

**To Daiwa Securities Capital Markets
Algorithmic Trading Suites**

VWAP4.2 Algorithm Specifications

Confidential

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【Revision History】

Version	Chapter	Details	Date	Editor
1.0	—	First edition	2011/03/02	Kobayashi
1.1	5	Volume Limit can be set second decimal place.	2011/03/02	Kobayashi
	4.2	While SQ. VWAP doesn't cancel cross.	2011/03/02	Kobayashi
	4.3	The target qty right after open is the same as continuous session.	2011/03/03	Kobayashi
	1.2	NSE is supported.	2011/03/03	Kobayashi
	4.2	Cross qty is capped by trading qty.	2011/03/03	Kobayashi
	4, 8	Add VWAP4.1 spec.	2011/03/03	Kobayashi
1.2	4.1.1	Calculate volume curve (B) and (C) with fourth decimal place in order to avoid volume curve (B) and (C) being the same qty.	2011/03/03	Kobayashi
	4.2	When cumQty < volume curve(B), amend the slice on near side to more aggressive price by 1 tick	2011/03/03	Kobayashi
1.3	4.1.2	The insufficient qty is not sliced from the slice at pm auction.	2011/03/07	Kobayashi
	4.1.1	Curve C start as a negative number.	2011/03/07	Kobayashi
	4.5.7	Change the calculation of time risk factor to prevent delay of small order.	2011/03/07	Kobayashi
	4.1.2	vwap can borrow qty by Curve A + 0.5lot	2011/03/07	Kobayashi
	4.1	If the far side is out of limit price, cross qty is zero	2011/03/07	Kobayashi
	3.3.4	Front-weight short sells and finish early	2011/03/07	Kobayashi
	-	Delete "Calculation of release size in case "Number of Release Points" is equal to Number of Order Slices."	2011/03/07	Kobayashi
	-	Delete "Child Order Release and Amendment" because now these are based on volume curves and ahead/behind time.	2011/03/07	Kobayashi
	4.1, 4.2, 4.4	Add VWAP4 new and amend order spec.	2011/03/07	Kobayashi
	3.2	Change the calculation of Theoretical # slices in order to keep queue priority.	2011/03/07	Kobayashi
1.4	8	Dark Limit and Dark Peg	2011/03/14	Kobayashi
1.5	4	Add "Ahead Time Weight" and "Behind Time Weight" parameters	2011/03/16	Kobayashi
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1. Purpose and Overview of VWAP

1.1 Algorithm Overview

Newly enhanced algorithm calculates number of child orders, release timing, and order quantity based on historical 20 days volume, and releases the order along with volume curve. This aims to achieve sophisticated release schedule to meet VWAP (Volume Weighted Average Price) in full.

1.2 Targeted Exchanges

TSE, OSE, Hercules, Jasdaq and NSE are supported.

2. Preconditions

2.1 Tick Data Capturing

Source data to generate volume curve is captured from PT2 database. In case tick data is not available on PT2, the name is out of the scope for this algorithm.

2.2 Caution / Particular Note with the Model

Caution/particular when using this algorithm is as follows.

- Volume curve data
 - Newly listed name is out of scope for volume curve analysis. In this case, 3 or more business days' (including listing date) tick-data does not exist.
 - ※ To meet with existing VWAP (VWAP1) specification, historical 3-business days' is required at least.
 - The case of merger between listed companies
Volume curve for new symbol after the merger is applied.
e.g. If name A (symbol "1111") and name B (symbol "9999") are merged and symbol "1111" is taken over for newly merged company, volume curve for "1111" is continuously used.
 - The case that number of issued shares has got changed by 20% due to corporate action
for first 3 business days since corporate action day, only 1 trading lot is placed in opening auction with volume limit.
 - If appropriate volume curve does not exist, use fixed volume curve.
 - * In SQ day, use fixed volume curve for SQ day.

- Inferential average volume (regression analysis)

In the following case, the model is numerically not applicable.

- Only 2 or less days' data is available within historical 20 days' tick-data (No trades on 18 days)
 - ① tick exist in the same minute for only 2 or less days
 - ② There is 1 tick per trading session (either AM or PM session) in a day
(in this case, tick is opening auction only and data is ignored from intra day analysis)
 - ③ There are only 2 ticks per trading session (either AM or PM session) in a day and second tick is closing auction one.
(Since only opening and closing tick are available, this is out of scope from intra day analysis)
 - ④ There are only opening tick and closing tick in either AM session or PM session, and there is no data excluding opening one and closing one.

In the following case, the model may not work properly.

- 3 or more days' data is available within historical 20 days' tick-data but inferential average volume calculated from intraday tick analysis (slope of regression line with Tick-Volume plot) becomes zero or negative number.
 - ① Not many enough sampling points within Tick-Volume plot
 - ② Number of tick during intra day is increasing, but volume is decreasing
 - ③ 2 or more than minimum values of standard deviation exist in the same order period but the number of ticks is less than 3 in the same period
 - * This can happen when the order is extremely huge

The above situation can happen, if average number of ticks per day is less than 100 and liquidity (participation rate against average daily volume, %ADV hereby) is over 100%.
- Number of total issued shares has got changed remarkably by corporate action within historical 20 business days
 - * Remarkable change mentioned above means over 20% changes (impact may be different for each name)
- Liquidity (%ADV) is over 30%

3. Parent Order Analysis Process

3.1 Release Points

Release points are time slots that each algorithmic trading model can release new child order. Release points for VWAP model are every 1-minute during continuous trading session and AM/PM session opening auction.

In case of TSE, release point is as follows.

AM session 121 points (AM opening and every 1-minute from 9:00 to 11:00(※))

PM session 151points (PM opening and every 1-minute from 12:30~15:00(※), 161 for OSE from 12:30 to 15:10)

Total 272 points (282 points for OSE)

※ This model does not release the order on trading session end time, but it includes end time as release point to calculate order exclusion points.

However, the model excludes the following release point.

- ✓ AM session end time (11:00)
- ✓ Order exclusion points including PM session end time
If the parameter [Order Exclude Point] is "4", then release point becomes until 14:56. In case of OSE, release point is until 15:06.
- ✓ If the parameter [Board End Time Exclude Point] is set on client master, the model excludes the minutes of these slots before PM session end time from release point.
- ✓ If the parameters [Order Start Time] and [Order End Time] are set on parent order, the model excludes any other time slots from release point.

3.2 AM% function

Create schedule that can execute AM% of the order size in AM session by adjusting volume curve.
(AM% is algorithm parameter)

1. Adjust AM%

$$\text{Adjusted AM\%} = ((\text{OrderQty} \times \text{AM\%}) - \text{CumQty}) / \text{OrderQty}$$

2. CalculateAM VolumeCurveAdjustRatio, PM VolumeCurveAdjustRatio

$$\text{AM VolumeCurveAdjustRatio} = \text{Adjusted AM\%} / \text{sum of AM VolumeRatio}$$

$$\text{PM VolumeCurveAdjustRatio} = (100 - \text{Adjusted AM\%}) / \text{sum of PM VolumeRatio}$$

3. Multiply each am volume curve ratio and AM VolumeCurveAdjustRatio

Multiply each pm volume curve ratio and PM VolumeCurveAdjustRatio

* If order size <= 3 lot, AM% does not work.

* After 11:00, AM% cannot be amended.

* Amended AM% < CumQty / OrderQty *100 -> reject

* Reslice after AM% amended.

* After 11:00 receive order with AM% > 0% -> reject

3.3 Child Order Release schedule

1. Correction of Volume Ratio

The model obtains volume ratio from volume curve table and corrects volume ratio considering trade start time, end time, and order exclusion points.

2. Number of Order Slices

The model decides the number of child order slices as follows.

① Compute theoretical number of child order slices

$$\text{Theoretical \# slices} = \text{MAX}(\text{ord qty} \div (\text{inferential avg vol} \times \text{inferential avg vol adjustment(\%)}), \text{min \# slices, Order duration} / ((\text{Allowed ahead time} + \text{Allowed behind time}) \div 2))$$

※ Round up decimal points

※ Inferential average volume adjustment (%) is defined on parameters table

② Calculate actual number of order slices by "theoretical # slices", "order quantity / lot-size", and "release schedule on parent order parameters".

$$\text{\# order slices} = \text{MIN}(\text{theo \# order slices, number of trading lot, \# release point})$$

3. Release Point Ratio (%)

Calculate release point ratio by number of order slices decided in 4.2.2 (AM open and PM open are out of the calculation). Avoid the case that final release slot= trade end time. ※ round up at 4 decimal points

(In case that trade time includes AM open and PM open)

$$\text{Release point ratio (\%)} = (100(\%) - \text{volume ratio of AM opening and PM opening (\%)}) \div (\text{\# order slices} - 1)$$

(In case that trade time does not include PM open)

$$\text{Release point ratio (\%)} = (100(\%) - \text{volume ratio of AM opening (\%)}) \div \text{\# order slices}$$

(In case that trade time does not include AM open)

$$\text{Release point ratio (\%)} = (100(\%) - \text{volume ratio of PM opening (\%)}) \div \text{\# order slices}$$

(In case that trade time includes neither AM open nor PM open)

$$\text{Release point ratio (\%)} = (100(\%)) \div (\text{\# order slices} + 1)$$

4. Release Points

① Sum up volume ratio excluding AM/PM opening, and treat the points above release point ratio as theoretical release points.

If order has trade start/end time parameters, recalculate volume curve based on trade start/end time.

※ may be less than number of order slices

※ Regenerate volume curve without order exclusion points, if order parameter [Order Exclude Point] or [Board End

- Time Exclude Point] on client master is set.
- ② Adjust theoretical release points by adjustment points and use them as adjusted release points. These adjusted release points are used as actual release points.
 - ※ if theoretical release points are on AM opening or PM opening, the model does not make this adjustment
 - ③ As the result of making this adjustment, there may be a case that adjusted release points are outside of effective trade time. In such a case, consolidate release points into first release point if adjustment point is negative, last release point if positive.
 - ※ Exclude AM open/close and PM open/close
 - ※ If adjusted release points in PM session come across lunch time, put all together into PM session start time(12:30).
- If “Number of release points” is equal to number of order slices
Treat all available release points as release point
- Release points in case 2 or more orders with same name, same exchange, same B/S side exist
Multiple orders may have same release points in this case, but the model slides actual release timing randomly at parent order level. (Please refer to Section 5 about child order release more in detail)

The below is the sample of release points methodology.

