1. Introduction

This document is a catch all response to address the action stated within the below stated compliance assessment reports received 23/02/2021:

- Hope Cement Works Q1 2020 Monitoring CAR BP3731VJ-0386746
- Hope Cement Works Q2 2020 Monitoring CAR BP3731VJ-0386982
- Hope Cement Works Q3 2020 Monitoring CAR BP3731VJ-0386984
- Hope Cement Works Q4 2020 and Annual Monitoring CAR BP3731VJ-0387047

Action - By 23rd March 2021, please review the instances where the new derogation limit has been exceeded and explain why this is the case, and what Hope Cement Works is doing to ensure compliance with this ELV prior to the completion of the shale replacement project.

Prior to addressing the specifics of the above action, Breedon Cement LTD would like to address some key points.

The mechanisms for sulphur dioxide (SO_2) generation at Hope Cement Works and the ongoing compliance strategy were covered extensively by Hope Cement Works substantial variation request document Ref BCSVR18/19 section 3.0 / 3.1. These details have remained largely unchanged from the time of submission and we would encourage that this document is reviewed in full to save duplication of work in relation to understanding SO_2 emissions at Hope Cement Works. Additional details will be provided below as a reminder.

The exceedances have been recorded as “risk category 3 breach (a minor impact on human health, quality of life or the environment)”. During a meeting 26th September 2018 attended by Environment Agency staff Mark Taylor – (Principal Permitting Officer) and Paul Stevens – (E&B Senior Advisor), it was minuted that breaches would be classified as a category 4 breach only.
To further justify this Hope Cement Works would also like to refer you to section 3.2 of the derogation document BCSVR18/19 which outlines the output of detailed dispersion modelling that was undertaken in 2017 by Bureau Veritas which summarises that sulphur dioxide emissions from the cement kiln stack are not expected to cause adverse effects upon the health of the local population or cause adverse effects upon local ecological sites. This dispersion modelling was also separately submitted to the Environment Agency 29/09/2017.

As agreed, this document covers the submission of Improvement Programme Requirement 16 of the recently issued permit EPR/BP3731VJ/V006 (extract shown below).

Table S1.3 Improvement programme requirements		
Reference	**Requirement**	**Date**
IP16	The operator shall submit a report to the Environment Agency (for approval in writing) detailing progress towards compliance with BAT conclusion 21, which sets a BAT-AEL for cement kiln oxides of sulphur (SOx) emissions of <50-400mg/Nm^3 (daily average), for which a derogation has been requested and granted. The report shall include, but not be limited to, the following: 1. current performance against the BAT-AEL; 2. progress towards achieving planning permission and installing the necessary infrastructure for increasing shale substitution by utilising a range of Alternative Raw Materials (ARMs); 3. any alterations to the initial plan, together with proposals for amended timescales; 4. the level of substitution of ARMs (as total and by type) achieved at the time of report submission.	Progress reports by: 30/04/2021 29/10/2021

2. SO_2 ELV Exceedances

Hope Cement Works derogation document BCSVR18/19 section 3.0 provides a detailed account of the main sources of SO_2 emissions from the Hope Works process. A selected extract from the document is as follows which summarises the background information.

Sulphur dioxide (SO_2) is generated by two mechanisms at Hope Works. Firstly, it is produced by the combustion of fuels, which, at Hope, are introduced at the clinker discharge (or front) end of the kiln and, in smaller quantities, at the gas riser from the kiln (or back end). Through the preheater, the combustion products are in intimate contact with alkaline materials, in particular within the lower, hotter stages of the preheater, with calcium oxide at temperatures up to 900ºC. Under these conditions the oxides of sulphur are absorbed by the lime with only insignificant quantities remaining for contribution to emissions.
Secondly, SO_2 is produced by the clinker raw materials as they are heated in the presence of oxygen, in their travel from the point of input – between stages 1 and 2 of the preheater to the kiln.
Sulphur is present in two main forms in the raw materials: as sulphides and sulphates. As the temperature of the raw materials is raised, SO_2 is more likely to be formed from sulphides. This is because sulphates are more stable under the prevailing conditions in the preheater; consequently, the majority of the sulphur generated by sulphates is trapped in the clinker. The SO_2 from the oxidation of sulphides is, however, produced further up the preheater, where temperatures are lower and there are small amounts of CaO (free lime) and therefore the SO_2 absorption rate is low.
Pyritic sulphur (present predominantly as FeS_2) will generate SO_2 when material is heated above 450-600°C, corresponding to the upper (1st & 2nd) stages of the Hope preheater tower. The form of the pyrites in the raw meal is often small crystals or assemblies of crystals embedded in the individual meal particles. The retention time for the particles in the upper part of the preheater, and the size of the individual pyrite-containing particles, together with their type and form, are all parameters decisive for the rate at which the SO_2 is formed and therefore, the fraction, typically between 40% and 60% of the potential SO_2 from the sulphide, that will be emitted. Analysis has determined that at Hope Works, this fraction is around 40%.

