# ENVIRONMENTAL IMPACT STATEMENT

## SPACEX STARSHIP-SUPER HEAVY LAUNCH VEHICLE AT LAUNCH COMPLEX 39A

at the Kennedy Space Center, Merritt Island, Florida

Final, Volume II, Appendix B.3, Part 4

**January 2026**

Federal Aviation Administration

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at the Kennedy Space Center, Florida
8 April 2025
Federal Aviation Administration
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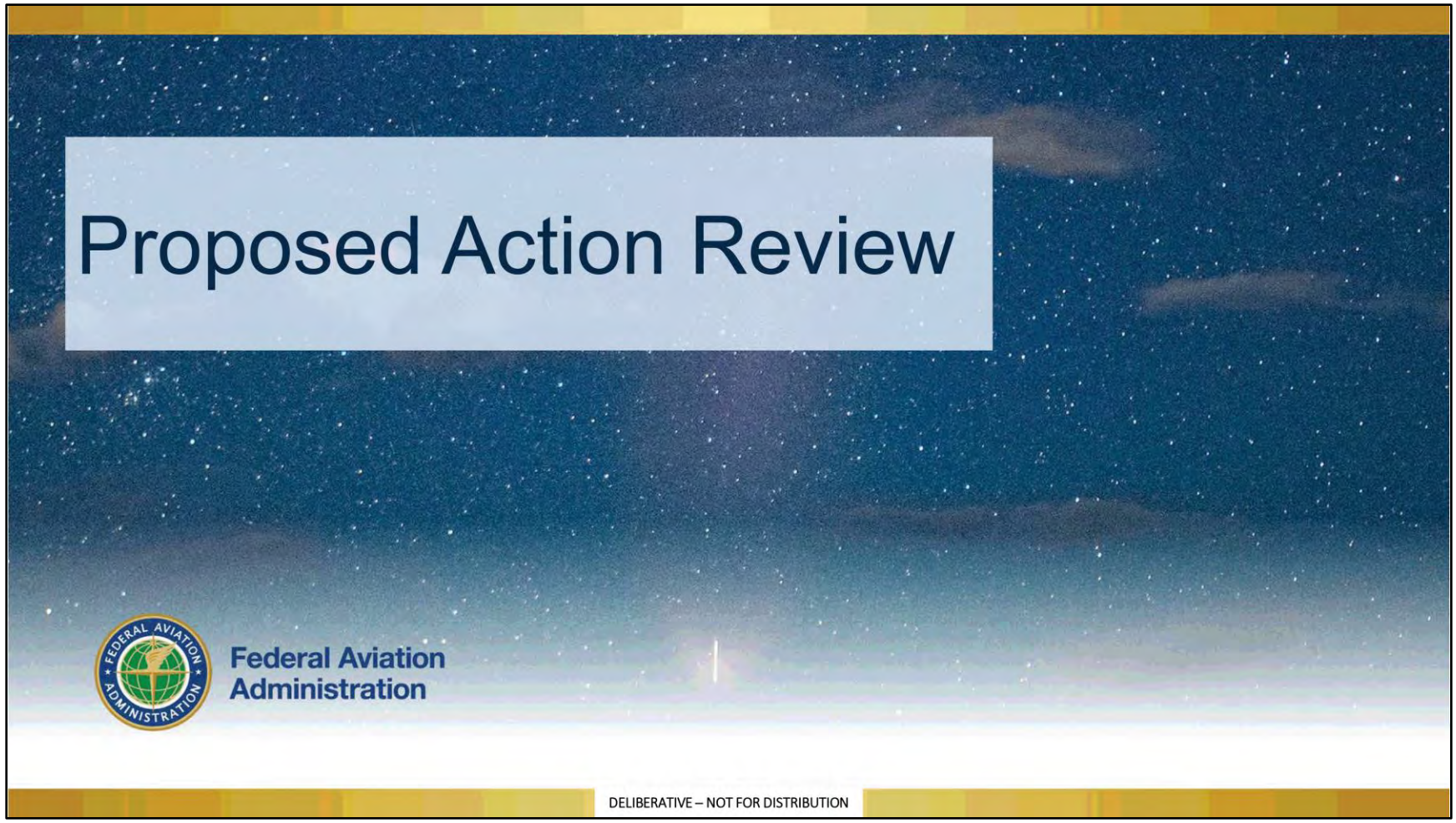
Proposed Action Review
Federal Aviation Administration
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# Starship-Super Heavy LC-39A

Federal Aviation Administration

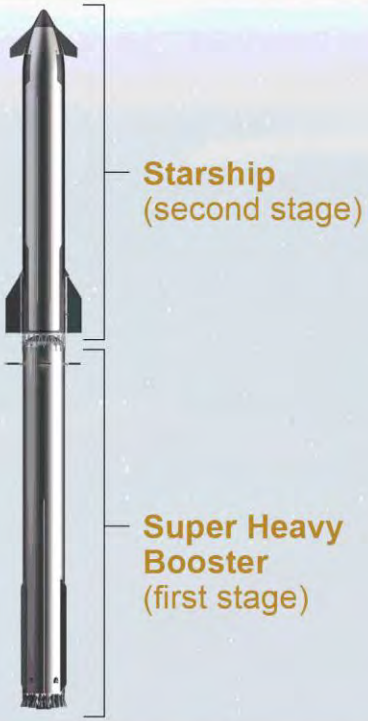
## Proposed Action Review

### Starship-Super Heavy Vehicle

- Composed of 2 stages
  - Super Heavy (booster) – 35 Raptor Engines
  - Starship – 9 Raptor Engines

### Operations

- Pre-launch – testing and rehearsals
  - Static Fires – 1 for each stage prior to launch (88 total)
- Starship-Super Heavy Launches – 44
  - 50% Day / Night (10pm – 7am) Split
- Starship Landings - 44
  - LC-39A, droneship in Atlantic, expended in Atlantic / Pacific / Indian Ocean >5nm
  - Contingency: soft water landing 1nm-5nm in Atlantic 50 nm north/south of LC-39A
- Super Heavy Landings – 44
  - LC-39A, droneship in Atlantic, expended in Atlantic >5nm

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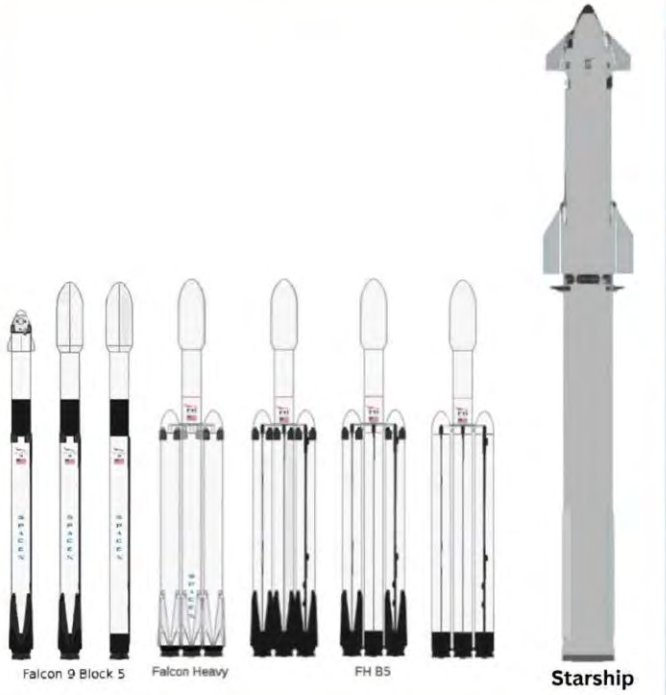
# SpaceX Launch Vehicle Comparison

Federal Aviation Administration




| | Falcon 9 | Falcon 9 Heavy | Starship Superheavy |
|---|---|---|---|
| Engines | 9 | 27 | 35 |
| Thrust | 1,710,000 lbf | 5,130,000 lbf | 23,000,000 lbf |
| Duration – Static Fire | 7-15 seconds | | |
| Duration - Launch | <7-15 seconds | | |

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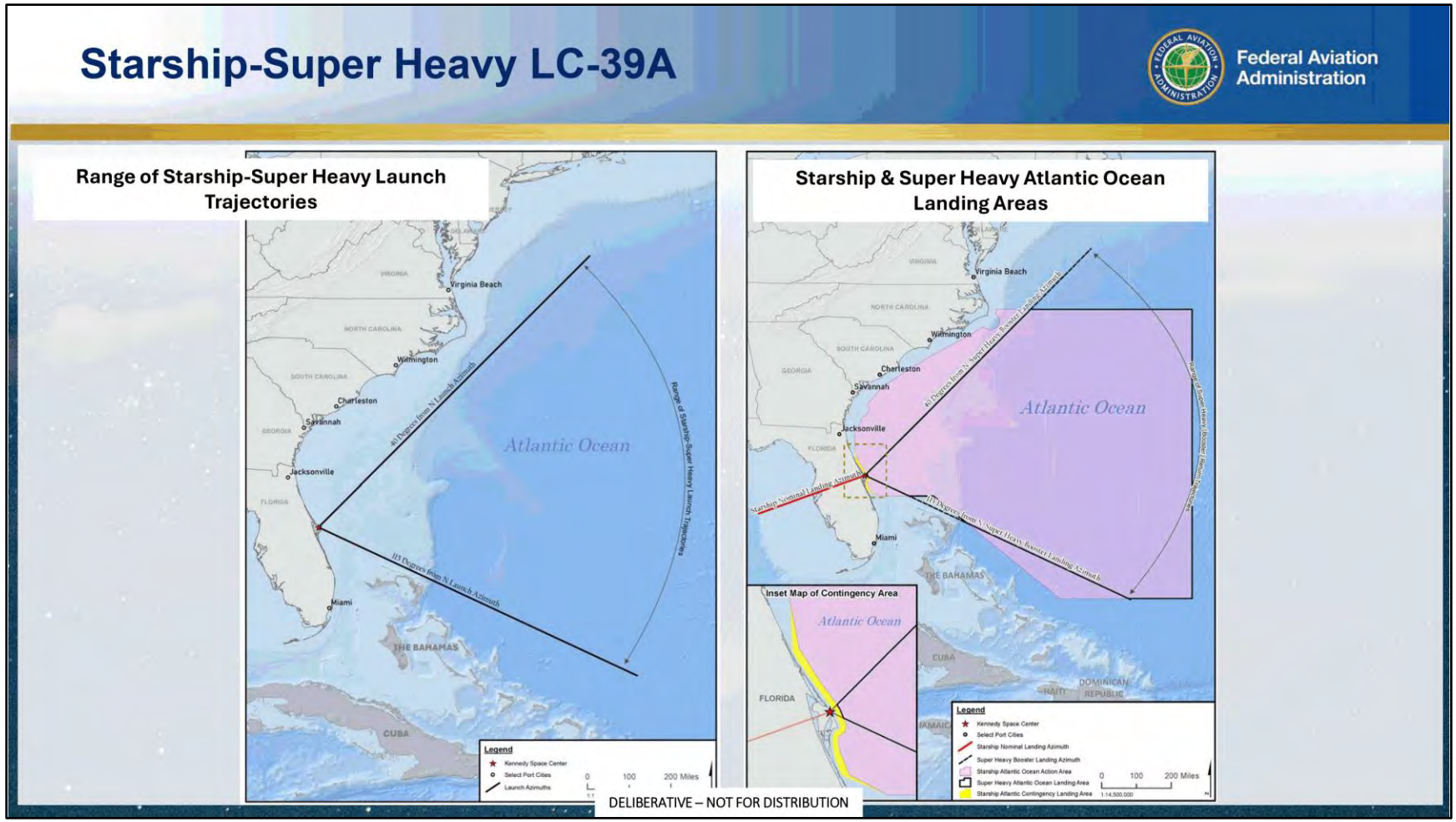
Starship-Super Heavy LC-39A
Federal Aviation Administration
Range of Starship-Super Heavy Launch Trajectories
Starship & Super Heavy Atlantic Ocean Landing Areas
Virginia Beach
Wilmington
Charleston
Savannah
Jacksonville
Miami
Atlantic Ocean
THE BAHAMAS
CUBA
FLORIDA
Inset Map of Contingency Area
Legend
Kennedy Space Center
Select Port Cities
Launch Azimuths
Starship Nominal Landing Azimuth
Super Heavy Booster Landing Azimuth
Starship Atlantic Ocean Action Area
Super Heavy Atlantic Ocean Landing Area
Starship Atlantic Contingency Landing Area
0 100 200 Miles
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# Starship-Super Heavy LC-39A

Federal Aviation Administration

## Proposed LC-39A Infrastructure

Previously approved (2019 NASA EA*):

- LOX Farm (65,454 square feet [SF])
- Methane Farm (78,876 SF)
- Launch Mount (36,568 SF)
- Integration Tower (6,184 SF)
- Ponds (68,799 SF)
- Vaporization Farm (9,650 SF)
- LZ (72,672 SF)
- LN2 Farm (13,342 SF)
- Water Farm (17,955 SF)

Included as part of this Action:

- Air Separation Unit (222,071 SF)
- Catch Tower (5,992 SF)
- Deluge Pond (121,963 SF)
- Liquefaction – includes natural gas pretreatment and methane liquefier (17,246 SF)
- MegaPacks (34,979 SF)
- Power Hub (28,998 SF)

*Final Environmental Assessment for the SpaceX Starship and Super Heavy Launch Vehicle at Kennedy Space Center

Total Approximate Square Footage: 800,647


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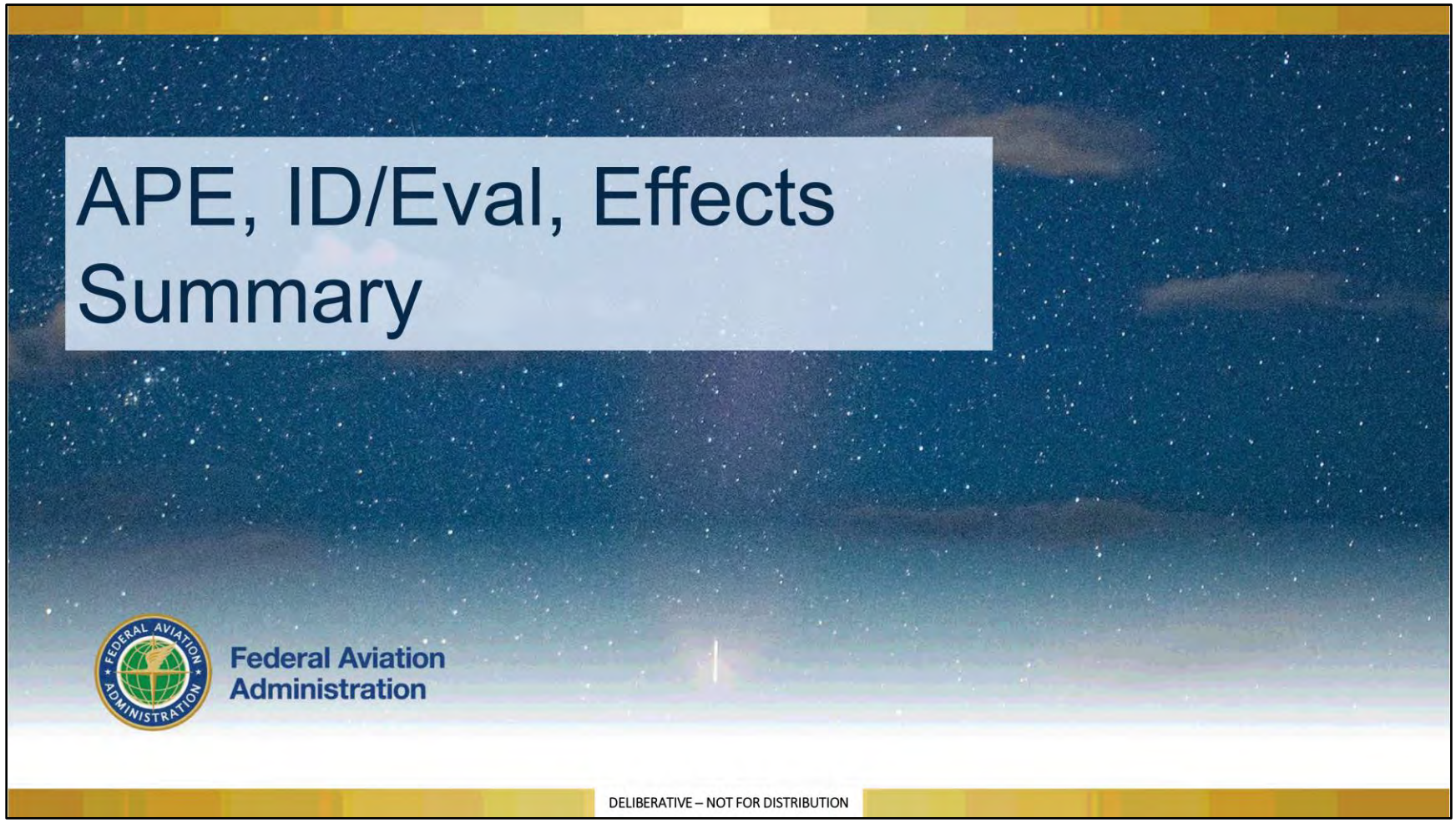
APE, ID/Eval, Effects Summary
Federal Aviation Administration
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# HISTORICAL RESOURCES – Area of Potential Effects

