Annual Report for 2020

of the Operating Committee of the Plan to Address Extraordinary Market Volatility

Submitted March 31, 2021

I. Introduction

On May 31, 2012, the Securities and Exchange Commission ("SEC" or "Commission") approved, on a pilot basis, a National Market System Plan, known as the Limit Up/Limit Down ("LULD") Plan, to address extraordinary market volatility. The Plan was approved by the Commission on a permanent basis on April 11, 2019, as part of the eighteenth amendment ("Amendment 18") to the Plan.[1]

The LULD Plan is administered by the LULD Operating Committee, comprising a representative from each of the Participants. The current Participants are Cboe BYX Exchange, Inc., Cboe BZX Exchange, Inc., Cboe EDGA Exchange, Inc., Cboe EDGX Exchange, Inc., the Financial Industry Regulatory Authority, Inc. ("FINRA"), Investors Exchange LLC, Long-Term Stock Exchange, MEMX LLC, MIAX Pearl, LLC, NASDAQ BX, Inc., NASDAQ PHLX LLC, The NASDAQ Stock Market LLC, New York Stock Exchange LLC, NYSE Arca, Inc., NYSE American LLC, NYSE Chicago, Inc., and NYSE National, Inc. The Plan and any amendments to it are filed with and approved by the Commission in accordance with Section 11A of the Securities Exchange Act of 1934.

Pursuant to Appendix B.II.A of the Plan, the Operating Committee is submitting this Annual Report for the year 2020.

A. Overview

The Plan is designed to prevent trades in NMS Stocks from occurring outside specified price bands, which are set at a percentage level above and below the reference price of a security over the preceding five-minute period. The percentage level is determined by a security's designation as a Tier 1 or Tier 2 security. **Tier 1** comprises all securities in the S&P 500, the Russell 1000, and select Exchange Traded Products ("ETPs"). **Tier 2** comprises all other NMS Stocks, except for rights and warrants, which are specifically excluded from coverage. The Plan does not apply to options. The Plan applies during regular trading hours of 9:30 am ET - 4:00 pm ET.

In order to determine which ETPs are eligible to be included as Tier 1 securities, the Plan requires that, on January 1 and July 1 of each year, the Participants identify all ETPs across multiple asset classes and issuers, including domestic equity, international equity, fixed income, currency, and commodities and futures. All leveraged ETPs are classified as Tier 2 securities, and the remaining ETPs are then sorted by notional consolidated average daily volume ("CADV"). The period used to measure CADV is from the first day of the previous fiscal half year up until one week before the beginning of the next fiscal half year. Daily volumes are multiplied by closing prices and then

[1] See Securities Exchange Act Release No. 85623 (April 11, 2019), 84 FR 16086 (April 17, 2019) (File No. 4-631).

averaged over the period. Non-leveraged ETPs (including inverse ETPs) that trade over $2,000,000 CADV are classified as Tier 1 securities for the six-month period. The remaining ETPs are classified as Tier 2 securities.

B. Calculation of Price Bands

The Plan's price bands, consisting of a Lower and Upper Price Band for each NMS Stock, are calculated by the two securities information processors ("SIPs") – the Securities Industry Automation Corporation and Nasdaq. The SIPs calculate the Lower and Upper Price Bands by applying a formula to a Reference Price, which is the arithmetic mean price of Eligible Reported Transactions over the prior five-minute period. (The first Reference Price of the day is either the primary market's opening price or the primary market's previous day's closing price/last sale when opening on a quote.) If no eligible trades have occurred in the prior five minutes, the previous Reference Price remains in effect. The Reference Price is updated after 30 seconds only if a new Reference price would be at least 1% away from the current Reference Price.

The Price Bands are calculated by multiplying the current Reference Price by the applicable Percentage Parameter, and then adding or subtracting that value from the Reference Price and rounded to the nearest penny:

$$\textit{Price Band} = (\textit{Reference Price}) \pm ((\textit{Reference Price}) \times (\textit{Percentage Parameter}))$$

Table A below shows the Percentage Parameters in effect for all Tier 1 securities and for Tier 2 securities at or below $3.00, from 9:30 a.m. to 3:35 p.m. Table B shows the Percentage Parameters that apply to Tier 2 securities priced above $3.00 from 9:30 a.m. to 4:00 p.m. Price Bands are doubled during the last 25 minutes of the regular trading day for all Tier 1 securities and for Tier 2 securities at or below $3.00.[2]

[2] As discussed in Section III, effective February 24, 2020, Amendment 18 eliminated double-wide bands from 9:30 a.m. to 9:45 a.m. for all securities, and eliminated double-wide bands from 3:35 p.m. to 4:00 p.m. for all Tier 2 securities priced above $3.00.

Table A: Pricing Parameters for Tier 1 Securities	
Previous Closing Price	**Percentage Parameter**
Greater than $3.00	5%
$0.75 up to and including $3.00	20%
Less than $0.75	Lesser of $0.15 or 75%

Table B: Pricing Parameters for Tier 2 Securities	
Previous Closing Price	**Percentage Parameter**
Greater than $3.00	10%
$0.75 up to and including $3.00	20%
Less than $0.75	Lesser of $0.15 or 75%

C. Annual Reporting Obligation

As required, the Annual Report comprises information concerning the Plan's performance during the preceding calendar year, including:

(1) an update on the Plan's operations;

(2) an analysis of any amendment to the Plan implemented during the period covered by the report; and

(3) an analysis of potential material emerging issues that may directly impact the operation of the Plan.

