

## **STRESS TEST VALUE CALCULATION GUIDE**

Hong Kong Exchanges and Clearing Limited  
VaR Platform  
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## 1. INTRODUCTION

Hong Kong Securities Clearing Company Limited (“HKSCC”) adopts Next Generation stress testing model to determine the Stress Test Value (“STV”) of Clearing Participants’ (“CPs”) portfolios.

The Next Generation stress testing model is developed in accordance with the regulatory requirements and international best practices e.g., CPMI-IOSCO principle for Financial Market Infrastructure. To promote transparency of the model, files containing key risk parameters required for calculating STV (a.k.a., “Stress Testing Risk Parameter Files”, or “STVRPFs”) will be disseminated to all HKSCC’s CPs on a daily basis upon the launch of Next Generation stress testing model.

This document outlines how to use the Stress Testing Risk Parameter Files to calculate the STV of a portfolio for HKSCC clearable instruments in Hong Kong market.

## 2. STRESS TESTING RISK PARAMETER FILES

### 2.1 Layouts of Stress Testing Risk Parameter Files

Three Stress Testing Risk Parameter Files<sup>1</sup> (i.e., RPF02, RPF03 and RPF04) will be generated in csv format and can be downloaded by CPs on each business day. The layouts of the 3 files are shown as below:

#### RPF02:

This file includes instrument price returns based on theoretical correlation boost scenarios.

Valuation_DT	31/12/2018											
STV_Corr_Type	1											
STV_Corr_Count	1000											
STV_Corr_CL	0.994											
STV_Corr_Measure	4											
InstrumentID	FieldType	1	2	3	4	5	6	7	8	9	10	
5	141	-0.18879	0.050834	0.050601	-0.23081	0.039646	0.27911	-0.40261	0.001602	-0.23044	-0.30086	
388	141	0.237805	-0.16029	-0.49396	-0.24565	0.220481	-0.22991	-0.44957	0.458194	-0.36172	0.053977	
700	141	-0.1575	-0.1699	0.092884	0.445066	-0.41851	0.040911	0.052565	0.169623	-0.06841	-0.44291	
2382	141	0.264066	0.343014	-0.36818	0.085666	-0.44283	-0.32307	-0.24207	-0.07291	-0.16851	-0.28198	
3988	141	0.129854	0.044897	-0.05036	-0.4809	0.408862	0.210569	0.461171	-0.4901	-0.41387	-0.36183	
5	142	0.022281	-0.16238	0.137352	-0.14947	-0.02671	0.148286	0.147342	-0.08711	-0.01287	-0.067	
388	142	-0.06227	-0.04168	-0.08126	-0.05646	-0.16662	0.113688	-0.09646	-0.00603	-0.1309	-0.09629	
700	142	-0.14234	-0.04514	-0.09756	0.131923	0.003562	0.162121	-0.15249	0.124549	0.177046	-0.09404	
2382	142	0.104542	-0.10215	-0.1511	-0.10711	-0.05708	-0.03292	0.159095	0.038235	-0.17028	-0.07513	
3988	142	0.048732	0.061443	0.19179	-0.05465	-0.18555	0.046	0.065368	-0.07517	-0.13255	0.091011	
5	143	0.009618	0.035954	-0.15201	-0.03694	-0.15836	0.01878	0.15771	-0.10206	0.023888	-0.07769	
388	143	-0.18125	0.098013	-0.12092	-0.01084	-0.1421	0.072348	-0.07504	-0.12302	0.025156	0.061045	
700	143	0.050461	0.199555	-0.11204	0.132055	-0.0907	0.123947	-0.09216	-0.194	0.076832	0.107149	
2382	143	-0.18843	0.059562	-0.01253	0.157377	0.198419	-0.16239	-0.08075	-0.12921	0.02189	-0.01361	
3988	143	-0.08021	-0.13766	0.147057	0.098127	0.078717	-0.19949	-0.01553	0.116043	0.136818	0.026092	
5	144	-0.0441	0.076024	-0.13735	0.012686	-0.04226	-0.07905	-0.17032	0.09145	-0.08114	-0.04034	
388	144	-0.10471	-0.02181	0.050905	-0.18663	-0.01816	-0.08718	-0.16719	-0.19626	0.179586	-0.1605	
700	144	-0.13076	0.079897	-0.04839	-0.18218	-0.12598	-0.14623	-0.03852	0.150143	0.051578	-0.13773	
2382	144	0.039896	-0.00558	0.069996	0.097354	-0.11743	0.116962	-0.16769	-0.08606	0.037782	-0.13491	
3988	144	0.016322	-0.10507	-0.06349	-0.17796	-0.02446	0.103186	0.147509	-0.17088	-0.11253	0.11707	

