 2019 and start of the time series in January 2007 for 5 modellable and 5 non-modellable risk factors for the 28 risk factor sub-categories would lead for 256 trading days per year to 12.25y × 10 × 28 × 256 lines/y = 878080 lines for one portfolio. While there is

overlap in the sets of the relevant risk factors for the different portfolios, there are probably more risk factors due to the completeness condition for curves and surfaces.

59. Due to the limitations listed above, we envisaged separating the risk factor time series data from the Excel template as a viable solution.

60. The risk factor time series data should be provided as **compressed tab-separated value (TSV) files**. We invite you to use a common compression format, such as .zip or .bzip2. For TSV files, the same format requirements apply as for the Excel template. In particular, please use the date format **YYYY-MM-DD**, **tab as a column separator and foremost no thousand separator** for numbers.

<u>Integrity conditions:</u>

- All RF_IDs must be contained in the tab "Risk_factors".

3.8 SSRM_stress_periods

61. This tab contains information on the on the 12-month period of stress across all NMRFs in the same risk class as referred to in BCBS_d457, MAR33.16.

62. The 12-month stress periods per broad risk factor category (class) should be determined on a best effort basis for the all NMRF of the institution for the top-level portfolio for market risk under IMA scope as referred to in BCBS_d457, MAR33.16.

63. It is acceptable that only one stress period is used for all risk classes, or that the stress period of 30 June 2008 to 30 June 2009 is used for the purpose of this exercise, when a more detailed analysis is considered burdensome. This specification is without any prejudice to future regulation.

64. Please provide any relevant comment on the stress periods data and selection in tab "Comments".

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	SSRM_stress_period_broad_risk_factor_category	Broad risk factor category as defined in Art. 325bd Table 2 of the CRR2	String, predefined
C	SSRM_stress_period_start	The starting date of the stress period for the broad risk factor category	YYYY-MM-DD
D	SSRM_stress_period_end	The end date of the stress period for the broad risk factor category	YYYY-MM-DD

3.9 NMRF_figures_per_PofxRF

65. This tab contains the SSRM related key figures per NMRF needed to determine and the resulting values of the stress scenario risk measure, $SS_{D^*}^{method,j}$ for all risk factors relevant for a portfolio as specified in tab “Map_portfolios_to_RF” for all portfolios defined in tab “Portfolios”.

66. While some of the data fields depend only on the risk factor, not on the portfolio (like the number of returns in the stress period), and could therefore be placed in tab “Risk_factors”, they are also relevant for the calculation of the different SSRM steps. Thus they are reported in this tab, in order to keep all variables for the SSRM computation together on this tab, however this means that the same value could be reported in several rows.

67. In case of daily data available, additionally the single risk factor expected shortfall should be provided.

68. Where participating institutions supply data for a curve, surface, or cube using regulatory buckets in sheet “NMRF_figures_per_PofxRegBucket” and consider the approach is reliably implemented, they may choose not to provide additionally the data on individual risk factor level for some or all the ones that are covered in the related regulatory buckets in this sheet, in order to reduce the burden in data delivery.

69. In case a value for a risk factor CSSRFR bound is violating a sensibility condition (e.g. volatility < 0), please put “NA” in the field and provide a brief explanation in tab “Comments”.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter.	Integer
B	Pof_ID	Unique ID of the “portfolio” (instrument, desk, portfolio, in the meaning of this exercise) as defined in tab “Portfolios”.	String
C	RF_ID	Unique ID of the risk factor as defined in tab “Risk_factors”	String
D	NMRF_value_at_figure_date	The value of the risk factor at the figure date. Please note that if different figure dates are used for the different portfolios, this can lead to different numbers in this tab for the same risk factor but different portfolios.	Float
E	NMRF_Nobs	The number of value observations M of the risk factor in the relevant stress period	Integer
F	NMRF_Nret	The number of returns N of the risk factor in the relevant stress period according to the Consolidated SSRM methodology for the purpose of this exercise (which is lower than M).	Integer

Column	Field	Description and instructions	Format
G	NMRF_stddev	The estimate of the standard deviation of the 10 day returns as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 108.	Float
H	NMRF_CS_down_historical	If NMRF_Nret ≥ 250, the calibrated down shock to the risk factors computed as empirical expected shortfalls of the returns according to the historical method in paragraph 107; Else NA	Float or NA
I	NMRF_CS_up_historical	Same for up shock.	Float or NA
J	NMRF_CS_sigma	If NMRF_Nret ≥ 12, the calibrated down/up shock to the risk factors computed based on the standard deviation of the returns according to the return sigma method in paragraph 109;107 Else NA	Float or NA
K	NMRF_CSSRFR_low_hist	If NMRF_Nret ≥ 250, the lower bound of the CSSRFR interval according to the return historical method; Else NA	Float or NA
L	NMRF_CSSRFR_high_hist	Same for upper bound	Float or NA
M	NMRF_CSSRFR_low_sigma	If NMRF_Nret ≥ 12, the lower bound of the CSSRFR interval according to the return sigma method; Else NA.	Float or NA
N	NMRF_CSSRFR_high_sigma	Same for upper bound.	Float or NA
O	NMRF_CSSRFR_low_fallback	The lower bound of the CSSRFR interval according to the fallback method. To be provided for all risk factors.	Float
P	NMRF_CSSRFR_high_fallback	Same for upper bound	Float
Q	NMRF_FS_historical	If NMRF_Nret ≥ 250, the value of the future shock from the return historical method, $FS_{D^*}^{\text{historical}}[r_j]$ as defined in paragraph 116; Else NA	Float or NA
R	NMRF_FS_historical_is_at_bound	Flag whether the future shock in the return historical method occurs at a CSSRFR bound. If "Y", the non-linearity adjustment kappa needs to be calculated.	"Y" or "N" or NA

Column	Field	Description and instructions	Format
S	NMRF_FS_sigma	If NMRF_Nret ≥ 12, the value of the future shock from the return sigma method, $FS_{D^*}^{\text{sigma}}[r_j]$ as defined in paragraph 116; Else NA	Float or NA
T	NMRF_FS_sigma_is_at_bound	Flag whether the future shock in the return sigma method occurs at a CSSRFR bound. If “Y”, the non-linearity adjustment kappa needs to be calculated.	“Y” or “N” or NA
U	NMRF_FS_fallback	The value of the future shock from the fallback method, $FS_{D^*}^{\text{fallback}}[r_j]$ as defined in paragraph 116	Float or NA
V	NMRF_FS_fallback_is_at_bound	Flag whether the future shock in the fallback method occurs at a CSSRFR bound. If “Y”, the non-linearity adjustment kappa needs to be calculated.	“Y” or “N” or NA
W	NMRF_Gamma_historical	If NMRF_FS_historical_is_at_bound == “Y”, $\Gamma^{\text{historical},j}$ for the return historical method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 125.	Float or NA
X	NMRF_Kappa_historical	Kappa $\kappa_{D^*}^{\text{historical},j}$ for the return historical method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 126.	Float
Y	NMRF_Gamma_sigma	If NMRF_FS_sigma_is_at_bound == “Y”, $\Gamma^{\text{sigma},j}$ for the return sigma method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 125.	Float or NA
Z	NMRF_Kappa_sigma	Kappa $\kappa_{D^*}^{\text{sigma},j}$ for the return sigma method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 126.	Float
AA	NMRF_Gamma_fallback	If NMRF_FS_fallback_is_at_bound == “Y”, $\Gamma^{\text{fallback},j}$ for the fallback method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 125.	Float or NA
AB	NMRF_Kappa_fallback	Kappa $\kappa_{D^*}^{\text{fallback},j}$ for the fallback method as per the Consolidated SSRM methodology for the purpose of this exercise, paragraph 126.	Float
AC	RF_SS_direct	If NMRF_Nret ≥ 250 and the participant chooses to calculate the quantity, the value of the stress scenario risk measure, $SS_{D^*}^{\text{direct},j}$ using the direct method for this single risk factor with ID RF_ID, as calculated for the figure date for Pof_ID Pof_figure_date	Float, 2 decimals or NA
AD	RF_SS_historical	If NMRF_Nret ≥ 250 the value of the stress scenario risk measure, $SS_{D^*}^{\text{historical},j}$ using the return historical method	Float, 2 decimals