We address those issues below.

II. Update on the Plan's Operations in 2020

2020 represented the first time since the inauguration of the LULD Plan that the U.S. equity markets were faced with an extended period of high volatility. During the last 10 months of the year, only two days saw an intraday low in the CBOE VIX® index below 20. By comparison, for all

of 2019, the intraday high for VIX® exceeded 20 on just 35 days and closed above 20 just 15 times. The 2019 intraday peak was 28.53, which was well below the average closing value of VIX® from February 24 to year-end of 2020 of 31.63.

Table 1 below shows the full year results for 2020 and reflects that LULD events for the full year were well above the results from the 2019 Measured Period.[3] The average daily number of pauses in 2020 was 53, up from 10 in the 2019 Measured Period, and average daily limit states rose to 351 in 2020 from 196 in the 2019 Measured Period. Straddle states increased in 2020 to an average of 3,045 per day from 1,782 per day in the 2019 Measured Period.

During 2020, LULD events were more likely to occur during the early part of the trading day. Despite accounting for just 4% of the trading day (except short days), the first 15 minutes contained 20% of LULD pauses, 23% of limit states, and 43% of straddle states. The opposite is true of the end of the day, during which far fewer LULD events occurred in all categories. The last 25 minutes accounted for 6% of the trading day (except short days), but represented just 4% of pauses and 3% of limit and straddle states.

[3] Amendment 18 imposed the new requirement on the Operating Committee to gather and publish data in quarterly Monitoring Reports. As these requirements were not finalized until April 2020, the 2019 Annual Report covered the first three quarters of 2019 (referred to in this Report as the "2019 Measured Period").

	Limit State, Trading Pause and Straddle State 2019 Q1 - Q3 (excl. 8/12/2019)		
Daily	**Limit**	**Pause**	**Straddle**
Average	196	10	1,782
Median	78	9	1,286
90th %-ile	280	19	3,202
Low	4	1	431
High	7,443	57	9,438

Table 1:

2020 Full Year Limit Up Limit Down Pause, Limit and Straddle Results

		Median	Average	90 %-ile	Total
9:30 - 9:45	**LULD Pauses**	4.0	10.7	20.8	2,700
	Limit States	30.0	79.2	160.2	20,049
	Straddle States	1,103.0	1,302.5	2,201.6	329,536
9:45 - 25 min before close	**LULD Pauses**	13.0	40.2	58.6	10,175
	Limit States	91.0	262.3	440.4	66,373
	Straddle States	666.0	1,653.9	2,590.0	418,449
Last 25 minutes	**LULD Pauses**	0.0	1.9	2.8	478
	Limit States	1.0	9.6	22.8	2,428
	Straddle States	34.0	93.3	161.4	23,596
Total	**LULD Pauses**	19.0	52.8	78.6	13,353
	Limit States	144.0	351.2	688.0	88,850
	Straddle States	1,857.0	3,044.7	4,762.0	771,581

As shown in **Table 2** below, single day peaks for LULD pauses and straddle states rose in 2020 compared to the 2019 Measured Period, but the day with the highest number of limit states in 2020 barely exceeded the highs in 2019.

Table 2:

Single Day Peaks: 2020 vs. 2019 Measured Period

	2020	2019 Measured Period
LULD Pauses	1,691	57
Limit States	7,540	7,443
Straddle States	34,789	9,438

The exceptional volatility in 2020 makes comparisons with prior periods difficult. However, as **Table 3** below shows, if we exclude the most volatile period of 2020, from February 24 through May 1 (the "High Volatility Period"), some of the statistics for the remainder of 2020 are little changed from the 2019 Measured Period. Excluding the High Volatility Period, the median daily limit states in 2020 rose to 117 from 78 in the 2019 Measured Period, and median daily straddle states rose to 1,706 in 2020 from 1,286 in the 2019 Measured Period.[4] However, even when

[4] We generally discuss medians instead of averages due to the skew caused by the most volatile periods during the study periods. Medians are a fairer representation of more normal activity, and we refer to the 90th percentile data to exhibit more extreme days. We do, however, include some data and discussion on averages for comparison purposes.

excluding the High Volatility Period, the median daily number of LULD pauses rose to 15 in 2020 from 9 in the 2019 Measured Period.

The 90th percentile of LULD pauses during the 2019 Measured Period was 19, which is less than half the 90th percentile of 43 in 2020 when the High Volatility Period is excluded. Similarly, the 90th percentile for limit states rose to 456 in 2020 from 280 in the 2019 Measured Period, while the 90th percentile for straddle states was little changed in 2020, slipping to 2,963 from 3,202 in the 2019 Measured Period.

