

**BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20554**

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Application of)	
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SPACE EXPLORATION HOLDINGS, LLC)	Call Signs: S3069/S2992
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For Modification of Authorization for the)	ICFS File No. SAT-MOD-_____
SpaceX Gen2 NGSO Satellite System)	
_____)	

**MODIFICATION OF AUTHORIZATION
FOR THE SPACEX GEN2 NGSO SATELLITE SYSTEM**

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SUMMARY

In the nearly two years since SpaceX first launched satellites into its second-generation (“Gen2”) satellite system, it has continually sought opportunities to provide ever-better service to ever-more consumers while leading the way on responsible, sustainable operations in space. Building upon its considerable on-orbit experience, this modification application seeks several small-but-meaningful updates to the orbital configuration and operational parameters for its Gen2 space station authorization to improve space sustainability, better respond to evolving demand, and more efficiently share spectrum with other spectrum users. The application also seeks several conforming changes to align the Gen2 authorization with the Commission’s flexible use policies, the Space Innovation Agenda, and recent updates in Commission policy and international rules following the International Telecommunications Union (“ITU”) 2023 World Radiocommunication Conference (“WRC-23”).

In parallel to this application, SpaceX submits an amendment to the pending part of the Gen2 application requesting additional upgrades to its Gen2 system that the Commission has not yet addressed, including SpaceX’s orbital shells below 400 km and frequencies beyond those requested in the original application. Together, this modification and its companion amendment will enable the Gen2 system to deliver gigabit-speed, truly low-latency broadband and ubiquitous mobile connectivity to all Americans and the billions of people globally who still lack access to adequate broadband. Because the modification and amendment will affect the overall Gen2 system, SpaceX has prepared certain showings in its Technical Attachment to demonstrate that, taken as a whole, SpaceX’s proposed Gen2 upgrade will benefit the public interest and will not cause significant interference problems to other users.

Orbital reconfiguration of the 500 km shells to improve space sustainability and dynamically respond to evolving consumer demand. SpaceX first modifies the orbital parameters

of its current Gen2 authorization to improve the sustainability of its currently authorized Gen2 system and keep pace with rapidly evolving consumer demand for high-quality broadband globally. Specifically, SpaceX requests authority to lower the nominal altitudes of its shells at 525 km, 530 km, and 535 km to 480 km, 485 km, and 475 km altitude, respectively. For the lower-altitude shell at 475 km, SpaceX requests authority to reduce the nominal inclination from 33 degrees to 32 degrees.

<i>Gen2 Order</i>			2024 Gen2 Modification	
Altitude (km)	Inclination (deg)		Altitude (km)	Inclination (deg)
525	53	→	480	53
530	43	→	485	43
535	33	→	475	28 or 32 ¹

With the exception of its shell at 475 km altitude, SpaceX requests to modify its authorization to more flexibly distribute satellites in up to 56 planes per shell and up to 120 satellites per plane. While this reconfiguration will result in a higher potential maximum number of orbital planes and satellites per plane for all but one shell at 475 km, the total number of satellites in the Gen2 system will not exceed 29,988 satellites, and the first tranche of satellites in the Gen2 system will remain 7,500 satellites until such time that the Commission permits deployments beyond that first tranche.² Finally, SpaceX requests to align the altitude tolerance and inclination tolerance in its Gen2 authorization with the tolerances that the ITU has established for NGSO operations—i.e., an altitude tolerance of +/- 100 km and an inclination tolerance of +/- 2 degrees.

¹ SpaceX requests authority to operate satellites in its 475 km shell at 32 degrees inclination to accommodate upcoming Starship launches of satellites for SpaceX’s Gen2 system from its Starbase launch facilities in Boca Chica, TX. If the Federal Aviation Administration (“FAA”) does not allow for Starship launches at 32 degrees from Starbase, TX, SpaceX requests for authority to launch into the 28-degree inclination at 475 km altitude.