<sup>1</sup> The number of scenario types is subject to change from time to time and will be reflected in the STVRPFs. HKSCC will notify CPs before any change is made in accordance with applicable CCASS rules/operational procedures.

**RPF03:**

This file includes instrument price returns based on theoretical correlation break scenarios.

Valuation_DT	31/12/2018										
STV_Corr_Type	2										
STV_Corr_Count	1000										
STV_Corr_CL	0.994										
STV_Corr_Measure	4										
InstrumentID	FieldType	1	2	3	4	5	6	7	8	9	10
5	151	0.042785	-0.01543	-0.01145	-0.07724	0.085643	0.019257	-0.05005	0.024593	-0.04111	0.083232
388	151	-0.11201	-0.38704	-0.3573	0.257174	-0.33294	0.145409	0.306879	-0.36538	-0.27966	-0.13866
700	151	-0.08792	0.209312	-0.47142	0.40716	-0.32047	-0.22076	-0.46963	0.37638	0.36665	0.21155
2382	151	-0.16407	-0.39387	0.260085	0.149679	0.038775	-0.00401	-0.14783	0.000955	0.45865	0.364747
3988	151	0.327098	0.467861	0.031924	-0.39301	0.389593	0.224297	0.439745	-0.38357	-0.32952	0.190893
5	152	0.152461	-0.17231	-0.08747	0.165909	-0.16213	0.013785	-0.01215	-0.04377	-0.16121	0.025916
388	152	-0.0191	0.127477	0.03654	-0.04792	-0.17465	0.068532	-0.15807	-0.09536	-0.10209	-0.00848
700	152	-0.11458	0.064708	-0.04071	-0.06039	0.174856	0.136617	0.16064	-0.12153	-0.01664	0.103371
2382	152	-0.17284	0.184443	-0.09304	0.154146	-0.13617	0.11319	-0.06767	-0.15546	0.177506	0.199026
3988	152	0.028799	-0.12513	0.055664	-0.08348	0.003479	0.121075	0.018829	-0.18753	0.055642	0.187428
5	153	0.124111	0.099477	0.140481	-0.11623	-0.09318	-0.19042	0.061231	0.171526	-0.02407	-0.17344
388	153	0.089352	0.149179	-0.09512	0.132425	-0.11972	0.136078	0.012483	-0.16106	-0.19156	0.109139
700	153	0.121131	-0.09652	-0.01788	-0.00248	-0.04523	-0.13583	0.053251	-0.12813	0.095186	-0.10538
2382	153	0.002067	-0.12369	0.037874	0.04932	-0.17246	-0.14923	-0.08221	0.162254	-0.10957	-0.03193
3988	153	0.072513	-0.13058	-0.17164	-0.15128	-0.00541	0.159497	0.044046	-0.06535	0.197505	0.041857
5	154	-0.17152	0.031143	-0.04457	0.081296	-0.05378	0.148783	0.028958	-0.04597	-0.03716	-0.08071
388	154	-0.18146	0.199085	-0.09401	0.092357	0.062826	0.185001	0.152124	-0.09221	-0.1506	0.112995
700	154	0.085422	-0.03221	-0.08649	0.119846	0.195032	0.014166	-0.15512	0.064789	0.068589	0.019141
2382	154	-0.00472	-0.05165	-0.1633	0.089213	-0.10072	0.151029	-0.1831	-0.16184	0.063938	0.009832
3988	154	0.157378	-0.02037	0.169272	-0.01829	-0.11741	0.184122	0.068445	-0.19536	0.057308	-0.07257

**RPF04:**

This file includes instrument price returns based on all other stress scenarios (i.e., historical stress scenarios, hypothetical macroeconomic stress scenarios, idiosyncratic stress scenarios and corporate action scenarios).