(example 1) All day VWAP order, 『Release Point Ratio = 1.2%』, 『Adjustment point = -1』

20 days	Time	AM OP	9:00	9:01	9:02	9:03	9:04	9:05	9:06	9:07	9:08	9:09	9:10	9:11	9:12	~
Average	Volume ratio	7.40%	0.29%	0.24%	0.30%	0.22%	0.17%	0.49%	0.53%	0.45%	0.27%	0.46%	0.39%	0.43%	0.90%	~
	cumulative vol ratio	—	0.29%	0.53%	0.83%	1.05%	1.22%	1.71%	2.24%	2.69%	2.96%	3.42%	3.81%	4.24%	5.14%	~
	Theo release point	○					○			○			○		○	~
	Adj release point	○				○			○			○		○		~

(Example 1) All day VWAP order, 『Release Point Ratio = 1.2%』, 『Adjustment point = -5』

20 days	Time	AM OP	9:00	9:01	9:02	9:03	9:04	9:05	9:06	9:07	9:08	9:09	9:10	9:11	9:12	~
Average	Volume ratio	7.40%	0.29%	0.24%	0.30%	0.22%	0.17%	0.49%	0.53%	0.45%	0.27%	0.46%	0.39%	0.43%	0.90%	~
	cumulative vol ratio	—	0.29%	0.53%	0.83%	1.05%	1.22%	1.71%	2.24%	2.69%	2.96%	3.42%	3.81%	4.24%	5.14%	~
	Theo release point	○					○			○			○		○	~
	Adj release point	○	○		○			○		○			○			~

- ※ Theo release point at 09:04 turns into 8:59 order with “-5” adjustment and it is out of the release range.
Thus, move it into 9:00 release point where first eligible release point other than opening.

(Example 2) Time VWAP order [09:30~10:30], 『Release Point Ratio = 1.2%』, 『Adjustment point = -2』

20 days	Time	09:30	09:31	09:32	09:33	09:34	09:35	09:36	09:37	09:38	09:39	09:40	09:41	09:42	09:43	~
Average	Volume ratio	0.18%	0.27%	0.30%	0.24%	0.26%	0.36%	0.57%	0.16%	0.20%	0.32%	0.38%	0.22%	0.37%	0.28%	~
	Timed volume ratio	1.16%	1.77%	1.98%	1.55%	1.67%	2.37%	3.73%	1.05%	1.31%	2.07%	2.47%	1.45%	2.41%	2.33%	~
	Cumulative timed volume ratio	1.16%	2.93%	4.92%	6.47%	8.14%	10.51%	14.24%	15.29%	16.60%	18.68%	21.15%	22.60%	25.01%	26.86%	~
	Theo release point		○	○	○	○	○	○	○	○	○	○	○	○	○	~
	Adj release point	○	○	○	○	○	○	○	○	○	○	○	○	○	○	~

- ※ Timed volume ratio is re-calculated from volume ratio, as cumulative volume ratio from 09:30 to 10:30 is 100%.
Note: 0% at 09:29
- ※ Theoretical release point at 09:31 turns into 9:29 order with “-2” adjustment and it is out of release range. Thus, move it into 9:30 release point where first eligible release point.
- ※ In this case, actual number of order slices is less than computed number of order slices.

3.4 Child Order Release size

3.4.1 Calculation Method of Release Size based on Volume Curve

- ① Calculate volume ratio every minute based on historical 20 days' volume curve.
- ② Generate cumulative adjusted volume ratio where cumulative volume ratio at final theoretical release point becomes 100%.
- ③ Calculate cumulative release size at each theoretical release point by cumulative adjusted volume ratio. (round down by lotsize)
- ④ Consider (cumulative release size – already released size)[※] as release size at each theoretical release point.
 ※ If (cumulative release size - already release size) is zero excepting AM/PM opening, no release at that point.

(Example 1) 『Order size = 10,000』, 『Cumulative volume ratio at final release point = 99.14%』, 『No volume limit』

20 days' Average	Time	AM OP	9:00	9:01	9:02	9:03	9:04	9:05	9:06	9:07	9:08	9:09	9:10	09:11	09:12	~
	Volume ratio	7.40%	0.29%	0.24%	0.30%	0.22%	0.17%	0.49%	0.53%	0.45%	0.27%	0.46%	0.39%	0.43%	0.90%	~
	Cumulative vol ratio	7.40%	7.69%	7.93%	8.23%	8.45%	8.63%	9.12%	9.65%	10.11%	10.38%	10.84%	11.23%	11.66%	12.56%	~
	Cumulative adj volume ratio	7.46%	7.76%	8.00%	8.30%	8.52%	8.70%	9.20%	9.73%	10.20%	10.47%	10.93%	11.33%	11.76%	12.67%	~
	Theo release point	○				○			○			○			○	~
	Cumulative release size	700	700	800	800	800	800	900	900	1,000	1,000	1,000	1,100	1,100	1,200	~
	Adj release point	○			○			○			○			○		~
	Release size	700			100			100			100			100		~

(Example 2) 『Order size = 10,000』, 『Cumulative adjusted volume ratio at final release point = 99.14%』, 『No volume limit』.

20 days' Average	Time	09:30	09:31	09:32	09:33	09:34	09:35	09:36	09:37	09:38	09:39	09:40	09:41	09:42	09:43	~
	Volume ratio	0.18%	0.27%	0.30%	0.24%	0.26%	0.36%	0.57%	0.16%	0.20%	0.32%	0.38%	0.22%	0.37%	0.28%	~
	Timed volume ratio	1.16%	1.77%	1.98%	1.55%	1.67%	2.37%	3.73%	1.05%	1.31%	2.07%	2.47%	1.45%	2.41%	2.33%	~
	Cumulative timed volume ratio	1.16%	2.93%	4.92%	6.47%	8.14%	10.51%	14.24%	15.29%	16.60%	18.68%	21.15%	22.60%	25.01%	26.86%	~
	Cumulative adj volume ratio	1.17%	2.96%	4.96%	6.53%	8.21%	10.60%	14.36%	15.42%	16.74%	18.84%	21.33%	22.80%	25.23%	27.09%	~
	Theo release point		○	○	○	○	○	○	○	○	○	○	○	○	○	~
	Cumulative release size	100	200	400	600	800	1,000	1,400	1,500	1,600	1,800	2,100	2,200	2,500	2,700	~
	Adj release point	○	○	○	○	○	○	○	○	○	○	○	○	○	○	~
	Release size	400	200	200	200	400	100	100	200	300	100	300	200	300		~

※ Adjusted release point 09:30 is consolidated point with 09:31 and 09:32, so consider release size as cumulative release size at final theoretical order release point(09:32).

3.4.2 Immediate Child Order Release when receiving the Order during Continuous Trading Session

When receiving order without volume limit during continuous trading session, the model runs the following processes for immediate child order release.

- Create child order for immediate release just after analyzing order.
- Release size should be half (round up by lotsize) of originally scheduled child order release size.

3.4.3 Adjust final order point in continuous session

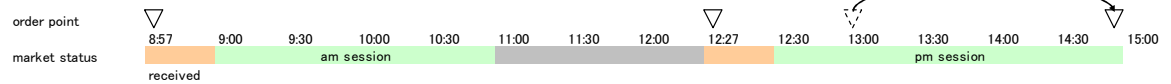
There is modification that the final order point will be set just before the "Order Exclude Point". Order points that meet the following conditions are the targets to be adjusted.

- Order point in continuous session
- The final order point of continuous session.
- Not the first order point (including pre-open)

No1

open order	ON
order point	3
order unit	5
end time	15:00
order exclude point	3

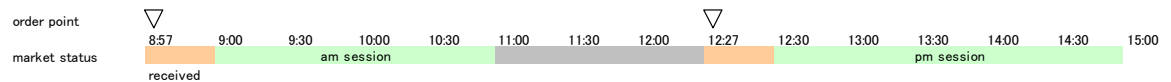
Adjust



No2

open order	ON
order point	2
order unit	5
end time	15:00
order exclude point	3

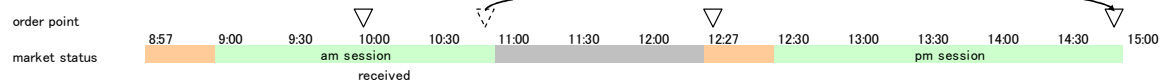
Not Adjust



No3

open order	ON
order point	3
order unit	5
end time	15:00
order exclude point	3

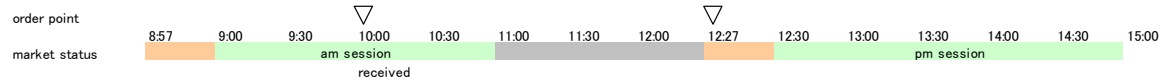
Adjust



No4

open order	ON
order point	2
order unit	5
end time	15:00
order exclude point	3

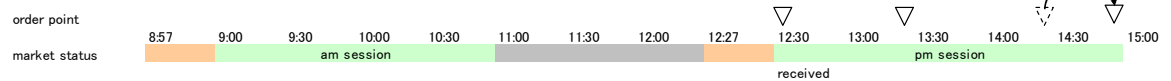
Not Adjust



No5

open order	ON
order point	3
order unit	5
end time	15:00
order exclude point	3

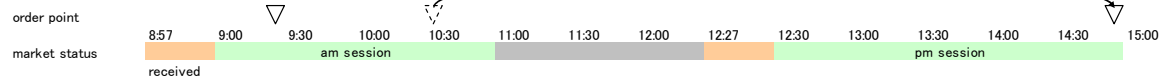
Adjust



No6

open order	OFF
order point	2
order unit	5
end time	15:00
order exclude point	3

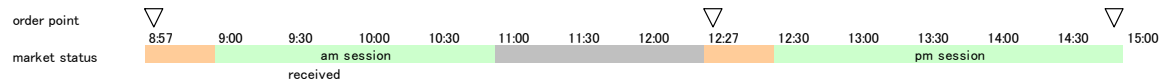
Adjust



No7

open order	ON
order point	3
order unit	5
end time	15:00
order exclude point	3

Not Adjust



3.4.4 Front-weight short sells and finish early

Short sell orders have low odds of completing. So do following.

1. Look at how many minutes of the end of the volume curve it would take historically to execute the average historic queue size (times 2 for bid and offer).
2. This then becomes the time the last slice gets sent out.
3. Set a cap in seconds by "Max SS OEP % of duration" that is algorithm parameter.
4. Ensure that it is not more than x% of the order's duration.
5. Floor it by the order exclude point.

No	Parameter Name	Description	Required	Parametric in FIX	Amendable	Default Value
1	Max SS OEP % of duration	Cap of front-weight %.	N	-	-	50
2	SS OEP Adjust Ratio	The ratio to adjust the average historic queue size.	N	-	-	1

The whole schedule then gets compressed to end that amount of time before the specified end time / market close.

3.4.5 Slice schedule and size of order which is received after order exclude point

If order receipt time is after the "order exclude point", the order's slice schedule and size will be as follows.

- Slice schedule
 - ✓ Time for additional order
Additional orders can be released between the final release point and the trade end time.
 - ✓ Timing of additional order
Additional orders can be released every 5 seconds (*1) +/- 1 second.
- Release size
 - ✓ Order with no volume limit
[Release size] = [parent order quantity]
 - ✓ Order with volume limit
[Release size] = LOB volume * volume limit - sliced quantity

3.5 Correction of Child Order Release Time

Generate random 0~34 seconds (correction time of order release) per parent order and slide release point calculated in 『4.2 Child Order Release schedule』 by correction time of order release.

※ Applied roughly 30 seconds fibonacci number for random number interval.