Table 3:

2020 Excluding 2/24 - 5/1 Limit Up Limit Down Pause, Limit and Straddle Results

		Median	Average	90 %-ile	Total
9:30 - 9:45	**LULD Pauses**	3.0	4.7	11.0	958
	Limit States	22.0	55.9	113.4	11,404
	Straddle States	1,048.0	1,003.8	1,511.0	204,765
9:45 - 25 min before close	**LULD Pauses**	11.0	15.3	32.7	3,121
	Limit States	77.5	139.5	276.4	28,453
	Straddle States	568.5	790.5	1,702.7	161,253
Last 25 minutes	**LULD Pauses**	0.0	0.5	2.0	111
	Limit States	1.0	5.1	14.0	1,039
	Straddle States	26.0	39.5	87.1	8,056
Total	**LULD Pauses**	15.0	20.5	43.0	4,190
	Limit States	116.5	200.5	455.6	40,896
	Straddle States	1,706.0	1,833.7	2,962.5	374,074

As shown in **Table 4** below, unsurprisingly, LULD events rose substantially during the High Volatility Period. In this period, the median number of pauses during the midday period was 44 (**Table 4**), while the median number of pauses for the remainder of 2020 was just 11 (see **Table 3** above). Similarly, limit and straddle state medians were about three times higher during the High Volatility Period (see **Table 4**) than they were during the balance of 2020 (see **Table 3**).

The average daily number of LULD pauses during the High Volatility Period was 187 (**Table 4**), which is more than 9 times higher than the average daily number of LULD pauses of 20.5 for the rest of 2020 (**Table 3**), and more than 18 times higher than the 10 average daily number of LULD pauses in the 2019 Measured Period. Similarly, limit state and straddle state averages during the High Volatility Period were both between four and five times higher than for the remainder of 2020, as well as for the 2019 Measured Period. Also noteworthy is that for the period of 9:45 a.m. - 3:35 p.m., LULD pauses averaged 144 per day during the High Volatility Period, an amount almost ten times higher than the average daily LULD pause count of 15 during that time of day for the rest of 2020.

Table 4:

2/24 - 5/1/2020 Limit Up Limit Down Pause, Limit and Straddle Results

		Median	Average	90 %-ile	Total
9:30 - 9:45	**LULD Pauses**	20.0	35.6	93.0	1,742
	Limit States	83.0	176.4	425.0	8,645
	Straddle States	1,942.0	2,546.3	4,827.8	124,771
9:45 - 25 min before close	**LULD Pauses**	44.0	144.0	334.2	7,054
	Limit States	212.0	773.9	2,747.6	37,920
	Straddle States	2,189.0	5,248.9	15,112.8	257,196
Last 25 minutes	**LULD Pauses**	1.0	7.5	21.6	367
	Limit States	7.0	28.3	64.2	1,389
	Straddle States	128.0	317.1	879.0	15,540
Total	**LULD Pauses**	69.0	187.0	457.8	9,163
	Limit States	328.0	978.7	3,218.0	47,954
	Straddle States	4,397.0	8,112.4	24,708.4	397,507

A review of the details provides some interesting results. **Table 5** below shows the breakouts of LULD event by (i) the LULD Tier of a security, (ii) whether the security is an ETP (and if an ETP, if it was leveraged), and (iii) the security's closing price.[5] As expected, there were far more LULD events in Tier 2 symbols than in Tier 1 symbols. For most categories, the median number of LULD pauses in 2020, despite the high volatility, remained at or near zero. However, the skew caused by the initial reaction to the COVID-19 pandemic resulted in noticeable differences in average daily and 90th percentile figures.

[Table 5 appears on the next page]

[5] In this table and the tables below, categories are not included if there were only *de minimis* numbers of symbols meeting the requirements.

Table 5:

LULD Summary Statistics by Tier, ETP and Price Groups (Full Year 2020)							
CATEGORIES:							
Tier	1	1	2	2	2	2	2
ETP Flag	N	Y	N	N	N	Y	Y
Leverage	N	N	N	N	N	N	Y
Close Price	≥ $3.00	≥ $3.00	< $0.75	$0.75-$3.00	≥ $3.00	≥ $3.00	≥ $3.00
Avg. # of Symbols	1002.1	735.8	167.6	658.4	4,361.2	1,132.4	167.3
Avg. Limits Early	17.5	0.8	2.5	7.5	46.8	3.9	0.4
Avg. Limits Midday	42.5	3.4	19.4	25.6	160.2	9.3	2.5
Avg. Limits Late	0.3	0.1	0.4	0.0	8.6	0.3	0.0
Avg. Pauses Early	1.2	0.2	0.5	0.9	7.2	0.5	0.1
Avg. Pauses Midday	4.3	1.1	2.8	2.7	26.8	2.5	0.2
Avg. Pauses Late	0.0	0.0	0.0	0.0	1.8	0.1	0.0
Avg. Straddles Early	100.5	15.6	6.6	32.0	906.8	229.2	15.9
Avg. Straddles Midday	128.1	23.7	41.7	64.0	1,001.2	347.5	49.6
Avg. Straddles Late	0.8	0.2	0.9	0.3	69.9	20.6	0.9
Median Limits Early	0.0	0.0	0.0	0.0	16.0	0.0	0.0
Median Limits Midday	0.0	0.0	2.0	4.0	56.5	0.0	0.0
Median Limits Late	0.0	0.0	0.0	0.0	1.0	0.0	0.0
Median Pauses Early	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Median Pauses Midday	0.0	0.0	0.0	1.0	9.0	0.0	0.0
Median Pauses Late	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Median Straddles Early	43.0	7.0	1.0	11.0	874.5	111.0	2.0
Median Straddles Midday	6.0	0.0	6.0	13.0	478.0	35.0	0.0
Median Straddles Late	0.0	0.0	0.0	0.0	28.0	4.0	0.0
90th %-ile Limits Early	32.9	0.0	8.0	19.0	112.7	5.9	0.0
90th %-ile Limits Midday	64.7	0.0	60.9	56.8	228.6	4.9	0.0
90th %-ile Limits Late	0.0	0.0	0.0	0.0	21.7	0.0	0.0
90th %-ile Pauses Early	2.0	0.0	2.0	3.0	14.9	1.0	0.0
90th %-ile Pauses Midday	3.9	0.0	7.0	7.0	42.0	2.0	0.0
90th %-ile Pauses Late	0.0	0.0	0.0	0.0	2.9	0.0	0.0
90th %-ile Straddles Early	186.3	21.8	20.8	91.9	1,444.0	487.6	11.0
90th %-ile Straddles Midday	229.0	5.9	122.7	172.6	1,744.2	597.0	10.0
90th %-ile Straddles Late	0.0	0.0	0.9	1.0	134.0	18.9	1.0