² SpaceX is also submitting, in parallel, an amendment to the deferred portion of its Gen2 application (collectively, “Gen2 Upgrade Applications”) with a request for authority to deploy SpaceX’s full Gen2 system. For avoidance of doubt, SpaceX seeks to operate both its authorized 7,500 first tranche of satellites and its pending request for the remaining 22,488 satellites across all updated Gen2 orbital shells, including those proposed in this modification and in SpaceX’s parallel amendment. Moreover, while neither the Commission’s rules nor the *Gen2 Authorization* require SpaceX to file a modification or amendment to request Commission action on the deferred remainder of SpaceX’s Gen2 Application, for completeness, SpaceX requests that as a part of any grant of the Gen2 Upgrade Applications that it authorize SpaceX to deploy its entire requested Gen2 system, as modified and amended.

This reconfiguration will enable SpaceX to deliver better broadband coverage and service quality for American consumers in areas of high demand and respond to evolving consumer demand by rapidly and flexibly deploying capacity across the United States and around the world where it is needed most.

Additional flexibility to enhance service quality and network capacity. As 6G interweaves mobile and fixed services, and terrestrial and satellite networks, next-generation satellite operators will require not just reliable access to spectrum resources, but also more flexible use of that spectrum. To that end, SpaceX requests to modify its Gen2 authorization to use Ka-, V-, and E-band frequencies for either mobile- or fixed-satellite use cases where the U.S. or International Table of Frequency Allocations permits such dual use and where the antenna parameters would be indistinguishable. SpaceX also seeks to modify its authorization to clarify the proposed uses of its stations with phased array antennas and those with parabolic antennas. These small modifications, which align with Commission precedent, do not involve any changes to the technical parameters of SpaceX's authorization, but would permit significant additional flexibility to meet the diverse connectivity and capacity needs of consumer, enterprise, industrial, and government users.

Lower minimum elevation angles to improve network performance. To deliver continually higher quality service to consumers, SpaceX requests to modify its minimum elevation angle for communications with earth stations for satellites operating in shells at nominal altitudes below 500 km. Specifically, SpaceX seeks to lower its minimum elevation angle from 25 degrees to 20 degrees for satellites operating between 400 and 500 km altitude. Reducing the minimum elevation angle in this way will enhance customer connectivity by allowing satellites to connect to more earth stations directly and to maintain connections with earth stations for a longer period of time while flying overhead.

* * *

This Modification will vastly improve the coverage, quality, and reliability of the authorized portion of SpaceX's Gen2 system for American consumers and people around the world, and will do so without causing significant interference problems for other licensed operators or increasing any orbital debris mitigation risk. Accordingly, the Commission should find that grant of this modification would serve the public interest.

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**MODIFICATION OF AUTHORIZATION FOR
THE SPACEX GEN2 NGSO SATELLITE SYSTEM**

Space Exploration Holdings, LLC (“SpaceX”) submits this application to modify its authorized next-generation non-geostationary orbit (“NGSO”) satellite system (the “Gen2 system”) to further improve the sustainability of its Gen2 system and—together with its companion amendment—deliver gigabit-speeds, low-latency broadband and ubiquitous mobile connectivity to all Americans and the billions of people around the world who lack adequate broadband.³ This modification application reflects SpaceX’s iterative approach to satellite innovation and the significant on-orbit experience it has gained in the nearly two years since SpaceX first launched satellites into its Gen2 satellite system. This experience has only further emphasized the sustainability and consumer benefits of operating satellites at lower, self-cleaning altitudes. It also reflects the need for operational flexibility to ensure that U.S.-licensed satellite operators not only keep pace with growing and evolving consumer demand for high-speed, low-latency broadband and ubiquitous mobile connectivity, but also remain globally competitive amidst the rise of state-owned and state-backed satellite systems that have been deploying at a rapid clip.

³ See Application for Approval of Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, ICFS File No. SAT-LOA-20200526-00055 (filed May 26, 2020); Amendment, ICFS File No. SAT-AMD-20210818-00105 (filed Aug. 18, 2021) (collectively, “Original Application”).

A completed Form 312, accompanying Schedule S, Technical Attachment, and Waiver Requests are associated with this application, consistent with the information required by the Commission’s rules in support of the requested authorization.