Valuation_DT	31/12/2018										
Hist_Scen_Count	280										
Hypo_Scen_Count	60										
Idio_Scen_Count	2										
CA_Count	2										
InstrumentID	FieldType	1	2	3	4	5	6	7	8	9	10
5	111	0.015255	-0.31184	0.097077	-0.41698	-0.4151	0.300343	-0.36325	-0.02806	-0.35634	0.230026
388	111	0.039385	-0.01077	-0.36205	-0.09183	-0.49631	-0.28764	-0.03218	-0.21194	-0.04712	-0.36756
700	111	-0.21866	0.057106	-0.36478	0.188223	0.397756	-0.44455	-0.37821	-0.08746	0.283614	0.126334
2382	111	0.034012	-0.52175	-0.49008	0.376572	0.220803	0.403259	0.241571	-0.32431	0.413783	-0.01823
3988	111	0.145886	-0.3536	-0.18198	0.141961	-0.03581	-0.13838	-0.40672	-0.00146	0.455902	0.49105
5	121	0.035128	0.136897	-0.41699	0.194295	-0.00619	-0.00797	-0.48128	-0.31189	-0.47004	0.112402
388	121	-0.22625	-0.42921	-0.02185	-0.32652	-0.21022	-0.41635	-0.33571	-0.27413	-0.00254	-0.21627
700	121	-0.02967	-0.22839	0.168302	-0.07197	0.26778	0.030897	-0.00917	0.147003	0.33789	0.245275
2382	121	-0.1981	-0.03751	-0.14194	0.002568	-0.16485	0.184694	-0.46117	0.276549	-0.41091	0.457551
3988	121	-0.43387	-0.33047	0.210104	-0.09636	-0.36201	0.031261	0.063613	-0.1372	-0.12829	-0.32137
5	131	0.4	-0.4								
388	131	0.4	-0.4								
700	131	0.4	-0.4								
2382	131	0.4	-0.4								
3988	131	0.4	-0.4								
DSP700	161	0.5	-0.5								
SRI2382	161	0.5	-0.5								

## 2.2 Specifications of Stress Testing Risk Parameter Files

Field Name	Description	Format
Valuation_DT	Valuation date	DD/MM/YYYY
STV_Corr_Type	Type of theoretical stress scenarios	1 – Theoretical correlation boost scenarios 2 – Theoretical correlation break scenarios
STV_Corr_Count	Number of theoretical correlation break and boost stress scenarios	INTEGER (X,0) <sup>2</sup> ; e.g. 1,000 means 1,000 theoretical correlation break and 1,000 correlation boost scenarios
STV_Corr_CL	Confidence level of theoretical correlation break and boost stress scenarios	DECIMALS (X,10) <sup>2</sup> ; e.g. 0.994
STV_Corr_Measure	Risk measure type of theoretical correlation break and boost stress scenarios	4 – FHS ES (Discrete) <sup>3</sup>
Hist_Scen_Count	Number of historical stress scenarios	INTEGER (X,0); e.g. 280
Hypo_Scen_Count	Number of hypothetical macroeconomic stress scenarios	INTEGER (X,0); e.g. 60
Idio_Scen_Count	Number of idiosyncratic stress scenarios	INTEGER (X,0); e.g. 2
CA_Count	Number of Corporate action (“CA”) scenarios	INTEGER (X,0); e.g. 2
InstrumentID	Instrument identifier for HKSCC products	TEXT
FieldType	Type of stress scenarios	111 - Historical stress scenarios 121 - Hypothetical macroeconomic stress scenarios 141 - 144 Theoretical correlation boost scenarios 151 - 154 Theoretical correlation break scenarios 131 - Idiosyncratic stress scenarios 161 - Corporate action scenarios
Numbers next to FieldType	Scenario numbers	INTERGER (X,0); e.g. 1
RiskScen (values under each scenario)	% return scenarios for various FieldTypes	DECIMALS (X,10); e.g. 0.222 means 22.2%

## 3. CALCULATION OF STRESS TEST VALUE (“STV”)

### 3.1 Required Inputs

#### 3.1.1 Risk Parameters

All required risk parameters are included in the Stress Testing Risk Parameter Files as described in §2, which will be disseminated to CPs on a daily basis.