Column	Field	Description and instructions	Format
		for the risk factor with ID RF_ID, as calculated for the figure date for Pof_ID Pof_figure_date.	
AE	RF_SS_sigma	If NMRF_Nret ≥ 12 the value of the stress scenario risk measure, $SS_{D^*}^{\text{sigma},j}$ using the return sigma method for the risk factor with ID RF_ID, as calculated for the figure date for Pof_ID Pof_figure_date.	Float, 2 decimals
AF	RF_SS_Fallback	The value of the stress scenario risk measure , $SS_{D^*}^{\text{fallback},j}$, calculated according to the fallback approach for the risk factor with ID RF_ID, as calculated for the figure date for Pof_ID Pof_figure_date.	Float, 2 decimals

Integrity conditions:

- The set of Pof_IDs must match the list of Pof_IDs contained in the tab "Portfolios" (modulo ordering).
- The set of RF_IDs per Pof_ID must match the list of RF_IDs contained in the tab "Map_portfolios_to_RF" (modulo ordering) for the matching Pof_ID.
- The aggregation (cf. section 4.5.12) of the values in column RF_SS_* in tabs "NMRF_figures_per_PofxRF" and "NMRF_figures_per_PofxRegBucket" matches the total SSRM values for this portfolio in tab "Portfolios".

3.10 NMRF_figures_per_PofxRegBucket

70. This tab contains the SSRM related key figures per NMRF needed to determine and the resulting values of the stress scenario risk measure, $SS_{D^*}^{method,j}$ for all relevant regulatory buckets for a portfolio as specified in tab "Map_portfolios_to_RF" in conjunction with tab "Risk_factors" for all portfolios defined in tab "Portfolios". The instructions are analogous to the ones for tab "NMRF_figures_per_PofxRF".

71. The columns referring to risk factor values and interval bounds, like "NMRF_value_at_figure_date", "NMRF_Nobs", "NMRF_Nret", "NMRF_stddev", "NMRF_CS*", "NMRF_CSSRFR_*" should be understood for the representative risk factor (as defined in the Consolidated SSRM methodology for the purpose of this exercise, paragraph 34). They depend only on the risk factor "RF_RegBucket_representative_RF_ID", and are in that sense redundant. The columns are however kept to maintain consistency for data processing.

The following table summarises the differences to tab "NMRF_figures_per_PofxRF":

Column	Field	Description and instructions	Format
C	RF_**bucket**_ID (instead of RF_ID)	Unique ID of the regulatory bucket as defined in tab "Risk_factor_buckets" where RF_bucket_is_RegBucket=="Y"	String

Column	Field	Description and instructions	Format
D	NMRF_*	The values to be provided refer to the **representative risk factor** for the regulatory bucket with ID RF_bucket_ID as defined in tab “Risk_factor_buckets”	Float

Integrity conditions:

- The set of Pof_IDs must match the list of Pof_IDs contained in the tab “Portfolios” (modulo ordering).
- For all RF_bucket_ID, RF_bucket_is_RegBucket==”Y” as defined in tab “Risk_factor_buckets”
- The set of RF_bucket_IDs per Pof_ID must be contained in (and ideally match, when regulatory buckets are comprehensively used) the list of RF_bucket_ID contained in the tab “Risk_factors” (with RF_bucket_is_RegBucket==”Y”) where the risk factors for this bucket are relevant for the portfolio as defined in tab “Map_portfolios_to_RF”
- The aggregation (cf. section 4.5.12) of the values in column RF_SS_* in tabs “NMRF_figures_per_PofxRF” and “NMRF_figures_per_PofxRegBucket” matches the total SSRM values for this portfolio in tab “Portfolios”.

3.11 PV_functions_per_PofxRF

72. The purpose of the following dataset is to assess the scanning of the calibrated stress scenario risk factor range CSSRFR and the 2nd order non-linearity adjustment by data on the functional behaviour of the portfolio value (or loss) when a risk factor is changed. The pilot phase identified the provision of PV (or loss) functions as very burdensome. Therefore, the data collection focusses on relevant data and attempts to reduce the effort for participants. This tab contains the present value (or loss) of the portfolios when changing the value of a single risk factor out of a subset of relevant risk factors for a portfolio (as defined tab “Map_portfolios_to_RF”) for all portfolios defined in tab “Portfolios”.

73. Participants are free to consistently provide portfolio present values or losses. Please explain in tab “Comments” if PV or loss data is provided.

74. The minimum sub-set of risk factors for which PV or loss function data is provided should be obtained in two steps:

    1) Similar as for the time series data, identify for each portfolio and each risk factor sub-category of Article 325bd, Table 2 of the CRR2, which is relevant for the portfolio, the 5 most material (individual) modellable risk factors and the 5 most material (individual) non-

modellable risk factors as measured with the SSRM return sigma method, and the fallback method, where there is insufficient data for the return sigma method.

2) Of those, compute the non-linearity adjustment without the floor (cf. paragraph 126) using the chosen method and provide the data for those risk factors for which there is a noticeable non-linearity, i.e.

$$\left| \frac{\Gamma^{method,j}}{2} \times (\phi - 1) \times CS_{\text{down/up}}^{method}\left(r_j\right)^2 \right| > 2\%$$

Participating institutions are free to provide more data in case they want to highlight specific features considered relevant for the SSRM methodology.

75. For each PV(portfolio, risk factor) function (or loss function), please provide at minimum 50 values spanning reasonably uniformly the calibrated stress scenario risk factor range $CSSRFR^{method}\left(r_j(D^*)\right)$ extended to the side of the future shock by $2 \times h$, where the step width $h = \frac{CS_{\text{down/up}}^{method}(r_j)}{5}$.

76. For consistency with the SSRM calculations, the set of risk factor values should contain the following 13 values: 11 scanning values of $\mathrm{CSSRFR}^{\mathrm{method}}\left(\mathrm{r_j}(\mathrm{D}^*)\right)$ used to obtain the maximum loss as a set out in paragraph 119, as well as $\mathrm{FS}_{\mathrm{D}^*}^{\mathrm{method}} \pm \mathrm{h}$ (+ if FS is at the higher bound of CSSRFR, - otherwise), and $\mathrm{FS}_{\mathrm{D}^*}^{\mathrm{method}} \pm 2 \times \mathrm{h}$.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	Pof_ID	Unique ID of the "portfolio" (instrument, desk, portfolio, in the meaning of this exercise) as defined in tab "Portfolios"	String
C	RF_ID	Unique ID of the risk factor as defined in tab "Risk_factors"	String
D	RF_value	Values of the risk factor with the ID as specified in column "RF_ID". The set of values for the risk factors must contain must contain the 13 values specified in paragraph 76 For convenience, the RF_values should be ordered in ascending or descending order.	Float
E	Pof_PV_at_RF_value	The present value of the portfolio where the risk factor with ID as specified in column "RF_ID" is set to the value specified in column "RF_value".	Float, 2 decimals

Integrity conditions:

- The set of Pof_IDs must match the list of Pof_IDs contained in the tab "Portfolios" (modulo ordering).