Federal Aviation Administration

## Construction APE

- Previously surveyed/existing boundary of LC-39A

## Operational APE

- Considers auditory and vibratory effects of launch and landing activities
- Area of Lmax sound level ≥ 130 dB from launch effects
- Area of ≥ 2 pounds per square foot (psf) of sonic boom overpressure from reentry effects


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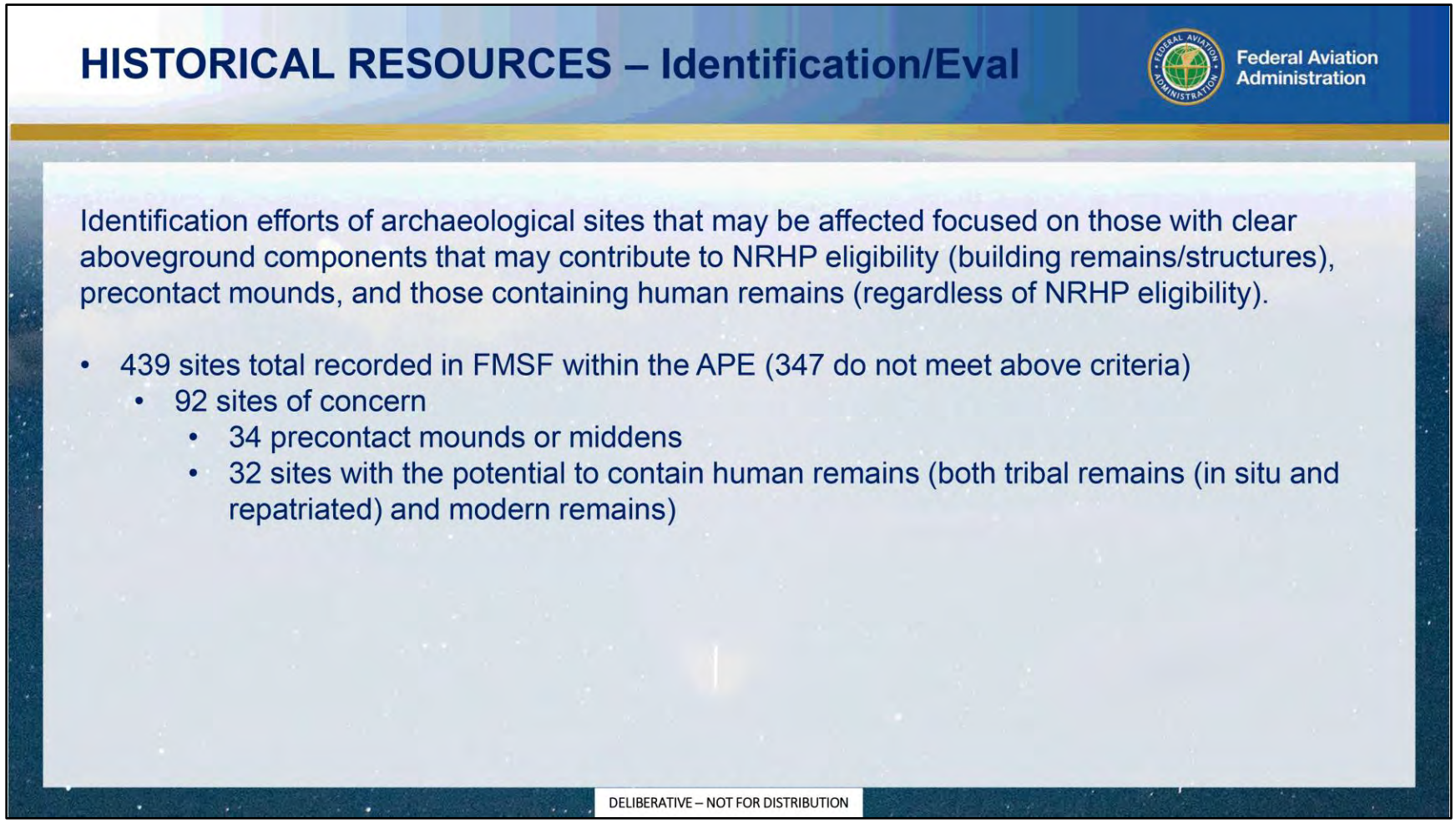
HISTORICAL RESOURCES – Identification/Eval
Federal Aviation Administration
Identification efforts of archaeological sites that may be affected focused on those with clear aboveground components that may contribute to NRHP eligibility (building remains/structures), precontact mounds, and those containing human remains (regardless of NRHP eligibility).
• 439 sites total recorded in FMSF within the APE (347 do not meet above criteria)
• 92 sites of concern
• 34 precontact mounds or middens
• 32 sites with the potential to contain human remains (both tribal remains (in situ and repatriated) and modern remains)
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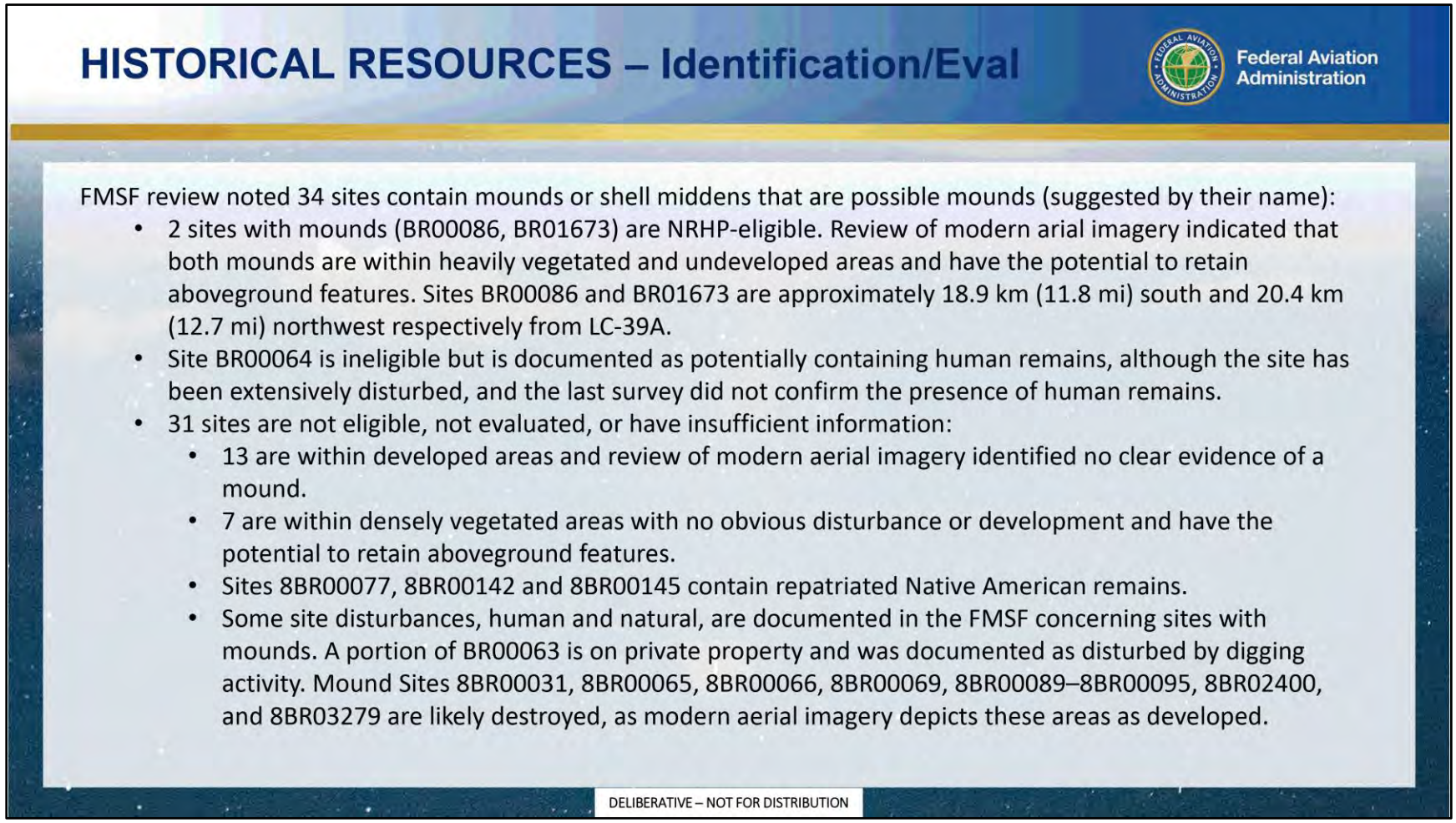
HISTORICAL RESOURCES – Identification/Eval
Federal Aviation Administration
FMSF review noted 34 sites contain mounds or shell middens that are possible mounds (suggested by their name):
• 2 sites with mounds (BR00086, BR01673) are NRHP-eligible. Review of modern arial imagery indicated that both mounds are within heavily vegetated and undeveloped areas and have the potential to retain aboveground features. Sites BR00086 and BR01673 are approximately 18.9 km (11.8 mi) south and 20.4 km (12.7 mi) northwest respectively from LC-39A.
• Site BR00064 is ineligible but is documented as potentially containing human remains, although the site has been extensively disturbed, and the last survey did not confirm the presence of human remains.
• 31 sites are not eligible, not evaluated, or have insufficient information:
• 13 are within developed areas and review of modern aerial imagery identified no clear evidence of a mound.
• 7 are within densely vegetated areas with no obvious disturbance or development and have the potential to retain aboveground features.
• Sites 8BR00077, 8BR00142 and 8BR00145 contain repatriated Native American remains.
• Some site disturbances, human and natural, are documented in the FMSF concerning sites with mounds. A portion of BR00063 is on private property and was documented as disturbed by digging activity. Mound Sites 8BR00031, 8BR00065, 8BR00066, 8BR00069, 8BR00089–8BR00095, 8BR02400, and 8BR03279 are likely destroyed, as modern aerial imagery depicts these areas as developed.
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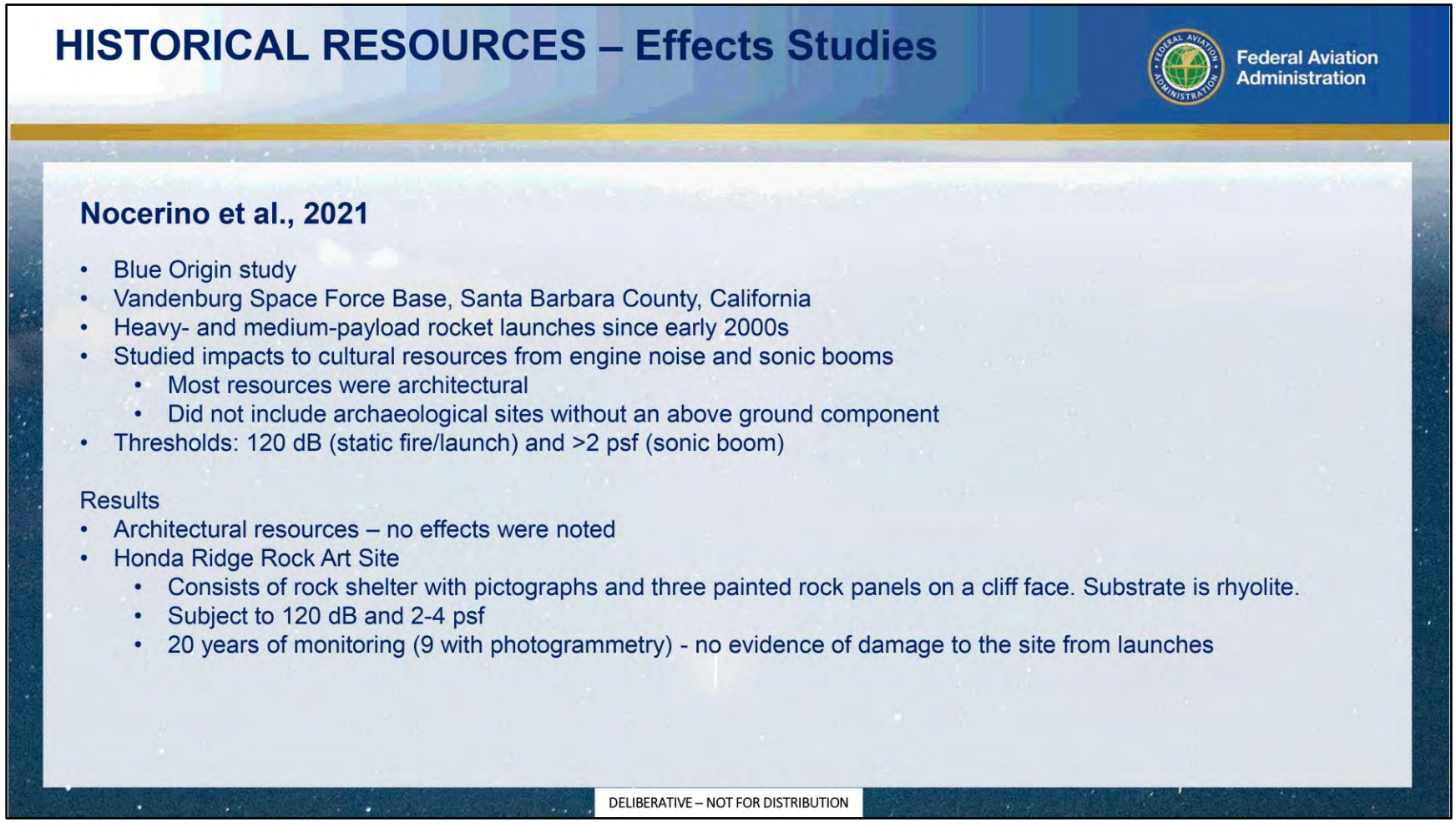
HISTORICAL RESOURCES – Effects Studies
Federal Aviation Administration
Nocerino et al., 2021
• Blue Origin study
• Vandenburg Space Force Base, Santa Barbara County, California
• Heavy- and medium-payload rocket launches since early 2000s
• Studied impacts to cultural resources from engine noise and sonic booms
• Most resources were architectural
• Did not include archaeological sites without an above ground component
• Thresholds: 120 dB (static fire/launch) and >2 psf (sonic boom)
Results