Note: "**Early**" refers to 9:30 a.m. - 9:45 a.m. "**Midday**" means 9:45 a.m. - 3:35 p.m. "**Late**" means 3:35 p.m. - 4:00 p.m.

Table 6 shows the incidence of LULD events per day per symbol for each statistical measure: average, median, and 90th percentile. In other words, **Table 6** takes the measure in **Table 5** and divides it by the average number of symbols per day in that category, to adjust for the different number of stocks in each group, since **Table 5** shows the aggregate count per group, and not per symbol.

Table 6 shows some interesting results.

- The median limit state incidence was zero for all time periods for Tier 1 non-ETPs ≥ $3.00, but was above zero for Tier 2 non-ETPs.
- For the early and midday periods, the 90th percentile for limit states was higher for Tier 1 non-ETP securities than for Tier 2 non-ETP securities. This was reversed for the late period, where the 90th percentile for limit states was higher for Tier 2 non-ETP securities than for Tier 1 non-ETP securities.
- Non-leveraged Tier 2 ETPs did have a slightly higher average incidence of limit states than Tier 1 ETPs during the early and midday periods. Both Tier 1 and Tier 2 non-leveraged ETPs had an average incidence of limit states of 0% in the late period.
- The very low average and median incidence of LULD pauses in ETPs is consistent regardless of price and leverage category.
- In all comparable categories for both ETPs and non-ETP securities, the comparable average incidence of straddle states is higher in Tier 2 than Tier 1.

[Table 6 appears on the next page]

Table 6:

LULD Summary Statistics by Tier, ETP and Price Groups (Full Year 2020)							
Tier	1	1	2	2	2	2	2
ETP Flag	N	Y	N	N	N	Y	Y
Leverage	N	N	N	N	N	N	Y
Close Price	≥ $3.00	≥ $3.00	< $0.75	$0.75-$3.00	≥ $3.00	≥ $3.00	≥ $3.00
Avg. # of Symbols	1002.1	735.8	167.6	658.4	4,361.2	1,132.4	167.3
Avg. Limits Early	1.8%	0.1%	1.5%	1.1%	1.1%	0.3%	0.2%
Avg. Limits Midday	4.2%	0.5%	11.6%	3.9%	3.7%	0.8%	1.5%
Avg. Limits Late	0.0%	0.0%	0.2%	0.0%	0.2%	0.0%	0.0%
Avg. Pauses Early	0.1%	0.0%	0.3%	0.1%	0.2%	0.0%	0.0%
Avg. Pauses Midday	0.4%	0.1%	1.6%	0.4%	0.6%	0.2%	0.1%
Avg. Pauses Late	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avg. Straddles Early	10.0%	2.1%	4.0%	4.9%	20.8%	20.2%	9.5%
Avg. Straddles Midday	12.8%	3.2%	24.9%	9.7%	23.0%	30.7%	29.6%
Avg. Straddles Late	0.1%	0.0%	0.5%	0.0%	1.6%	1.8%	0.5%
Median Limits Early	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%
Median Limits Midday	0.0%	0.0%	1.2%	0.6%	1.3%	0.0%	0.0%
Median Limits Late	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Median Pauses Early	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Median Pauses Midday	0.0%	0.0%	0.0%	0.2%	0.2%	0.0%	0.0%
Median Pauses Late	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Median Straddles Early	4.3%	1.0%	0.6%	1.7%	20.1%	9.8%	1.2%
Median Straddles Midday	0.6%	0.0%	3.6%	2.0%	11.0%	3.1%	0.0%
Median Straddles Late	0.0%	0.0%	0.0%	0.0%	0.6%	0.4%	0.0%
90th %-ile Limits Early	3.3%	0.0%	4.8%	2.9%	2.6%	0.5%	0.0%
90th %-ile Limits Midday	6.5%	0.0%	36.3%	8.6%	5.2%	0.4%	0.0%
90th %-ile Limits Late	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%
90th %-ile Pauses Early	0.2%	0.0%	1.2%	0.5%	0.3%	0.1%	0.0%
90th %-ile Pauses Midday	0.4%	0.0%	4.2%	1.1%	1.0%	0.2%	0.0%
90th %-ile Pauses Late	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
90th %-ile Straddles Early	18.6%	3.0%	12.4%	14.0%	33.1%	43.1%	6.6%
90th %-ile Straddles Midday	22.9%	0.8%	73.2%	26.2%	40.0%	52.7%	6.0%
90th %-ile Straddles Late	0.0%	0.0%	0.5%	0.2%	3.1%	1.7%	0.6%

Note: "**Early**" refers to 9:30 a.m. - 9:45 a.m. "**Midday**" means 9:45 a.m. - 3:35 p.m. "**Late**" means 3:35 p.m. - 4:00 p.m.