I. DESCRIPTION OF MODIFICATION

The Commission has granted in part and deferred in part SpaceX’s application for its Gen2 satellite system, authorizing SpaceX to deploy and operate a first tranche of 7,500 satellites operating using Ku-, Ka-, V-, and E-band spectrum in three orbital shells at nominal altitudes of 525, 530, and 535 km.⁴ Since then, SpaceX has made considerable progress deploying the system, launching nearly 3,000 satellites that—together with SpaceX’s separate first-generation system—now serve over four million people around the world. This modification seeks to further improve the coverage, service quality, reliability, and sustainability of the Gen2 system by updating the orbital parameters, satellite distribution, service allocations, and operational parameters of the currently authorized part of the Gen2 system. These updates reflect both technological innovations and regulatory developments in the Commission’s Space Innovation Agenda since SpaceX filed its initial Gen2 application, and will allow SpaceX to keep pace with growing and evolving demand from millions of Americans and people around the world for fiber-like, low-latency broadband wherever they live or travel. As noted above, in parallel with this modification application, SpaceX will submit an amendment to the part of the Gen2 application that remains pending.

Orbital reconfiguration of 500 km shells. SpaceX requests several changes to the orbital parameters of its operations between altitudes of 525 km and 535 km. First, SpaceX requests

⁴ See *Space Exploration Holdings, LLC*, Order and Authorization, 37 FCC Rcd. 14882 (2022) (“*Gen2 Order*”); *Space Exploration Holdings, LLC*, ; *Request for Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System*, DA 24-222, ICFS File Nos. SAT-LOA-20200526-00055 SAT-AMD-20210818-00105 SAT-AMD-20221216-00175, Call Sign: S3069 (SB rel. Mar. 8, 2024) (granting authority for E-band payloads); Stamp Grant, ICFS File No. SAT-MOD-20230322-00062 (SB reissued Nov. 9, 2023) (granting authority for V-band payloads).

authority to lower the nominal altitudes of its shells at 525 km, 530 km, and 535 km to 480 km, 485 km, and 475 km altitude, respectively. For the lower-altitude shell at 475 km, SpaceX requests authority to reduce the nominal inclination from 33 degrees to 28 or 32 degrees.⁵ Together, these modifications result in the following configuration:

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Altitude (km)	Inclination (deg)		Altitude (km)	Inclination (deg)
525	53	→	480	53
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535	33	→	475	28 or 32

Lowering the nominal altitude of the authorized shells between 525 km and 535 km will promote space sustainability by lowering the passive-decay collision probability and post-mission disposal timeframe of Gen2 satellites. Lowering these nominal altitudes will also benefit consumers by further reducing broadband latency for consumers. Reducing the nominal inclination of the 475 km orbital shell to 32 degrees—or as low as 28 degrees—will enable SpaceX to more quickly leverage launches of its Starship launch vehicle from Boca Chica, TX, which may initially require lower-inclination launches than SpaceX’s workhorse Falcon launch vehicles.

Consistent with recent updates to the Radio Regulations following the 2023 World Radiocommunication Conference, SpaceX requests to operate these Gen2 orbital shells within an altitude tolerance of +/- 100 km and within an inclination tolerance of +/- 2 degrees.⁶ Beyond aligning SpaceX’s operations with those of non-U.S. satellite competitors seeking to provide similar services, updating the orbital and inclination tolerance of orbital shells within the Gen2 system would promote space sustainability as a greater number of NGSO satellite systems deploy

⁵ If the Federal Aviation Administration (“FAA”) does not allow for Starship launches at 32 degrees from Starbase, TX, SpaceX requests for authority to launch into the 28-degree inclination at 475 km altitude.

⁶ See ITU Radio Regs., Resolution 8 (WRC-23).

in and around similar orbits.

To better adapt the system to evolving end-user demand, SpaceX also requests to distribute satellites in its shells at 480 km and 485 km in up to 56 planes per shell with up to 120 satellites per plane. While this reconfiguration will result in a higher maximum number of orbital planes and satellites per plane, the complete Gen2 system will not exceed 29,988 satellites, and, as the Technical Attachment shows, the reconfiguration will neither cause unacceptable interference to GSO systems nor cause significant interference problems for NGSO systems.