• Architectural resources – no effects were noted
• Honda Ridge Rock Art Site
• Consists of rock shelter with pictographs and three painted rock panels on a cliff face. Substrate is rhyolite.
• Subject to 120 dB and 2-4 psf
• 20 years of monitoring (9 with photogrammetry) - no evidence of damage to the site from launches
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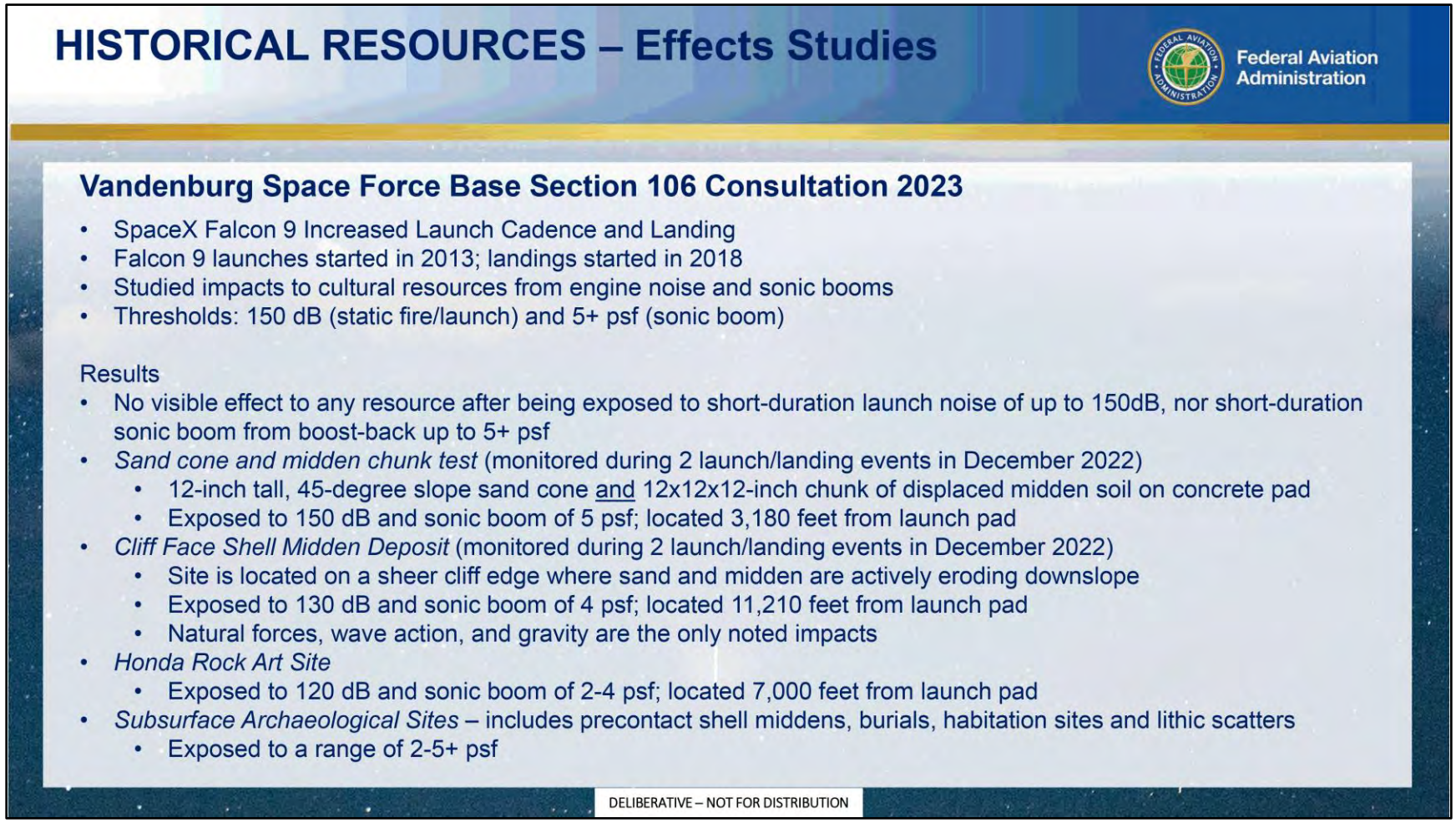
HISTORICAL RESOURCES – Effects Studies
Federal Aviation Administration
Vandenburg Space Force Base Section 106 Consultation 2023
• SpaceX Falcon 9 Increased Launch Cadence and Landing
• Falcon 9 launches started in 2013; landings started in 2018
• Studied impacts to cultural resources from engine noise and sonic booms
• Thresholds: 150 dB (static fire/launch) and 5+ psf (sonic boom)
Results
• No visible effect to any resource after being exposed to short-duration launch noise of up to 150dB, nor short-duration sonic boom from boost-back up to 5+ psf
• Sand cone and midden chunk test (monitored during 2 launch/landing events in December 2022)
• 12-inch tall, 45-degree slope sand cone and 12x12x12-inch chunk of displaced midden soil on concrete pad
• Exposed to 150 dB and sonic boom of 5 psf; located 3,180 feet from launch pad
• Cliff Face Shell Midden Deposit (monitored during 2 launch/landing events in December 2022)
• Site is located on a sheer cliff edge where sand and midden are actively eroding downslope
• Exposed to 130 dB and sonic boom of 4 psf; located 11,210 feet from launch pad
• Natural forces, wave action, and gravity are the only noted impacts
• Honda Rock Art Site
• Exposed to 120 dB and sonic boom of 2-4 psf; located 7,000 feet from launch pad
• Subsurface Archaeological Sites – includes precontact shell middens, burials, habitation sites and lithic scatters
• Exposed to a range of 2-5+ psf
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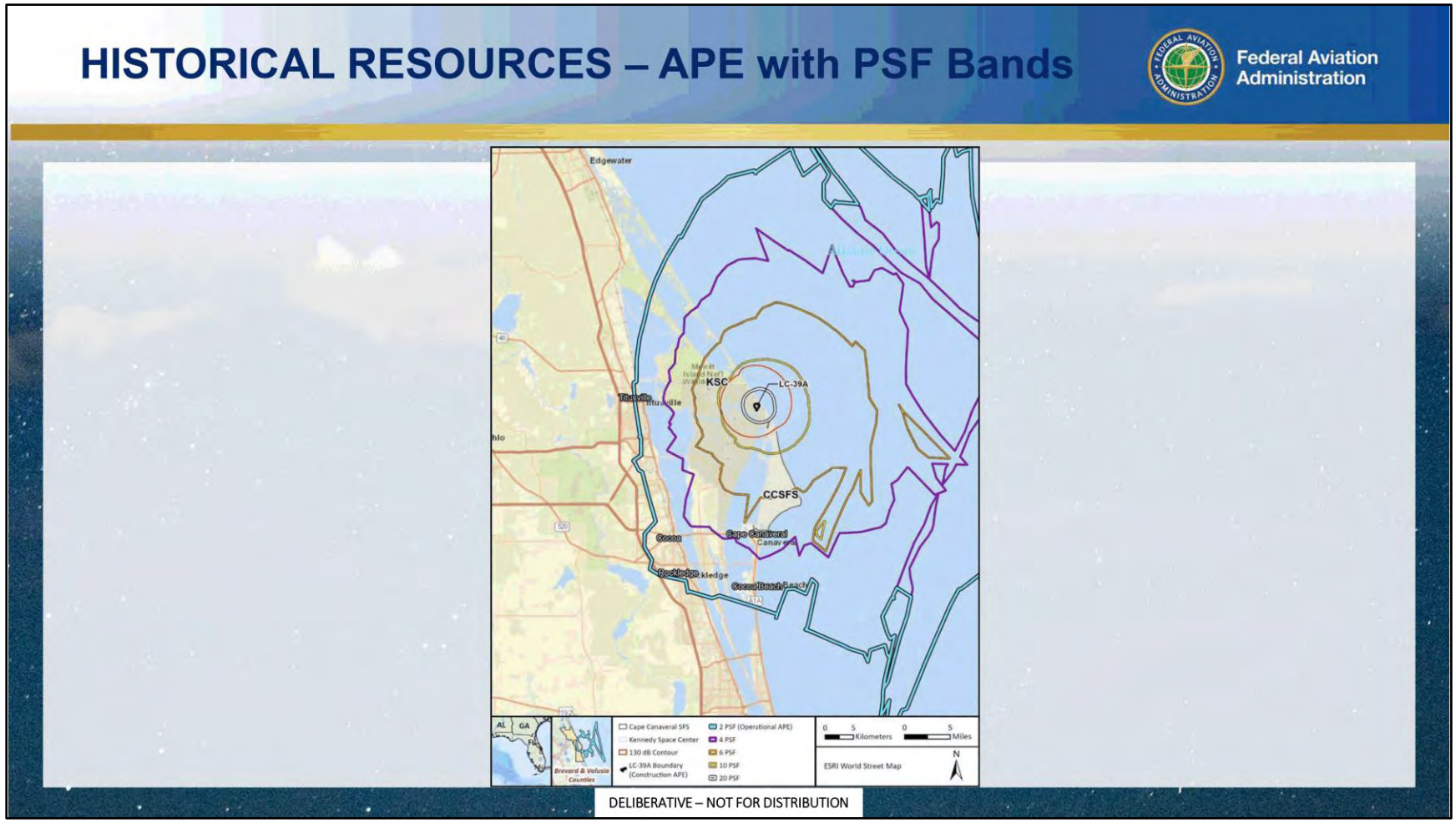
HISTORICAL RESOURCES – APE with PSF Bands
Federal Aviation Administration
Edgewater
KSC
LC-39A
CCSFS
Cape Canaveral
Cocoa
Titusville
Cape Canaveral SFS
Kennedy Space Center
130 dB Contour
LC-39A Boundary (Construction APE)
2 PSF (Operational APE)
4 PSF
6 PSF
10 PSF
20 PSF
Kilometers
Miles
ESRI World Street Map
N
AL
GA
Brevard & Volusia Counties
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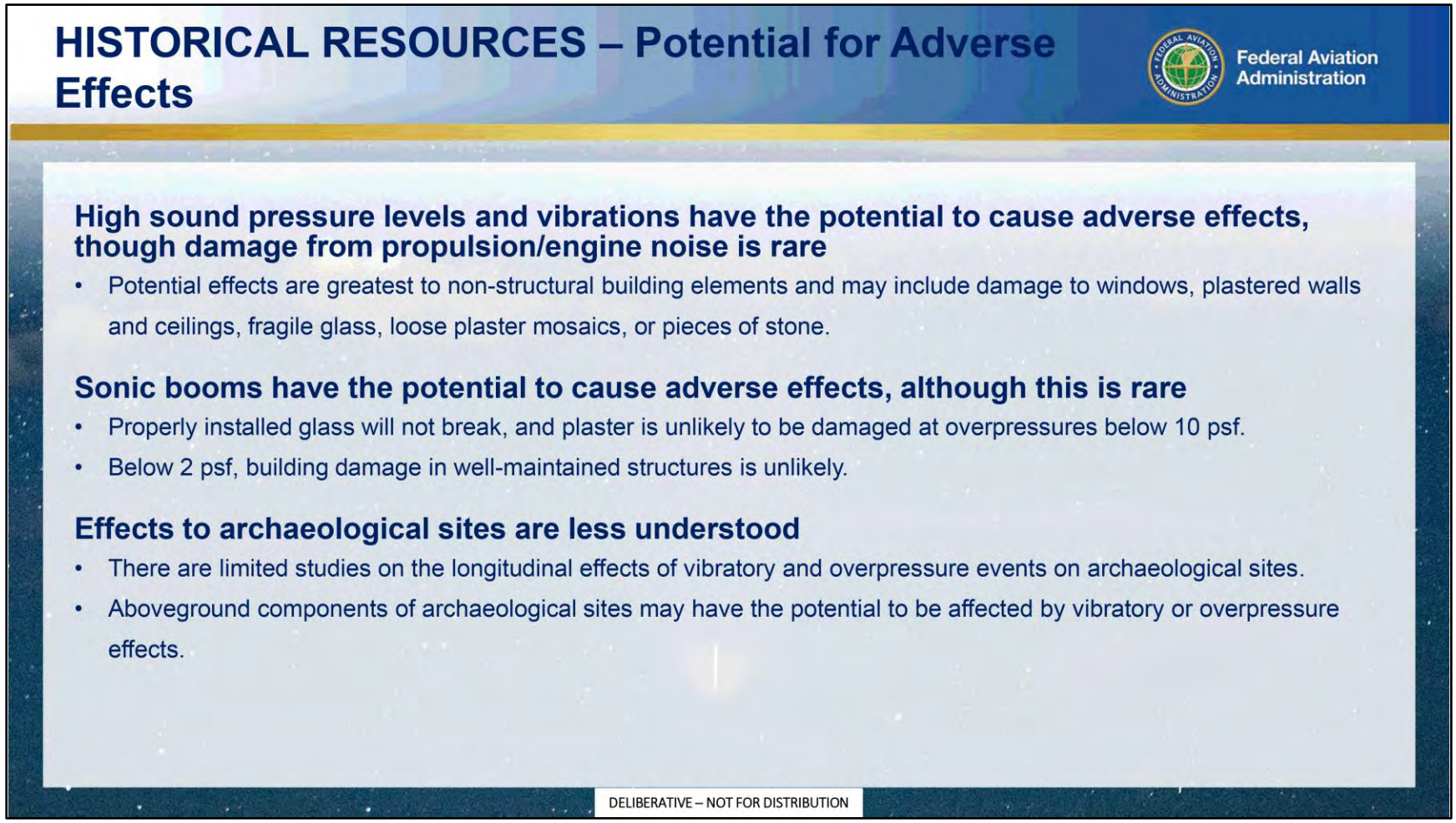
| psf | Number of Sites | Site List | |
|---|---|---|---|
| 20 psf | 1 | 8BR206 (Pepper Hammock) | |
| 10 psf | 2 | 8BR151 (NN*)<br>8BR205 (Max Hoeck Mound and Midden) | |
| 6 psf | 5 | 8BR83 (De Soto Grove Burial Mound*)<br>8BR150 (Oyster Prong Creek Mound*)<br>8BR145 (Clark Slough*)<br>8BR158 (Penny Plot*)<br>8BR3152 (Clark Slough Earthwork) | |
| 4 psf | 20 | 8BR62 (Moore Mound*)<br>8BR63 (Sams Mound*)<br>8BR64 (Tiffin Mound*)<br>8BR77 (Nauman's Place*)<br>8BR85 (Burns*)<br>8BR86 (Holmes Mound*)<br>8BR87 (Gulbransen Mound)<br>8BR88A (Hammock Mound A*)<br>8BR88C (Hammock Mound C)<br>8BR89 (Norris Mound*) | 8BR90 (Fuller Mound A*)<br>8BR91 (Fuller Mound B*)<br>8BR92 (Fuller Mound C)<br>8BR93 (Fuller Mound D*)<br>8BR94 (Fuller Mound E*)<br>8BR95 (Fuller Mound F)<br>8BR156 (NN)<br>8BR161 (Cocoa Beach Mound*)<br>8BR2085 (Odyssey Street Remains*)<br>8BR3274 (The Dunal Ridge Midden) |