We also reviewed LULD events based on quote volatility. We measured quote volatility as the average mid-point to mid-point price change each second. **Table 7** below shows the distribution of daily quote volatility measures, broken out by whether the security is an ETP and its LULD Tier.

Regarding non-ETPs: While Tier 2 non-ETPs average somewhat higher volatility than Tier 1 non-ETPs, this is due to the skew for the most volatile periods. At the lowest part of the distribution (e.g., 10th percentile), quote volatility for Tier 2 non-ETPs was lower than quote volatility for Tier 1 non-ETPs, but at higher parts of the distribution (e.g., 90th percentile), this result was flipped and quote volatility for Tier 2 non-ETPs was higher than quote volatility for Tier 1 non-ETPs. This stands to reason, since at lower percentiles, Tier 2 non-ETPs have fewer quote updates, so their volatility is lower. However, when less-liquid securities become more volatile, it results in a concomitant larger increase in quote volatility.

Regarding ETPs: There was not the same disparity in quote volatility when comparing Tier 1 ETPs vs. Tier 2 ETPs. In general, quote volatility for ETPs was well below that of non-ETPs.

Table 7:

Quote Volatility
(Full Year 2020, basis points)

			Percentile				
ETP Flag	**LULD Tier**	**Average**	**10**	**25**	**50**	**75**	**90**
N	**1**	0.387	0.132	0.185	0.282	0.461	0.746
	2	1.019	0.024	0.079	0.185	0.381	0.912
Y	**1**	0.244	0.006	0.036	0.119	0.245	0.438
	2	0.468	0.009	0.034	0.110	0.307	0.848

Table 8 below compares trading pauses, limit states, and straddle states on a per symbol per day level. We find that pauses in Tier 2 non-ETPs are not impacted significantly by increased volatility, suggesting that Tier 2 non-ETPs are more affected by liquidity gaps. We reach this conclusion because pauses per day per symbol are similar across all volatility levels. We also find that Tier 1 ETPs are less impacted than Tier 1 non-ETPs by volatility, although pause rates generally increase with quote volatility. Because volatility ranges much higher for non-ETPs, at our highest breakout, we do see a substantially greater likelihood of an LULD pause in non-ETPs, regardless of the security's Tier.

Increases in limit and straddle states are more obvious as volatility rises. Note that these tables count the number of events, which we consider more relevant than the time spent in these states, and include straddle states.

Table 8:

Per Symbol Pauses, Limits and Straddles by Daily Quote Volatility

LULD Tier		1	2	1	2
ETP (Y/N)	Quote Volatilty	N	N	Y	Y
Pauses	< 0.5	0.000	0.001	0.000	0.001
	0.5 - 1.0	0.005	0.017	0.007	0.007
	1.0 - 1.5	0.035	0.060	0.036	0.012
	1.5 - 2.0	0.098	0.086	0.079	0.013
	2.0 - 2.5	0.255	0.063	0.133	0.017
	>= 2.5	0.621	0.056	0.116	0.030
Limits	< 0.5	0.001	0.005	0.001	0.003
	0.5 - 1.0	0.054	0.057	0.024	0.013
	1.0 - 1.5	0.308	0.333	0.103	0.036
	1.5 - 2.0	0.977	0.703	0.235	0.049
	2.0 - 2.5	3.193	0.251	0.486	0.088
	>= 2.5	7.446	0.483	0.566	0.227
Straddles	< 0.5	0.040	0.146	0.025	0.099
	0.5 - 1.0	0.275	0.625	0.234	0.468
	1.0 - 1.5	1.193	2.014	0.815	1.026
	1.5 - 2.0	2.961	2.490	1.294	1.851
	2.0 - 2.5	9.112	2.342	2.190	3.335
	>= 2.5	19.311	2.638	3.405	10.727

Table 9 below describes the distribution of pauses, limit states, and straddle states broken out by daily quote volatility, LULD Tier, and whether or not the security is an ETP. The overall distribution of pauses, limit states, and straddle states is less closely tied to volatility than on a per symbol basis, except in general at the lowest quote volatility and highest quote volatility levels. This is made clear by the fact that the distribution of pauses, limits and straddles in Table 9 do not consistently rise as quote volatility increases. There appears to be a greater impact from high volatility on Tier 2 non-ETPs than on the other categories of securities. Interestingly, for Tier 2 non-ETPs, the lowest volatility periods also result in a large share of LULD events. This is likely tied to liquidity gaps, where after a period of quiescence, the quote moves, resulting in a straddle, limit, or pause.