Flexible use of authorized frequencies. The Commission has authorized SpaceX to use Ku-, Ka-, V-, and E-band frequencies on its Gen2 satellites to deliver high-speed, low-latency broadband service to consumers around the world. Consistent with the Commission's long-standing flexible-use policies and space station licensing precedent, this modification requests authority to expand the range and quality of beneficial services that the Gen2 system can provide to people on the ground and on the go. SpaceX updates its Schedule S and the Technical Attachment to reflect these proposed modifications.

SpaceX seeks authority to use its authorized frequency ranges in the Ku-, Ka-, V-, and E-band for both Fixed-Satellite Service ("FSS") and Mobile-Satellite Service ("MSS") in frequency ranges that share allocations for both FSS and MSS. Specifically, SpaceX requests that the Commission permit satellites in its authorized Gen2 constellation to provide both FSS and MSS operations in the (1) 14-14.5 GHz (uplink) band; (2) 19.7-20.2 GHz (downlink) and 29.5-30.0 GHz (uplink) band; (3) 40-40.5 GHz (downlink) globally, 40.5-41 GHz (downlink) on a secondary basis in Region 2; and (4) 71-74 GHz (downlink) and 81-84 GHz (uplink) bands.⁷ MSS operations in

⁷ SpaceX requests similar authority in certain additional frequencies in the accompanying amendment request.

these bands will have the same characteristics—including highly directional beams—as SpaceX’s FSS operations, and therefore would be indistinguishable from FSS operations in the bands.

In addition, SpaceX requests to modify its Gen2 authorization to permit use of all authorized Gen2 frequencies in the Ku-, Ka-, V-, and E-bands—except for those frequencies identified solely for TT&C—for either gateway earth stations or non-gateway earth stations (e.g., user links). Doing so will not involve changes to the operating parameters of SpaceX’s space stations using these bands, but would better enable SpaceX to deploy equipment for consumer, enterprise, and government use cases to meet individual capacity needs. In any event, authorized earth station operations will comply with relevant technical limits and licensing requirements—including individual or blanket licensing as applicable. For clarity, SpaceX refers herein to different earth stations by their antenna type—parabolic or phased array—where earth stations with phased array antennas will be used for communications in Ku- and Ka- band, while earth stations with parabolic antennas will be used for communications in the Ka-, V-, and E-band.

Modern, efficient GSO-NGSO sharing. For spectrum bands governed by the overly conservative equivalent power flux-density (“EPFD”) limits of the ITU, SpaceX requests to waive the current EPFD limits for downlink operations within the United States, reflecting Commission policy finding that those limits are outdated, overly restrictive, and harm consumers, competition, and satellite innovation. SpaceX submits with this application a waiver request and technical analysis demonstrating that its proposed Gen2 satellite system can continue to protect GSO FSS and Broadcasting-Satellite Service (“BSS”) networks from unacceptable interference at the operating levels requested herein.

Lower minimum elevation angle for earth stations. SpaceX requests to modify its Gen2 system to update the minimum elevation angle for communications with SpaceX’s parabolic and

phased array earth stations for satellites operating in shells at nominal altitudes below 500 km. Specifically, SpaceX seeks to operate down to a minimum elevation angle of 20 degrees for satellites operating between 400 and 500 km altitude.⁸

II. GRANT OF THIS MODIFICATION WOULD SERVE THE PUBLIC INTEREST

Granting this modification would promote the public interest by improving the coverage, quality, reliability, and sustainability of SpaceX's Gen2 system without causing significant interference problems for other non-geostationary orbit systems or unacceptable interference for geostationary orbit systems, or increasing orbital debris risk. Together with its companion Gen2 upgrade amendment, this modification will deliver fiber-like broadband and ubiquitous mobile connectivity to help close the digital divide for billions of people around the world who still lack access to adequate connectivity.