* = potential for human remains


HISTORICAL RESOURCES – Potential for Adverse Effects
Federal Aviation Administration
High sound pressure levels and vibrations have the potential to cause adverse effects, though damage from propulsion/engine noise is rare
• Potential effects are greatest to non-structural building elements and may include damage to windows, plastered walls and ceilings, fragile glass, loose plaster mosaics, or pieces of stone.
Sonic booms have the potential to cause adverse effects, although this is rare
• Properly installed glass will not break, and plaster is unlikely to be damaged at overpressures below 10 psf.
• Below 2 psf, building damage in well-maintained structures is unlikely.
Effects to archaeological sites are less understood
• There are limited studies on the longitudinal effects of vibratory and overpressure events on archaeological sites.
• Aboveground components of archaeological sites may have the potential to be affected by vibratory or overpressure effects.
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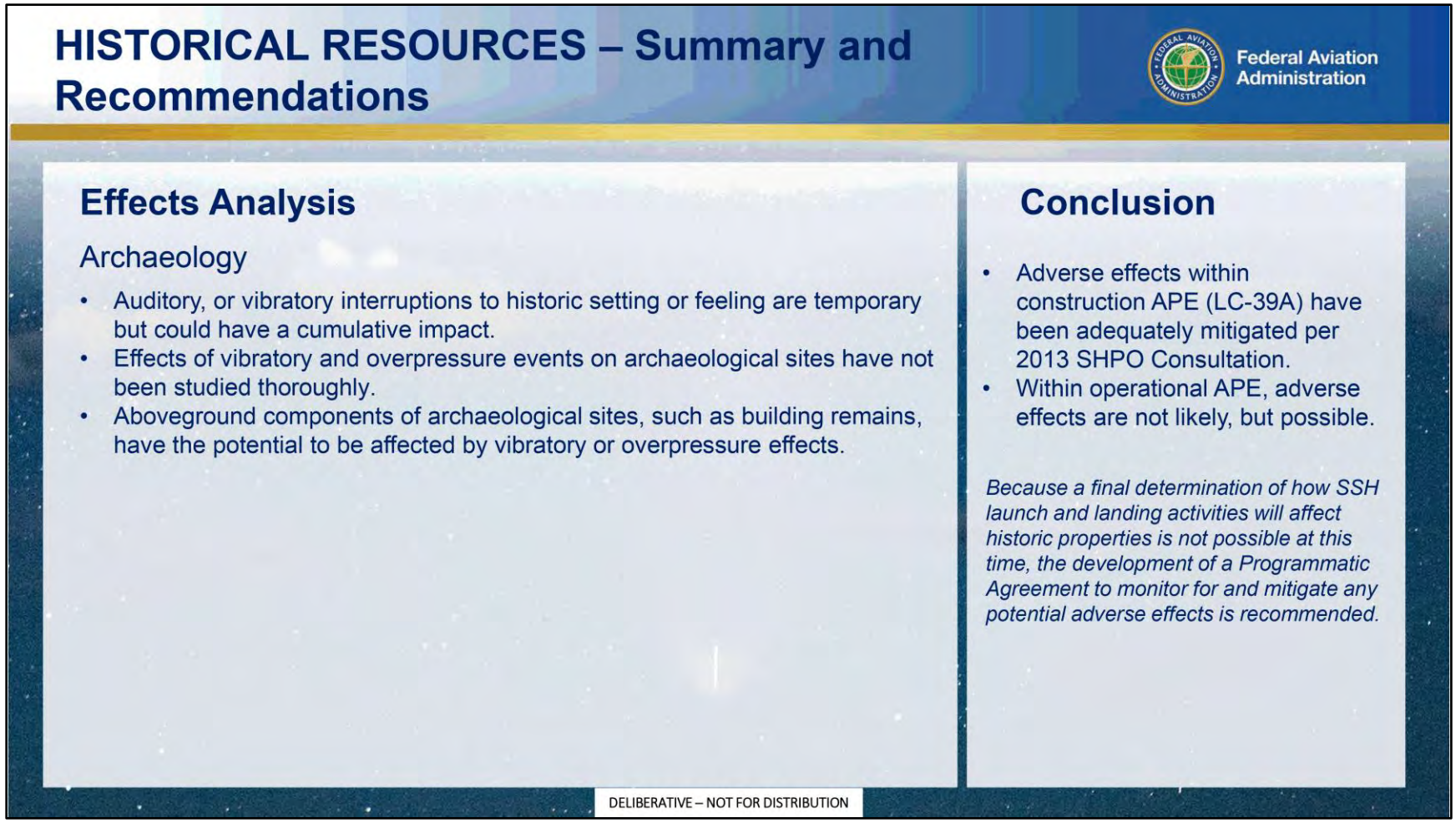
HISTORICAL RESOURCES – Summary and Recommendations
Federal Aviation Administration
Effects Analysis
Archaeology
• Auditory, or vibratory interruptions to historic setting or feeling are temporary but could have a cumulative impact.
• Effects of vibratory and overpressure events on archaeological sites have not been studied thoroughly.
• Aboveground components of archaeological sites, such as building remains, have the potential to be affected by vibratory or overpressure effects.
Conclusion
• Adverse effects within construction APE (LC-39A) have been adequately mitigated per 2013 SHPO Consultation.
• Within operational APE, adverse effects are not likely, but possible.
Because a final determination of how SSH launch and landing activities will affect historic properties is not possible at this time, the development of a Programmatic Agreement to monitor for and mitigate any potential adverse effects is recommended.
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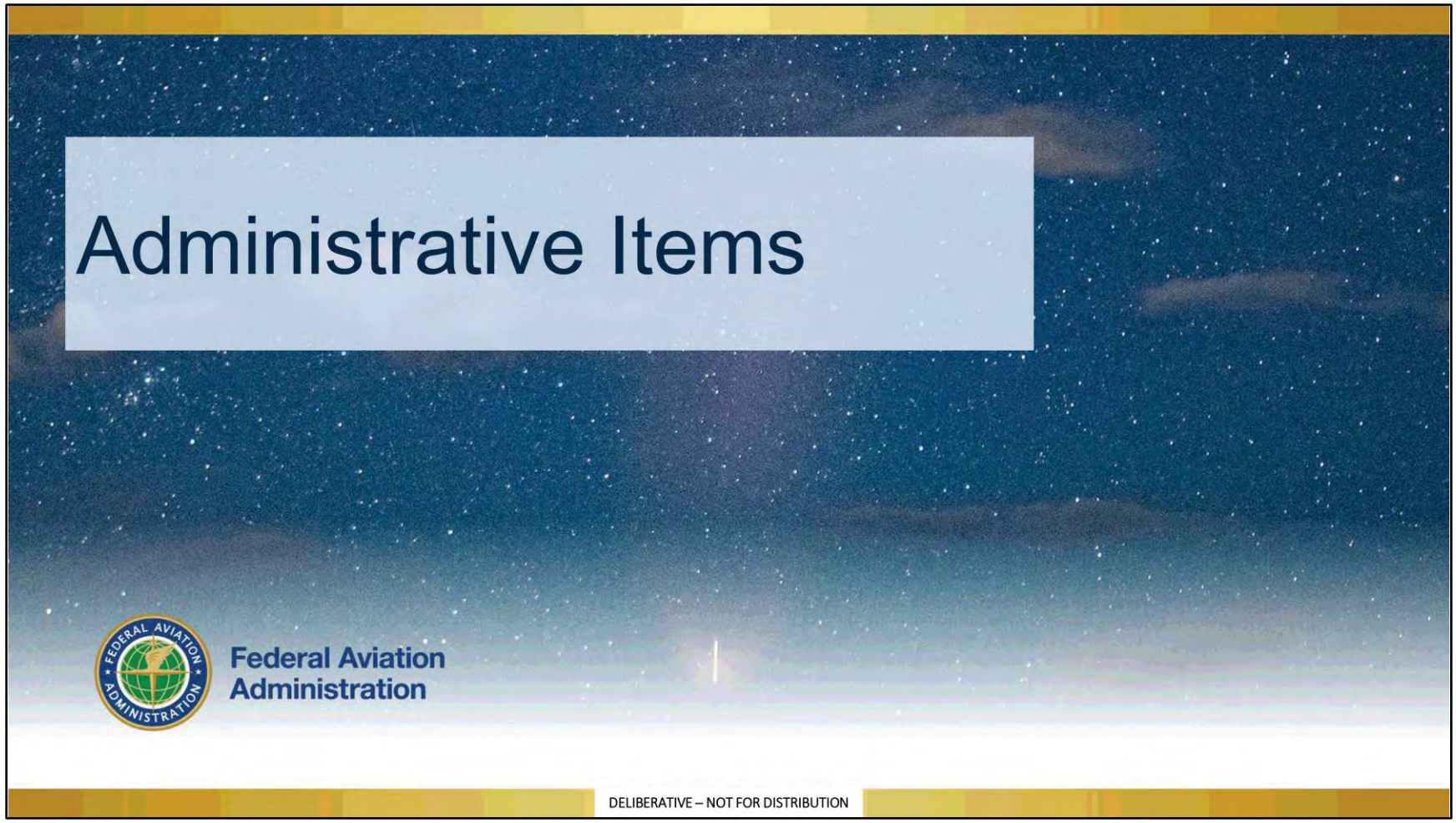
Administrative Items
Federal Aviation Administration
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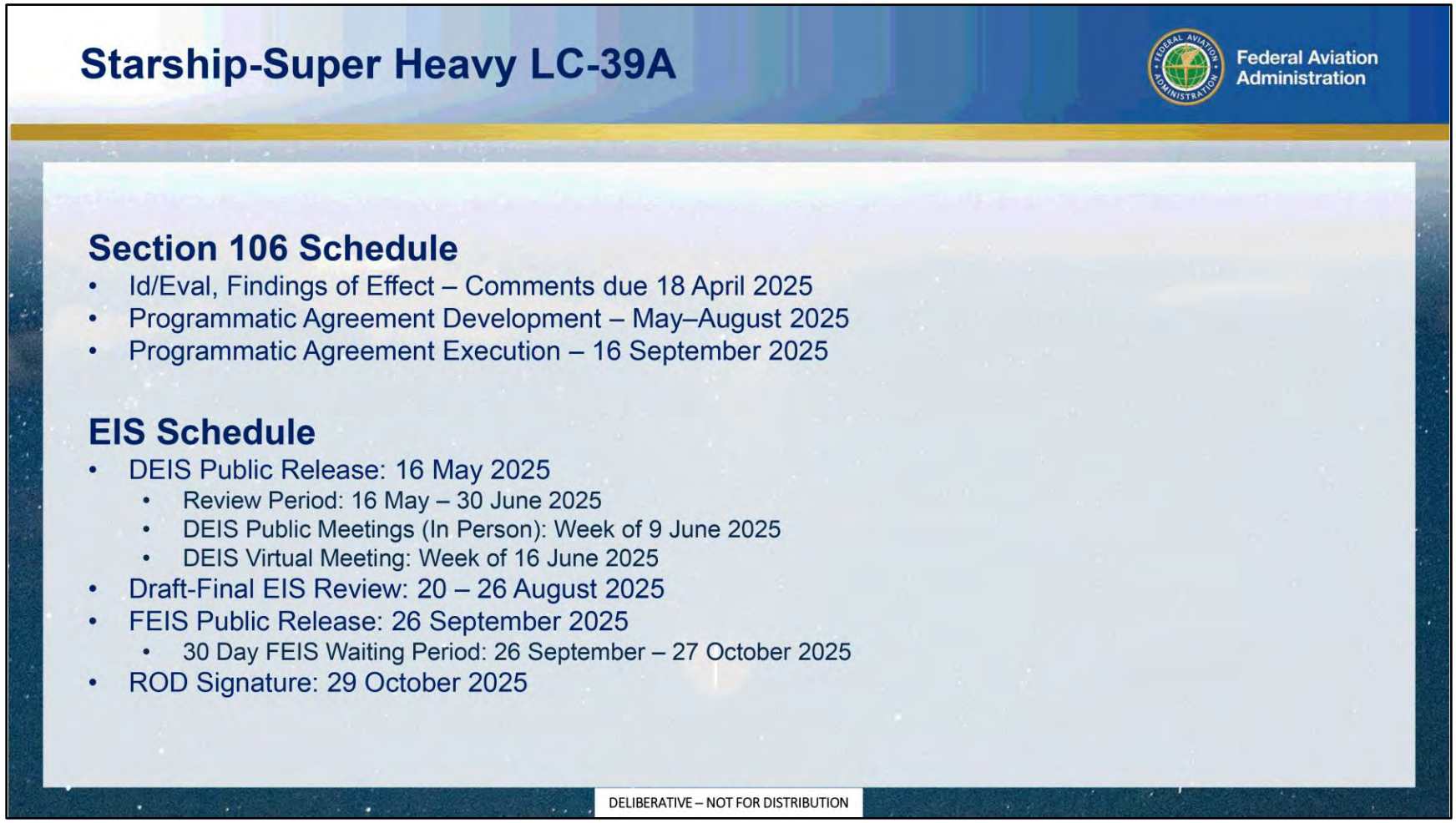
Starship-Super Heavy LC-39A
Federal Aviation Administration
Section 106 Schedule
• Id/Eval, Findings of Effect – Comments due 18 April 2025
• Programmatic Agreement Development – May–August 2025
• Programmatic Agreement Execution – 16 September 2025
EIS Schedule
• DEIS Public Release: 16 May 2025
• Review Period: 16 May – 30 June 2025
• DEIS Public Meetings (In Person): Week of 9 June 2025
• DEIS Virtual Meeting: Week of 16 June 2025
• Draft-Final EIS Review: 20 – 26 August 2025
• FEIS Public Release: 26 September 2025
• 30 Day FEIS Waiting Period: 26 September – 27 October 2025
• ROD Signature: 29 October 2025
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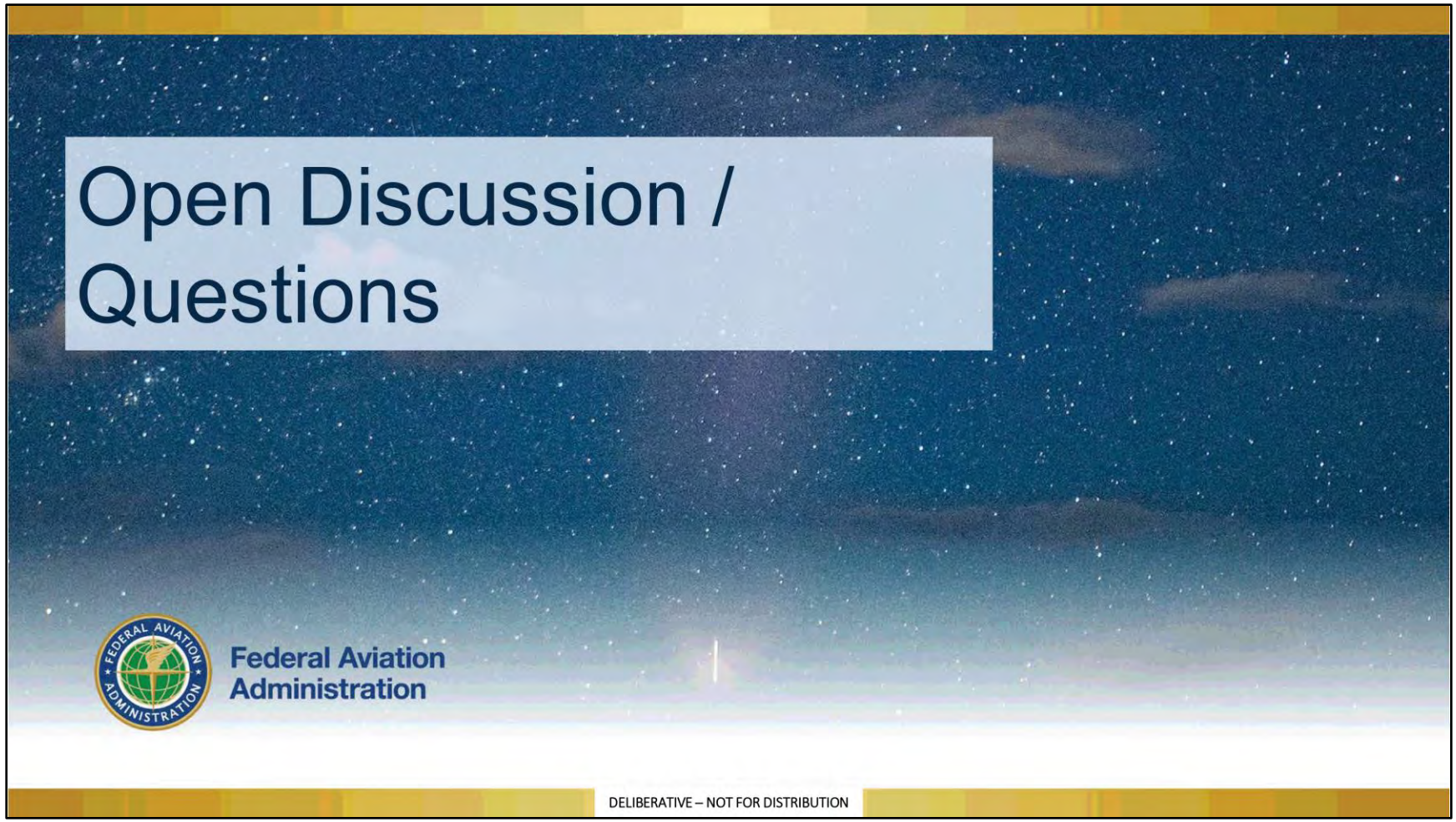
Open Discussion / Questions
Federal Aviation Administration
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**From:** Zeringue, Katherine S. (KSC-SIE30)
**To:** Akstulewicz, Kevin D. [US-US]; tim.parsons@searchinc.com; Bill Werner
**Cc:** Steven.Sherman@icf.com; Schanel, Pam; Hanson, Amy (FAA); Brooks, James T. (KSC-SIE30); Long, Eva (FAA); Dankert, Donald J. (KSC-SIE30); Kim Tice; Ward, Carmen J. [US-US]; Hall, Patrice (KSC-SIE30)
**Subject:** 4_8_25 STOF Meeting Outcomes SpaceX SSH LC-39A EIS - NHPA Consultation
**Date:** Thursday, April 10, 2025 1:00:00 PM
**Attachments:** image001.png
image002.png