3.6 Sample of Child Order Release Schedule

(Example) Toyota (7203) 『inferential average volume = 6,700』、『inferential avg vol adjustment(%) = 50%』、『min # slices = 34』

When receiving the order 167,500 shares (Amount is roughly 520M JPY) (※ Amount is based on close price as of 6-Feb-2009 3,090 Yen)

- ① Calculate number of order slices.

$$\text{Number of order slices} = 167,500 \text{ shares} \div (6,700 \times 50\%) = 50$$

- ② Calculate release point ratio

$$\text{Release point ratio} = (100\% - (6.30\% + 1.74\%)) \div (50 - 2 + 1) = 1.877\%$$

※ Round up at 4 decimal points

③ Generate theoretical release points and release size.

NO	Time	Vol ratio	Cum vol ratio (no opening)	Theo release point	Cum vol ratio	Adj vol ratio	Cum release size	Release size
1	AM Open	6.30%	-	○	6.30%	6.39%	10,700	10,700
2	0903	0.34%	1.98%	○	8.28%	8.40%	14,000	3,300
3	0907	0.46%	3.80%	○	10.10%	10.25%	17,100	3,100
4	0910	0.69%	5.81%	○	12.11%	12.29%	20,500	3,400
5	0913	0.62%	7.95%	○	14.24%	14.45%	24,200	3,700
6	0916	0.83%	10.01%	○	16.31%	16.54%	27,700	3,500
7	0919	0.48%	11.58%	○	17.88%	18.14%	30,300	2,600
8	0923	0.55%	13.48%	○	19.78%	20.07%	33,600	3,300
9	0926	0.61%	15.32%	○	21.62%	21.93%	36,700	3,100
10	0930	0.37%	17.11%	○	23.41%	23.75%	39,700	3,000
11	0934	0.33%	18.89%	○	25.19%	25.55%	42,700	3,000
12	0938	0.48%	20.78%	○	27.08%	27.47%	46,000	3,300
13	0943	0.33%	22.75%	○	29.05%	29.47%	49,300	3,300
14	0948	0.55%	24.67%	○	30.97%	31.41%	52,600	3,300
15	0953	0.29%	26.49%	○	32.78%	33.26%	55,700	3,100
16	0958	0.34%	28.34%	○	34.64%	35.14%	58,800	3,100
17	1004	0.41%	30.31%	○	36.61%	37.14%	62,200	3,400
18	1008	0.34%	31.97%	○	38.26%	38.81%	65,000	2,800
19	1014	0.23%	33.86%	○	40.16%	40.74%	68,200	3,200
20	1019	0.45%	35.84%	○	42.14%	42.75%	71,600	3,400
21	1026	0.28%	37.66%	○	43.96%	44.59%	74,600	3,000
22	1032	0.39%	39.57%	○	45.87%	46.53%	77,900	3,300
23	1039	0.42%	41.41%	○	47.71%	48.39%	81,000	3,100
24	1046	0.23%	43.34%	○	49.64%	50.35%	84,300	3,300
25	1052	0.28%	45.21%	○	51.51%	52.25%	87,500	3,200
26	1057	0.36%	47.09%	○	53.39%	54.16%	90,700	3,200
27	PM Open	1.74%	-	○	55.92%	56.72%	95,000	4,300
28	1233	0.41%	49.12%	○	57.16%	57.98%	97,100	2,100
29	1238	0.27%	50.73%	○	58.77%	59.61%	99,800	2,700
30	1245	0.30%	52.66%	○	60.70%	61.57%	103,100	3,300
31	1252	0.30%	54.72%	○	62.77%	63.67%	106,600	3,500
32	1257	0.56%	56.39%	○	64.43%	65.36%	109,400	2,800
33	1305	0.27%	58.42%	○	66.47%	67.42%	112,900	3,500
34	1310	0.20%	60.08%	○	68.12%	69.10%	115,700	2,800
35	1319	0.33%	62.12%	○	70.16%	71.17%	119,200	3,500
36	1326	0.39%	64.15%	○	72.20%	73.23%	122,600	3,400
37	1333	0.21%	65.69%	○	73.73%	74.79%	125,200	2,600
38	1342	0.14%	67.61%	○	75.66%	76.74%	128,500	3,300
39	1351	0.18%	69.53%	○	77.57%	78.68%	131,700	3,200
40	1359	0.23%	71.53%	○	79.57%	80.71%	135,100	3,400
41	1405	0.33%	73.38%	○	81.43%	82.59%	138,300	3,200
42	1411	0.37%	75.30%	○	83.34%	84.54%	141,600	3,300
43	1418	0.23%	76.95%	○	84.99%	86.21%	144,400	2,800
44	1426	0.31%	79.05%	○	87.10%	88.34%	147,900	3,500
45	1433	0.33%	80.97%	○	89.01%	90.28%	151,200	3,300
46	1438	0.38%	82.70%	○	90.75%	92.04%	154,100	2,900
47	1444	0.40%	84.81%	○	92.86%	94.19%	157,700	3,600
48	1449	0.41%	86.69%	○	94.73%	96.09%	160,900	3,200
49	1453	0.51%	88.49%	○	96.54%	97.92%	164,000	3,100
50	1457	0.63%	90.55%	○	98.59%	100.00%	167,500	3,500

④ Slide release point by adjustment point. The following is the case of 『adjustment point =-1』.

Time	Release size
AM Open	10,700
0902	3,300
0906	3,100
0909	3,400
0912	3,700
0915	3,500
0918	2,600
~omission~	
1456	3,500

(Example) Toyota (7203) 『inferential average volume = 6,700』、『inferential avg vol adjustment(%) = 50%』、『min # slices = 34』

When receiving the order 134,000 shares (Amount is roughly 410M JPY) (※ Amount is based on close price as of 6-Feb-2009 3,090 Yen)

- ① Calculate number of order slices.

$$\text{number of order slices} = 167,500 \text{ shares} \div (6700 \times 50\%) = 40$$

- ② Calculate release point ratio.

$$\text{Release point ratio} = (100\%) \div (40 + 1) = 2.439\%$$

※ Round up at 4 decimal points

- ③ Generate theoretical release points and release size.

NO	Time	Vol ratio	Cum vol ratio (no opening)	Adj vol ratio	Cum adj volume ratio	Theo release point	Cum release size	Release size
1	0931	0.47%	0.84%	2.14%	3.82%	○	5100	5100
2	0932	0.45%	1.29%	2.08%	5.89%	○	7800	2700
3	0933	0.53%	1.82%	2.40%	8.29%	○	11100	3300
4	0934	0.33%	2.14%	1.49%	9.79%	○	13100	2000
5	0936	0.46%	3.07%	2.08%	14.00%	○	18700	5600
6	0937	0.49%	3.56%	2.26%	16.26%	○	21700	3000
7	0938	0.48%	4.04%	2.19%	18.45%	○	24700	3000
8	0939	0.33%	4.37%	1.50%	19.95%	○	26700	2000
9	0941	0.56%	5.34%	2.58%	24.38%	○	32600	5900
10	0943	0.33%	6.01%	1.49%	27.44%	○	36700	4100
11	0945	0.53%	6.77%	2.42%	30.91%	○	41400	4700
12	0946	0.35%	7.11%	1.58%	32.49%	○	43500	2100
13	0948	0.55%	7.92%	2.49%	36.19%	○	48500	5000
14	0949	0.45%	8.37%	2.04%	38.23%	○	51200	2700
15	0950	0.34%	8.71%	1.56%	39.79%	○	53300	2100
16	0951	0.45%	9.16%	2.06%	41.85%	○	56000	2700
17	0953	0.29%	9.74%	1.32%	44.49%	○	59600	3600
18	0955	0.27%	10.38%	1.25%	47.43%	○	63500	3900
19	0956	0.44%	10.82%	2.01%	49.44%	○	66200	2700
20	0957	0.43%	11.26%	1.97%	51.42%	○	68800	2600
21	0959	0.33%	11.92%	1.49%	54.47%	○	72900	4100
22	1001	0.31%	12.53%	1.43%	57.23%	○	76600	3700
23	1002	0.33%	12.86%	1.52%	58.76%	○	78700	2100
24	1004	0.41%	13.57%	1.86%	61.98%	○	83000	4300
25	1005	0.37%	13.94%	1.69%	63.66%	○	85300	2300
26	1007	0.49%	14.88%	2.23%	67.96%	○	91000	5700
27	1008	0.34%	15.22%	1.56%	69.53%	○	93100	2100
28	1009	0.39%	15.61%	1.77%	71.30%	○	95500	2400
29	1011	0.26%	16.24%	1.19%	74.21%	○	99400	3900
30	1012	0.35%	16.59%	1.58%	75.78%	○	101500	2100
31	1014	0.23%	17.12%	1.06%	78.19%	○	104700	3200
32	1016	0.43%	18.01%	1.97%	82.29%	○	110200	5500
33	1017	0.32%	18.33%	1.45%	83.74%	○	112200	2000
34	1019	0.45%	19.10%	2.08%	87.25%	○	116900	4700
35	1020	0.31%	19.41%	1.43%	88.68%	○	118800	1900
36	1022	0.17%	19.85%	0.77%	90.66%	○	121400	2600
37	1024	0.31%	20.41%	1.43%	93.26%	○	124900	3500
38	1026	0.28%	20.92%	1.28%	95.55%	○	128000	3100
39	1028	0.29%	21.48%	1.34%	98.12%	○	131400	3400

※ When calculating theoretical release points from volume ratio, number of order slices becomes less than 40.

Slide release point by adjustment point. The following is the case of 『adjustment points = -1』, 『Order exclusion points = 4』

Time	Release size
0930	5100
0931	2700
0932	3300
0933	2000
0935	5600
0936	3000
0937	3000
~omission~	
1026	7500

※ Consolidate order releases after 10:26 into 10:26, due to 『Order exclusion points = 4』.

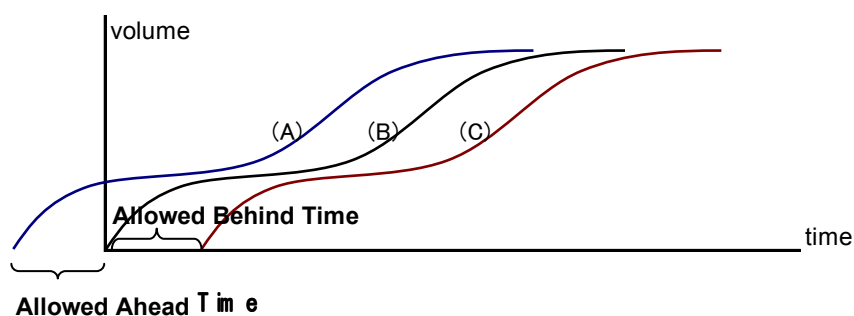
4. Child Order Release and Amendment

4.1 Specification of new order and amendment (Continuous session)

[Continuous session]

VWAP execute based on three volume curves.