- The set of RF_IDs per Pof_ID must be contained in the list of RF_IDs contained in the tab “Map_portfolios_to_RF” for the matching Pof_ID.
- The number of elements in the set of values in column RF_value for each risk factor should be 50 at minimum.
- The set of values for RF_value must contain the 13 specified values of paragraph 76.

3.12 PV_functions_per_PofxRegBbucket

77. This tab contains the present value (or losses) of the portfolios when **changing the values of the risk factors in regulatory buckets by parallel shifts** based on the representative risk factor for this bucket. The instructions are otherwise analogous to the ones for tab “PV_functions_per_PofxRF”.

Column	Field	Description and instructions	Format
A	Line_of_data	Line of data counter	Integer
B	Pof_ID	Unique ID of the “portfolio” (instrument, desk, portfolio, in the meaning of this exercise) as defined in tab “Portfolios”	String
C	RF_bucket_ID	The ID of the risk factor bucket	String
D	RF_value	Values of the risk factor bucket representative pertaining to this bucket. The set of values for the risk factor must contain the 13 values specified in paragraph 76. For convenience, the RF_values should be ordered in ascending or descending order.	Float
E	Pof_PV_at_RF_value	The present value of the portfolio where the risk factors in the bucket with ID as specified in column “RF_bucket_ID” are shifted in parallel by the same shift value like the representative risk factor in column “RF_value”.	Float, 2 decimals

Integrity conditions:

- The set of Pof_IDs must match the list of Pof_IDs contained in the tab “Portfolios” (modulo ordering).
- For all RF_bucket_ID, RF_bucket_is_RegBucket==”Y” as defined in tab “Risk_factor_buckets”
- The set of RF_bucket_IDs per Pof_ID must be contained in the list of RF_bucket_ID contained in the tab “Risk_factors” (with RF_bucket_is_RegBucket==”Y”) where the risk

factors for this bucket are relevant for the portfolio as defined in tab "Map_portfolios_to_RF"

- The number of elements in the set of values in column RF_value for each risk factors must be 50 at minimum.
- The set of values for RF_value must contain the 13 specified values of paragraph 76.

4 Consolidated SSRM methodology and definitions for the purpose of the NMRF SSRM data collection exercise

4.1 Notation and definitions

$\boldsymbol{D^*}$	Figure date, i.e. for which date the figures are calculated
$\boldsymbol{j}$	Identifier of the NMRF
$\boldsymbol{D_1 < \ldots < D_M}$	Dates at which a value of the NMRF has been recorded
$\boldsymbol{D_{t+1} - D_t}$	Number of business days from D_t to D_{t+1}
$\boldsymbol{r_j(D)}$	Value of the NMRF j at date D
$\boldsymbol{r_j^*}$	Value of the NMRF r_j at figure date D^*, $r_j^* \equiv r_j(D^*)$.
$\oplus$,$\ominus$	Operators for the positive or negative application of an NMRF return to a starting value of the NMRF according to the return type applicable to this NMRF
$\boldsymbol{LH(j)}$	Liquidity horizon of the NMRF
$\boldsymbol{Ret(r_j, t, 10)}$	Estimated return of the NMRF between D_t and $D_t + 10$ business days
$\boldsymbol{\hat{\sigma}_{Ret(j)}}$	Estimated standard deviation of 10-day returns of the NMRF
$\boldsymbol{CS_{\text{up/down}}(r_j)}$	Calibrated shocks for upward and downward shocks for the NMRF
$\boldsymbol{CSSRFR(r_j)}$	Calibrated stress scenario risk factor range for the NMRF around a value r_j
$\boldsymbol{FS_{D^*}[r_j]}$	Extreme scenario of future shock for the NMRF on date D^*
$\boldsymbol{\text{loss}_{D^*}^X(r_j)}$	Loss to the portfolio on date D^* when the NMRF takes a value r_j or the NMRF in a bucket are moved
$\boldsymbol{\kappa_{D^*}^j}$	Adjustment factor for tail non-linearity of $loss_{D^*}(r_j)$
$\boldsymbol{SS_{\text{10 days},D^*}^j}$	Stress scenario risk measure on the 10 days horizon for NMRF j on date D^*
$\boldsymbol{SS_{D^*}^j}$	Stress scenario risk measure for NMRF j on date D^*

4.2 Purpose of this consolidated methodology description

78. The purpose of this chapter is to define a consolidated methodology for the purpose of EBA SGMR NMRF stress scenario risk measure (SSRM) data collection exercise for definiteness. Institutions should follow it when providing data in the data collection exercise in order to obtain comparable data sets.

79. While the methodology described in this document is closely related to the methodology presented in a previous EBA discussion paper, it should neither be construed as the final EBA proposed methodology nor as future regulatory standard. Instead, the data gathered in this exercise will help refining the methodology and ensuring an appropriate calibration.

4.3 Overview of the method variants of the SSRM calculation [NEW]

80. The present document provides an overview of several methods (or variations) of the SSRM calculations, which are applicable depending on the number of risk factor observations and hence number of returns available in the relevant data period. They are explained in detail in the following.

81. While the uncertainty compensation $\left(1+\frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$ is derived for the statistical estimation error of the standard deviation under the normality assumption, it is part of all methods, including the ones where no standard deviation is estimated. This is because it also covers the uncertainty due to the lower observability of non-modellable risk factors, and the uncertainty in the underlying distribution.

82. Note that the number of risk factor value observations, M, has in general no simple relationship to the number of return observations, N, besides $M-1 \geq N$. For daily data and $M=255$ values, there are $N=250$ returns in the period, due to the blockout-period at the end of the observation period, as explained in paragraph 102.

Name of method	***Description of how the SSRM $SS^{j}_{D^*}$ for risk factorj is calculated (or a regulatory bucket)***	***Required number of risk factor value observations, M or returns, N for the method. For regulatory buckets, referring to all risk factors in a bucket.***
Direct (Optional)	Direct calculation of the **expected shortfall of the losses** when historical returns are applied: The future shock $FS_{D^*}[r_j]$ is implicitly the loss weighted average of the tail scenarios. A non-linearity adjustment is not needed. $SS^{j}_{10\text{ days},D^*} = \widehat{\mathrm{ES}}_{\mathrm{Right}}[\mathrm{loss}^{X}_{D^*}(\mathrm{r_j})] \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$	N ≥ 250 M ≥ 255
Return historical	Maximal loss in the calibrated stress scenario risk factor **range (CSSRFR) spanned by the left and right tail historical ES of the returns**. If the future shock $FS_{D^*}[r_j]$ leading to the maximal loss occurs at a boundary, the non-linearity adjustment $\kappa^{j}_{D^*}$is applied using the historical tail shape parameter: $CS_{\mathrm{up/down}}(r_j) = \widehat{\mathrm{ES}}_{\mathrm{Left/Right}}(Ret(j)) \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$ $FS_{D^*}[r_j] \in [r_j \ominus CS_{\mathrm{down}}(r_j), r_j \oplus CS_{\mathrm{up}}(r_j)]$ $\phi = \hat{\phi}_{\mathrm{Left/Right}}(Ret(j))$, i.e. the historical estimate $\kappa^{j}_{D^*} = \max\left[\kappa_{\min}, 1 + \frac{\Gamma}{2} \times (\phi - 1) \times CS_{\mathrm{down/up}}(r_j)^2\right]$ $SS^{j}_{10\text{ days},D^*} = \kappa^{j}_{D^*} \times \mathrm{loss}^{X}_{D^*}(FS_{D^*}[r_j])$	N ≥ 250 M ≥ 255
Return sigma	Maximal loss in the calibrated stress scenario risk factor **range (CSSRFR) spanned by a multiple of standard deviations**. If the future shock $FS_{D^*}[r_j]$ leading to the maximal loss occurs at a boundary, the non-linearity adjustment $\kappa^{j}_{D^*}$ is applied using a prescribed tail shape parameter: $C_{\mathrm{ES\ equiv,up/down}} = 3$ $CS_{\mathrm{up/down}}(r_j) = C_{\mathrm{ES\ equiv,up/down}} \times \hat{\sigma}_{Ret(j)} \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$ $FS_{D^*}[r_j] \in [r_j \ominus CS_{\mathrm{down}}(r_j), r_j \oplus CS_{\mathrm{up}}(r_j)]$ $\phi = 1.05$ $\kappa^{j}_{D^*} = \max\left[\kappa_{\min}, 1 + \frac{\Gamma}{2} \times (\phi - 1) \times CS_{\mathrm{down/up}}(r_j)^2\right]$ $SS^{j}_{10\text{ days},D^*} = \kappa^{j}_{D^*} \times \mathrm{loss}^{X}_{D^*}(FS_{D^*}[r_j])$	N ≥ 12