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Hi All,

We had a really good meeting with the Seminole Tribe of Florida. Here are some key take aways:

1. **ID Approach**: We will need to change our identification approach to archaeological sites. Since we don't have any statistically valid studies to point to that definitely say archaeological sites (subsurface or otherwise) won't be affected, STOF has requested that the list of archaeological sites within the APE include ALL NRHP-listed or NRHP-eligible, or those whose NRHP eligibility is unknown. They are primarily concerned with those in the 4+psf bands. They have discussed their concerns with the FL SHPO; so I suspect we will see similar comments from SHPO as well.
2. **Paleo Concerns**: They also asked about and expressed concerns related to the juxtaposition of paleo sites and near shore water landings. They stated they are not concerned with anything past the shelf.
3. **Effects**: Their concerns are related to long-term, cumulative effects of archaeological sites. The two studies we have are the Nocerino and the Vandenburg study which are limited in scope and duration. The Vandenburg study, which builds upon the Nocerino study, only notes effects to archaeological sites that were visible to the naked eye, only covered 2 launches, and only accounted for sites exposed to 5psf or less. At KSC, we have multiple sites within the 20 – 5 psf bands which is beyond the Vandenburg scope.
4. **Monitoring**: We conceptually spoke about designing a monitoring program that would address these concerns. They would like monitoring to account for the subsidence and compaction of subsurface site components, the movement of artifacts within the strata, as well as accelerated erosion rates to shoreline sites resulting from vibration and overpressure effects (i.e. BR206/Pepper Hammock which is eroding into the Banana River and within the 20 psf band). One suggestion would be to do baseline subsurface test units at/around sites where stratigraphy and measurements are clearly noted in past survey reports (pre-project baseline). They want some sort of appropriate sample size and sampling strategy on a variety of site types in the different psf bands and also emphasized the testing locations should be accessible. Don Dankert has explored the potential for non-invasive methods using NASA Helio physics folks utilizing seismographic data; we'll still need to have conversations to determine if their methods would be able to address soils within roughly 4 feet of soil. So we'll have to put our heads together on suggestions for what makes sense. The Tribe definitely would prefer non-invasive methods to avoid impacting sites through our monitoring program.

5. **Study Accessibility**: They are supportive of having this study completed especially to inform future actions with the hope that future Section 106 consultation that may be able to conclude "No Effects".
6. **Tribal Monitoring**: They do not have the capacity or ability to engage in tribal monitoring, but are supportive if other tribes have the desire and ability to do so.
7. **Programmatic Agreement**: As for the PA, they potentially requested Invited Signatory status on the Programmatic Agreement but will need to verify with the Tribal council. They feel our timeline is doable, but noted that if they are Signatories, they may need 3-4 weeks to get a Signature on the document (depending upon whether the THPO or the Tribal Chief will sign on behalf of the Tribe).
8. **Communication/Engagement**: STOF stated that they may participate in group tribal meetings that offer project/information updates, but if feedback or workshopping is necessary, it should be done one-on-one with the Tribe. They are not seeking formal government to government consultation at this time.

Do Outs:

1. I need an updated list of archaeological sites that includes ALL listed- or NRHP-eligible sites, sites whose NRHP status is unknown, or sites with human remains (regardless of NRHP status); a general descriptor of each site type; and the sites organized in numerical order according to the psf band in which they fall. We should also create maps to help facilitate discussions with the Tribes.
2. I must admit that I don't fully understand their paleo/ocean shelf concerns – so if anyone has any insight or suggestions on how to address this, let me know.
3. After the meeting Eva and I also spoke about FAA's role within the PA (Signatory, Invited Signatory). I had assumed that FAA would be a Signatory since they have a federal action for which Section 106 compliance is required, but it sounds like FAA will need to discuss this internally. So the do out is for FAA to let us know what role they want in the document as we being drafting it. This decision will affect language within the roles and responsibilities Stipulations.

Other future actions:

1. SEARCH to begin drafting PA (already requested)
2. We should start planning dates for our PA kick-off consulting party meetings – one will be with SHPO and consulting parties; tribes should also be invited. However, we should also plan on having a separate tribal kick-off with all Tribes either on the same date or within a day or two of that meeting. We should also plan out future meetings and internal drafting deadlines for the PA. The schedule right now only accounts for one round of draft PA review with consulting parties which I don't think is realistic. I think it will take at least 2 draft versions before we have a final document for signature. I think we will likely also need at least 2 total consulting party meetings and at least 2 group Tribal meetings. HOWEVER, all of this is doable

within the schedule timeframe. But I'd like to start planning out a more detailed schedule. If its easier for Tim and I to workshop this off line and bring something back to the group, let me know.

Talk to you on Wednesday,

**Katherine Zeringue**
**Cultural Resources Manager**
Spaceport Integration and Services
Kennedy Space Center
Mail Code: SI-E3
Kennedy Space Center, FL 32899
O: 321-867-8454
katherine.s.zeringue@nasa.gov

FLORIDA DEPARTMENT of STATE

**RON DESANTIS**
Governor

**CORD BYRD**
Secretary of State

Katherine Zeringue
NASA KSC Cultural Resources Manager
John F. Kennedy Space Center
Kennedy Space Center, FL 32899

April 18, 2025

RE: DHR Project File No.: 2024-3285-C, Received by DHR: March 17, 2025
*Continuing Consultation, SpaceX Starship Super Heavy Launch and Reentry Vehicles at Launch Complex (LC)-39A, Kennedy Space Center (KSC)*

To Whom It May Concern:

The Florida State Historic Preservation Officer reviewed the referenced project for possible effects on historic properties listed, or eligible for listing, on the *National Register of Historic Places (NRHP)*. The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended, and its implementing regulations in *36 CFR Part 800: Protection of Historic Properties*.

Thank you for continuing consultation with our office and providing us with an opportunity to review and comment on the *Cultural Resource Survey for the Starship-Superheavy Project at LC-39A, Kennedy Space Center, Brevard County, Florida (CRS)*, which details NASA KSC's efforts to identify and evaluate properties within the undertaking's area of potential effects (APE).

We concur with NASA KSC's determination that the undertaking's effects to historic properties cannot be definitively determined at this time and their proposal for the development of a programmatic agreement pursuant to 36 CFR Part 800.14(b)(1)(ii). We will provide comments or concurrence with the NRHP eligibility recommendations provided in the CRS via separate letter.

If you have any questions, please contact me by email at *Kelly.Chase@dos.myflorida.com*, or by telephone at 850.245.6344.

Sincerely,

Kelly L Chase
For

Alissa Lotane
Director, Division of Historical Resources
& State Historic Preservation Officer

**Division of Historical Resources**
**R.A. Gray Building • 500 South Bronough Street• Tallahassee, Florida 32399**
**850.245.6300 • 850.245.6436 (Fax) • FLHeritage.com**

Historical Resources

# United States Department of the Interior

NATIONAL PARK SERVICE
Canaveral National Seashore
212 S. Washington Ave.
Titusville, FL 32796

IN REPLY REFER TO:
1.A.2 (CANA)

Ms. Katherine Zeringue
Cultural Resources Manager
Kennedy Space Center
Kennedy Space Center, FL 32899

Dear Ms. Zeringue:

Canaveral National Seashore (CANA), a unit of the National Park Service (NPS) has received your letter regarding SpaceX Starship Super Heavy Launch and Reentry Vehicles at Launch Complex (LC)-39A dated March 17, 2025. As a consulting party for this undertaking CANA offers the following comments regarding the identification, evaluation and assessment of effects contained within the Cultural Resource Survey (CRS) completed by SEARCH.

It should be acknowledged that NASA owns the majority of land under CANA's jurisdiction, however, as CANA serves a wholly distinct purpose from NASA, it is important to acknowledge CANA's boundary throughout the document, including in all relevant figures and texts.

CANA agrees with many of the conclusions and recommendations in the CRS. It appears from the CRS that properties on federal lands, including CANA, were not evaluated further and that eligibility determinations are based upon Integrated Cultural Resource Management Plans. While helpful, those plans may not be accurate. The NPS National Historic Landmark (NHL) program has consulted previously on potential adverse effects to the Cape Canaveral Space Force Station NHL. During that consultation, it became clear that Launch Complex (LC)-13 had been demolished in 2015. In addition, much of LC-14 was proposed for demolition by that United States Space Force (USSF) undertaking and the USSF shared its self-reported intention of managing the NHL through "demolition by neglect." As a result, the regional NHL team recommended (in a letter dated 4/2/2024) that USSF initiate the process to have the property studied for withdrawal of designation following the NHL regulations at 36 CFR 65.9. The State Historic Preservation Office (SHPO) staff to whom this letter is addressed and copied (Chase and Lotane) were party to that consultation. It becomes relevant on this project as Table 4-7 might benefit from (1) distinguishing the resources that are contributing resources to the NHL and (2) updating that table to differentiate those NHL resources that have subsequently been demolished. As such, this will inform the identification effort and therefore any resulting Programmatic Agreement.

The discussion of Effects Evaluation (p. 6-25), notes less possibility for adverse effects "in well-maintained structures . . ." Does the management strategy of demolition by neglect, acknowledged as being in force for LC-14, apply to other locations across the USSF property? That information would be a key component of the effects evaluation.

The CRS notes that adaptation efforts and retrofitting may reduce the potential for adverse effects but it does not identify whether these adaptations have been done to historic buildings. Many of the historic buildings have not been altered and the CRS does not address the potential that adverse effects may be heightened by the fact that historic materials may not meet modern thresholds and standards.

CANA agrees that the potential for adverse effects does exist and those effects have not been adequately evaluated at this time. Therefore, CANA will continue to be a consulting party for this undertaking and in developing a Programmatic Agreement pursuant to 36 CFR 800.14(b)(1)(ii).

Sincerely,

JOHN REUS Digitally signed by JOHN REUS Date: 2025.04.18 11:48:50 -04'00'

*for* Superintendent,
Canaveral National Seashore

# CONSULTING PARTY MEETING #1 MINUTES:

## SpaceX Starship-Super Heavy Launch and Landing at LC-39A, Kennedy Space Center

**Date:** 13 May 2025
**Location:** Microsoft Teams Virtual Meeting

**ATTENDEES:**
**NASA KSC**: Katherine Zeringue, James Brooks
**FAA**: Eva Long, Amy Hanson, Nicholas Baker
**SpaceX**: Brian Pownall
**ICF (Contractor Support)**: Pam Schanel, Steve Sherman
**Leidos (Contractor Support)**: Kevin Akstulewicz, Jay Austin, Carmen Ward
**SEARCH (Contractor Support)**: Tim Parsons, Bill Werner
**Florida Division of Historical Resources**: Alissa Lotane, Kelly Chase, Scott Edwards
**Seminole Tribe of Florida**: Danielle Simon, Victoria Menchaca
**Seminole Nation of Oklahoma**: Jeff Harjo
**Canaveral National Seashore**: Carmen Thompson, Kristen Kneifl, Meredith Dennis, Steve Rogers
**Cape Canaveral Lighthouse Foundation**: Becky Zingarelli
**City of Titusville**: Tabitha Armstrong
**North Brevard Heritage Foundation**: Roz Foster

### MEETING SUMMARY

- Introductions
- Mr. Akstulewicz provided a brief overview of the proposed action and area of potential effects (APE)
  - Noise and vibration effects are the main concern for Section 106
  - Construction APE is previously surveyed; no effects anticipated
  - Super Heavy booster return/landing is the focus of the Operational APE (sonic boom overpressure of 2 psf or greater)
  - Starship-Super Heavy launch effects (measured at 130 dB or greater) are accounted for within the Operational APE
  - The majority of noise exceeding 2 psf associated with Super Heavy booster return is over water
- Dr. Parsons summarized the historic property identification efforts
  - Ms. Chase asked a question regarding federal versus non-federal resources within the APE. Dr. Parsons clarified that the Operational APE is inclusive of both federal and non-federal lands.
  - Discussion of resources within the 130 dB contour for launch effects

- The Beach House is the only non-purpose-built historic structure within the 130 dB contour
- There are 14 archaeological sites within the 130 dB contour