Table 9:

LULD Event Distribution by Quote Volatility, Tier and ETP Flag

LULD Tier		1	2	1	2
ETP (Y/N)	Quote Volatilty	N	N	Y	Y
Pauses	< 0.5	1.8%	13.3%	17.8%	19.4%
	0.5 - 1.0	14.7%	18.2%	22.5%	21.2%
	1.0 - 1.5	21.6%	12.6%	25.7%	14.1%
	1.5 - 2.0	17.7%	8.2%	15.1%	7.5%
	2.0 - 2.5	15.4%	5.4%	8.3%	5.8%
	>= 2.5	28.9%	42.3%	10.7%	32.0%
Limits	< 0.5	1.4%	8.1%	18.4%	19.4%
	0.5 - 1.0	15.1%	9.8%	23.1%	8.8%
	1.0 - 1.5	17.6%	10.9%	21.5%	9.1%
	1.5 - 2.0	16.2%	10.7%	13.0%	5.9%
	2.0 - 2.5	17.8%	3.4%	8.8%	6.0%
	>= 2.5	31.9%	57.2%	15.2%	50.8%
Straddles	< 0.5	13.6%	29.3%	37.7%	16.1%
	0.5 - 1.0	20.2%	13.6%	23.4%	7.5%
	1.0 - 1.5	18.0%	8.4%	17.7%	6.3%
	1.5 - 2.0	13.0%	4.8%	7.5%	5.5%
	2.0 - 2.5	13.4%	4.0%	4.1%	5.6%
	>= 2.5	21.8%	39.8%	9.5%	58.6%

Clearly Erroneous Executions (CEEs)

CEEs remain infrequent when the LULD bands are in effect. As shown in **Table 10** below, for the full year 2020, there were 33 CEEs, of which 27 were in non-ETPs and six in ETPs. Tier 2 securities accounted for 22 of the 33 CEEs. Fourteen CEEs occurred in the first 15 minutes of trading, with the remainder occurring between 9:45 a.m. and 25 minutes prior to the close. No CEEs occurred during the last 25 minutes of the trading day.

Of the 33 CEEs in 2020, six occurred on the days where market-wide circuit breaker ("MWCB") halts were triggered: one (on March 18) during the first 15 minutes of trading, with the rest occurring between 9:45 a.m. and 3:35 p.m. on various MWCB days. 17 CEEs – more than half of the 33 total CEEs in 2020 – took place during the higher volatility period of February 24 through May 1, and only five occurred in the second half of the year.

Table 10:

2020 CEEs

Non-ETP CEEs

	Q1		Q2		Q3		Q4	
	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
9:30 - 9:45	1	0	1	6	0	0	0	4
9:45 - 25 min. before close	3	3	3	5	0	1	0	0
Last 25 Minutes	0	0	0	0	0	0	0	0

ETP CEEs

	Q1		Q2		Q3		Q4	
	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
9:30 - 9:45	0	1	0	1	0	0	0	0
9:45 - 25 min. before close	2	1	1	0	0	0	0	0
Last 25 Minutes	0	0	0	0	0	0	0	0

III. Analysis of Amendments Implemented

In December 18, 2018, the Participants filed Amendment 18 to the Plan, which proposed to eliminate double-wide bands for all securities during the first fifteen minutes of trading, and for Tier 2 stocks in the $3.00 and above category for the last 25 minutes of the trading day.[6] In support of these proposed changes, the Plan Participants presented data showing the disproportionate number of limit states and trading pauses that occur at or shortly after 9:45 a.m., the only time the price bands contracted intraday. The Participants believed that wider price bands could cause displayed quotations that are within the price bands prior to 9:45 a.m. to then be outside of the price bands once they contracted. This, in turn, resulted in an increased number of limit states and trading pauses starting at 9:45 a.m., due to quotations not being updated quickly enough. Participants' data in support of Amendment 18 also showed that the number of limit states and trading pauses then decreased as trading adjusts to the tighter price bands; specifically, that over 21% of all trading pauses occurred in the five minutes following the contraction of the price bands at 9:45 a.m. Data also showed that the increase in trading pauses

[6] See Securities Exchange Act Release No. 84843 (December 18, 2018), 83 FR 66464 (December 26, 2018) (File No. 4–631).

at 9:45 a.m. was not due to an increase in volatility at or around 9:45 a.m., but was primarily driven by the sudden contraction of price bands as was required by the Plan.

On April 17, 2019, the Commission approved Amendment 18 and directed that the elimination of double-wide bands be implemented on or before April 17, 2020. On February 24, 2020, these changes were implemented. We review the impact of those changes here.

Ideally, we would have chosen to compare LULD events during the relevant time periods immediately before and after the changes to double-wide bands went into effect on February 24, 2020. Unfortunately, and coincidentally, market volatility accelerated on exactly the first day that the double-band removal was implemented. An alternate idea might have been to compare to a similar volatile period in the past. However, we find no extended periods of similar volatility since LULD was implemented. Additionally, the removal of "leaky" bands and prior amendments, which resulted in a changes to how securities resumed after a pause and the use of the prior close instead of the first quote mid-point for stocks that do not open with a trade, make comparisons with earlier LULD regimes challenging.

Due to these challenges, we decided upon the following strategy:

1. Compare Q4 2019 to Q4 2020. We use fourth quarter of 2020 as a comparison point, since it was the least volatile period of 2020 (although volatility was still somewhat elevated), and compare it to the same quarter in 2019.

2. Compare changes in events after the removal of double-wide bands for three periods: 9:30-9:45 a.m. (early), 9:45-3:35 p.m. (midday), and 3:35-4:00 (late). In other words, we want to see, even if the frequency of LULD events changed, were the changes similar for the midday period when no changes were made, compared to the early and late periods. We did not expect to be able to make a meaningful observation about the late period, because Tier 1 stocks rarely halt or even enter limit states in the last 25 minutes of the trading day.