Name of method	***Description of how the SSRM $SS^{j}_{D^*}$ for risk factorj is calculated (or a regulatory bucket)***	***Required number of risk factor value observations, M or returns, N for the method. For regulatory buckets, referring to all risk factors in a bucket.***
Return fallback	Maximal loss in the calibrated stress scenario risk factor **range (CSSRFR) spanned by fallback values from a table (including an uncertainty compensation)**. If the future shock $FS_{D^*}[r_j]$ leading to the maximal loss occurs at a boundary, the non-linearity adjustment $\kappa^{j}_{D^*}$is applied. $CS_{\text{up/down}}(r_j) = RS_{\text{up/down}}(r_j) \times RS_{\text{scale}}(r_j)$ $FS_{D^*}[r_j] \in [r_j \ominus CS_{\text{down}}(r_j), r_j \oplus CS_{\text{up}}(r_j)]$ $\phi = 1.05$ $\kappa^{j}_{D^*} = \max\left[\kappa_{\text{min}}, 1 + \frac{\Gamma}{2} \times (\phi - 1) \times CS_{\text{down/up}}(r_j)^2\right]$ $SS^{j}_{10\text{ days},D^*} = \kappa^{j}_{D^*} \times \text{loss}^{X}_{D^*}(FS_{D^*}[r_j])$	

4.4 General provisions for the calculation of the SSRM for the data collection

83. Institutions should calculate the stress scenario risk measure $SS^{j}_{\boldsymbol{D}^*}$ for a single NMRF j on figure date (i.e. the date for which the figures are computed) $\boldsymbol{D}^*$according to the following paragraphs.

84. Due to the computational effort required, computing the SSRM with the direct method is optional. The calculations using the other SSRM methods should be performed whenever sufficient data is available.

85. Generally, for the calculation of the stress scenario risk measure, shocks to risk factors should be applied in the same manner like envisaged in the expected shortfall model. Thus, in particular, regarding the passage of time effect (“theta” –effect), if the ES model is based on instantaneous shocks, the same should hold for the stress scenario risk measure.

4.4.1 Calculation for both single risk factors and regulatory buckets

86. Subject to supervisory approval, an institution may be permitted to calculate stress scenario capital requirements at the bucket level (using the same buckets that the bank uses to assess modellability) for risk factors that belong to curves, surfaces or cubes.[8] Thus, for risk factors that belong to the same regulatory bucket[9] a single SSRM calculation may be performed.

[8] Cf. BCBS_d457, MAR33.16

[9] Cf. BCBS_d457, MAR31.16(2)

Therefore, the data for the SSRM calculation for the applicable methods should ideally be provided for **both**:

a. On **single risk factor level**, i.e. without applying bucketing

b. On **regulatory bucket level.**

Having both allows a comparison of the SSRM charge.

87. However, where participating institutions supply data for a curve, surface, or cube using regulatory buckets and consider the approach is reliably implemented, they may choose not to provide additionally the data on individual risk factor level for some or all the ones that are covered in the related regulatory buckets, in order to reduce the burden in data delivery.

4.4.2 Portfolio loss functions $\boldsymbol{loss^{X}_{D^*}(r_j)}$

88. The portfolio loss function $loss_{D^*}(r_j)$ measures changes of the portfolio's value on the figure date when a risk factor changes, which is a difference of two present values. We denote the portfolio present value depending on all risk factors $\vec{r} = \{r_l\}$ (modellable and non-modellable) by $PV(\vec{r})$.

89. The present values should be calculated accurately – as generally in the internal model approach. While using full portfolio revaluation where feasible would be ideal, in particular for assessing non-linearity effects for the purpose of this exercise, other loss function calculations, e.g. a sensitivities based methods, or other suitable methods can be used (please explain in the comment section of the template).

90. The sign convention is that the **worst losses have a positive sign**, when the present value upon changing risk factors gets lower than on the figure date.

91. The loss occurring when one single the risk factors r_j has a value different from the initial value $r_j^* = r_j^*(D^*)$ at the figure date is:

$$\mathrm{loss}_{D^*}^{\mathrm{single}}(r_j) = PV(\vec{r}^*) - PV(r_j, \vec{r}^*_{i \neq j})$$

This means that only r_j is set to a specific value, while the current values of the other risk factors $\vec{r}_{i \neq j}$ are not changed. One does *not* need to know the joint distribution of risk factors r_j and $\vec{r}_{i \neq j}$, because $\vec{r}_{i \neq j}$ are not changed.

92. For a regulatory bucket $B$of risk factors, $\{r_j \in B\}$, the loss occurring when all risk factors in the regulatory bucket B have values different from the initial values $\{r_j^*(D^*) \in B\}$ at the figure date is

$$\mathrm{loss}_{D^*}^{\mathrm{Bucket}}(\{r_j \in B\}) = PV(\{r_j^* \in \mathrm{B}\}, \{r_i^* \notin \mathrm{B}\}\ \text{fixed}) - PV(\{r_j \in B\}, \{r_i^* \notin \mathrm{B}\}\ \text{fixed})$$

93. For a regulatory bucket B of risk factors $\{r_j \in B\}$, the loss occurring when all risk factors in the regulatory bucket change in a **parallel shift** (under the respective return approach) from the initial values $\{r_j(D^*), r_j \in B\}$ to $\{r_j(D^*) \oplus (r_B - r_B(D^*)), r_j \in B\}$, i.e. all risk factors in the bucket change in a parallel shift **determined by the representative risk factor** r_B for the bucket, and the loss in that regulatory bucket due to a parallel shift of the bucket's risk factors is:

$$\text{loss}_{D^*}^{\text{Bucket,parallel}}(\{r_j \in B\})$$
$$= PV(\{r_j^* \in B\}, \{r_i^* \notin B\} \text{ fixed}) - PV(\{r_j(D^*) \oplus (r_B - r_B(D^*)), r_j \in B\}, \{r_i^* \notin \mathrm{B}\} \text{ fixed})$$

where each risk factor in the bucket $\{r_j \in B\}$ is shifted according to the relevant return approach (absolute, relative, log-returns, etc.) indicated with the symbol $\oplus$ and its inverse $\ominus$.

94. The **representative risk factor for a bucket** is defined as the risk factor with the **highest volatility** of all risk factors $\{r_j \in B\}$ in the regulatory bucket B, i.e.

$$r_B = \underset{r_j \in B}{\operatorname{argmax}}[\hat{\sigma}_{Ret(j)}]$$

(where $\hat{\sigma}_{Ret(j)}$ should be determined in accordance with paragraph 109 below). Such a representative risk factor for a regulatory bucket is flagged accordingly in tab “Risk_factor_buckets” and “Risk_factors”. It is used to determine the future shock applied in a parallel shift to all risk factors in that bucket for $\text{loss}_{D^*}^{\text{Bucket,parallel}}(\{r_j \in B\})$.