- A) Volume curve (adjusted by allowed ahead time)
 Slice schedule is based on this curve, which is cap of execution schedule.
 Allowed ahead time is Algo Parameter.
- B) Volume curve (target)
 Target execution schedule is based on this curve.
- C) Volume curve (adjusted by allowed behind time)
 Cross schedule is based on this curve, which is floor of execution schedule.
 Allowed behind time is Algo Parameter.



4.1.1 Volume Curves (How to create volume curve with Ahead / Behind Bands)

Volume Curve A is generated from slice schedule. Moreover, Curve B is generated from Curve A and allowed ahead time, and Curve C is generated from Curve B and allowed behind time.

Calculate Ahead / Behind time as follows.

$$\text{Ahead / Behind time} = \min(\max(A * \max(B, C), D), E) * \text{Ahead/BehindTimeWeight}$$

The variable A, B, C, D and E are calculated as follows.

A: $\sqrt{\text{SprdWeight} * \frac{\text{sprd}}{\text{sd}}}$

sprd = avg spread (bp)

sd = standard deviation (bp) = $10000 * \text{vola} * \sqrt{\frac{\text{sdPeriod}}{270}/255}$

vola = historical close-close volatility (%)

sdPeriod = MaxAhead/2 or MaxBehind/2

B: $\text{ATlweight} * \text{ATl}$

ATl = average trade interval (s) = $270 * 60 / (\max(\text{avgtrades} - 4, 1))$ note -4 is to remove auctions, max is to make sure there are no negatives

C: $\text{Queueweight} * \text{QueueClearTime}$

QueueClearTime (s) = amount of time it takes to clear the queue = $(\text{AvgAskQueue} + \text{AvgBidQueue}) / (\text{advc} / (270 * 60))$

advc = average daily volume continuous (e.g. excluding auctions)

D: $\text{IntervalWeight} * \text{AvgSliceInterval}$

AvgSliceInterval (s) = average time between this order's slices

E: $\text{DurationWeight} * \text{OrderDuration}$

OrderDuration (s) = Duration of this order

This formula is as same as

$$\text{Ahead / Behind time} = \min(\max(\sqrt{\text{SprdWeight} * \frac{\text{sprd}}{\text{sd}}} * \max((\text{ATlweight} * \text{ATl}), (\text{Queueweight} * \text{QueueClearTime})), \text{IntervalWeight} * \text{AvgSliceInterval}), (\text{DurationWeight} * \text{OrderDuration})) * \text{AheadTimeWeight}$$

Calculate quantities every 3-7 (random) seconds.

(A) **TargetQty:** $\{\text{POV}(\text{mv} - \text{cumQty}) + 0.5\text{lot}\} / (1 - \text{POV})$ Rounded down to nearest lot.

* Consider its own open quantity and be able to get 1/2 lot ahead. (mv = market volume within limit price since order's start. when volume limit was reset, mv will also be reset.) In case that this value decreased, use the previous value.

(B) **Behind%TriggerQty:** (A) * TargetFilledRatio

(C) **TimeTriggerQty:** $\text{POV} * \text{mv}$ AllowedBehindTime ago (Do not use the volume before the volume limit start time.)

* See Table1 for 'TargetFilledRatio' and 'AllowedBehindTime'

(D) **MinCumQty:** $\min[\text{OrderQty}, \max((B), (C))]$

(E) **CumQty** (When base time of volume limit was reset, CumQty will also be reset.)

(F) **TradingQty**

(G) **AdditionalQty:** $(A) - (E) - (F) [= [0.5\text{lot} + \text{POV} * \text{mv} + (\text{POV} - 1) * \text{TradingQty} - \text{CumQty}] / [1 - \text{POV}]]$

* $0 \leq (G) \leq \text{OrderQty} - (E) - (F)$

(H) **CrossQty:** $\max[(D) - (E), (G) * \text{CrossRatio}] (\geq 0)$ Rounded down to nearest lot. CrossRatio is value of No.1 in Table2.

[Buy]

If $(G) \geq (H)$, then cross the spread with (H), and split remaining quantity $[(G) - (H)]$ to bestBid and bestBid-1 to maintain the balance in Table2. (If there is any slice on bestBid-2 or lower, amend the slice in first.)

If $(G) < (H)$, then cross the spread with (G), and move slice $[(H) - (G)]$ from bid side to bestAsk.

[Sell]

If $(G) \geq (H)$, then cross the spread with (H), and split remaining quantity $[(G) - (H)]$ to bestAsk and bestAsk+1 to maintain the balance in Table2. (If there is any slice on bestAsk+2 or higher, amend the slice in first.)

If $(G) < (H)$, then cross the spread with (G), and move slice $[(H) - (G)]$ from ask side to bestBid.

Table1. Algo-parameters' value according to the style

Style	1	2	3	4	5	6	7	8	9
TargetFilledRatio*	50%	55%	60%	65%	70%	75%	80%	85%	90%
AllowedBehindTime	300sec.	270sec.	240sec.	210sec.	180sec.	150sec.	120sec.	90sec.	60sec.

* After OrderEndTime-3min, add to TargetFilledRatio 1/3 of the way to 100% (round half up). E.g. If chosen style is 7, TargetFilledRatio will be: -3min: 87%, -2min: 93%, -1min: 100%.

* Shaded region means that these numbers will not be set automatically because the template only has style [passive:3], [normal:5], and [aggressive:7].

Table2. Allocate slice size according to the style

Style									
No.*	1	2	3	4	5	6	7	8	9
1	0%	0%	10%	20%	30%	40%	50%	70%	90%
2	30%	50%	50%	45%	40%	40%	50%	30%	10%
3	70%	50%	40%	35%	30%	20%	0%	0%	0%

* buy: No.1=BestAsk, No.2=BestBid, No.3=BestBid-1, sell: No.1=BestBid, No.2=BestAsk, No.3=BestAsk+1

※Notes

Particular notes of this specification are as follows.

- Amendment
 1. Always amend down or cancel the last slice sent to any price level.
 2. Never move a slice to a more passive slice, even if it means the style balance is broken.
 3. Never leave a slice on the 3rd best.
 4. If necessary, amend a passive slice quantity down, and after received the result of the amendment, send new slice (with amended quantity) either to cross the spread or put on best.
(e.g. If CrossQty=100, AdditionalQty=60, amendable sliceQty (without amend qty down)=30, first cross the spread with 90 (AdditionalQty and amendable sliceQty) and amend slice qty down by 10, and after received the result, send new slice with 10 to cross the spread. See case6 of "1.4 Example of Life of a POV order" for another example.)
 5. If the bid-ask spread is larger than 2 ticks, amend the slice on near side to more aggressive price by 1 tick in 7% of the time. (7% is settable in set-up-parameter.)
- Trigger
 1. TargetQty=OrderQty does not trigger any special behavior.
 2. MinCumQty=OrderQty finishes off the order.
 3. After OrderEndTime-30sec., all slices will be market order.
- Cross
 1. Use IOC to cross the spread.
 2. While SQ, VWAP doesn't cancel the cross in order to keep queue priority during SQ and to get fill at the end of SQ.

Details are as follows.

Order quantity: 4,000

Trade unit: 100

Allowed ahead time: 70 sec

Allowed behind time: 250 sec

		VolumeCurve A			VolumeCurve B			VolumeCurve C			
Time	Slice Schedule	Time	Volume	Ratio	Time	Volume	Ratio	Time	Volume	Ratio	
Open	200				9:00:10	200	0.05	9:04:20	200	0.05	Sum of Open, 9:00 (slice schedule)
9:00:00	100	9:00:00	300	0.08	9:01:10	300	0.08	9:05:20	300	0.08	Linearly - Interpolated between 9:00 and 9:04 ratio
9:01:00		9:01:00		0.08	9:02:10		0.08	9:06:20		0.08	
9:02:00		9:02:00		0.09	9:03:10		0.09	9:07:20		0.09	Curve A Time + Allowed ahead time.
9:03:00		9:03:00		0.09	9:04:10		0.09	9:08:20		0.09	
9:04:00	100	9:04:00	400	0.10	9:05:10	400	0.10	9:09:20	400	0.10	Curve B Time + Allowed behind time.
10:57:00	100	10:57:00	1,800	0.45	10:58:10	1,800	0.45	12:32:20	1,800	0.45	
10:58:00		10:58:00		0.46	10:59:10		0.46	12:33:20		0.46	
10:59:00		10:59:00		0.47	11:00:10			12:34:20			Linearly - Interpolated between 10:57 and open ratio, time of which is regarded 11:00.
Open	100		1,900	0.48	12:30:10	1,900	0.48	12:34:20	1,900	0.48	
12:30:00	100	12:30:00	2,000	0.50	12:31:10	2,000	0.50	12:35:20	2,000	0.50	
12:31:00		12:31:00		0.51	12:32:10		0.51	12:36:20		0.51	
12:32:00		12:32:00		0.51	12:33:10		0.51	12:37:20		0.51	
12:33:00		12:33:00		0.52	12:34:10		0.52	12:38:20		0.52	
12:34:00	100	12:34:00	2,100	0.53	12:35:10	2,100	0.53	12:39:20	2,100	0.53	
14:51:00	100	14:51:00	3,900	0.98	14:52:10	3,900	0.98	14:56:20	3,900	0.98	Adjust ratio to cross by end time - 1 min. 14:57 ratio is interpolated by 14:56 and 14:59.
14:52:00		14:52:00		0.98	14:53:10		0.98	14:57:20		0.98	And 14:58 ratio is same as above.
14:53:00		14:53:00		0.98	14:54:10		0.98	14:58:20		0.99	
14:54:00		14:54:00		0.99	14:55:10		0.99	14:59:00		1.00	
14:55:00		14:55:00		0.99	14:56:10		0.99	14:59:20		1.00	
14:56:00		14:56:00		1.00	14:57:10		1.00	15:00:20		1.00	
14:57:00	100	14:57:00	4,000	1.00	14:58:10	4,000	1.00	15:01:20		1.00	
14:58:00		14:58:00		1.00	14:59:10		1.00	15:02:20	4,000	1.00	
14:59:00		14:59:00		1.00	15:00:10		1.00	15:04:20		1.00	
15:00:00		15:00:00		1.00	15:01:10		1.00	15:05:20		1.00	

Notes

- Calculate volume curve (B) and (C) with fourth decimal place in order to avoid volume curve (B) and (C) being the same qty.
- Curve C start as a negative number because Curve C is supposed to be a fairly constant distance from Curve B (target schedule).

[Timing of generating Volume Curve]

No.	Event	Re-generate
1	Receiving order	Y
2	Amendment with Re-analyze	Y
3	Re-slice	Y
4	Modify slice schedule	Y
5	Reset Volume Limit	N
6	Force exec order	N
7	Force exec child order	N

4.1.1.1 Trading slices after re-sliced by manual control

If parent order is resumed with re-slice and do not cancel trading orders, trading qty will be scheduled at Re-Slice time in new re-sliced schedule.

Example is below.