In summary there is a clear correlation between SO_2 emissions and kiln feed sulphide. When there is a lower level of sulphide in the kiln feed, the emitted SO_2 would also be lower. SO_2 emissions that lead to an exceedance of the ELV, are often caused by increased SO_3 within the raw materials fed into the preheater.

This would typically be caused when a less desirable blend of low, medium and high sulphur shale is sent for use within the raw mix. This at times could be exacerbated due to reductions in the supply of Pulverised Fuel Ash (PFA) which is used to substitute shale in the raw mix.

3. Ongoing compliance

There are three operational levers presently used to achieve compliance with the 695 mg/Nm^3 limit these are:

Utilising Run of Station (ROS) PFA from other sources - Breedon Cement LTD currently has a contract with a power station until the end of 2021 to use all ROS PFA generated when available. Hope Cement Works is also utilising a source of biomass PFA when available from another power station which is also under contract.

Raw meal sulphur content control - The sulphur content within the shale used at Hope Cement Works is very variable. The blends of high, medium, and low sulphur shales used for raw mix must be monitored continually and adjusted as the SO_3 content of the different shales vary. Raw meal samples are taken hourly and analysed by the on-site laboratory. The resultant SO_3 content of the raw meal is recorded continually within the site's Process Information system. Quarry management monitor the raw meal SO_3 results on a daily basis and instruct the shale extraction operators to increase or decrease the amount of high sulphur shale input into the blend to maintain the raw meal SO_3 target. Furthermore, the shale extraction team are instructed only to feed low sulphur shale at the start of each day as part of the blending process. This is to avoid a sudden spike of high SO_3 raw meal being produced which could cause process instability and elevate the SO_2 levels in the kiln exhaust gas. Kiln exhaust gas emissions, including SO_2, are continually monitored, levels and this information is displayed on the environmental screen in the Control Room.

Operating with a base level of conditioned Pulverised Fuel Ash (PFA) in the raw mix- Hope Cement Works continues to trial two sources of conditioned PFA brought in via road.

4. Current performance against SO_2 BAT-AEL

Kiln 1

Kiln 1 performance against the BAT-AEL and the derogated 695 mg/Nm^3 ELV is summarised in the table below. Please also refer to Appendix A. Kiln 1 underwent its annual shutdown in January 2021 and was offline from 03/01/21- 02/02/2021.

Kiln 1				
	Days Less than 400 mg/Nm^3 ELV	% compliance with 400 mg/Nm^3 ELV	Days Less than 695 mg/Nm^3 ELV	% compliance with 695 mg/Nm^3 ELV
January	30	97%	31	100%
February	22	79%	28	100%
March	19	61%	31	100%
Q1 Mean		79%		100%

Kiln 2

Kiln 1 performance against the BAT-AEL and the derogated 695 mg/Nm^3 ELV is summarised in the table below. Please also refer to Appendix A.

Kiln 2				
	Days Less than 400 mg/Nm3 ELV	% compliance with 400 mg/Nm^3 ELV	Days Less than 695 mg/Nm^3 ELV	% compliance with 695 mg/Nm^3 ELV
January	21	68%	31	100%
February	17	61%	28	100%
March	21	68%	31	100%
Q1 Mean		66%		100%