- The handouts include additional information about resources

- Discussion of effects from noise, vibration, and overpressure
  - Ms. Simon asked about cumulative effects; how does the frequency of launches and landings proposed at KSC compare to that addressed in previous studies of effects to cultural resources?
    - Dr. Parsons clarified that there are no longitudinal studies of effects to archaeological sites for analogous actions.
  - Ms. Chase requested to be provided GIS shapefiles of the psf and dB contours.
  - Ms. Simon asked about the number of proposed launches per year.
    - Mr. Akstulewicz clarified that there are 220 separate static fire, launch or landing events planned per year (44 integrated launches, 88 static fires, and 88 returns).
  - Ms. Simon asked about the effects of weather cancellations on the number of proposed launches.
    - Mr. Akstulewicz indicated that this would be difficult to predict, but that the number of actual launches would not be higher than the number of planned launches. We're assessing what is being planned as the conservative approach. The number of launches will never go over but may be less than what is being presented.
- Discussion of previous studies from Boca Chica and Vandenburg Space Force Base that examined effects of noise and vibration to cultural resources.
  - Ms. Zeringue caveated that the infrastructure at the Boca Chica site is different than what will be at LC-39A and will result in different noise and vibration effects, so Boca Chica and KSC should not be understood as analogous.
    - Ms. Hanson elaborated on the differences between the launch infrastructure (trench and deluge systems) at the two locations; effects at KSC will be significantly less than at Boca Chica
  - Ms. Zingarelli asked how far the lighthouse at Boca Chica is from the launch pad.
    - FAA confirmed the distance is approximately 8 miles.
  - Ms. Zingarelli asked how the Fresnel lens at the Boca Chica lighthouse was hardened prior to launches (the Cape Canaveral Lighthouse Museum also has a Fresnel lens within its museum, not within the lighthouse itself).
    - Ms. Hanson explained that the Boca Chica lighthouse staff manage the protective systems themselves with training that was provided. Also, it should be noted that the Fresnel lens at Boca is modern, not historical. So, its protection is for operational purposes, not historic preservation purposes.
  - Ms. Foster asked if there were any studies of effects from the Saturn V launches.
    - Dr. Parsons noted that there were some studies completed in the 1960s to examine effects from the Apollo program and that the conclusions were similar to those of later studies discussed in the presentation and the CRAS,

e.g., that vulnerable features such as single-pane windows are susceptible to breakage at noise levels of 130 dB or greater.
        - Dr. Parsons pointed out that studies from the Apollo era did not consider effects to archaeological sites.
    - Ms. Foster also asked about the significance of the 150 dB threshold noted in the Vandenburg studies versus the 130 dB threshold discussed in relation to the current proposed action.
        - Ms. Zeringue noted that the 150 dB is where the resource being monitored was located and the dB to which the resource was exposed.
        - Dr. Parsons noted that even with exposure to 150 dB no effects to historic properties were noted. Additionally, the APE is following FAA's standard approach by using the 130 dB threshold as the limit for possible effects, which includes any resources that may be exposed to the 150 dB.
    - Ms. Lotane asked about a previous comment by Dr. Parsons that buildings are unlikely to be affected unless they are "poorly maintained" and noted that this may be a subjective quality
        - Dr. Parsons clarified that he meant that certain structures may be at greater risk due to multiple factors related to physical condition, including condition of joints, types of windows, etc.
- Ms. Zeringue discussed the development of a Programmatic Agreement
    - Ms. Zeringue stated that the need for a Programmatic Agreement is derived from the fact that effects are unknown, so the agreement document will focus more on processes than outcomes.
    - Ms. Zeringue requested that the consulting parties provide feedback on additional efforts for historic properties identification and monitoring, including specific details regarding expectations for the scope and duration of a monitoring program.
        - Ms. Chase elaborated on the SHPO's request for additional survey/identification efforts. These efforts should focus on recording the historic districts discussed in the cultural resource survey report and identifying the contributing resources. The goal is not to record every structure in the APE but rather to provide additional information about the specific areas of concern in order to focus the additional identification and monitoring efforts.
        - Ms. Lotane added that resource forms are primarily needed for districts and resource groups in order to assign numbers and boundaries; forms are not needed for every building.
        - Ms. Lotane noted that monitoring should focus on resources previously listed or determined eligible for listing on the NRHP.
        - Ms. Chase added that cumulative effects are the biggest concern and that formally recording the historic districts is needed in order to start assessing long-term effects.
    - Ms. Zeringue asked the FAA representatives to comment on their standard approach and treatment of historic districts under Section 106.

- Ms. Hanson noted that for similarly large APEs the focus has been on existing districts, not the nomination of new districts.
- Ms. Lotane clarified that SHPO is not expecting NRHP nominations to be part of the survey and recordation effort.

- Ms. Zeringue asked FAA or SpaceX to speak to SpaceX's damage reporting program.
  - Mr. Pownall noted that SpaceX is required to hold liability insurance by the Commercial Space Launch Act.
  - Ms. Dennis asked whether the claims include interior/non-structural damage.
  - Ms. Long noted that window damage is certainly covered.
  - Mr. Pownall said he would get more details on what is covered under the program.
- Ms. Foster would like more information on whether the liability insurance would include elements susceptible to cracking such as brick/concrete piers, foundations, and chimneys and asked that the monitoring program document any such features exposed to greater than 130 dB noise levels.
  - Ms. Zeringue clarified that the 130 dB threshold does not extend outside of federal property.
  - Mr. Akstulewicz noted that the 150 dB contour is very close to the launch pad itself.
  - Dr. Parsons noted that the same is true at Vandenburg.
  - Mr. Akstulewicz commented that the decibel contours are based on noise modeling that takes into account atmospheric conditions (wind, temperature, humidity) that vary daily and seasonally by location and should not be construed as definitive boundaries.

- Ms. Zeringue concluded the meeting by summarizing the next steps
  - The cultural resource assessment survey report will be updated based on comments received to date from Tribes regarding archaeological sites as well as minimal updates to architectural resources.
  - Consulting parties need to provide input regarding scope of the monitoring program by May 23.
  - Ms. Lotane asked the other consulting parties, especially residents local to the APE, to identify historic buildings of the most concern. Ms. Zeringue requested that both SHPO and NASA KSC be copied if this information is sent.

## ACTION ITEMS

All

- Provide feedback on the preferred scope of the monitoring program and any additional historic properties identification efforts that are requested.

SEARCH

- Provide shapefile of psf and dB contours to FDHR.

SpaceX

- Provide consulting parties with information about the scope of the liability insurance coverage.

**From:** Zeringue, Katherine S. (KSC-SIE30)
**To:** Long, Eva (FAA); Hanson, Amy (FAA); Tim Parsons; Bill Werner; Akstulewicz, Kevin D. [US-US]; Austin, Jay K. [US-US]; thpocompliance@semtribe.com; DanielleSimon@semtribe.com; VictoriaMenchaca@semtribe.com; JasonD@miccosukeetribe.com; Section106@muscogeenation.com; swaters@muscogeenation.com; Logan Guthrie; Jeffery Harjo; thpo@tttown.org
**Cc:** Dankert, Donald J. (KSC-SIE30); Bremner, Paul M. (MSFC-ST13); Steven Sherman; Schanel, Pam
**Subject:** EXTERNAL: RE: Tribal Specific Meeting - NASA KSC SpaceX Starship Superheavy
**Date:** Monday, May 19, 2025 5:12:08 PM
**Attachments:** image001.png
image002.png
5_13_2025 CP SpaceX SSH Mtg 1.pdf
SSH LC-39A Tribal Consultation Meeting 5-16-25_Minutes.docx
SpaceX Starship Superheavy Monitoring Plan Feedback.docx

Hello All,

Thank you to those who were able to join us on Friday. I have attached a few items for your records:

- The PPT presentation
- Meeting minutes – if anyone has any edits or corrections, please forward those to me NLT May 30.
- Consulting Party Feedback Questionnaire – NASA KSC requested feedback from Tribes related to the development of the historic property monitoring program. This questionnaire identifies the critical elements for which NASA KSC is seeking feedback. However, feel free to provide any information you feel is relevant. We request feedback from the Tribes NLT **May 30**.

I look forward to hearing from you by May 30. In the meantime, should you have any questions, feel free to reach out.

Sincerely,

**Katherine Zeringue**
**Cultural Resources Manager**
Spaceport Integration and Services
Kennedy Space Center
Mail Code: SI-E3
Kennedy Space Center, FL 32899
O: 321-867-8454
katherine.s.zeringue@nasa.gov

-----Original Appointment-----
**From:** Zeringue, Katherine S. (KSC-SIE30)
**Sent:** Friday, May 2, 2025 3:24 PM
**To:** Zeringue, Katherine S. (KSC-SIE30); Long, Eva (FAA); Hanson, Amy (FAA); Tim Parsons; Bill Werner; Akstulewicz, Kevin D. [US-US]; Austin, Jay K. [US-US]; thpocompliance@semtribe.com; DanielleSimon@semtribe.com; VictoriaMenchaca@semtribe.com; JasonD@miccosukeetribe.com; Section106@muscogeenation.com; swaters@muscogeenation.com; Logan Guthrie; Jeffery Harjo; thpo@tttown.org
**Cc:** Dankert, Donald J. (KSC-SIE30); Bremner, Paul M. (MSFC-ST13); Steven Sherman; Schanel, Pam
**Subject:** Tribal Specific Meeting - NASA KSC SpaceX Starship Superheavy

# TRIBAL CONSULTATION MEETING MINUTES:

## SpaceX Starship-Super Heavy Launch and Landing at LC-39A, Kennedy Space Center

**Date:** 16 May 2025
**Location:** Microsoft Teams Virtual Meeting

**ATTENDEES:**
**NASA KSC**: Katherine Zeringue, Paul Bremner, Aiden Woo
**FAA**: Eva Long, Nicholas Baker
**ICF (Contractor Support)**: Pam Schanel
**Leidos (Contractor Support)**: Kevin Akstulewicz, Jay Austin
**SEARCH (Contractor Support)**: Tim Parsons, Bill Werner
**Miccosukee Tribe of Indians of Florida:** Jason Daniel
**Seminole Tribe of Florida**: Danielle Simon, Victoria Menchaca

### MEETING SUMMARY

- Introductions
- Mr. Akstulewicz provided a brief overview of the proposed action and area of potential effects (APE)
- Dr. Parsons summarized the historic property identification efforts and the potential effects of noise, vibration, and overpressure to historic properties
- Dr. Parsons discussed previous studies from Boca Chica and Vandenburg Space Force Base that examined effects of noise and vibration to cultural resources.
    - Ms. Zeringue noted that Vandenburg has been monitoring archaeological sites for years via surface inspection and laser imagery (for rock art) and has not observed any effects from noise, vibration, or overpressure
- Ms. Zeringue discussed the development of a Programmatic Agreement
    - Ms. Zeringue stated that the need for a Programmatic Agreement is derived from the fact that effects are unknown, so the agreement document will focus more on processes than outcomes.
- Open Discussion
    - Ms. Menchaca asked about baseline noise/vibration conditions
        - Mr. Akstulewicz explained that baseline measurements are an average over time and are not directly comparable to the effects of specific events
        - Mr. Austin added that baseline overpressure is not a focus of the study
        - Baseline/no action scenarios are described in the EIS but this information is presented in terms of C-weighted Day-Night Average Noise Levels (CDNL), which is a measurement provided in decibels that incorporates the effects of overpressure

- Ms. Zeringue summarized various ideas that have been discussed for monitoring effects to subsurface archaeological sites
- Ms. Simon asked about the planned sample size for monitoring archaeological sites
  - Ms. Zeringue responded that we are seeking Tribes' feedback on this question
  - Ms. Simon stated that they would like to ensure that Seminole Tribe of Florida requests are reasonable with consideration of time, expense, and research validity
  - Dr. Parsons suggested that the archaeological monitoring program should prioritize a robust research design over statistical sampling; statistical sampling has been problematic for the discipline of archaeology
  - Ms. Simon stated that they aim for a purposeful study that can serve as a useful reference point for future consultations.
- Mr. Bremner summarized his seismographic research at KSC and how it might be applied to the monitoring of archaeological sites.
  - Mr. Bremner and his colleagues use an array of sensors to create a "heat map" showing how seismic waves propagate through the ground
  - Additional sensors can be placed in specific areas of interest, once special interest areas are defined, such as archaeological sites, to provide more granular data
  - Generally speaking, data at a 1-centimeter scale of accuracy would require up to 100 sensors at a single archaeological site
- Ms. Simon stated that they would like to minimize destructive testing and recommended selecting sites with previously documented stratigraphy.
- Ms. Zeringue summarized several sites within KSC's secure areas that are able to be located, accessible, and that may be good candidates for monitoring based on 2024 field visits; this includes 8BR206 (Pepper Hammock)/20 psf, 8BR170 (Opposite Futch Cove)/10 psf, and 8BR62 (Moore Mound)/4 psf
- General discussion of accessibility of federal vs. non-federal lands; placement on non-federal lands presents additional logistical and security challenges.
- Mr. Bremner explained that impervious surfaces (e.g., paved parking lots at 8BR170)/Opposite Futch Cove) would not impede placement of sensors on the ground surface. However, Mr. Bremner described that it would be better to observe sites without public traffic (e.g., at nighttime or within zones that are restricted during launches) to minimize noise interference. Since 8BR170 is co-located at the Saturn V/Apollo Visitor Center site, this may pose monitoring challenges.
- Ms. Simon noted that the Seminole Tribe of Florida would need to discuss internally whether to consider including sites with burials within the monitoring program (e.g. 8BR62/Moore Mound).
- Ms. Simon asked about the possibility of including Cape Canaveral Space Force Station in the discussion of monitoring plans, to prevent redundancy of

conversation and monitoring/research efforts. She also asked if a joint or collaborative PA is possible.

- Ms. Zeringue advised that although a joint PA is not possible, there is a desire on everyone's part for coordination between KSC and CCSFS.
- Ms. Long elaborated that there is a desire for consistency but confirmed that two PAs are necessary. She plans to engage with colleagues at DAR/CCSFS more moving forward to sync up as much as possible.

- Mr. Bremner noted that LiDAR has potential for monitoring ground water to a limited extent, and that other methods, in addition to seismic studies, may be possible. His team is researching these other methods and more details are forthcoming.
- Ms. Simon said that the Seminole Tribe of Florida will confer internally to identify suitable candidates for site monitoring and will provide feedback.
- Ms. Long asked Mr. Bremner about the duration of deployment for sensors, and about the logistics for the seismic studies.
  - Mr. Bremner replied that senor rentals can be for years at a time, and that extended sensor placement is possible and that there is flexibility. Some coordination is necessary to ensure that the sensors do not interfere with daily operations at KSC or with mission operations.
- Ms. Long asked if the sensor data can be remotely accessed or if it is stored locally.
  - Mr. Bremner replied that remote access is possible, but that data cards can be swapped out at intervals and that physical data would be preferable at the KSC and CCSFS facilities.