[Example]

Trading qty on Re-Slice: 2,700

Allowed ahead Time: 60

Allowed behind Time: 240

Time	Slice Schedule	Curve A	Curve B	Curve C
910	2,900 (2,700)	2,900	2,700	2,500
911	0	2,900	2,900	2,500
912	100	3,000	2,900	2,500
913	200	3,200	3,000	2,700
914	100	3,300	3,200	2,900
915	300	3,600	3,300	2,900

4.1.1.2 Volume curves for orders received after the OrderExcludePoint

Volume curve of order accepted after order exclude point is generated as follows.

- Volume Curve A

Generate usually Volume Curve A.

- Volume Curve B, C

If adjusted time of Volume Curve B, C is after end time - 60 sec, this volume curve ratio is regarded as 100%

Volume Curve B, C must have point at the time that is max (end time -180 sec, order received time).

Receive time: 14:58

Order quantity: 4,000

Trade unit: 100

Allowed ahead time: 70 sec

Allowed behind time: 250 sec

VolumeCurve A				VolumeCurve B			VolumeCurve C			
Time	Slice Schedule	Time	Volume	Ratio	Time	Volume	Ratio	Time	Volume	Ratio
14:58:00	4000	14:58:00	4,000	1.00	14:58:00		0.00	14:58:00		0.00
14:59:00		14:59:00		1.00	14:59:00		1.00	14:59:00		1.00
15:00:00		15:00:00		1.00	14:59:10	4,000	1.00	15:03:20	4,000	1.00

Order qty is regarded as sliced on receiving time.

Adjust ratio to cross by end time - 1 min.

* After OrderEndTime-30sec., all slices will be market order.

4.1.2 Execution schedule

VWAP strategy crosses the spread and executes trades regularly so that the cumQty may not fall below the volume curve(C). Specifically, if cumQty fall below the volume curve(C) larger than 1lot, amend/send slices and cross to get filled until cumQty is more than volume curve(C)

VWAP strategy crosses randomly in certain probability with intention to avoid sending many small slices; crossing spread should occur at least once per minute* under this condition.

* To guarantee this, increase the probability of crossing every event (the interval is 3-7 sec) until crossing. The following table shows an example.

Event Time	Cross	Curve C – Cum qty	Probability
10:01:05	N	< 1lot	8%
10:01:10	N	< 1lot	17%
10:01:13	N	>= 1lot	25%
10:01:16	Y	>= 1lot	33%
10:01:20	N	< 1lot	8%
10:01:24	N	< 1lot	17%
10:01:29	N	< 1lot	25%
10:01:33	N	< 1lot	33%
10:01:40	N	< 1lot	42%
10:01:44	N	< 1lot	50%
10:01:50	N	>= 1lot	58%
10:01:54	N	>= 1lot	67%
10:01:57	N	>= 1lot	75%
10:02:01	Y	>= 1lot	83%
10:02:06	N	< 1lot	8%

[Example: Work of Cross Trigger]

Time	Condition 1		Condition 2		
	Cross Trigger	Curve C - Cum qty	Judge Count	Probability	Result by lot
10:01:05	Not work	Under 1 lot	1	8%	Not chosen
10:01:10	Not work	Under 1 lot	2	17%	Not chosen
10:01:13	Not work	Over 1 lot	3	25%	Not chosen
10:01:16	Work	Over 1 lot	4	33%	Chosen
10:01:20	Not work	Under 1 lot	1	8%	Chosen

[Cross Trigger work conditions]

If cumQty is less than curve(C)-1lot, cross the spread with certain probability*;

This probability is calculated as follows.

Cross Probability = Judge Count (*) x 5 ÷ 60 (about 8%)

* Judge Count is count up every judge timing. If cross judge is chosen, Judge Count is reset.

* If crossed every time the cumQty <= curve(C)-1lot, (small size) slices would increase in number.

If the cross qty calculated by Cross Trigger is more than new qty, the insufficient qty is sliced from next slice qty (※1) in order to observe queue priority. However, the qty sliced from next slice must be less than or equal to [Curve A + 0.5lot(※2) - Cum qty - Trading qty].

(※1) The insufficient qty is not sliced from the slice at pm auction in order to avoid the slices at the end of am session not being too large by getting insufficient qty from the qty at pm auction that is relatively large.

(※2) In order to keep queue priority, vwap can borrow qty by Curve A + 0.5lot. 0.5lot is setup parameter (vwap4-ahead-lots-for-volume-curve-a).

[Cross qty]

Cross qty = Min (Far side queue size x cross take ratio *1, Max (Cross qty by cross trigger, Cross qty by allocation), Trading qty)

Cross qty by cross trigger = random (Curve B *4, Curve C *4) - Cum qty

Cross qty by allocation = New qty x cross ratio by style *3

*1 After end time-30 sec, Cap of far side queue size is not used. Round up by trade unit.

*2 If the bid-ask spread is larger than 2 ticks, use curve C.

*3 CrossRatio is value of No.1 in [Allocate slice size according to the style]. Cross by allocation is not depends on Cross Trigger work Conditions.

*4 This volume is calculated by linearly interpolated. Details are as follows.

Current Time: 9:01:35, 9:01:20 volume ratio: 15%, 9:02:20 volume ratio: 20%

9:01:35 volume ratio = 15% + (20% - 15%) x ((9:01:35 - 9:01:20) / (9:01:20 - 9:02:20)) = 16.25%

*5 If the bid-ask spread is larger than 2 ticks and cumQty < volume curve(B), amend the slice on near side to more aggressive price by 1 tick in 7% of the time. (7% is settable in set-up-parameter.)

*6 If the far side is out of limit price, cross qty is zero. Because the price limited cross qty cannot get fill.

[Example: Cross schedule]

Example: Cross triggered												
Time	Slice	Quantities				Curve A		Curve B		Curve C		Notes
		Sliced	Trading	Cum	Cross	Volume	Ratio	Volume	Ratio	Volume	Ratio	
Open	200	200	200	0	0	omitted				0	0	
9:00:20	100	300	100	200	0					0	0	
9:01:00		300	100	200	0					0	0	
9:04:05	100	400	200	200	0	omitted				175.00	0.044	Curve C Volume - Cum qty is less than 1 lot. So cross trigger do not occurred.
9:04:09		400	200	200	0					181.67	0.045	
9:04:13		400	200	200	0					188.33	0.047	
9:04:18		400	200	200	0					196.67	0.049	
9:04:23		400	200	200	0					205.00	0.051	
9:05:22		400	100	200	100	445.56	0.11	406.67	0.10	300.83	0.075	Curve C Volume - Cum qty is more than 1 lots. So cross trigger occurred. Cross qty [100] = Random(Curve B - Curve C) - Cum qty
9:05:27		400	100	300	0	omitted		omitted		302.92	0.076	
9:07:00	100	500	200	300	0	omitted						
9:09:21		600	200	300	200	656.67	0.16	578.89	0.14	400.56	0.10	Curve C Volume - Cum qty is more than 1 lot. So cross trigger occurred. Cross qty [200] = Random(Curve B - Curve C) - Cum qty New slice qty from next slice qty [100] = Curve A - Trading qty - Cum qty
9:10:00	200/100	700	200	400	0	omitted						

[Allocate slice size according to the style]

No.*	Style								
	1	2	3	4	5	6	7	8	9
1	0%	0%	0%	0%	0%	0%	10%	20%	30%
2	20%	30%	40%	50%	60%	70%	70%	70%	70%
3	80%	70%	60%	50%	40%	30%	20%	10%	0%

* buy: No.1=BestAsk, No.2=BestBid, No.3=BestBid-1, sell: No.1=BestBid, No.2=BestAsk, No.3=BestAsk+1

* Use IOC to cross the spread. While SQ, VWAP doesn't cancel the cross in order to keep queue priority during SQ and to get fill at the end of SQ.

4.1.3 Cross trigger with volume limit

If sliced qty reach volume limit, this strategy substitute behind time trigger for Cross trigger.

Behind time is specified by Max Allowed behind time.

Max new qty by volume limit is calculated as follows.

Max new qty by Volume Limit = $[\text{Volume Limit} \times mv + (\text{Volume Limit} - 1) \times \text{TradingQty} - \text{CumQty}] \div [1 - \text{Volume Limit}]$

4.2 Specification of new order and amendment (Auction)

New	Limit Price	Market price *If parent order specified limit price, use the limit price of parent order.
	Timing	3 min. before market opens
	Size	Order size is based on slid release point calculated in 『4.2 Child Order Release schedule』(*1) .
Amendment	Limit Price	Not amend.
	Timing	Before 9:00 / 12:30, amends every 30 secs. After 9:00 / 12:30, amends every 5 secs. At 8:59:50 - 55 / 12:29:50 - 12:29:55, amends once.
	Size	In the following cases, release additionally, reduce order size, or cancel order. <ul style="list-style-type: none"> Cap Size by Volume Limit(*2) > released size Release additional child order. The size of child order is Min ('Cap Size by Volume Limit' – 'Released Size', 'Scheduled Size') Cap Size by volume limit < released size Reduce or cancel child order. The size of reduce / cancel child order is Min('Released Size' – 'Cap Size by Volume Limit')

*1 If parent order has volume limit, release child order, the size of which is within Cap Size by Volume Limit (*2).

*2 Cap Size by Volume Limit = $\text{Min}(\text{Best Bid Size}, \text{Best Ask Size}) + \text{LOB Time Volume}) \times \text{POV} \times \text{Adjust Open Volume Ratio}$
If spread between Best Bid and Best Ask is 2 ticks or more, Cap Size by Volume Limit is 0

*3 After open, if target volume < Released size, reduce or cancel child order.

The size of reduce / cancel child order is 'Released Size' - (target volume)

Target volume = $\{\text{POV}(mv - \text{cumQty}) + 0.5\text{lot}\} \div (1 - \text{POV})$, Rounded down to nearest lot. (The same as continuous session).

4.3 Observe queue priority

See POV queue priority. (VWAP4.2 use the same spec.)

4.4 MaxTradingQty

A limit on how much open quantity we can have on the exchange at one time.

[Calculation]

$\text{MaxTradingQty} = \text{MaxTradingQtyWeight} * \max(\text{round-lots} * \text{lotsize}, \text{min-notional} / \text{base price}, \max(\text{AQS-weight} * \text{AQS}, \text{ATS-weight} * \text{ATS}))$

* MaxTradingQtyWeight is an algorithm parameter and this value is 0 means uncapped.

*round-lots is setup parameter.

*min-notional is setup parameter.

*min-notional / base price rounded down.

*AQS-weight and ATS-weight is determined by following condition and priority of applying weights is 1 > 2 > 3. Each weight is setup parameter.

1. Orders where the far side is outside their limit price.
2. SS orders.
3. Everything else.

*Cap removed during finish up logic.

*If we are crossing the spread, this cap don't apply to new slice qty. (not including the case, orders where the far side is outside their limit price.)

*This cap does not work in finish up logic.