5. Alternative Raw Material (ARM) Project Update

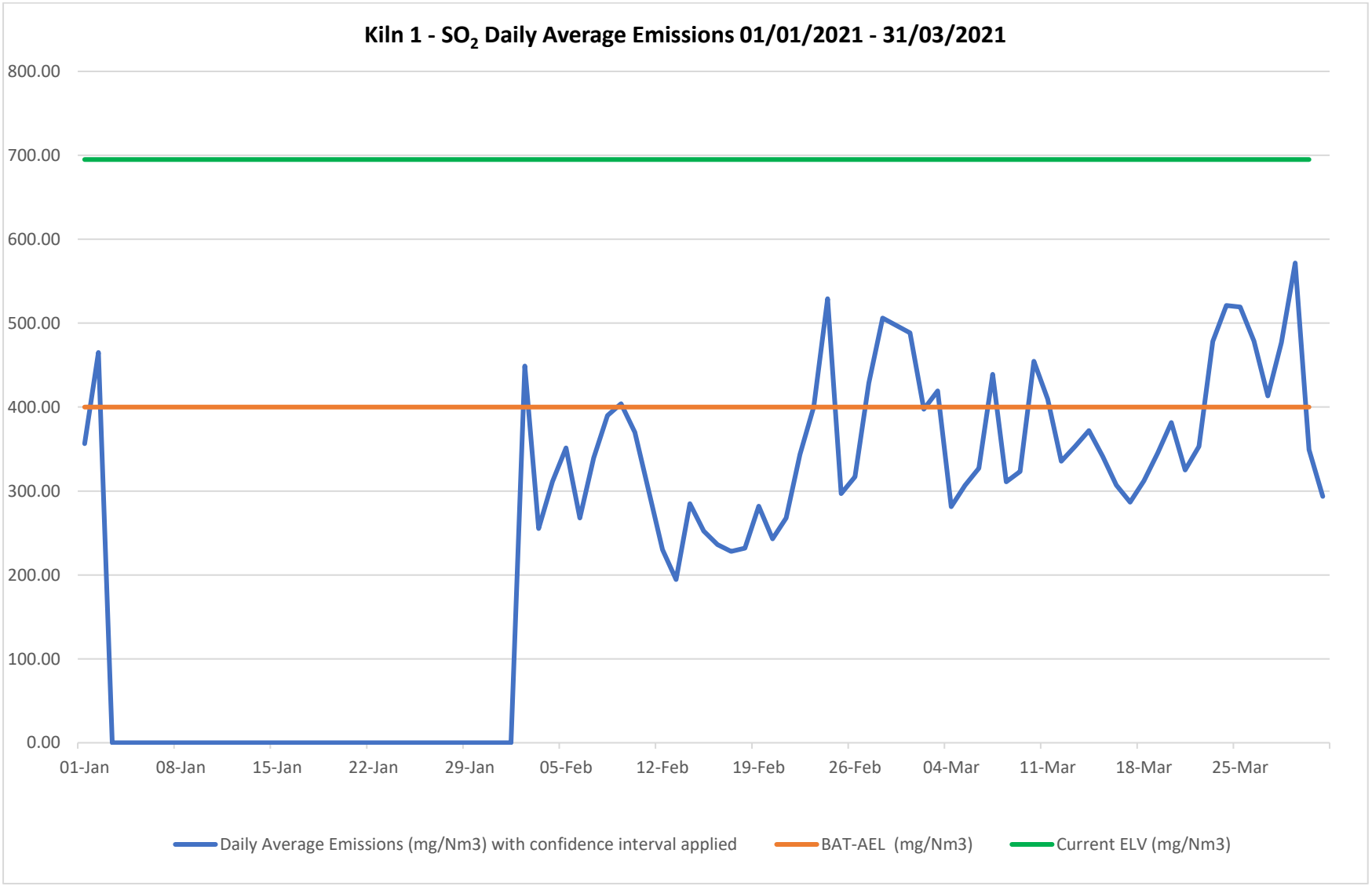
Final planning application was submitted on 1st October 2020, and Breedon Cement LTD has responded to requests for information from the Peak District National Park Authority (PDNPA).