4.5 Calculation of the SSRM

95. The following paragraphs describe the steps in the calculation of the SSRM. For the direct method, steps 3 to 7 are combined, while for the other methods, steps 3 to 7 should be performed.

4.5.1 Step 1: Stressed periods for the risk factor data

96. For the purpose of this exercise, institutions should use the risk factor values $r_j(D_1)$, …, $r_j(D_M)$ of the NMRF j from the pertaining stressed period containing the dates $\{D_1, \dots, D_M\}$ relevant for the institution for the calculation of the SSRM. The 12 month stress periods per broad risk factor category (class) should be determined on a best effort basis for the all NMRF of the institution for the top level portfolio for market risk as referred to in BCBS_d457, MAR33.16. **It is acceptable that only one stress period is used for all risk factor classes, or that the stress period of 30 June 2008 to 30 June 2009 is used**, when a more detailed analysis is considered burdensome. This specification is without any prejudice to future regulation.

97. Institutions should recognize only one risk factor value per day, and stale data should only be considered if it represents actual market data. In particular, non-trading days data therefore should not be used.

98. Furthermore, the calculation requires the value $\mathrm{r_j}(\mathrm{D}^*)$ of the NMRF on the figure date. If no observation of the NMRF is available on that date, institutions should use a proxy in accordance with their common practices.

4.5.2 Step 2: Estimate nearest to 10-days returns

99. Given the sample $r_j(D_1), \dots, r_j(D_M)$ of values of the NMRF, nearest to 10-days returns should be estimated according to the following methodology.

100. The days refer to business days. Thus, the exact results depend on the business days used. Please provide information on the business days used. For the purpose of this exercise, the assumption that every weekday is a business day is acceptable.

101. For each date index $t \in \{1, \dots, M-1\}$ a "nearest to 10-days" candidate should be determined by

$$t_{nn}(t) = \underset{\substack{t' > t \\ D_M - D_t > 5 \text{ days}}}{\operatorname{argmin}} \left[\left|\frac{10 \text{ days}}{D_{t'} - D_t} - 1\right|\right]$$

102. The return for date index t should only be considered when $D_M - D_t > 5$ days, in order to avoid having too many returns using the last data point $r_j(D_M)$. **As a result of this "blockout period", the number N of sample returns might be smaller than the number of risk factor value observations, $M-1$.**

103. Then, for each such t, such nearest to 10-days return should be estimated either as

$$Ret(r_j, t, 10) = \left(r_j\left(D_{t_{nn}(t)}\right) - r_j(D_t)\right) \times \sqrt{\frac{10 \text{ days}}{D_{t_{nn}(t)} - D_t}}$$

or

$$Ret(r_j, t, 10) = \log\left(\frac{r_j\left(D_{t_{nn}(t)}\right)}{r_j(D_t)}\right) \times \sqrt{\frac{10 \text{ days}}{D_{t_{nn}(t)} - D_t}}$$

depending on whether absolute or logarithmic returns are used for the NMRF.

104. In case of another return approach, e.g. an approach for interest rates where absolute returns for low levels of interest are mixed with and cross over to relative returns for high levels of interest, the method for the 10-day return calculation of the previous paragraph should be applied accordingly.

4.5.3 Step 3 to 7, Direct method: Estimate the expected shortfall of losses [NEW]

105. Given the sample $Ret(r_j, 1{,}10)$, …, $Ret(r_j, N, 10)$ of estimated nearest to 10-days returns of the NMRF and the portfolio loss function, the stress scenario risk measure at the 10 day liquidity horizon for NMRF *j* should be calculated in the Direct method as the expected shortfall of the worst losses:

$$SS_{10\text{ day},D^*}^{\text{direct},j} = \widehat{\text{ES}}_{\text{Right}}\left[\text{loss}_{D^*}^{\text{single}}\left(r_j(D^*) \oplus Ret(r_j, t, 10)\right), \alpha\right] \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

where the risk factor *j* is shifted according to its nearest to 10 days returns according to the return approach chosen (absolute, relative, log-returns, etc.) indicated with the symbol $\oplus$.

$CL_{\text{sigma}} = 90\%$ should be used for the purpose of this exercise. Based on the NMRF data collection exercise the parameter values will be reviewed for the formulation of the draft RTS.

106. For a regulatory bucket B, the stress scenario risk measure at the 10 day liquidity horizon for the bucket B containing a set of risk factors $\{r_j \in B\}$, should be calculated analogously as:

$$SS_{10\text{ day},D^*}^{\text{direct},B} = \widehat{\text{ES}}_{\text{Right}}\left[\text{loss}_{D^*}^{\text{Bucket}}\left(\{r_j(D^*) \oplus Ret(r_j, t, 10), r_j \in B\}\right), \alpha\right] \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

where each risk factor in the bucket $\{r_j \in B\}$ is shifted according to its nearest to 10 days returns (i.e. non-parallel shifts) according to the return approach chosen (absolute, relative, log-returns, etc.) indicated with the symbol $\oplus$.

$CL_{\text{sigma}} = 90\%$ should be used for the purpose of this exercise. Based on the NMRF data collection exercise the parameter values will be reviewed for the formulation of the draft RTS.

4.5.4 Step 3, Return historical method: Estimate the calibrated shocks historically as expected shortfalls[NEW]

107. Given the sample $Ret(r_j, 1{,}10)$, …, $Ret(r_j, N, 10)$ of nearest to 10-day returns of the NMRF, the calibrated up and down shocks to the risk factors should be estimated as the empirical expected shortfalls of the returns for the right and left tail:

$$CS_{\text{down}}^{\text{historical}}(r_j) = \widehat{\text{ES}}_{\text{Left}}(Ret(j), \alpha) \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

and

$$CS_{\text{up}}^{\text{historical}}(r_j) = \widehat{\text{ES}}_{\text{Right}}(Ret(j), \alpha) \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

$CL_{\text{sigma}} = 90\%$ should be used for the purpose of this exercise. Based on the NMRF data collection exercise the parameter values will be reviewed for the formulation of the draft RTS.

4.5.5 Step 3, Return sigma method: Estimate the calibrated shocks historically as multiples of the standard deviation $\hat{\boldsymbol{\sigma}}_{\boldsymbol{Ret(j)}}$

108. Given the sample $Ret(r_j, 1{,}10)$, …, $Ret(r_j, N, 10)$ of nearest to 10-day returns of the NMRF, the standard deviation of nearest to 10-day returns should be estimated as

$$\hat{\sigma}_{Ret(j)} = \sqrt{\frac{1}{N-1.5} \times \sum_{t=1}^{N} \left(Ret(r_j, t, 10) - \overline{Ret(r_j, \cdot, 10)}\right)^2}$$

where $\overline{Ret(r_j, \cdot, 10)}$ denotes the mean of the sample of returns.

109. Given the estimated standard deviation $\hat{\sigma}_{Ret(j)}$ of 10-day returns of the NMRF, the calibrated shock should be calculated as

$$CS_{\mathrm{down}}^{\mathrm{sigma}}(r_j) = C_{\mathrm{ES\ equiv,down}} \times \hat{\sigma}_{Ret(j)} \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

and

$$CS_{\mathrm{up}}^{\mathrm{sigma}}(r_j) = C_{\mathrm{ES\ equiv,up}} \times \hat{\sigma}_{Ret(j)} \times \left(1 + \frac{\Phi^{-1}(CL_{sigma})}{\sqrt{2(N-1.5)}}\right)$$

where $C_{\mathrm{ES\ equiv,down}} = C_{\mathrm{ES\ equiv,up}} = 3$ and $CL_{\mathrm{sigma}} = 90\%$ should be used for the purpose of this exercise. Based on the NMRF data collection exercise the parameter values will be reviewed for the formulation of the draft RTS.