<sup>2</sup> The second number in INTEGER() and DECIMALS() refers to the maximum decimal places supported by STVRPFs.

<sup>3</sup> FHS ES stands for Filtered Historical Simulation Expected Shortfall, also known as Conditional Value-at-Risk (“CVaR”) or Expected Tail Loss (“ETL”) or average tail loss. It is the risk measure calculated based on Exponential Weighted Moving Average (“EWMA”) rescaled historical returns in the look-back period. “Discrete” means only discrete data points on the distribution tail will be selected for calculation. There is no interpolation required between discrete data points.

### 3.1.2 Positions

The following position details of portfolios are required to calculate STV:

- InstrumentID (e.g., 5 for HSBC Holdings)
- Quantity<sup>4</sup> (e.g., -400 means to deliver 400 shares)
- Market value<sup>5</sup> in HKD equivalent

The above information for CPs' entire portfolios can be retrieved from "Marginable Position Report", which will be disseminated to CPs after each margin call and day-end margin estimation process<sup>6</sup>. When using the information in the "Marginable Position Report", please note that:

- For non-HKD denominated instruments, market values are converted to HKD equivalent, using the latest available FX rates without haircut when the position snapshot is captured;
- Positions covered by specific stock / cash collateral are excluded; and
- All positions are adjusted for corporate actions. CPs may access the relevant information in Marginable Position Report.

A sample portfolio is shown for illustration purpose as follows:

InstrumentID	Quantity	Market value in HKD equivalent
5	1,100	65,000
388	-110	-27,500
700	200	35,000
2382	-120	-14,000
3988	11,900	37,000
DSP700	50	1,000
SRI2382	-20	-500

## 3.2 Calculation Process

### 3.2.1 Overview of the Calculation Process for STV

STV is calculated based on the returns of stress scenarios in Stress Testing Risk Parameter Files and the positions of portfolios according to the steps as follows:

- Identify corporate action ("CA") positions and non-CA positions (See §3.2.2);
- Calculate scenario returns for non-CA positions (See §3.2.3);
- Calculate portfolio returns for CA positions (See §3.2.4); and
- Calculate the STV of the portfolio (See §3.2.5).

### 3.2.2 Identify Corporate Action ("CA") Positions and Non-CA Positions

CA positions are the entitlement-related positions after making corporate action adjustments (e.g., rights to be received), while non-CA positions are the normal positions after performing trade execution. The InstrumentID of CA positions can be identified by using the information under "FieldType 161" in Stress Testing Risk Parameter Files in RPF04.csv.

<sup>4</sup> Positive values refer to long positions. Negative values refer to short positions.

<sup>5</sup> The sign is determined by the position quantity. (i.e., Negative quantity means that market value is also negative.)

<sup>6</sup> The dissemination time is around 4:45 p.m. HKT on the same day.

Positions of the sample portfolio are separated to non-CA and CA positions as follows:

	InstrumentID	Quantity	Market value in HKD equivalent
<b>Non-CA positions</b>	5	1,100	65,000
	388	-110	-27,500
	700	200	35,000
	2382	-120	-14,000
	3988	11,900	37,000
<b>CA positions</b>	DSP700	50	1000
	SRI2382	-20	-500

### 3.2.3 Calculate Scenario Returns for Non-CA Positions

Non-CA positions are subject to stress testing scenarios as follows:

- Historical and hypothetical macroeconomic scenarios (FieldTypes 111 and 121);
- Hypothetical correlation boost scenarios (FieldTypes 141 to 144);
- Hypothetical correlation break scenarios (FieldTypes 151 to 154); and
- Idiosyncratic stress scenarios (FieldType 131).

Step-by-step calculation process is shown as follows:

**Step 1: For each stress scenario under FieldType 111 (i.e. historical scenarios), there is a price return for each instrument.**

FieldType	InstrumentID	Scenario 1	Scenario 2	...	Scenario 280
111	5	0.015255	-0.311836	...	-0.295591
111	388	0.039385	-0.010769	...	-0.435796
111	700	-0.218663	0.057106	...	-0.157170
111	2382	0.034012	-0.521747	...	0.447506
111	3988	0.145886	-0.353600	...	0.228651

For example, returns of each of the instruments in scenario 1 are calculated as follows:

**= Instrument market value (A) x Relevant scenario return (B)**

InstrumentID	Market value in HKD equivalent (A)	Scenario 1 return (B)	Instrument return of Scenario 1 (C) = (A) x (B)
5	65,000	0.015255	991.5750
388	-27,500	0.039385	-1,083.0875
700	35,000	-0.218663	-7,653.2050
2382	-14,000	0.034012	-476.1680
3988	37,000	0.145886	5,397.7820
<b>Portfolio return of scenario 1 = sum of all instrument returns</b>			<b>-2,823</b> <i>(rounded off to the nearest integer)</i>

**Step 2: Repeat the same calculation process for other stress scenarios under FieldType 111.**

FieldType	InstrumentID	Scenario 1	Scenario 2	...	Scenario 280
111	5	991.5750	-20,269.3400	...	-19,213.4150
111	388	-1,083.0875	296.1475	...	11,984.3900
111	700	-7,653.2050	1,998.7100	...	-5,500.9500
111	2382	-476.1680	7,304.4580	...	-6,265.0840
111	3988	5,397.7820	-13,083.2000	...	8,460.0870
<b>Portfolio return under FieldType 111</b>		<b>-2,823</b>	<b>-23,753</b>	<b>...</b>	<b>42,165</b>

**Step 3: Repeat the same calculation process for stress scenarios under FieldType 121 (i.e., hypothetical macroeconomic scenarios).**

FieldType	InstrumentID	Scenario 1	Scenario 2	...	Scenario 60
<b>Portfolio return under FieldType 121</b>		<b>-5,813</b>	<b>1,006</b>	<b>...</b>	<b>-10,535</b>

**Step 4: Repeat the same calculation process for stress scenarios under FieldTypes 141, 142, 143, 144, 151, 152, 153 and 154 (i.e., hypothetical correlation boost and break scenarios).**

FieldType	InstrumentID	Scenario 1	Scenario 2	...	Scenario 1,000
<b>Portfolio return under FieldType 141</b>		<b>-23,216</b>	<b>-1,375</b>	<b>...</b>	<b>-22,686</b>
<b>Portfolio return under FieldType 142</b>		<b>-1,482</b>	<b>-7,285</b>	<b>...</b>	<b>-7,327</b>
<b>Portfolio return under FieldType 143</b>		<b>7,046</b>	<b>699</b>	<b>...</b>	<b>-3,990</b>
<b>Portfolio return under FieldType 144</b>		<b>-4,518</b>	<b>4,528</b>	<b>...</b>	<b>2,502</b>
<b>Portfolio return under FieldType 151</b>		<b>17,184</b>	<b>39,791</b>	<b>...</b>	<b>4,715</b>
<b>Portfolio return under FieldType 152</b>		<b>9,910</b>	<b>-19,653</b>	<b>...</b>	<b>1,806</b>
<b>Portfolio return under FieldType 153</b>		<b>12,504</b>	<b>-4,115</b>	<b>...</b>	<b>3,875</b>
<b>Portfolio return under FieldType 154</b>		<b>2,720</b>	<b>-4,608</b>	<b>...</b>	<b>4,279</b>

**Step 5: A portion of the non-CA positions are also subject to stress testing under idiosyncratic stress scenarios (FieldType 131).**

(A) Determine non-CA positions subject to stress testing under idiosyncratic stress scenarios

- (i) Rank the market value in HKD equivalent of
- Each non-CA position with Quantity  $\geq 0$  in descending order; or
  - Each non-CA position with Quantity  $< 0$  in ascending order



- (ii) Count the total number of non-CA positions with Quantity  $\geq 0$  and that with Quantity  $< 0$

Non-CA positions with	Quantity $\geq 0$			Quantity $< 0$		
Rank	Instrument ID	Quantity	Market value in HKD equivalent	Instrument ID	Quantity	Market value in HKD equivalent
1	5	1,100	65,000	388	-110	-27,500
2	3988	11,900	37,000	2382	-120	-14,000
3	700	200	35,000			
<b>Total number of instruments</b>	3			2		

For all non-CA positions, their respective numbers of instruments subject to stress testing under idiosyncratic scenarios are calculated as follows:

$$= \text{Total numbers of instruments} \times 1\%^7$$

(rounding up to the nearest integer)