The orbital reconfiguration of the 500 km shells will promote space sustainability and enable more adaptive deployment to meet demand. SpaceX has continually sought opportunities to lead the way in space sustainability, including by operating its satellites at lower altitudes even when doing so comes at great cost to SpaceX. Permitting SpaceX to lower the nominal altitude of its satellites in its 500 km shells to the 475 km to 485 km range will enhance space sustainability. As the Commission recognized in the *Gen2 Order*, "lower altitudes present lower risk than at higher altitudes, where remaining orbital lifetimes are longer."⁹ Lowering satellites in the 500 km shells downward will reduce the passive-decay collision probability of satellites in those shells as well as the post-mission disposal timeframe. This adjusted nominal altitude also provides additional flexibility for the Gen2 system to operate below emerging constellations with less

⁸ SpaceX will continue to operate down to five degrees minimum elevation angle at latitudes in polar regions, i.e., above 62 degrees.

⁹ *Gen2 Order* ¶ 85.

operational experience, including foreign systems that do not publish their ephemerides or covariance data.

Shifting the nominal altitude of these shells downward will also help to anticipate upcoming changes in the solar cycle. When SpaceX initially applied for its Gen2 system in 2020, it did so in anticipation of upcoming solar maximum, where operating above nominal altitudes can help to overcome increased solar activity and the resulting atmospheric drag on satellites. With solar maximum now predicted to occur as early as this year, flexibility to operate above nominal altitudes remains important. But after solar maximum, the calculation shifts as solar activity decreases toward solar minimum. As it does, operating below nominal altitudes will ensure that passive decay times and the object-year impact remain low.

Revising SpaceX's current Gen2 nominal altitudes downward will also help to compensate for the current restriction that limits SpaceX's Gen2 operations to below 580 km.¹⁰ The Commission imposed that restriction at the request of Amazon, which claims, when convenient, its future satellite system will be too fragile to share altitude ranges with other constellations. And while Amazon now seems to claim that it is in fact capable of operating in orbits overlapping with other systems, it has notably failed to request that the limitation it sought on SpaceX's operations be removed. So, while Amazon still has not deployed a single commercial satellite, the condition has real-world impacts for SpaceX right now, providing tens of kilometers less room to maneuver above its nominal orbital shell altitudes than it otherwise would be able to use. Revising the nominal altitude for these 500 km shells would help to compensate for this restriction.

The updated orbital configuration for the 500 km shells will also enable SpaceX to more responsively adapt its network deployment to efficiently respond to evolving consumer demand

¹⁰ *Id.* ¶ 135aa.

on a global scale. As next-generation satellite systems provide an increasing array of beneficial services to people on the ground—from consumer broadband and cellular backhaul to Internet of Things and supplemental coverage—network demand has rapidly grown and evolved. This demand from consumers, enterprises, industries, and government users—including first responders in emergency situations—far outpaces one-to-two-year space station application processing timeframes, creating significant risks of coverage and capacity constraints that could otherwise be swiftly addressed through targeted deployments. Just as terrestrial operators are not required to commit to specific base station locations at the time of licensing, SpaceX’s proposed Gen2 orbital configuration would enable it to launch satellites and deploy capacity where it is needed most in anticipation of, and in response to, evolving consumer demand. In so doing, SpaceX can more efficiently deploy a global service free from capacity constraints and with a high quality of service for consumers anywhere in the world.

Finally, aligning SpaceX’s altitude and inclination tolerance with those that the ITU adopted at WRC-23—namely an altitude tolerance of +/- 100 degrees and an inclination tolerance of +/- 2 degrees—will ensure that SpaceX retains the same operational flexibility that its global competitors have to respond to space sustainability risks.

Permitting flexible use of the authorized Gen2 frequencies will enhance network capacity and service quality for consumers and set the stage for 6G. The Commission has repeatedly recognized how reliable access to Ku-, Ka-, and V-band frequencies enables next-generation satellite systems to deliver high-speed, low-latency connectivity to consumer, business, industrial, and government end users. As 6G interweaves mobile and fixed, as well as terrestrial and satellite, networks, next-generation satellite operators will require not just reliable access to these frequencies, but more flexible access too. Indeed, in the near future, an end user will be able

to seamlessly switch from a home fixed satellite broadband connection to a terrestrial cell tower to supplemental coverage from space and then to an ESIM-enabled Wi-Fi connection on an airplane or vessel over the course of a single day. The Commission has long supported flexible terrestrial use of millimeter wave bands that share both fixed and mobile allocations, and expanded this policy to NGSO FSS and MSS allocations when it authorized Amazon to use the 19.7-20.2 GHz and 29.5-30.0 GHz bands for both fixed and mobile use cases, noting the increasing convergence of fixed and mobile satellite transmissions over the last 15 years.¹¹ Permitting SpaceX to use its authorized FSS frequencies for MSS operations in bands that share both FSS and MSS allocations will further this fundamental Commission policy and accelerate realization of 6G connectivity in the same way that the Commission's flexible use policies for millimeter wave 5G connectivity allowed America to win the race to 5G.