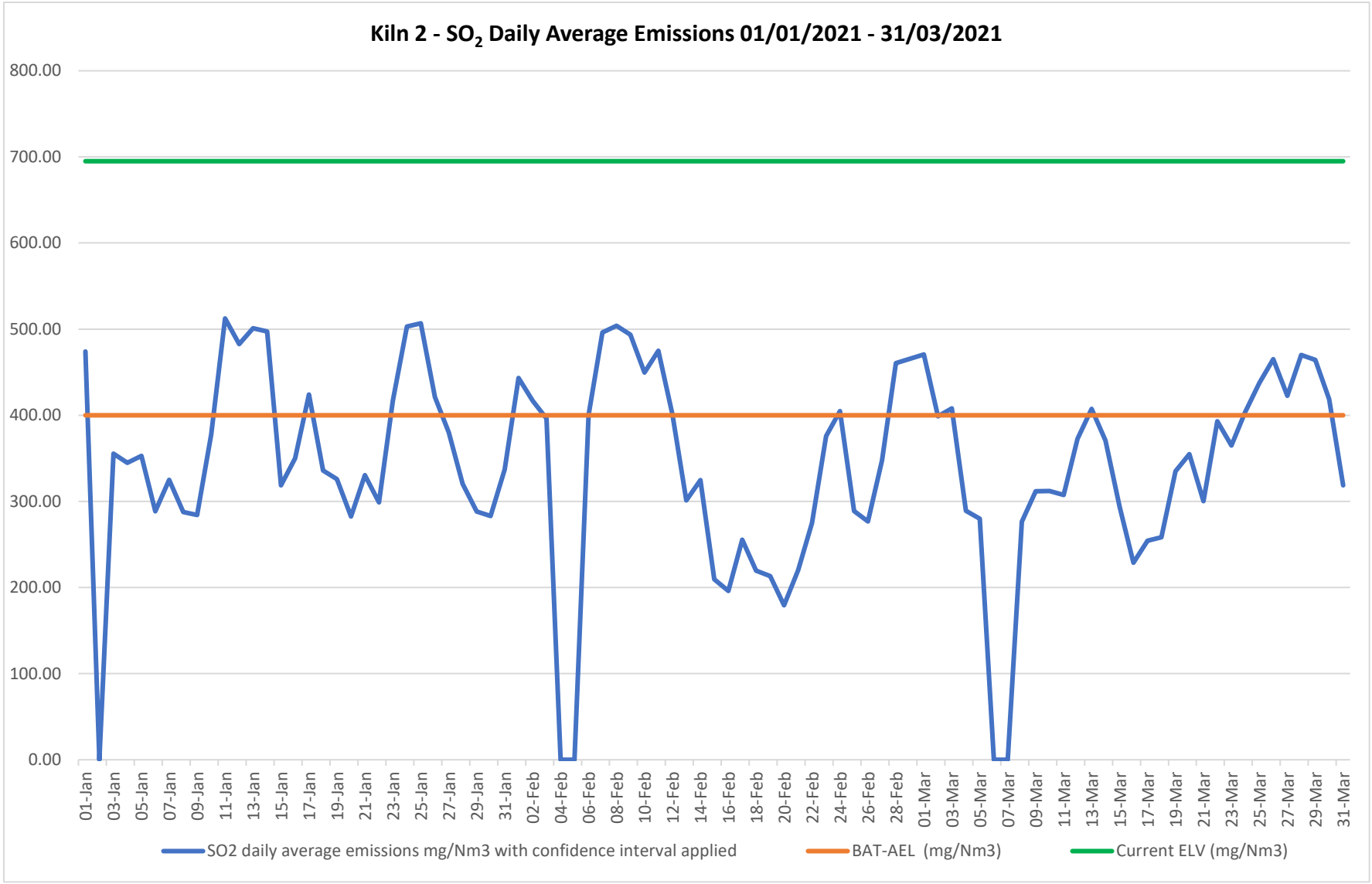
6. ARM substitution

As stated above in section 3, Hope Cement Works has continued to utilise different sources of PFA to aide Shale substitution rates. The table below summarises the tonnages used and the substitution percentages for January - March.

	January	February	March
Raw Materials			
Raw Meal Used in Kilns	96799	165624	180448
Shale Usage	10068	24225	27614
ARM			
Soda Ash	0	29	24
PFA Biomass	1508	642	1945.67
PFA Dry	2610	6400	386
PFA Conditioned	2596	4942	6956
Total PFA Usage	6714	11984	9288
Summary			
PFA % Shale Substitution	67%	49%	34%
PFA % Raw Mix substitution	7%	7%	5%

APPENDIX A_ Performance against SO2 BAT-AEL




Kiln 2 - SO2 Daily Average Emissions 01/01/2021 - 31/03/2021
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
01-Jan
03-Jan
05-Jan
07-Jan
09-Jan
11-Jan
13-Jan
15-Jan
17-Jan
19-Jan
21-Jan
23-Jan
25-Jan
27-Jan
29-Jan
31-Jan
02-Feb
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07-Mar
09-Mar
11-Mar
13-Mar
15-Mar
17-Mar
19-Mar
21-Mar
23-Mar
25-Mar
27-Mar
29-Mar
31-Mar
SO2 daily average emissions mg/Nm3 with confidence interval applied
BAT-AEL (mg/Nm3)
Current ELV (mg/Nm3)