## ACTION ITEMS

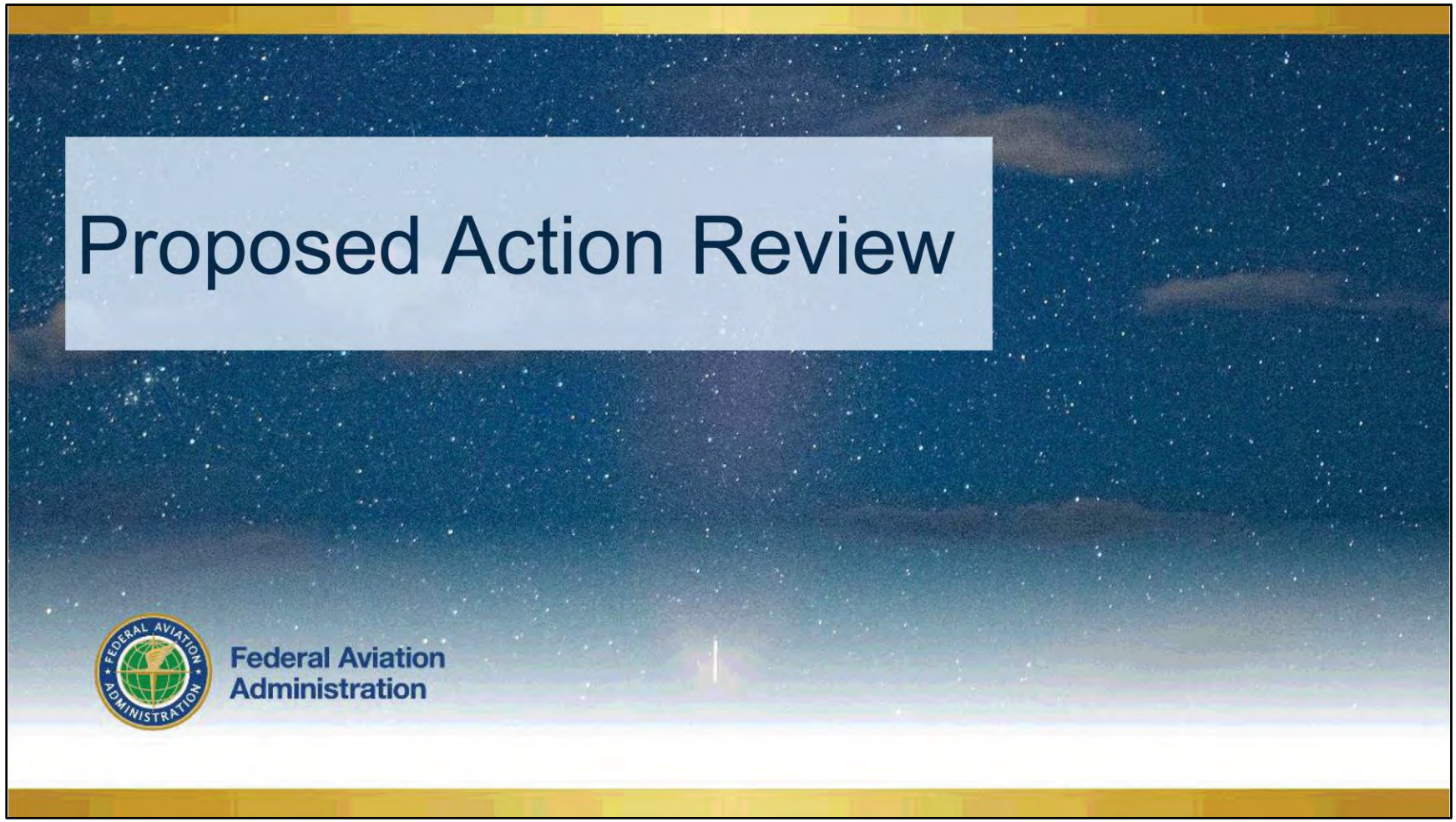
Tribes

- Provide feedback on the preferred scope of the monitoring program by May 30

SEARCH

- Provide access to KSC archaeological sites technical memo through SharePoint (completed 5.16.25).


Consulting Party Meeting #1
SpaceX Starship-Super Heavy Launch Vehicle at Launch Complex 39A
at the Kennedy Space Center, Florida
13 May 2025
National Aeronautics and Space Administration
Federal Aviation Administration


Proposed Action Review
Federal Aviation Administration

# Starship-Super Heavy LC-39A

Federal Aviation Administration

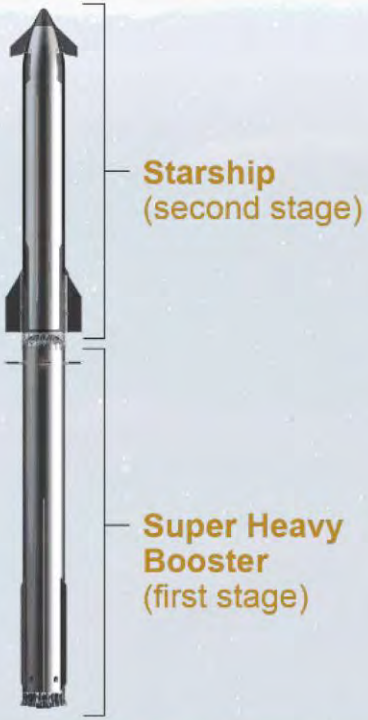
## Proposed Action Review

### Starship-Super Heavy Vehicle

- Composed of 2 stages
  - Super Heavy (booster) – 35 Raptor Engines
  - Starship – 9 Raptor Engines

### Operations

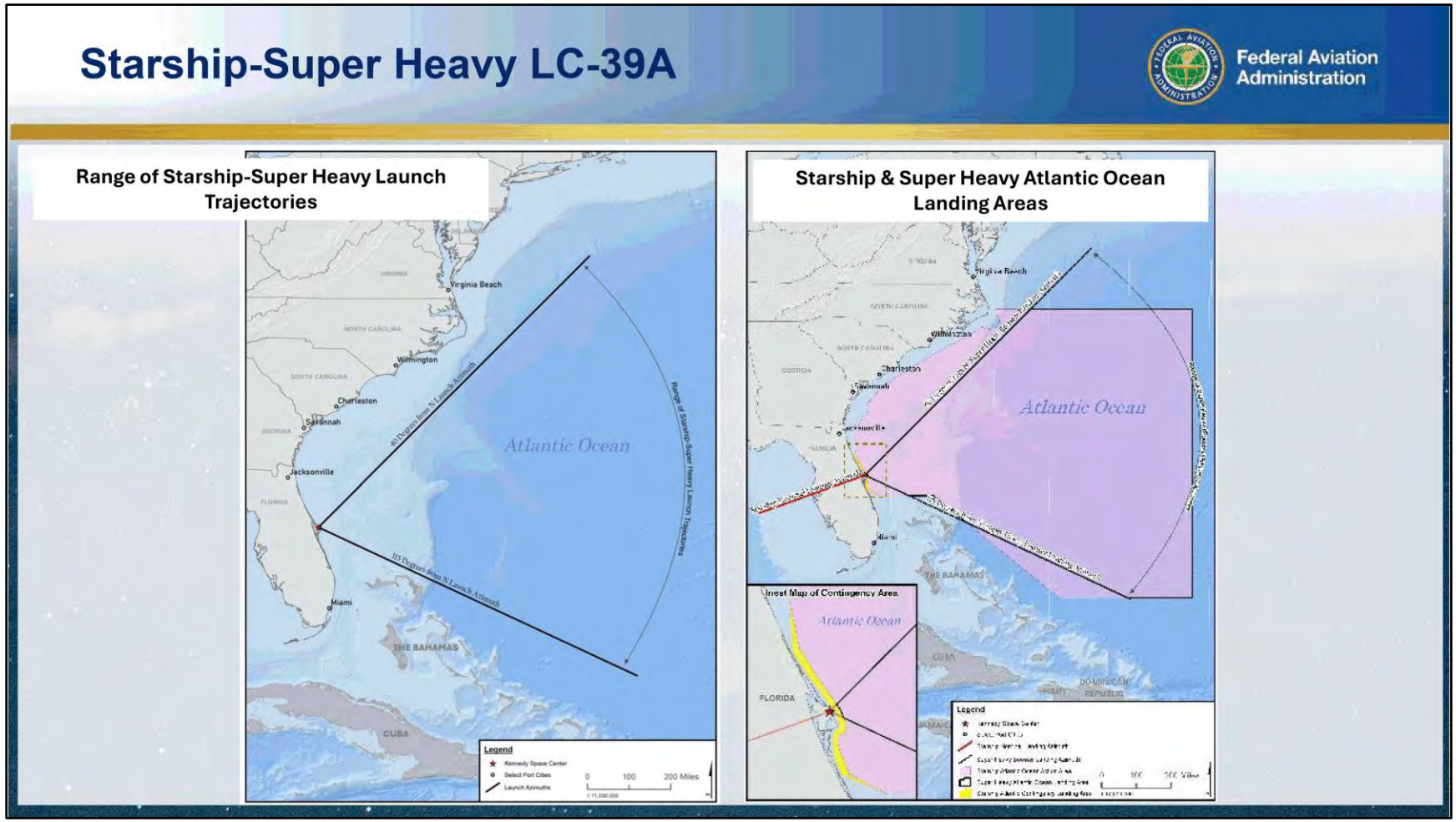
- Pre-launch – testing and rehearsals
  - Static Fires – 1 for each stage prior to launch (88 total)
- Starship-Super Heavy Launches – 44
  - 50% Day / Night (10pm – 7am) Split
- Starship Landings - 44
  - LC-39A, droneship in Atlantic, expended in Atlantic / Pacific / Indian Ocean >5nm
  - Contingency: soft water landing 1nm-5nm in Atlantic 50 nm north/south of LC-39A
- Super Heavy Landings – 44
  - LC-39A, droneship in Atlantic, expended in Atlantic >5nm



# SpaceX Launch Vehicle Comparison

Federal Aviation Administration


| | Falcon 9 | Falcon 9 Heavy | Starship Superheavy |
|---|---|---|---|
| Engines | 9 | 27 | 35 |
| Thrust | 1,710,000 lbf | 5,130,000 lbf | 23,000,000 lbf |


Starship-Super Heavy LC-39A
Federal Aviation Administration
Range of Starship-Super Heavy Launch Trajectories
Virginia Beach
Wilmington
Charleston
Savannah
Jacksonville
Miami
Atlantic Ocean
THE BAHAMAS
CUBA
40 Degrees from N Launch Azimuth
115 Degrees from N Launch Azimuth
Range of Starship-Super Heavy Launch Trajectories
Legend
Kennedy Space Center
Select Port Cities
Launch Azimuths
0 100 200 Miles
Starship & Super Heavy Atlantic Ocean Landing Areas
Virginia Beach
Wilmington
Charleston
Savannah
Jacksonville
Miami
Atlantic Ocean
THE BAHAMAS
CUBA
DOMINICAN REPUBLIC
Inset Map of Contingency Area
Atlantic Ocean
FLORIDA
Legend

# Starship-Super Heavy LC-39A

Federal Aviation Administration

## Proposed LC-39A Infrastructure

Previously approved (2019 NASA EA*):

- LOX Farm (65,454 square feet [SF])
- Methane Farm (78,876 SF)
- Launch Mount (36,568 SF)
- Integration Tower (6,184 SF)
- Ponds (68,799 SF)
- Vaporization Farm (9,650 SF)
- LZ (72,672 SF)
- LN2 Farm (13,342 SF)
- Water Farm (17,955 SF)

Included as part of this Action:

- Air Separation Unit (222,071 SF)
- Catch Tower (5,992 SF)
- Deluge Pond (121,963 SF)
- Liquefaction – includes natural gas pretreatment and methane liquefier (17,246 SF)
- MegaPacks (34,979 SF)
- Power Hub (28,998 SF)

*Final Environmental Assessment for the SpaceX Starship and Super Heavy Launch Vehicle at Kennedy Space Center