[Setup Parameter for max trading qty]

Parameter name	Default
MaxTradingQty-AQS-weight-limitprice	1.5
MaxTradingQty-AQS-weight-SS	1
MaxTradingQty-AQS-weight-normal	0.4
MaxTradingQty-ATS-weight-limitprice	5
MaxTradingQty-ATS-weight-SS	3
MaxTradingQty-ATS-weight-normal	2
MaxTradingQty-RoundLots	3
MaxTradingQty-Notional	500000

4.5 IndicatorToCrossSpread

Indicator to cross the spread framework

[Setup Parameter for time risk factor]

Parameter name	Default
MinCrossRatio	0.2
Max Time Risk Factor	2
Min Time Risk Factor	0.5
vwap4-ahead-lots-for-time-risk-factor	0.5
time-risk-factor-band	2

4.5.1 Indicators

Indicators give a signal (this signal is a number) as to whether now is a good time to cross.

There are 4 indicators based on historical statistics as below.

- Current / Historical Spread Indicator
- Current / RealTime Spread Indicator
- Far move Indicator
- Near Fill Indicator

VWAP strategy uses these indicators by multiplying them.

Each indicator is based on 1, where a 1 means there's no indication.

A smaller number (<1) indicates it's a good time to cross.

A larger number (>1) indicates it's not a good time to cross.

An indication of 0.5 is opposite to an indication of 2.0 - when multiplying these two indicators they cancel each other out.

[Example]

If the current spread is twice (2.0) the historic spread, it's equivalent but the opposite of the current spread being half (0.5) the historic spread.

※Each indicator will have bounds to prevent it from having excessive impact to the overall indication.

->Default bounds will be [0.5,2.0].

※Each indicator will have an exponent-based weight to affect how much it impacts the overall indication.

->Default exponent is 1. 0 turns the indicator off (e.g. the will always have a value of 1)

4.5.2 Each Indicator

Each Indicator has following parameters.

- Max Indication (each indicator)
- Min Indication (each indicator)
- Indication Exponent (each indicator)

Each indicator is restricted by these 3 parameters as follows.

Min(Max(Indicator ^ Indication Exponent, Min Indication), Max Indication)

4.5.3 Current / Historical Spread Indicator

This Indication is calculated as follows.

Current Spread / Historical Spread

* Historical Spread = Avg Bid/Ask Spread.

* Current Spread = 10000 * (Current Ask Price - Current Bid Price) / ((Current Ask Price + Current Bid Price)/2).
 If Bid or Ask is not quoted or Historical Spread doesn't exist, this indicator is 1.
 If market condition is kehai, this indicator is 1.

4.5.4 Current / RealTimeSpread Indicator

This Indication is calculated as follows.

* Current Spread = 10000 * (Current Ask Price - Current Bid Price) / ((Current Ask Price + Current Bid Price)/2).
 * RealTime Avg Spread = 10000 * Avg Bid/Ask Spread from [ahead time + behind time] before.
 Spread at before Open is excluded from RealTime Avg Spread.
 Spread at Kehai is excluded from RealTime Avg Spread.
 If market meets following conditions, this indicator is 1.
 RealTime Avg Spread or Historical Spread doesn't exist.
 Kehai
 The average calculating period is less than 1/4(*) the full period.
 * 1/4 is setup parameter.

4.5.5 Far move Indicator

This Indication is calculated as follows.

[Buy] Ask Size / Bid Size * ((Ask Price - Bid Price) / (Ask +1Price - Ask Price))
[Sell] Bid Size / Ask Size * ((Ask Price - Bid Price) / (Bid Price - Bid -1Price))

If Bid or Ask or Ask+1 is not quoted, this indicator is 1.
 If market condition is kehai, this indicator is 1.

4.5.6 Near Fill Indicator

This indicator is based on fill probability by ItaAlgoModel.

The steps are as follows.

1. This probability is calculated to each order at near side in the order of the queue priority from highest to lowest.

$$NearFill\ Probability = \sum_{i=0}^{i=k} (Fillprob * Sizeweight) / k$$

i = Accum order qty.

k = VolumeCurve B - CumQty or NearSide qty.

Sizeweight = Child order qty / k

2. Convert result of step 1 to indication.
 100% probability means 2
 50% probability means 1
 0% probability means 0.5
 Other points are interpolated

4.5.7 Decision to cross the spread

Each update the algo will make a decision as to whether to cross the spread. The steps are as follows

1. Finish up logic? - not covered on this page
2. CumQty is less than the Qty of Behind Band? and Random Factor is available -> cross the spread
3. Indicators say we should cross? -> cross the spread

※ In step 2, 3, the indicator's strength is compared to how close we are to the schedule(= time risk factor). Based on our current CumQty, a number is generated to compare:

The Midpoint between Curve B and Curve C is 1

Curve B is 0.5.

Curve C is 2.0.

Other points are interpolated as following.

$$\text{TimeRiskFactor} = 2(\text{※1})^{(-2/(B-C))} * (\text{CumQty} + 0.5\text{lot}(\text{※2})) + ((B+C)/(B-C))$$

(※1) 0.5lot is setup parameter (vwap4-ahead-lots-for-time-risk-factor).

(※2) Base number 2 is setup parameter (time-risk-factor-band).

In order to prevent delaying, cum qty is added 0.5lot.

Indicator < Time Risk Factor and CumQty < Target -> cross the spread

[How much to cross the spread for]

If the decision has been made to cross the spread, first a TargetCrossQty is calculated based on the cumulative indicator.

- this is the qty that gets us to where Cumulative Indicator = Time Risk Factor

This qty is then used in the following calculation to determine our actual qty to cross the spread:

max (TargetCrossQty, random((1 - MinCrossRatio) * MinCrossRatio, (1 + MinCrossRatio) * MinCrossRatio) * (Curve B - Curve C))

* so that we don't keep doing little chunks - if we're going to cross, we cross with conviction

min (above, Curve B - CumQty) * aim not to cross spread beyond Target Schedule

max (above, New Slice qty * allocation by style)

min (above, CrossTakeRatio * FarSize) * so we don't create a new price

max (above, 1 lot) * allow at least a round lot out

min (above, Curve A - CumQty) * never violate Curve A

min (above, Trading qty)

[Definitions]

Curve A = Ahead Band (e.g. the most we're allowed to get ahead of schedule)

* If sliced qty reach volume limit, Curve A is [(volume limit * mv + Exceed Vol Limit by Lots)/(1-POV)]

Curve B = Target Schedule

* If sliced qty reach volume limit, Curve B is [(volume limit * mv + Exceed Vol Limit by Lots)/(1-POV)]

Curve C = Behind Band (e.g. the most we're allowed to get behind schedule)

* If sliced qty reach volume limit, Curve C is [volume limit * mv behind time behind]

MinCrossRatio = the minimum % of qty between Curve C and B that we must cross if we're going to cross. Default 0.2.

CrossTakeRatio = how much of the far side we're willing to take. Default 1. Can be anything larger than 0 and smaller than 2. (Greater than 1 means we create a new price)

5. Algorithm Parameters

The "VWAP" model supports the following parameters.

No	Algorithm parameter	Description	Required	Parametric in FIX	Amendable	Default value
1	Start Time	Order Start Time (HH:MM)		<input type="radio"/>	<input type="radio"/>	—
2	End Time	Order End Time (HH:MM)		<input type="radio"/>	<input type="radio"/>	—
3	Auto Cancel	Flag to automatically cancel (If checkbox is on, auto cancel)	<input type="radio"/>	×	×	ON
4	Volume Limit (%)	Volume limit (%) (0.01~99.99)		<input type="radio"/>	<input type="radio"/>	—
5	Order Exclude Point	Order exclusion point (1~60 Integer)	<input type="radio"/>	×	×	3
6	Max Allowed Behind Time	Compared with target volume curve, Allowed behind time of execution schedule. (0~6,000 seconds)	Y	-	-	-
7	Min Allowed Behind Time	Compared with target volume curve, Allowed behind time of execution schedule. (0~6,000 seconds).	Y	-	-	-
8	Allowed Behind Time Ratio	Unused at the first release of VWAP4.	-	-	-	-
9	Max Allowed Ahead Time	Compared with target volume curve, Allowed ahead time of execution schedule. (0~6000 seconds)	Y	-	-	-
10	Min Allowed Ahead Time	Compared with target volume curve, Allowed ahead time of execution schedule. (0~6000 seconds).	Y	-	-	-
11	Allowed Ahead Time Ratio	Unused at the first release of VWAP4.	-	-	-	-
12	Cross Take Ratio	Use to cap cross qty. (1~100 %)	-	-	Y	100%
13	Open StdDeviation Ratio	Open standard deviation ratio (%) (0~100 Integer)	<input type="radio"/> ※1	×	×	100%
14	Adjust Order Point	Adjusted release point (-60~+60)	<input type="radio"/>	×	×	-1
15	Min Order Count	Minimum number of releases (Positive Integer)	<input type="radio"/>	×	×	34
16	Ita Algo	Decide to use Ita Algo logic	N	N	N	N

17	Style	1 Passive 2 Passive 3 Passive 4 Passive 5 Normal 6 Aggressive 7 Aggressive 8 Aggressive 9 Aggressive	N	Y	Y	5 Normal
18	AM Open Cap(%)					16
19	PM Open Cap(%)					8
20	Exceed Vol Limit by Lots					
21	Ahead Time Weight	Adjust calculated ahead time. (0~100000) Enable to specify 5 places of decimals. If set this parameter zero, default value is used.	-	N	N	PASS ->0.5 NORM/ AGGR -> 0.75
22	Ahead Befind Weight	Adjust calculated behind time. (0~100000) Enable to specify 5 places of decimals. If set this parameter zero, default value is used.	-	N	N	PASS ->1.5 NORM ->1 AGGR -> 0.67
23	Max Indication (each indicator)	0~10 Enable to specify 5 places of decimals.	N	-	N	2
24	Min Indication (each indicator)		N	-	N	0.5
25	Indication Exponent (each indicator)		N	-	Y	1
26	Indicator Sensitivity		N	-	Y	1
27	MaxTradingQtyWeight	0~100,000 Enable to specify 5 places of decimals.	N	-	Y	1
28	Max SS OEP % of duration	Cap of front-weight %.	N	-	-	50
29	SS OEP Adjust Ratio	The ratio to adjust the average historic queue size.	N	-	-	1
30	Dark Limit Point	Off Peg To Mid Peg To Mid, Far Peg To 1/4 Peg To 1/4, Mid Peg To 1/4, Mid, 3/4 Peg To 1/4, Mid, 3/4, Far (default)	N	-	Y	Off
31	AM%	Percent of volume that vWAP executes during AM session. 0.01~99.99	N	Y	Y	—

Parameter to specify the range is within the number given as parameter.

※1 Available only if “Volume Limit” is specified.

5.1 Order Start Time (Start Time)

Configure the time to start trading the algo order.

If not specified, order received time is set to Order Start Time by default.
Order Start Time is first release point, when calculating child order interval.

5.2 Order End Time (End Time)

Configure the time to finish trading the algo order.

If not specified, PM session end time (15:00 if TSE, 15:10 if OSE) is set to Order Start Time by default.

『Order End Time – Order exclusion point』 is final release point, when calculating child order interval.