In a similar way, permitting SpaceX to use its authorized Ku-, Ka-, V-, and E-band frequencies for either gateway or non-gateway use cases will promote the public interest by allowing SpaceX to flexibly tailor its offerings to individual capacity needs, particularly from enterprise, industrial, and government customers that require dedicated capacity or operate in areas that lack reliable access to fiber connectivity.

Upgraded Gen2 hardware will improve spectrum efficiency and sharing. The upgraded Gen2 system will feature enhanced hardware that can use higher gain and more advanced beam-forming and digital processing technologies and provide more targeted and robust coverage for American consumers. As a result, these upgraded satellites can maximize the use of the available bandwidth, enabling more efficient allocation of resources and facilitating a broader range of

¹¹ See *Kuiper Systems, LLC; Application for Authority to Deploy and Operate a Ka-band Non-Geostationary Satellite Orbit System*, Order and Authorization, 35 FCC Rcd. 8324, ¶ 23 (2020).

services.

Lower minimum elevation angles will improve network performance. SpaceX’s request to lower the minimum elevation angle of its earth station communications will improve end-user service and latency by reducing or eliminating the need for communications to transit over SpaceX’s laser mesh, reducing the end-to-end distance (and thus the potential round-trip latency) of transmissions over the network. Lowering the minimum elevation angle will also increase system reliability by allowing earth stations to maintain links with satellites for a longer period of time as they cross the sky. In addition, lowering the minimum elevation angles for SpaceX’s beams will promote more efficient spectrum sharing by increasing the portion of the sky that may be used for coordination.

The modification will not cause unacceptable interference to GSOs or significant interference problems for NGSOs. The Technical Attachment includes interference analyses demonstrating that the modified Gen2 system—coupled with its companion Gen2 amendment—can achieve all of the above-mentioned public interest benefits without causing unacceptable interference to GSOs or “any significant interference problems”¹² to NGSOs, and should therefore be granted. These analyses include updated NGSO-NGSO interference analyses reflecting the Commission’s recently adopted degraded throughput methodology,¹³ and GSO-NGSO interference analyses to demonstrate that SpaceX’s proposed operations will protect GSO FSS and BSS networks in downlink from unacceptable interference.

¹² *Space Exploration Holdings, LLC; Request for Modification of the Authorization for the SpaceX NGSO Satellite System*, Order and Authorization and Order on Reconsideration, 36 FCC Rcd. 7995, ¶9 (2021) (quoting *Teledesic LLC*, Order and Authorization, 14 FCC Rcd. 2261, ¶5 (IB 1999)).

¹³ *Revising spectrum Sharing Rules for Non-Geostationary Orbit, Fixed-Satellite Service Systems*, 38 FCC Rcd. 3699 ¶¶ 38-42 (2023).

III. ITU COST RECOVERY

SpaceX is aware that, as a result of the actions taken at the 1998 Plenipotentiary Conference, as modified by the ITU Council in 2005, the ITU now charges processing fees for satellite network filings. As a consequence, Commission applicants are responsible for any and all fees charged by the ITU. SpaceX confirms that it is aware of this requirement and accepts responsibility to pay any ITU cost recovery fees associated with this application. Invoices for such fees may be sent to the contact representative listed in the accompanying FCC Form 312.

CONCLUSION

For the foregoing reasons, and for the reasons set forth in the accompanying materials, SpaceX requests that the Commission find that authorizing SpaceX to upgrade its authorized Gen2 satellite system would serve the public interest, and issue such grant expeditiously.

Respectfully submitted,

SPACE EXPLORATION HOLDINGS, LLC

By: /s/ Jameson Dempsey
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