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	Kiln 1			Kiln 2	
	Daily Average (mg/Nm^3)	Factored Daily Average (mg/Nm^3)		Daily Average (mg/Nm^3)	Factored Daily Average (mg/Nm^3)
01-Jan	445.55	356.44		592.39	473.92
02-Jan	581.24	464.99		0.00	0.00
03-Jan	0.00	0.00		444.36	355.49
04-Jan	0.00	0.00		431.05	344.84
05-Jan	0.00	0.00		441.22	352.97
06-Jan	0.00	0.00		360.54	288.43
07-Jan	0.00	0.00		406.30	325.04
08-Jan	0.00	0.00		359.49	287.59
09-Jan	0.00	0.00		355.21	284.17
10-Jan	0.00	0.00		472.45	377.96
11-Jan	0.00	0.00		640.55	512.44
12-Jan	0.00	0.00		603.21	482.56
13-Jan	0.00	0.00		626.46	501.17
14-Jan	0.00	0.00		621.47	497.17
15-Jan	0.00	0.00		398.32	318.66
16-Jan	0.00	0.00		437.57	350.06
17-Jan	0.00	0.00		530.19	424.15
18-Jan	0.00	0.00		419.75	335.80
19-Jan	0.00	0.00		407.48	325.98
20-Jan	0.00	0.00		353.25	282.60
21-Jan	0.00	0.00		413.15	330.52
22-Jan	0.00	0.00		373.49	298.79
23-Jan	0.00	0.00		521.13	416.91
24-Jan	0.00	0.00		628.83	503.07
25-Jan	0.00	0.00		633.64	506.92
26-Jan	0.00	0.00		526.52	421.21
27-Jan	0.00	0.00		475.26	380.20
28-Jan	0.00	0.00		400.58	320.46
29-Jan	0.00	0.00		360.33	288.27
30-Jan	0.00	0.00		353.78	283.02
31-Jan	0.00	0.00		421.30	337.04
01-Feb	0.00	0.00		554.20	443.36
02-Feb	561.26	449.01		521.08	416.86
03-Feb	318.91	255.13		495.21	396.17
04-Feb	389.17	311.34		0.00	0.00
05-Feb	439.21	351.37		0.00	0.00
06-Feb	334.84	267.88		500.28	400.22
07-Feb	424.03	339.22		620.28	496.23
08-Feb	487.56	390.05		629.76	503.81

09-Feb	504.93	403.94		616.85	493.48
10-Feb	462.27	369.81		562.04	449.63
11-Feb	375.22	300.17		593.78	475.03
12-Feb	287.80	230.24		501.12	400.89
13-Feb	242.97	194.38		376.30	301.04
14-Feb	355.98	284.79		405.93	324.74
15-Feb	315.49	252.39		261.99	209.59
16-Feb	295.01	236.01		245.04	196.03
17-Feb	284.91	227.93		319.34	255.47
18-Feb	289.94	231.95		274.62	219.70
19-Feb	352.34	281.87		266.73	213.39
20-Feb	303.75	243.00		224.10	179.28
21-Feb	334.66	267.72		275.21	220.16
22-Feb	429.40	343.52		343.65	274.92
23-Feb	500.38	400.30		469.67	375.73
24-Feb	661.28	529.02		505.94	404.75
25-Feb	371.07	296.85		360.94	288.75
26-Feb	396.02	316.81		345.97	276.78
27-Feb	535.88	428.70		434.47	347.58
28-Feb	632.69	506.15		575.76	460.61
01-Mar	610.66	488.53		588.19	470.55
02-Mar	496.67	397.33		498.40	398.72
03-Mar	524.10	419.28		509.93	407.95
04-Mar	351.80	281.44		361.35	289.08
05-Mar	383.39	306.71		349.75	279.80
06-Mar	408.75	327.00		0.00	0.00
07-Mar	548.70	438.96		0.00	0.00
08-Mar	388.56	310.85		345.50	276.40
09-Mar	403.97	323.17		389.75	311.80
10-Mar	568.09	454.47		389.95	311.96
11-Mar	511.74	409.39		384.26	307.41
12-Mar	419.22	335.37		465.72	372.57
13-Mar	441.61	353.29		509.44	407.55
14-Mar	464.86	371.89		463.39	370.71
15-Mar	426.55	341.24		367.59	294.08
16-Mar	383.82	307.06		285.97	228.77
17-Mar	358.28	286.62		317.81	254.25
18-Mar	390.33	312.26		323.01	258.41
19-Mar	431.77	345.41		418.72	334.97
20-Mar	477.03	381.63		443.41	354.73
21-Mar	406.31	325.05		375.29	300.23
22-Mar	441.41	353.13		491.36	393.09
23-Mar	597.91	478.33		456.22	364.98
24-Mar	651.16	520.93		505.13	404.10

25-Mar	648.97	519.18	[redacted]	547.06	437.65
26-Mar	598.01	478.41		581.37	465.10
27-Mar	516.76	413.41		528.43	422.74
28-Mar	596.07	476.85		587.46	469.97
29-Mar	714.64	571.71		580.32	464.25
30-Mar	436.51	349.21		523.16	418.53
31-Mar	366.80	293.44		398.40	318.72