5.3 Volume Limit (%) (Volume Limit)

In case of the order with volume limit (%), The model controls released size not to exceed a certain ratio of timed trading volume in exchange.

5.3.1 Operation to check Release size with Volume Limit

With volume limit, the model carries out the following operation.

- ① Calculate time trading volume from market data, when releasing child order.
Timed trading volume = The last trading volume - Trading volume when starting trade (If trade start time is 10:00, apply last trading volume before 10:00)
- ② Compare releasable size within volume limit with projected release size, and adjust release size.

$$\text{Projected release size} \leq (\text{Timed trading volume} \times \text{volume limit} - \text{cumulative release size already placed})$$
 → No adjustment is made and release as projected.

$$\text{Projected release size} > (\text{Timed trading volume} \times \text{volume limit} - \text{cumulative release size already placed})$$
 → Newly calculated release size = (Timed trading volume × volume limit - cumulative release size already placed)
 ※ Round down by lotsize. If size is smaller than lotsize, no release.
- ③ Unreleased residual size
Store up unreleased residual size in special pool (scheduled at 99:99).
If the size calculated by 『(Timed trading volume × volume limit - cumulative release size already placed)』 is larger than projected child release size, increase release size from special pool (scheduled at 99:99) and place.
- ④ Unreleased residual size not to be placed in release point
If the model could not fully release child order at release point, release residual size up to cap within volume limit at each point by Order End Time.

(Example) 『Volume Limit = 1%』 Schedule child order slice is as follows.

Slice	Release point	09:00	09:01	09:02	09:03	~	99:99
	Cumulative release size	700	800	900	1000		—
	Projected release size	700	100	100	100		0
Market on the day	Market trading volume (Timed volume)	—	—	—	—	~	—
	Cap releasable size within volume limit	—	—	—	—		—
Actual release size		—	—	—	—		—

※ 09:00 (Trading volume in the market is 80,000 shares)

『Projected release size (700) ≤ Timed trading volume (80,000) × volume limit (0.01) - cumulative release size already placed (0)』

Since this is less than volume limit, release 700 shares as projected.

※ 09:01 (Trading volume in the market is 80,100 shares)

『Projected release size (100) ≤ Timed trading volume (80,100) × volume limit (0.01) - cumulative release size already placed (700)』

Since this is less than volume limit, release 100 shares as projected.

Slice	Release point	09:00	09:01	09:02	09:03	~	99:99
	Cumulative release size	700	800	900	1000		—
	Projected release size	700	100	100	100		0
Market on the day	Market trading volume (Timed volume)	80,000	80,100	—	—	~	—
	Cap releasable size within volume limit	800	801	—	—		—
Actual release size		700	100	—	—		—

※ 09:02(Trading volume in the market is 80,200 shares)

$\lfloor \text{Projected release size (100)} > \text{Timed trading volume (80,100)} \times \text{volume limit (0.01)} - \text{cumulative release size already placed (800)} \rfloor$

Since this is greater than volume limit, the model does not release projected release size.

Unreleased residual size is stored up in special pool (scheduled at 99:99).

Slice	Release point	09:00	09:01	09:02	09:03	~	99:99
	Cumulative release size	700	800	900	1000		—
	Projected release size	700	100	100	100		100
Market on the day	Market trading volume (Timed volume)	80,000	80,100	80,200	—	~	—
	Cap releasable size within volume limit	800	801	802	—		—
Actual release size		700	100	0 (no release)	—		—

※ 09:03(Trading volume in the market is 100,200 shares)

$\lfloor \text{Projected release size (100)} \leq \text{Timed trading volume (100,200)} \times \text{volume limit (0.01)} - \text{cumulative release size already placed (800)} \rfloor$

Since sum of projected released size(100) at 09:03 and 100 shares is less than volume limit, the mode releases total 200 shares from projected size (100) and extra 100 from special pool (scheduled at 99:99).

Slice	Release point	09:00	09:01	09:02	09:03	~	99:99
	Cumulative release size	700	800	900	1000		—
	Projected release size	700	100	100	100		0
Market on the day	Market trading volume (Timed volume)	80,000	80,100	80,200	100,200	~	—
	Cap releasable size within volume limit	800	801	802	1002		—
Actual release size		700	100	0 (no release)	200		—

5.4 Auto Cancellation Flag (Auto Cancel)

Automatically cancel the order at trade end time + 1 min. If the order is fully filled, no automatic cancellation happens.

➤ Exceptional case that trade end time is AM/PM closing

If trade end time is AM closing (11:00), automatic cancellation happens at PM order receiving start time (12:05).

If trade end time is PM closing (15:00 for TSE, 15:10 for OSE), no automatic cancellation occurs.

5.5 Order Exclusion Point (Order Exclude Point)

If this parameter is set, the model does not release any child orders after (Order End Time – order exclusion point).

(Lunch time is out of the calculation)

However, if the child order has been already placed, the model can run amendment operation.

Example: If Order End Time 15:00 and order exclusion point is 3, final order release point is 14:57.

Example: If Order End Time 12:32 and order exclusion point is 3, final order release point is 10:59.

5.6 Open Order Flag (Open Order)

Specify whether the model participates in opening auction or not. If open order flag is “OFF”, the model starts trading at trading session start time + 1 minute.

5.7 Open Standard Deviation Rate (%) (Open StdDeviation Rate)

Available only if volume limit is specified. Adjust release size on opening auction by this parameter. Please refer to 『4.4 Child Order Release Size on Opening Auction with Volume Limit』 more in detail.

5.8 Adjusted Release Point (Adjust Order Point)

Adjust child orders' release point. Please refer to『4.2 Child Order Release schedule』 more in detail.

6. Regulatory Short Sell

6.1 Short Sell Pegging

If side is regulatory short sell, the model releases and amends the child orders upon regulatory short sell rule as follows.

- Child order release at limit price upon up-tick rules.
- Automatic limit price amendment at most 120 times a minute upon up-tick rules.
- If child order is reject or expired by exchange due to up-tic rules violation, automatically re-send (re-send 5 times at most)

6.1.1 Design and Implementation

1. When releasing child order, limit price is either last price or last price + 1 tick based on up-tick rules.
However, in case of AM opening and when no last price, limit price shall be base price + 1 tick.
If there is a hard limit at parent order level, hard limit is the floor.
※ PM opening is considered as same as continuous trading session.
2. Automatic limit price amendment at most 120 times a minute upon up-tick rules.
When amending limit price, limit price is either last price or last price + 1 tick.
However, if there is a hard limit at parent order level, hard limit is the floor.
If recalculated limit price is equal to already released limit price, the model does not amend.
※ If the child order is released after (Order End Time or trading session end time – 120 minutes), number of amendment shall be 1~119 times based on the rest of the trading time.
※ If the child order is released just before AM closing and could not be amended 120 times, the model keeps counting number of amendment across PM session.
(If child order is release at 10:55, amend the order 4 times in 10:56~59 + 116 times in 12:31~14:26)
※ Amend opening order 120 times from 9:01 if AM opening, 12:31 if PM opening.
※ Once the order is expired by short sell error and resent, the model resets the counter of 120 times.
(If expired at 3rd amendment by short sell error, re-send new release and the model can amend not 117 times but 120 times)
※ The model starts this amendment process for child order released on opening session, once the market has been opened.
※ Number of automatic limit price amendment is defined in configuration parameter table.
3. When receiving reject message or expired message from the exchange after child order release/amendment, the model newly re-sends child order release immediately. (in case of partial fill, re-create with non-executed residual size)
However, "Re-sending" is up to 5 times and it does not happen over 5 times.
When newly re-sending child order, limit price should be either last price or last price + 1 tick upon up-tick rules.
However, if limit price is equal to previous one or previously amended one, limit price shall be previous limit price + 1 tick, and if there is a hard limit on parent order, limit price should be the floor.
※ Number of re-sending(5 times) is defined in configuration parameter table.

6.1.2 Remark

1. Short sell violation errors can be categorized into 4 types of errors. Reject/Expired for New order release and ReplaceReject/Expired for replace order.
The model does not re-send in case of ReplaceReject.
Volume limit (%) is applicable for short sell order.
However, the mode increases child release size only for initial new release, not for re-sending order.
Also, even if re-sending as many times as possible, rejected or expired child order release won't be re-sent.
(Special Pool (99:99) does not have short sell order)
With volume limit, release size is calculated as follows.
$$\text{Time trading volume} \times \text{volume limit (\%)} = \text{rejected or expired child order release size}$$

7. Parent Order Amendment

Whether the model re-analyzes or not depends on the parameter to be amended.

7.1 Amendable Parameters

VWAP algorithm allows the following parameters to be amended.

Amendable parameters	Remark
Order Qty	Only decreasing size is supported
Limit Price	If no limit price, 0
Order Start Time	Algo parameter
Order End Time	Algo parameter
Volume Limit (%)	Algo parameter

7.2 Restrictions

If the order status is one of the following cases, the order is not amendable and amend request is rejected.

- While the order status is already amending ※1
 - While the order status is canceling
 - When the order status is already fully filled
 - When DoneForDay has been already sent to client
 - After trading session
 - Period of 『Release point without order exclusion points – 1 minute』
- ※1・・・Cancellation while amending is not acceptable as well

7.3 Validations

Check if the strategy (which is not amendable parameter) has not been changed. If amended, send ExecutionReport(Rejected) to the client.

The following amendment cases are not acceptable (Reject).

- Amend request without any change
- Order size increase
- Amendment of order start time where Order Start Time < current time
Even though Order Start Time < current time, amend request is acceptable if it's same as previous value.
(Calculation is per minute. Acceptable if amend request of Order Start Time=10:30 at 10:30:45)
- Amendment where Order End Time < current time + order exclusion point
(Calculation is per minute. Acceptable if Order End Time=10:32 and order exclusion point =2 at 10:30:45)

7.3.1 Order Start Time when the Order is amended

If the model validates order start time as same as new order, it rejects amend request with "Order Start Time error", when amending the parameters other than start time after that time. Thus, if there is no change of order start time in order amend request, the model skips validation of start time.

Example) Amendment result of start time change for new release and amendment, when receiving the message at 10:00

Order Start Time before amend	Order Start Time after amend	Amendment result	Re-analyzed initial release point by amendment	Remark
9:15	9:00	Rejected	—	Rejected since amended start time is past
9:15	9:15	Accepted	10:00	Accepted since amended start time is past but it is equal to original start time
9:15	9:30	Rejected	—	Rejected since amended start time is past
9:15	10:30	Accepted	10:30	Accepted since amended start time is future time
9:15	<NONE>	Accepted	10:00	Accepted since amended start time defaults to order receiving time(10:00)
10:30	9:45	Rejected	—	Rejected since amended start time is past
10:30	10:15	Accepted	10:15	Accepted since start time is future
10:30	10:30	Accepted	10:30	Accepted since start time is future
10:30	10:45	Accepted	10:45	Accepted since start time is future
10:30	<NONE>	Accepted	—	Accepted since amended start time defaults to order receiving time(10:00)

7.4 Methodology to amend VWAP Order

Methodology to amend VWAP order by parameter is as follows.