4.5.6 Step 3, Fallback method: calibrated shocks from fallback table

110. In case less than 12 returns of the NMRF are available in the stress period identified for the risk factor's broad risk factor category in accordance with step 1, the fallback approach as defined in the following paragraphs should be applied.

111. Given the "regulatory scenarios of future shock", RS_{down} and RS_{up}, prescribed for the NMRF in the table below in paragraph 113, the calibrated upward and downward shock should be calculated as

$$CS_{\mathrm{down}}^{\mathrm{fallback}}(r_j) = RS_{\mathrm{down}}(r_j) \times RS_{\mathrm{scale}}(r_j)$$

and

$$CS_{\mathrm{up}}^{\mathrm{fallback}}(r_j) = RS_{\mathrm{up}}(r_j) \times RS_{\mathrm{scale}}(r_j)$$

where $RS_{\mathrm{scale}}(r_j) = 1.5$ should be used for the purpose of this exercise. Based on the NMRF SSRM data collection exercise the scaling factors $RS_{\mathrm{scale}}(r_j)$ will be reviewed for the formulation of the draft RTS.

112. In the Fallback method, $CS_{\mathrm{down}}^{\mathrm{fallback}}(r_j)$ and $CS_{\mathrm{up}}^{\mathrm{fallback}}(r_j)$ should be applied to $r_j(D^*)$ to obtain the calibrated stress scenario risk factor range, depending on whether absolute or relative returns are defined as per the table below in paragraph 113**Error! Reference source not found.**.

113. RS_{down} and RS_{up} should be determined according to the following table.

Broad risk factor categories	**Broad risk factor subcategories**	Return type	RS_{down}	RS_{up}
Interest rate	Most liquid currencies and domestic currency	absolute	1.2%	1.2%
	Other currencies (excluding most liquid currencies)	absolute	1.2%	1.2%
	Volatility	relative	40.8%	40.8%
	Other types	relative	40.8%	40.8%
Credit spread	Central government, including central banks, of Member States of the Union	absolute	0.4%	0.4%
	Covered bonds issued by credit institutions established in Member States of the Union (Investment Grade)	absolute	2.1%	2.1%
	Sovereign (Investment Grade)	absolute	0.7%	0.7%
	Sovereign (High Yield)	absolute	2.0%	2.0%
	Corporate (Investment Grade)	absolute	2.5%	2.5%
	Corporate (High Yield)	absolute	4.9%	4.9%
	Volatility	relative	28.9%	28.9%
	Other types	relative	28.9%	28.9%
Equity	Equity price (Large capitalisation)	relative	60.1%	60.1%
	Equity price (Small capitalisation)	relative	60.1%	60.1%
	Volatility (Large capitalisation)	relative	55.0%	55.0%
	Volatility (Small capitalisation)	relative	55.0%	55.0%
	Other types	relative	60.1%	60.1%
Foreign Exchange	Most liquid currency pairs	relative	10.6%	10.6%
	Other currency pairs (excluding most liquid currency pairs)	relative	10.6%	10.6%
	Volatility	relative	40.0%	50.0%
	Other types	relative	40.0%	50.0%
Commodity	Energy price and carbon emissions price	relative	42.4%	42.4%
	Precious metal price and non-ferrous metal price	relative	28.3%	28.3%
	Other commodity prices (excluding Energy price, carbon emissions price, precious metal price and non-ferrous metal price)	relative	32.7%	32.7%
	Energy volatility and carbon emissions volatility	relative	40.8%	40.8%
	Precious metal volatility and non-ferrous metal volatility	relative	40.8%	40.8%
	Other commodity volatilities (excluding Energy volatility, carbon emissions volatility, precious metal volatility and non-ferrous metal volatility)	relative	28.9%	28.9%
	Other types	relative	42.4%	42.4%

4.5.7 Step 4: Calculate the calibrated stress scenario risk factor range $CSSRFR^{method}\left(r_j(D^*)\right)$

114. Now, the calibrated shocks $CS_{\text{down/up}}^{method}(r_j)$ determined with a method should be applied to the risk factor at the figure date $r_j(D^*)$ in both directions to obtain the calibrated stress scenario risk factor range, i.e.

$$CSSRFR^{method}\left(r_j(D^*)\right) = \left[r_j(D^*) \ominus CS_{\text{down}}^{method}(r_j), r_j(D^*) \oplus CS_{\text{up}}^{method}(r_j)\right]$$

which means

$$CSSRFR\left(r_j(D^*)\right) = \left[r_j(D^*) - CS_{\text{down}}(r_j), r_j(D^*) + CS_{\text{up}}(r_j)\right]$$

or

$$CSSRFR\left(r_j(D^*)\right) = \left[r_j(D^*) \times e^{-CS_{\text{down}}(r_j)}, r_j(D^*) \times e^{+CS_{\text{up}}(r_j)}\right]$$

or

$$CSSRFR\left(r_j(D^*)\right) = \left[r_j(D^*) \times \left(1 - CS_{\text{down}}(r_j)\right), r_j(D^*) \times \left(1 + CS_{\text{up}}(r_j)\right)\right]$$

depending on whether absolute, logarithmic, or relative returns are used for the NMRF.

115. In case of another return approach, the calibrated stress scenario risk factor range should be calculated accordingly.

4.5.8 Step 5: Determination of the future shock $FS_{D^*}^{method}[r_j]$

116. Given the calibrated stress scenario risk factor range $CSSRFR\left(r_j(D^*)\right)$, the future shock should be determined as the risk factor movement in the range leading to the highest loss,

$$FS_{D^*}^{method}[r_j] = \underset{r_j \in CSSRFR^{method}\left(r_j(D^*)\right)}{\text{argmax}} \left[\text{loss}_{D^*}^{\text{single}}(r_j)\right]$$

117. If a risk factor r_B is used as a representative risk factor for the bucket B, all risk factors $\{r_j \in B\}$ in the bucket are moved in parallel, and the future shock should be determined as the representative risk factor movement in the range leading to the highest loss,

$$FS_{D^*}^{method}[\{r_j \in B\}] = \underset{r_B \in CSSRFR^{method}(r_B(D^*))}{\text{argmax}} \left[\text{loss}_{D^*}^{\text{Bucket,parallel}}(\{r_j \in B\})\right]$$

118. If the portfolio orientation can clearly be justified to be long or short with respect to the NMRF, institutions may set $FS_{D^*}[r_j]$ to the left or the right boundary of $CSSRFR\left(r_j(D^*)\right)$, respectively, without performing any optimisation.

119. If the portfolio is not clearly directional with respect to the NMRF, institutions should use the set of 11 values to scan for the maximum in $CSSRFR\left(r_j(D^*)\right)$, defined as follows:

$$\left\{r_j(D^*) \ominus i \times \frac{CS_{\text{down}}(r_j)}{5}, r_j(D^*), r_j(D^*) \oplus i \times \frac{CS_{\text{up}}(r_j)}{5} \mid i = 1, \dots, 5\right\}$$

120. If a risk factor $\mathrm{r_B}$ is used as a representative risk factor for all risk factors in the bucket $\{\mathrm{r_j} \in \mathrm{B}\}$, the scanning should be performed analogously.

4.5.9 Step 6: Tail shape parameter ϕ for the non-linearity adjustment

121. The tail shape parameter ϕ is used for approximating the difference of the ES of losses due to risk factor movements and the loss of the ES of risk factor movements in the tail of the risk factor movements in a quadratic approximation.