The comparison is in **Table 11** below:

Table 11:

Percent of Symbols with LULD Events

Q4 2019:		Early 9:30 - 9:45			Midday 9:45 - 3:35			Late 3:35 - 4:00		
Tier	**ETP**	**Pauses**	**Limits**	**Straddles**	**Pauses**	**Limits**	**Straddles**	**Pauses**	**Limits**	**Straddles**
1	**N**	0.00%	0.00%	0.40%	0.02%	0.03%	0.04%	0.00%	0.00%	0.00%
1	**Y**	0.00%	0.00%	0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
2	**N**	0.01%	0.02%	1.03%	0.08%	0.13%	1.28%	0.00%	0.00%	0.07%
2	**Y**	0.00%	0.01%	1.49%	0.01%	0.02%	0.41%	0.00%	0.00%	0.02%
Q4 2020:										
1	**N**	0.02%	0.09%	2.97%	0.01%	0.04%	0.07%	0.00%	0.00%	0.00%
1	**Y**	0.01%	0.01%	0.86%	0.01%	0.02%	0.08%	0.00%	0.00%	0.00%
2	**N**	0.05%	0.10%	15.65%	0.09%	0.15%	1.03%	0.01%	0.02%	0.20%
2	**Y**	0.02%	0.02%	6.52%	0.01%	0.02%	1.76%	0.00%	0.00%	0.19%
Q4 2020 minus Q4 2019:										
1	**N**	0.02%	0.09%	2.57%	-0.01%	0.01%	0.03%	0.00%	0.00%	0.00%
1	**Y**	0.01%	0.01%	0.80%	0.01%	0.02%	0.08%	0.00%	0.00%	0.00%
2	**N**	0.04%	0.09%	14.62%	0.02%	0.02%	-0.25%	0.01%	0.02%	0.13%
2	**Y**	0.01%	0.02%	5.02%	0.00%	0.00%	1.35%	0.00%	0.00%	0.17%

The data show that the percentage of symbols experiencing limit states and trading pauses increased slightly during the 9:30 - 9:45 a.m. time period in Q4 2020 over Q4 2019. Despite this increase, the likelihood of any symbol entering a limit state in Q4 2020 remained low, with no category reaching even 0.1%. And even with these increases, only 0.05% of symbol-days in Q4 2020 had trading pauses, which equates to one out of every 2,000 symbol-days. We also note that from Q4 2019 to Q4 2020, there was little change in the percentage of symbols with trading pauses and limit states in the 9:45-3:35 p.m. and 3:35-4:00 periods.

The data also show that a noticeable increase in the percentage of symbols that experienced straddle states from 9:30-9:45 a.m. in Q4 2020 over Q4 2019. More than 15% of Tier 2 non-ETPs entered a straddle state during the 9:30-9:45 a.m. period in Q4 2020, compared to just over 1% in Q4 2019. The number of Tier 2 ETPs entering straddle states during the 9:30-9:45 a.m. period also rose to 6.5% in Q4 2020, from 1.5% in Q4 2019. It is worth noting, however, that securities in a straddle state are still tradable and price discovery is still occurring, which is not the case during a trading pause. There was little change in the percentage of symbols with straddle states in the 9:45-3:35 p.m. and 3:35-4:00 p.m. periods from Q4 2019 to Q4 2020.

In Q4 2020, there were a significant number of stocks that went into straddle states on a serial basis. Specifically, there were 174 securities that had at least one straddle state on 90% of the

days during Q4 2020. All are in Tier 2, in the $3.00 and up category, with only 19 ETPs represented. Nearly half of these 174 stocks were preferred securities, with most of the remainder either closed end funds or structured products. These 174 stocks account for 20% of straddle states during Q4 2020.

Overall, although the amount of time stocks spent in a straddle state increased in 2020 over 2019, the total time spent in straddle states in Q4 2020 was still quite small: 0.67% for non-ETP Tier 2 stocks and 0.21% for Tier 2 ETPs, up from 0.24% and 0.10% in Q4 2019, respectively. Tier 1 stocks were rarely in a straddle state in Q4 2019 (less than 0.01% of the time), and still spent little time in a straddle state in 2020.

Table 12 shows the percentage of total time that a stock not in an LULD or regulatory pause spent in a straddle state. The statistic is calculated for each date and equal weighted for each day and each symbol.

Table 12:

Time in Straddle State Opening Period
(9:30-9:45 Q4 2019 and Q4 2020)

Tier	ETP	Q4 2019	Q4 2020
1	**N**	0.00%	0.04%
2	**N**	0.24%	0.67%
1	**Y**	0.00%	0.02%
2	**Y**	0.10%	0.21%

During Q4 2019, four symbols (out of 8,013 securities) remained in straddle states for at least one-third of the time during the 9:30-9:45 a.m. period. In Q4 2020, this number increased to seven symbols (out of 8,536). 97 stocks exceeded 10% of the time in a straddle state in Q4 2020, compared to 22 in Q4 2019.

As noted above, prior to the removal of double-wide bands at the open, symbols would periodically pause shortly after 9:45 a.m. as liquidity providers at times did not adjust their quotes quickly enough to allow for the tighter bands. We compared the number of pauses in the 9:45 a.m. and 9:46 a.m. minutes during Q4 2019 and Q4 2020. In Q4 2019, there were 51 such pauses, while in Q4 2020 there were 26, a drop of roughly 50%. This 50% decrease in pauses shortly after 9:45 a.m., despite higher volatility, is likely attributable to the removal of double-wide bands before 9:45 a.m.