- (iii) Select the non-CA positions from top to bottom based on the numbers of instruments determined above. These positions will be subject to stress testing under idiosyncratic scenarios as below:

Non-CA positions with	Quantity $\geq 0$			Quantity $< 0$		
<b>Number of instruments (rounding up to the nearest integer)</b>	= $3 \times 1\%$ = 1			= $2 \times 1\%$ = 1		
<b>Positions</b>	Instrument ID	Quantity	Market value in HKD equivalent	Instrument ID	Quantity	Market value in HKD equivalent
	5	1,100	65,000	388	-110	-27,500

(B) Determine portfolio returns under idiosyncratic stress scenarios

In FieldType 131 of RPF04.csv file, there are two stress scenarios with price returns for each instrument:

- Scenario 1 is applied to the positions with Quantity  $< 0$ ; and
- Scenario 2 is applied to the positions with Quantity  $\geq 0$ .

FieldType	InstrumentID	Scenario 1 return	Scenario 2 return
131	5	0.4	-0.4
131	388	0.4	-0.4

<sup>7</sup> The percentage floor is subject to change from time to time. HKSCC will issue circulars to notify the market before any change is made.

Calculate portfolio returns under idiosyncratic scenarios as follows:

**= Non-CA positions x Respective return for scenario 1 or 2**

InstrumentID	Quantity	Market value in HKD equivalent	Scenario 1 return	Scenario 2 return
5	≥ 0	65,000	-	-26,000
388	< 0	-27,500	-11,000	-

The portfolio returns in scenarios 1 and 2 under FieldType 131 are as follows:

FieldType	InstrumentID	Scenario 1	Scenario 2
Portfolio return under FieldType 131		-11,000	-26,000

### Step 6: Determine portfolio returns under each FieldType.

The portfolio returns of each FieldType are determined based on different methodologies as follows:

FieldType	Portfolio return determination methodology	Portfolio return
111	Minimum of the 280 scenarios	-54,394
121	Minimum of the 60 scenarios	-42,610
141	Average of the worst 6 scenarios <sup>8</sup> (out of the 1000 scenarios)	-62,401.8333
142		-24,866.8333
143		-23,977.3333
144		-26,720.5
151		-45,107.8333
152		-26,018.1667
153		-26,637.6667
154		-23,996.8333
131	Minimum of the 2 scenarios	-26,000

#### 3.2.4 Calculate Portfolio Returns for CA Positions

CA positions are stressed separately from non-CA positions.

The STV of CA positions is the sum of:

- (i) Market values in HKD equivalent of CA positions with Quantity ≥ 0 multiplied by the corresponding price return under FieldType 161 in scenario 2; and
- (ii) Market values in HKD equivalent of CA positions with Quantity < 0 multiplied by the corresponding price return under FieldType 161 in scenario 1.

<sup>8</sup> (1-99.4% (STV\_Corr\_CL)) x 1000 (STV\_Corr\_Count) scenarios = 6 scenarios, rounding up to the nearest integer.

The output is shown as follows:

FieldType	InstrumentID	Scenario 1	Scenario 2
161	DSP700	0.5	-0.5
161	SRI2382	0.5	-0.5

InstrumentID	Quantity	Market value in HKD equivalent (A)	Scenario return applied (B)	Instrument return (C) = (A) x (B)
DSP700	≥ 0	1,000	-0.5 (Scenario 2)	-500
SRI2382	< 0	-500	0.5 (Scenario 1)	-250
<b>Portfolio return of CA positions = sum of instrument returns</b>				<b>-750</b> <i>(rounded off to the nearest integer)</i>

### 3.2.5 Calculate the STV of the Portfolio

The STV is the sum of:

- (i) Absolute value of the worst portfolio return among different stress testing scenarios of non-CA positions; and
- (ii) Absolute value of the portfolio return of CA positions.

STV of the portfolio

= Absolute value of [Minimum (Portfolio returns FieldType 111, 121,141 to 144, 151 to 154, 131)] + Absolute value of [Portfolio return of scenario FieldType 161]

= Absolute value of [Minimum (-54,394 , -42,610 , -62,401.8333 , -45,107.8333 , -26,000)] + Absolute value of [-750]

= 62,402 (rounding up to the nearest integer) + 750

= **63,152**