122. In the direct method the tail shape parameter ϕ is not used.

123. In the return historical method, the tail shape parameter should be obtained as the historical estimate:

$$\phi_{\text{Left/Right}}^{\text{historical},j} = \hat{\phi}_{\text{Left/Right}}\big(Ret(j)\big) \stackrel{\text{def}}{=} \frac{E\left[Ret(j)^2 \mid Ret(j) \text{ in left/right } \alpha - \text{tail}\right]}{\left\{\widehat{\text{ES}}_{\text{Left/Right}}\big(Ret(j), \alpha\big)\right\}^2}$$

124. In the return sigma method and the fallback method, the tail shape parameter

$$\phi^{\text{fallback}} = 1.05$$

should be used for the purpose of this exercise. Based on the NMRF data collection exercise the parameter values will be reviewed for the formulation of the draft RTS.

4.5.10 Step 7: Calculate the non-linearity adjustment $\boldsymbol{\kappa_{D^*}^{method,j}}$

125. The curvature gamma, $\Gamma^{method,j}$, should be calculated as

$$\Gamma^{method,j} = \frac{1}{\text{loss}_{D^*}^{\text{single}}(r_{j,0})} \times \frac{\text{loss}_{D^*}^{\text{single}}(r_{j,-1}) - 2 \times \text{loss}_{D^*}^{\text{single}}(r_{j,0}) + \text{loss}_{D^*}^{\text{single}}(r_{j,1})}{h^2}$$

where

$$h = \frac{CS_{\text{down/up}}^{method}(r_j)}{5}$$

$$r_{j,0} = FS_{D^*}^{method} = \begin{cases} r_j(D^*) \ominus CS_{\text{down}}^{method}(r_j) \\ r_j(D^*) \oplus CS_{\text{up}}^{method}(r_j) \end{cases}$$

$$r_{j,\pm 1} = r_{j,0} \pm h$$

Thus, the two outermost points in the scanning of calibrated stress scenario risk factor range can be re-used in the curvature calculation.

126. Given the curvature $\Gamma^{method,j}$, the non-linearity adjustment $\kappa_{D^*}^{method,j}$ should be calculated as

$$\kappa_{D^*}^{method,j} = \max\left[\kappa_{\min}, 1 + \frac{\Gamma^{method,j}}{2} \times (\phi - 1) \times CS_{\text{down/up}}^{method}(r_j)^2\right]$$

$$= \max\left[\kappa_{\min}, 1 + \frac{\text{loss}_{D^*}^{\text{single}}(r_{j,-1}) - 2\times\text{loss}_{D^*}^{\text{single}}(r_{j,0}) + \text{loss}_{D^*}^{\text{single}}(r_{j,1})}{2\times\text{loss}_{D^*}^{\text{single}}(r_{j,0})} \times (\phi^{method} - 1) \times 25\right]$$

where ϕ is either the historical estimate for the return historical method or the pre-set value of 1.05 for the return sigma and the fallback method. The floor $\kappa_{\min} = 0$ should be used for the purpose of this exercise.

127. If a risk factor r_B is used as a representative risk factor for all risk factors in the bucket $\{r_j \in B\}$, the curvature $\Gamma^{method,B}$ and adjustment $\kappa_{D^*}^{method,B}$ should be calculated analogously, using $\text{loss}_{D^*}^{\text{Bucket,parallel}}$.

128. Given the future shock $FS_{D^*}^{method}[r_j]$ for a method and the non-linearity adjustment $\kappa_{D^*}^{method,j}$, the stress scenario risk measure at the 10 days liquidity horizon for NMRF j should be calculated as

$$SS_{10\text{ day},D^*}^{method,j} = \kappa_{D^*}^{j} \times \text{loss}_{D^*}^{\text{single}}\left(FS_{D^*}^{method}[r_j]\right)$$

129. If a risk factor r_B is used as a representative risk factor for all risk factors in the regulatory bucket $\{r_j \in B\}$, the stress scenario risk measure at the 10 day liquidity horizon for the regulatory bucket B should be calculated analogously as

$$SS_{10\text{ day},D^*}^{method,B} = \kappa_{D^*}^{B} \times \text{loss}_{D^*}^{\text{Bucket,parallel}}\left(FS_{D^*}^{method}[\{r_j \in B\}]\right)$$

4.5.11 Step 8: Scaling to the liquidity horizon to obtain the stress scenario risk measure $SS_{D^*}^{j}$

130. The liquidity horizon LH(j) for risk factor j should be determined as the greater of 20 days and the liquidity horizon assigned to the risk factor in accordance with Table 2 in Article 325bd of the CRR2.

Broad risk factor categories	Broad risk factor subcategories	Liquidity horizons	Length liquidity horizon (in days)
Interest rate	Most liquid currencies and domestic currency	1	10
	Other currencies (excluding most liquid currencies)	2	20
	Volatility	4	60
	Other types	4	60
Credit spread	Central government, including central banks, of Member States of the Union	2	20
	Covered bonds issued by credit institutions established in Member States of the Union (Investment Grade)	2	20
	Sovereign (Investment Grade)	2	20

	Sovereign (High Yield)	3	40
	Corporate (Investment Grade)	3	40
	Corporate (High Yield)	4	60
	Volatility	5	120
	Other types	5	120
Equity	Equity price (Large capitalisation)	1	10
	Equity price (Small capitalisation)	2	20
	Volatility (Large capitalisation)	2	20
	Volatility (Small capitalisation)	4	60
	Other types	4	60
Foreign Exchange	Most liquid currency pairs	1	10
	Other currency pairs (excluding most liquid currency pairs)	2	20
	Volatility	3	40
	Other types	3	40
Commodity	Energy price and carbon emissions price	2	20
	Precious metal price and non-ferrous metal price	2	20
	Other commodity prices (excluding Energy price, carbon emissions price, precious metal price and non-ferrous metal price)	4	60
	Energy volatility and carbon emissions volatility	4	60
	Precious metal volatility and non-ferrous metal volatility	4	60
	Other commodity volatilities (excluding Energy volatility, carbon emissions volatility, precious metal volatility and non-ferrous metal volatility)	5	120
	Other types	5	120

131. For the purpose of this exercise, no effective liquidity horizon for taking into account positions' maturities as contemplated in Article 325be(4) of the CRR2 should be applied.

132. The liquidity horizon of all risk factors in a bucket is the same (as they are all on the same curve, surface or cube) and in particular can be determined by the liquidity horizon of the bucket representative risk factor.

133. Given the stress scenario risk measure at the 10 day liquidity horizon $SS_{10\text{ days},D^*}^{method,j}$, the stress scenario risk measure for NMRF *j* should be calculated as

$$SS_{D^*}^{method,j} = \sqrt{\frac{LH(j)}{10}} \times SS_{10\text{days},D^*}^{method,j}$$

134. If a risk factor r_B is used as a representative risk factor for all risk factors in the bucket $\{r_j \in B\}$, the stress scenario risk measure for the bucket should be calculated analogously as

$$SS_{D^*}^{method,B} = \sqrt{\frac{LH(B)}{10}} \times SS_{10days,D^*}^{method,B}$$

4.5.12 Step 9: Aggregation of the stress scenario risk measure for a portfolio

135. To obtain the stress scenario risk measure for a portfolio on figure date D^*, institutions should identify the collection $j_1, \ldots, j_{N_P}$ of NMRFs relevant for that portfolio and calculate the respective individual stress scenario risk measures $SS_{D^*}^{j_1}, \ldots, SS_{D^*}^{j_{N_P}}$ following the methodology laid out in the previous section.