Additionally, the removal of double-wide bands in the 3:35-4:00 p.m. period for Tier 2 stocks at or above $3.00 appears to have had little impact. Limit states, pauses, and straddle states remained infrequent for these securities in Q4 2020 despite the narrowing of the bands.

During Q4 2019, there were eight CEEs, four of which occurred between 9:30 and 9:45 a.m. During Q4 2020, there were four CEEs, all occurring between 9:30 and 9:45 a.m.

Conclusions Regarding Impact of Amendment 18

A robust comparison of the impact of Amendment 18 was challenging, due to the much higher volatility in 2020 as compared to 2019. Despite the drop in the VIX® from the early 2020 highs during the fourth quarter of 2020, the average, median and 90th percentile VIX® levels in Q4 2020 were 25.67, 24.72, and 31.88, compared with 13.99, 13.13 and 17.46 in 2019.

The comparison shows that trading pauses increased in Q4 2020 relative to Q4 2019, but only very slightly. For Tier 2 non-ETPs, the percentage of symbols per day that had at least one limit state in the early morning period in Q4 2020 was a still tiny 0.10% – six to seven limit states per day – compared to 0.02% – or about one per day – in Q4 2019. While, on a percentage basis, this increase may appear large, the gross increase in limit states is not significant, especially given the fact that the number of trading pauses remained small.

We note that the impetus for removing the double-wide bands in Amendment 18 was two-fold: (1) to prevent securities' prices from moving too far before an LULD pause, resulting in investors receiving unexpected fills, and (2) to decrease the number of LULD pauses shortly after double-wide bands were removed at 9:45 a.m. that occurred due to liquidity providers not adjusting their quotes quickly enough. The 50% decrease in trading pauses in the minutes after 9:45 a.m. in Q4 2020 compared to Q4 2019, despite the notably higher volatility in Q4 2020, shows that eliminating the double-wide bands at from 9:30 - 9:45 a.m. in Amendment 18 had the intended effect.

Based on these facts, we consider that it was the correct decision to remove double-wide bands during the first 15 minutes of trading. We do note that in Q4 2020, the number of limit states and trading pauses increased slightly, although we are unable to determine whether this was the result of the narrowed bands or increased volatility in Q4 2020. Additionally, in Q4 2020, the percentage of symbols with a straddle state each day increased somewhat, especially in Tier 2 securities. But as Table 12 shows, the amount of time in straddle states was still small in Q4 2020. And while the amount of time in a straddle state for Tier 2 securities more than doubled from Q4 2019 compared to Q4 2020, Tier 1 stocks in Q4 2020 still spent little time in straddle states.

Additionally, the data show that the removal of double-wide bands at the close for Tier 2 stocks at or above $3.00 appears to have had almost no impact. Limit states, pauses, straddle states, and CEEs remained infrequent in Q4 2020, despite the narrowed bands.

IV. Analysis of Emerging Issues

A. Examination of LULD Pauses Preceding MWCB Halts

On September 17, 2020, SEC staff from the Division of Trading and Markets formally asked the national securities exchanges and FINRA to conduct a study of the volatility events of March 2020, which resulted in four trading halts prescribed by SRO rules governing Market Wide Circuit Breakers ("MWCB"). In examining the impact of LULD trading pauses on MWCB, the Working Group conducting the MWCB study noted that, in the 2012 approval order amending the MWCB pilot,[7] the Commission requested comment on how the proposed changes would interact with the single-stock circuit breaker pilot program or the proposed LULD Plan. In the order, the Commission further asked whether the MWCBs should be triggered if a sufficient number of single-stock circuit breakers or LULD price limits were triggered. One commenter hypothesized that calculating the SPX values might be difficult if symbols comprising SPX were halted.

After analyzing the real-world LULD trading pause data that preceded the three MWCB halts on March 9, 12, and 18, 2020,[8] the MWCB Working Group concluded that the data does not shed light on this issue. As shown in **Table 13**, comparatively few symbols had been paused and a miniscule number of symbols in SPX were in that state.

Table 13:

Symbols in LULD Pauses preceding MWCB Halts

	March 9	March 12	March 18
All Symbols	57	44	12
SPX Symbols	3	0	1

These results do not foreclose the possibility, however, that a future MWCB halt could be triggered when there are numerous securities in LULD trading pauses.

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[7] See, e.g., Securities Exchange Act Release No. 67090 (May 31, 2012), 77 FR 33531 (June 6, 2012) (SR-NYSE-2011-48).

[8] March 16, 2020 is excluded from this analysis because the MWCB halt occurred one second after the opening of regular trading hours.

B. PROPOSAL TO MOVE TIER 2 ETPS TO TIER 1

A significant portion of the 2019 Annual Report was devoted to evaluating Tier 2 ETPs in an effort to determine whether these securities should be included in Tier 1. This study was undertaken at the request of issuers concerned about price divergence from indicative index valuations that occurs within the twice-as-wide Tier 2 Price Band boundaries. The evaluation, which originally spanned 2018 and 2019, is now being extended to include 2020 and its significant period of high volatility. Since the study is not fully completed, it is not addressed in this 2020 Annual Report. The Operating Committee's focus will turn to completing that study.