Parameter	Methodology
Order Qty	Re-analysis
Limit Price	Amend limit price if already placed in the market and apply newly amended limit price from now on. Please refer to <8.4.1> more in detail.
Order Start Time	Re-analysis
Order End Time	Re-analysis
Volume Limit	Re-analysis

Please refer to <8.4.2> more in detail about re-analysis.

When multiple parameters are amended at the same time, the model runs re-analysis anyway.

7.4.1 Mechanism to amend Limit Price

Mechanism to amend limit price is as follows.

1. Pause child order release/amendment task.
2. Amend limit price as follows.
 - A) If residual size > 0, overwrite limit price at parent order level and apply newly amended limit price for newly released order/child order amendment.
 - B) If any active child orders in the market, calculate revised limit price at parent order level considering exchange price step for both before and after amendment. (※1)
 - ① If previous limit price = new limit price
do nothing for active child order in the market.
 - ② If previous limit price ≠ new limit price
Amend limit price for active child order in the market and await.
 1. In case of Limit order → Market order
Amend child order from limit price = previous limit price to At-Market.(※2、※3)
(Amend the order with limit price = cap for buy order, limit price = floor for sell order into At-Market)
《■e.g. if 800 yen→Mkt, amend active child orders with limit = 800 into At-Market》
 2. In case of Market order → Limit order
If buy order, amend child orders from market order or limit price > previous limit price into new limit price.
(Amend all active child orders that limit price is greater than new limit price into new limit price)
《■e.g. if Mkt→850, amend active child orders with previous limit > 850 into new limit price(850)》

In case of sell order, amend child orders from market order or limit price < previous limit price into new limit price.
(Amend all active child orders that limit price is less than new limit price into new limit price)
《■e.g. if Mkt→850, amend active child orders with previous limit < 850 into new limit price(850)》
 3. In case of limit price up ↑
If buy order, amend child orders that limit price = previous limit price into new limit price.
(Amend the order with limit price = upper cap)
《■e.g. if 1,200→1,300, amend active child orders with previous limit=1,200 into 1,300》

If sell order, amend child orders that limit price < previous limit price into new limit price.
(Amend the order with limit price < new lower limit)
《■e.g. if 1,200→1,300, amend active child orders with previous limit < 1,300 円 into 1,300》
 4. In case of limit price down ↓
If buy order, amend child orders that limit price > previous limit price into new limit price.
(Amend the order with limit price > new upper cap)
《■e.g. if 2,500→2,400, amend active child orders with previous limit > 2,400 into 2,400》

If sell order, amend child orders that limit price = previous limit price into new limit price. (※2)
(Amend the order with limit price = new lower limit)
《■e.g. if 2,500→2,400, amend active child orders with previous limit=2,500 into 2,400》

3. The following process runs based on the amendment result.
 - A) If not amended (= parent order was fully filled while amending)
Send "replace-reject" message back to client via FIX and show error message on client application as same as new-reject.
 - B) If unreleased child orders exist or successfully amend released child order
Send "replaced" message back to client via FIX.
4. Re-start child order release/amendment task.
Re-started child order release/amendment transaction applies amended new limit price.

※1...The model takes any formatted "Limit Price"(even though it is not valid price step). If not valid, limit price is revised (rounded), when child order is released to the market/amended. If buy order, revised limit price is rounded by price step which is equal to or less than "Limit Price". If sell order, revised limit price is rounded by price step equal to or more than "Limit Price".

※2...If regulatory short sell, limit price to amend should be either last or last + 1 tick upon up-tick rules.

※3...If last price or Best Ask/Bid = previous Limit Price, the child order shall be Mkt order.

7.4.2 Re-Analysis

Mechanism to re-analyze algorithm order is as follows.

1. Cancel scheduled release/automatic price amendment task.
2. Cancel active child orders and await.
As same as algorithm parent order is newly created, analyze and project child order releases and automatic amendment.
Start time of timed trading volume is set to new order start time.
However, even if there is no order start time specified or past, re-analyze as amendment time(current time) is trade start time.

Additional note) If there is no order start time specified, Start Time on GUI to calculate "Start Volume", "Time-Volume", and "Time-VWAP" defaults to order receiving time.

7.4.3 Sample of Parent Order Amendment

Example 1) Amendment from Limit order into Market order

	Amendment Time	Side	Order Qty	Limit Price	Start Time	End Time	Volume Limit
Before amendment	-	SELL	100,000	840	9:00	11:00	15%
After amendment	10:15	—	100,000	0	9:00	11:00	15%

If there are active child orders at 840, amend them into at Market order.

No re-analysis.

Example 2) 3 parameters change at the same time "Limit Price", "Order Qty", "Order End Time"

	Amendment Time	Side	Order Qty	Limit Price	Start Time	End Time	Volume Limit
Before amendment	-	SELL	100,000	840	9:00	11:00	15%
After amendment	10:15	—	60,000	0	9:00	14:00	15%

1. Re-analyze and cancel child orders, if any active child orders.
2. Resize from 100,000→60,000
3. Extend trade end time to 14:00.

Example 3) Amendment of Volume Limit

	Amendment Time	Side	Order Qty	Limit Price	Start Time	End Time	Volume Limit
Before amendment	-	SELL	100,000	840	9:00	11:00	15%
After amendment	10:15	—	100,000	840	9:00	11:00	20%

1. Re-analyze and cancel child orders, if any active child orders.
2. Participation rate from amendment time is 20% after amendment.

Example 4) 5 parameters change at the same time "Order Qty", "Limit Price", "Start Time", "End Time", "Volume Limit"

	Amendment Time	Side	Order Qty	Limit Price	Start Time	End Time	Volume Limit
Before amendment	-	SELL	100,000	840	9:00	11:00	15%
After amendment	10:15	—	60,000	0	13:00	14:00	20%

1. Re-analyze and cancel child orders, if any active child orders.
2. After amendment, participation rate from amendment time is 20% and there is no limit price.

8. Dark limit

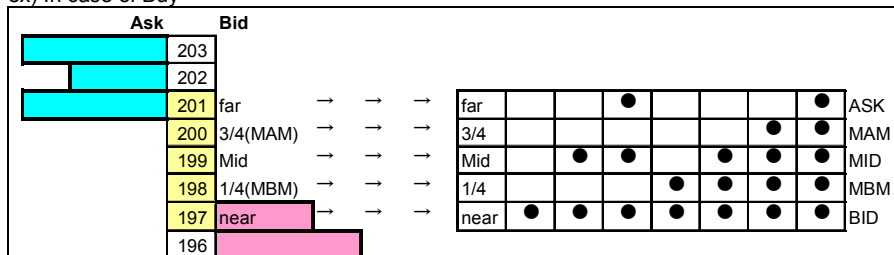
When an order is behind its schedule, Bravo calculates the limit price within dark pool(Dark Limit), considering the level of its delay and market situation at that time. The calculated Dark Limit is set to the child orders on the near. When an order isn't behind its schedule, Dark Limit isn't set. And Dark Limit isn't set to child orders not on the near.

8.1 Parameters for dark limit

[Algorithm parameters for dark limit]

No	Parameter Name	Description	Required	Parametric in FIX	Amendable	Default Value
1	Dark Limit Point	Off Peg To Mid Peg To Mid, Far Peg To 1/4 Peg To 1/4, Mid Peg To 1/4, Mid, 3/4 Peg To 1/4, Mid, 3/4, Far (default)	N	-	Y	Off

ex) In case of Buy



[Setup parameters for dark limit]

No	Parameter Name	Default
1	Peg To Level 1/4	0.15
2	Peg To Level Mid	0.4
3	Peg To Level 3/4	0.75
4	Peg To Level Far	1

8.2 Calculate Dark Limit

Dark Limit is calculated as follows.

1. Calculate Peg To Level

Peg To Level = (Adjusted Time Risk Factor / Indication)^2

Adjusted Time Risk Factor = $\min(2, \max(0.5, 2^{(-2 / (\text{Curve B} - \text{Curve C}))} * (\text{CumQty} + \text{CrossQty} + 0.5\text{lot}) + ((\text{Curve B} + \text{Curve C}) / (\text{Curve B} - \text{Curve C}))))$

2. Decide an appropriate Peg To Point from the Peg To Level Calculated at #1

PegToLevel	PegToPoint
PegTo Level <= PegTo Level 1/4	near
PegTo Level 1/4 < PegTo Level <= PegTo Level Mid	1/4
PegTo Level Mid < PegTo Level <= PegTo Level 3/4	mid
PegTo Level 3/4 < PegTo Level <= PegTo Level Far	3/4

3. Calculate Dark Limit from the price at the Peg To Point

[Buy]

Dark Limit = $\text{Max}(\text{Stop Low}, \text{Min}(\text{Stop High}(\text{Min}(\text{Parent Order's Limit Price}, \text{Price at Peg To Point}))))$

[Sell, SS]

Dark Limit = $\text{Min}(\text{Stop High}, \text{Max}(\text{Stop Low}(\text{Max}(\text{Parent Order's Limit Price}, \text{Price at Peg To Point}))))$

* If a customer's DarkDayHighLowCap is true in the customer master, all slices are capped with Day High and Day Low.

* Dark Limit is rounded off to four decimal places.

8.3 Short sell

Short sell rule is not applied in dark pool. So Bravo applies the same pricing logic as normal sell to Dark Limit.

Slices that want to cross the spread but can't because of short sell price limits will also have Dark Limit applied.

In finish up mode (at end of order's life), short sells have Dark Limit=Max(Parent's Limit Price, BID)

8.4 Conditions for Dark Limit

Dark Limit is enabled only when a order is behind its schedule in continuous session. To judge an order is behind schedule or not, we use the following condition.

Curve B > CumQty + CrossQty

When an order isn't behind its schedule, Bravo amends its slice's Dark Limit off.

Only the slice on the near has Dark Limit. If the slice is no longer on the near because the order was amended or market price changed, Dark Limit is removed (amended off).

* When the spread is more than 2 tick, Bravo can send the slice at BestBid+1 in case of Buy. In this situation, the slice at BestBid+1 has Dark Limit.

* If the slice can't be on the near because of limit price, the slice at limit price has Dark Limit. This is because of convenience of implementation.

* When there aren't near or far such as SQ, the order is judged as not filling Dark Limit condition.

8.5 Dark Day High Low Cap

DarkDayHighLowCap is specified in the customer master.

If DarkDayHighLowCap is true, all slices of the customer are capped with Day High and Day Low.

ex) In case of Buy

Timing	Situation	DarkLimit applied DarkDayHighLowCap
Before Opening	Limit Price On	Min(Parent's Limit Price, DayHigh)
	No Limit	DayHigh
Continuous Session	Far	Min(Child's Limit Price, DayHigh)
	Near	Min(Calculated DarkLimit, DayHigh)
	Near -1	Min(Child's Limit Price, DayHigh)
Finish Up Mode	Limit Price On	Min(Limit Price, DayHigh)
	No Limit	DayHigh

*When there is no Day High or Day Low, DarkDayHighLowCap is not applied the order.