136. For the purpose of this exercise, in case risk factor buckets for curves, surfaces or cubes are used, the indices j in the paragraph above should be understood as a bucket index and all calculations should be performed analogously as described above.

137. Of those N_P NMRF for the portfolio, institutions should determine on a best effort basis, those $N_{P,ICSR}$ NMRF which are non-modellable risk factors mapped to the credit spread broad risk factor category that represent idiosyncratic credit spread risks that are uncorrelated to other such NMRF as indicated by the flag “RF_is_idiosyncratic_CS” in tab “Risk_factors”.

138. Of those N_P NMRF for the portfolio, institutions should determine on a best effort basis, those $N_{P,IERF}$ NMRF which are non-modellable risk factors mapped to the equity broad risk factor category that represent idiosyncratic equity risk factors that are uncorrelated to other such NMRF as indicated by the flag “RF_is_idiosyncratic_ERF” in tab “Risk_factors”.

139. For determining the stress scenario risk measure $SS_{D^*}^{method}$ for a portfolio using a method should be calculated in accordance with the revised FRTB (BCBS_d457, MAR33.17), with $\rho = 0.6$ as follows:

$$SS_{D^*}^{method} = \sqrt{\sum_{\substack{m=1,\\ m \text{ idiosyncratic} \\ \text{credit spread risk}}}^{N_{P,ICSR}} \left(SS_{D^*}^{method,m}\right)^2} + \sqrt{\sum_{\substack{k=1,\\ k \text{ idiosyncratic} \\ \text{equity risk factor}}}^{N_{P,IERF}} \left(SS_{D^*}^{method,k}\right)^2}$$
$$+ \sqrt{\left(\rho \times \sum_{\substack{j=1,\\ j \text{ not idiosyncratic} \\ \text{credit spread} \\ \text{nor} \\ \text{idiosyncratic} \\ \text{equity risk factor}}}^{N_P - N_{P,ICSR} - N_{P,IERF}} SS_{D^*}^{method,j}\right)^2 + (1-\rho^2) \times \sum_{\substack{j=1,\\ j \text{ not idiosyncratic} \\ \text{credit spread nor} \\ \text{idiosyncaratic} \\ \text{equity risk factor}}}^{N_P - N_{P,ICSR} - N_{P,IERF}} \left(SS_{D^*}^{method,j}\right)^2}$$

4.6 Definitions of empirical estimators

4.6.1 Empirical estimator for the expected shortfall

140. For the calculation of the SSRM, as well as for filling in the NMRF SSRM data collection template, some empirical estimators are defined in case of sufficient data.

141. When sufficient data are available, the empirical estimator for the expected shortfall can be defined for the left and tight tail of a distribution as follows:

$$\widehat{\mathrm{ES}}_{\mathrm{Left}}(X,\alpha) \stackrel{\text{def}}{=} \frac{-1}{\alpha N} \times \left\{ \sum_{i=1}^{[\alpha N]} X_{(\mathrm{i})} + (\alpha N - [\alpha N]) X_{([\alpha N]+1)} \right\}$$

where $\alpha = 2.5\%$, X is the order statistics of the sample in question of size N, and $[\alpha N]$ denotes the integer part of the product αN.

Note that the sign convention leads to a positive number for the left tail of a distribution centered around zero.

142. This estimator[10] is slightly different from the simple historical estimator which uses the $[\alpha N]$ worst losses. It is more accurate and seems more natural for the expected shortfall being an α-tail mean[11]. It accounts for αN not being an integer and is somewhat more stable by incorporating 7 instead of 6 losses for N=250 and α=2.5%.

143. The right tail can be estimated accordingly as the α-tail mean of the negative sample,

$$\widehat{\mathrm{ES}}_{\mathrm{Right}}(X,\alpha) \stackrel{\text{def}}{=} \widehat{\mathrm{ES}}_{\mathrm{Left}}(-X,\alpha)$$

4.6.2 Empirical estimator for the ratio of expected shortfall over standard deviation for returns

144. When sufficient data are available, the ratio of the expected shortfall over the standard deviation for returns is defined for the left and right tail separately as follows:

$$\hat{\mathrm{C}}_{\mathrm{Left\ ES\ equiv}} \stackrel{\text{def}}{=} \frac{\widehat{\mathrm{ES}}_{\mathrm{Left}}(Ret(j),\alpha)}{\hat{\sigma}_{Ret(j)}}$$

$$\hat{\mathrm{C}}_{\mathrm{Right\ ES\ equiv}} \stackrel{\text{def}}{=} \frac{\widehat{\mathrm{ES}}_{\mathrm{Right}}(Ret(j),\alpha)}{\hat{\sigma}_{Ret(j)}}$$

[10] See equation (7) in F. Peracchi, A. Tanase, “On estimating the conditional expected shortfall”, Appl. Stochastic Models Bus. Ind. 2008; 24:471–493 and Equation (23) in S. Nadarajah, B. Zhang and S. Chan, “Estimation methods for expected shortfall,” Quantitative Finance, vol. 14, no. 2, pp. 271-291, 2014.

[11] See Definition 2.6 of C. Acerbi and D. Tasche, “On the coherence of Expected Shortfall”, https://arxiv.org/pdf/cond-mat/0104295.pdf

4.6.3 Empirical estimator for the tail shape parameter ϕ for returns

145. Employing the analogous empirical estimator as for the expected shortfall for the squared returns in the tails, the historical estimators for the tail shape parameter ϕ for the left and the right tail of the risk factor returns Ret(j) are defined as

$$\hat{\phi}_{\text{Left}}(Ret(j),\alpha) \stackrel{\text{def}}{=} \frac{E[Ret(j)^2\ |Ret(j)\text{ in left }\alpha-\text{tail}]}{\left\{\widehat{\text{ES}}_{\text{Left}}(Ret(j),\alpha)\right\}^2}$$

$$= \frac{\frac{1}{\alpha N}\times\left\{\sum_{i=1}^{[\alpha N]} Ret(j)_{(\text{i})}{}^2 + (\alpha N-[\alpha N])Ret(j)_{([\alpha N]+1)}{}^2\right\}}{\left\{\widehat{\text{ES}}_{\text{Left}}(Ret(j),\alpha)\right\}^2}$$

$$\hat{\phi}_{\text{Right}}(Ret(j),\alpha) \stackrel{\text{def}}{=} \frac{E[Ret(j)^2\ |Ret(j)\text{ in right }\alpha-\text{tail}]}{\left\{\widehat{\text{ES}}_{\text{Right}}(Ret(j),\alpha)\right\}^2}$$

$$= \frac{\frac{1}{\alpha N}\times\left\{\sum_{i=1}^{[\alpha N]}\left(-Ret(j)_{(\text{i})}\right)^2 + (\alpha N-[\alpha N])\left(-Ret(j)_{([\alpha N]+1)}\right)^2\right\}}{\left\{\widehat{\text{ES}}_{\text{Right}}(Ret(j),\alpha)\right\}^2}$$

4.6.4 Empirical estimator for the non-linearity adjustment

146. Similarly, the definition of a historical estimator for the non-linearity adjustment is defined as:

$$\hat{\kappa}_t^j = \frac{\widehat{\text{ES}}_{\text{Right}}(\text{loss}_{D^*}^X(\text{r}_\text{j}),\alpha)}{\text{loss}_{D^*}^X\left(\widehat{\text{ES}}_{\text{Left/Right}}(r_j,\alpha)\right)}$$

where the expected shortfall estimator in the nominator depends on the worst losses (thus, the right tail), while in the denominator the expected shortfall estimator for the loss function argument depends on if the lowest or highest values of the risk factor values observed lead to the worst losses.