Total Approximate Square Footage: 800,647

# Area of Potential Effects (APE) Summary

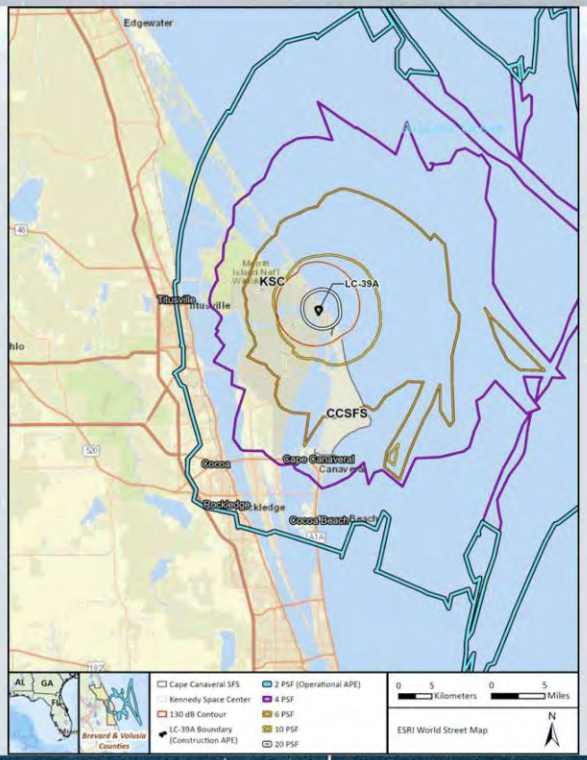
Federal Aviation Administration

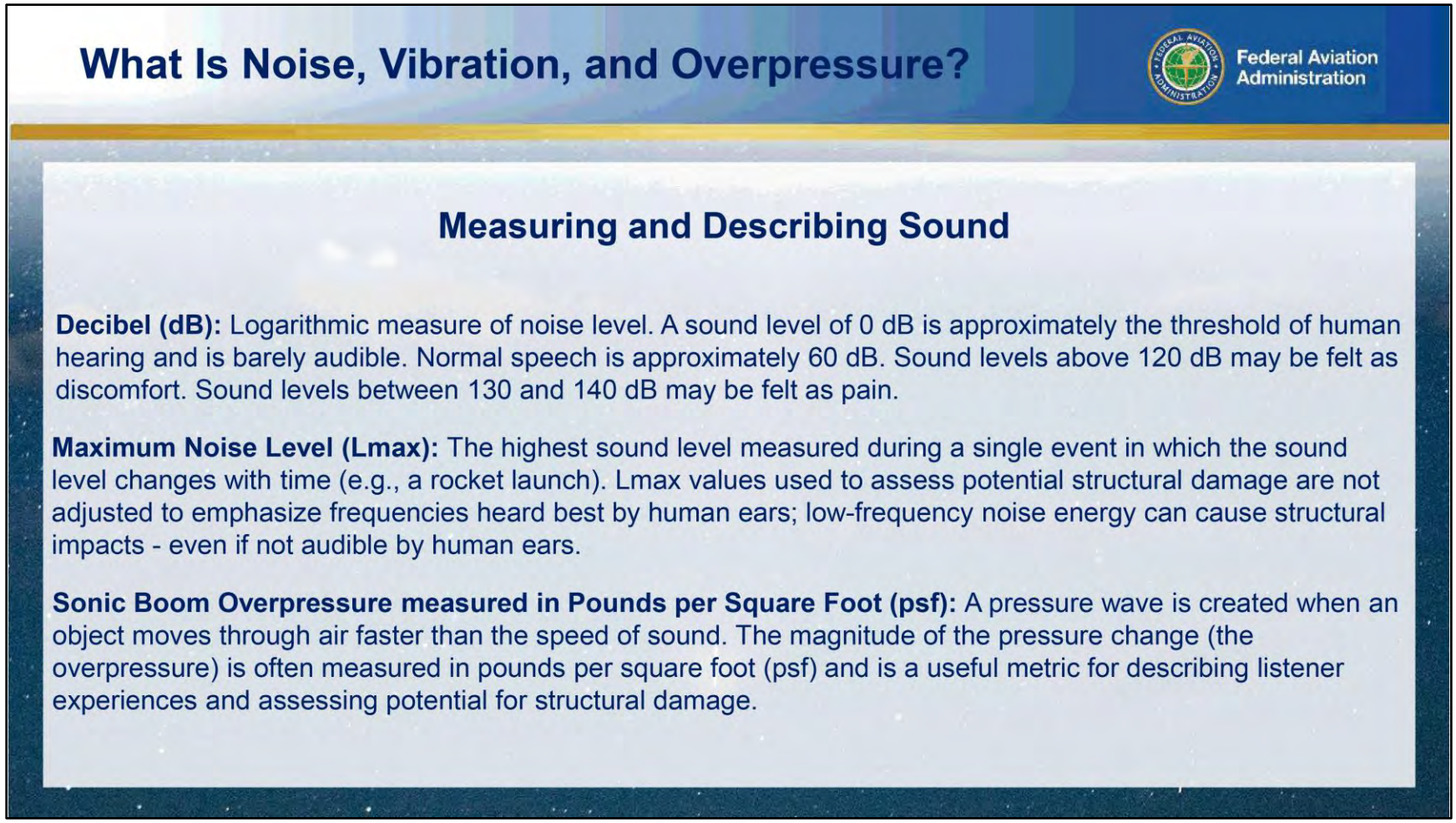
## Construction APE

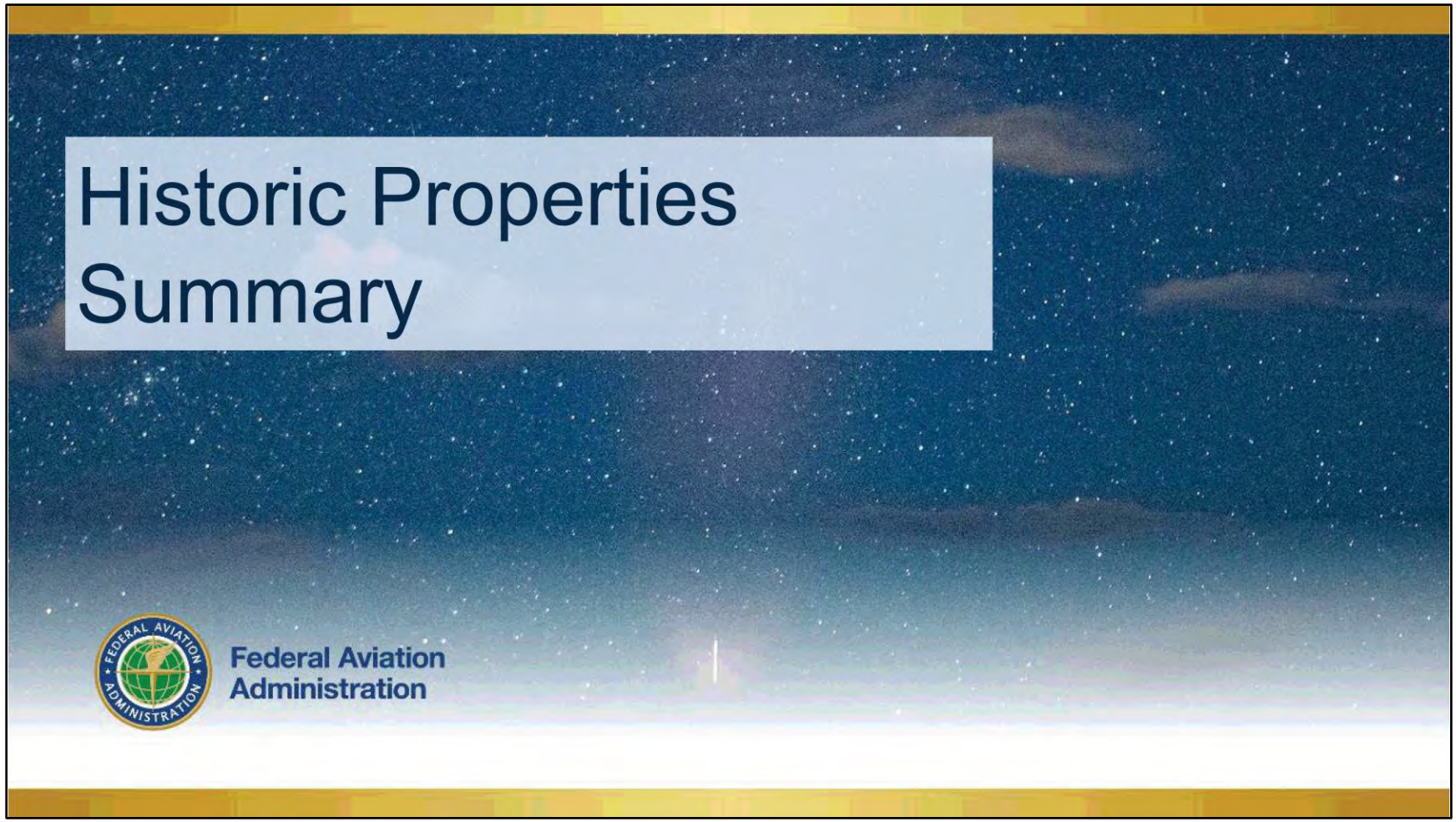
- Previously surveyed/existing boundary of LC-39A

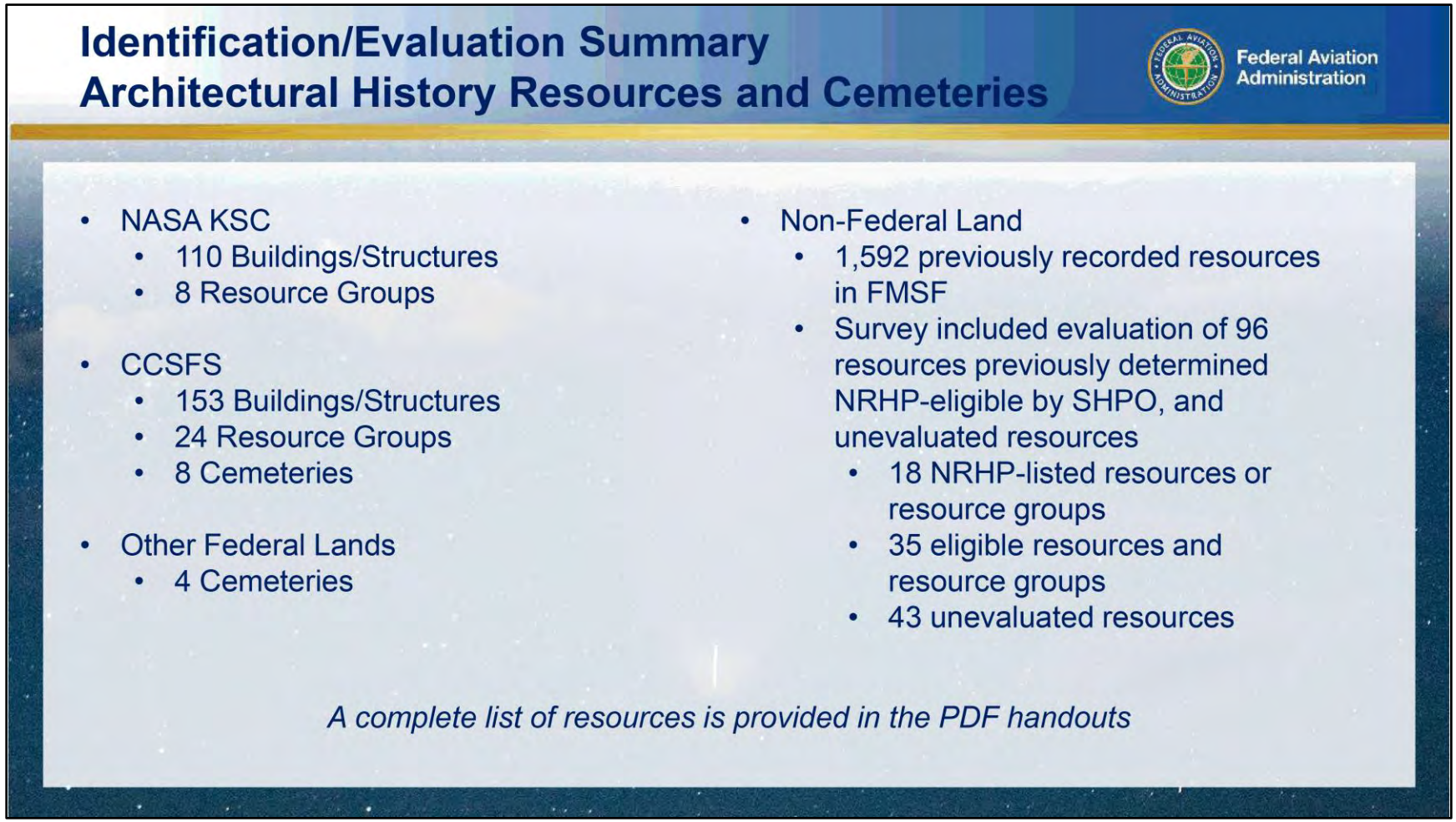
## Operational APE

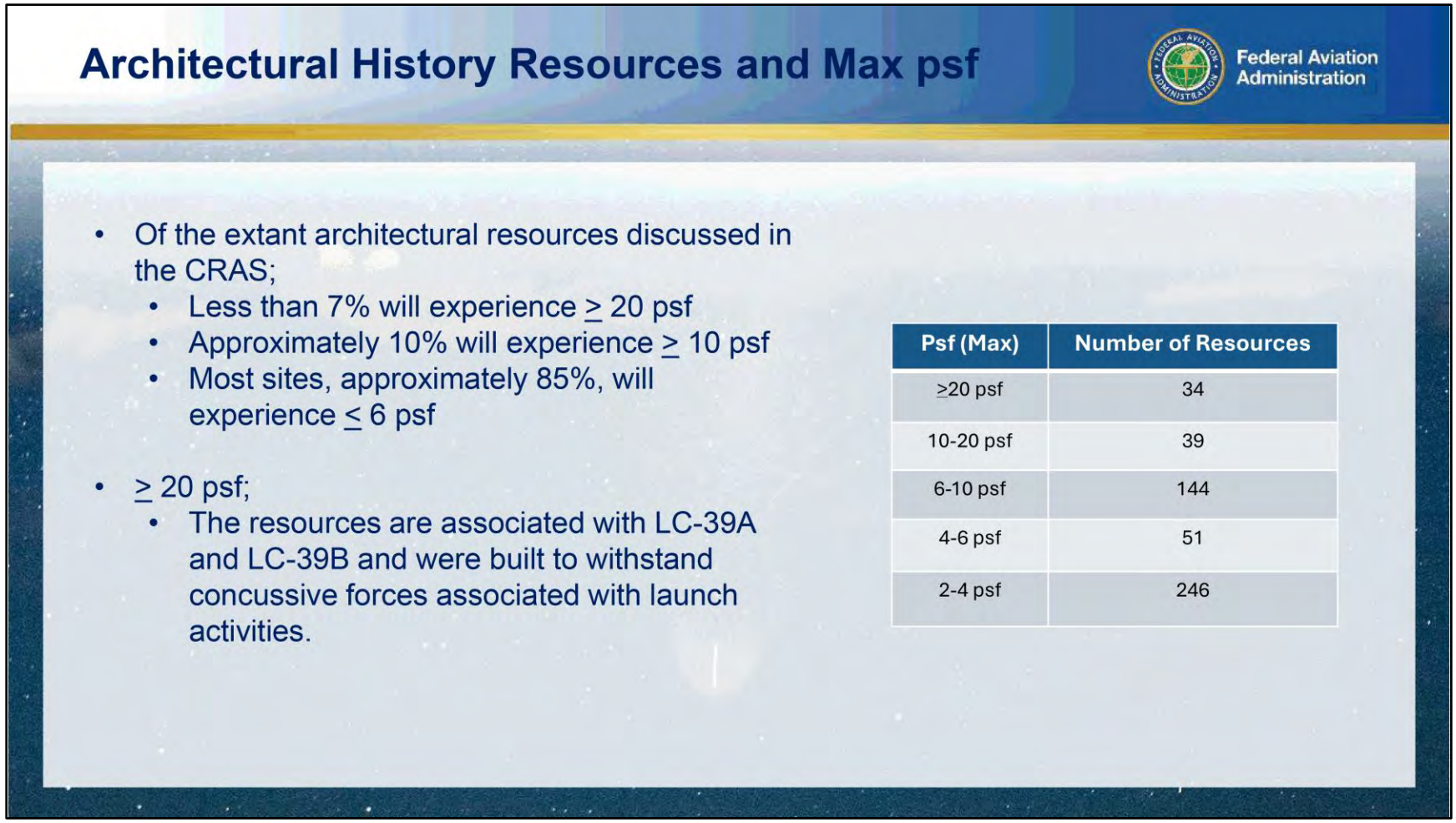
- Considers auditory and vibratory effects of launch and landing activities
- Area of Lmax sound level ≥ 130 dB from launch effects
- Area of ≥ 2 pounds per square foot (psf) of sonic boom overpressure from reentry effects




What Is Noise, Vibration, and Overpressure?
Federal Aviation Administration
Measuring and Describing Sound
Decibel (dB): Logarithmic measure of noise level. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible. Normal speech is approximately 60 dB. Sound levels above 120 dB may be felt as discomfort. Sound levels between 130 and 140 dB may be felt as pain.
Maximum Noise Level (Lmax): The highest sound level measured during a single event in which the sound level changes with time (e.g., a rocket launch). Lmax values used to assess potential structural damage are not adjusted to emphasize frequencies heard best by human ears; low-frequency noise energy can cause structural impacts - even if not audible by human ears.
Sonic Boom Overpressure measured in Pounds per Square Foot (psf): A pressure wave is created when an object moves through air faster than the speed of sound. The magnitude of the pressure change (the overpressure) is often measured in pounds per square foot (psf) and is a useful metric for describing listener experiences and assessing potential for structural damage.


Historic Properties
Summary
Federal Aviation
Administration


Identification/Evaluation Summary
Architectural History Resources and Cemeteries
Federal Aviation Administration
• NASA KSC
• 110 Buildings/Structures
• 8 Resource Groups
• CCSFS
• 153 Buildings/Structures
• 24 Resource Groups
• 8 Cemeteries
• Other Federal Lands
• 4 Cemeteries
• Non-Federal Land
• 1,592 previously recorded resources in FMSF
• Survey included evaluation of 96 resources previously determined NRHP-eligible by SHPO, and unevaluated resources
• 18 NRHP-listed resources or resource groups
• 35 eligible resources and resource groups
• 43 unevaluated resources
A complete list of resources is provided in the PDF handouts




| Psf (Max) | Number of Resources |
|---|---|
| ≥20 psf | 34 |
| 10-20 psf | 39 |
| 6-10 psf | 144 |
| 4-6 psf | 51 |
| 2-4 psf | 246 |

# Architectural History Resources and dB (>130 dB)

Federal Aviation Administration

- Of the architectural resources/resource groups discussed in the CRAS;
  - 83 are within the 130 dB area
- Within the 130 db area;
  - Most structures were built to withstand concussive forces associated with launch activities
  - 8BR02990 (Beach House) is eligible for NRHP-listing and within the 130 dB contour

| dB | Number of Resources |
|---|---|
| >130 dB | 83 |

# Identification/Evaluation Summary Archaeological Sites

Federal Aviation Administration

- 354 archaeological sites recorded in APE
  - 261 lack above ground components, were previously determined ineligible, or are not flagged for presence of human remains
  - 93 sites eligible/potentially eligible for NRHP, or are unevaluated, and have above ground components/landscape features, or may contain human remains including;
    - 33 flagged for human remains
    - 34 mounds, shell mounds/middens, or potential mounds
    - 55 with potential historic-era above ground components

*A complete list of archaeological sites in the APE is provided in the PDF handouts*

# Archaeological Sites and Max psf

Federal Aviation Administration

- Of the 354 archaeological sites recorded in APE;
  - Less than 2% will experience ≥20 psf area
  - Less than 11% will experience ≥ 10 psf
  - Most sites, approximately 89%, will experience 6 psf or less
- ≥ 20 psf;
  - Five sites were determined ineligible for the NRHP
  - One site has insufficient information to determine NRHP-eligibility

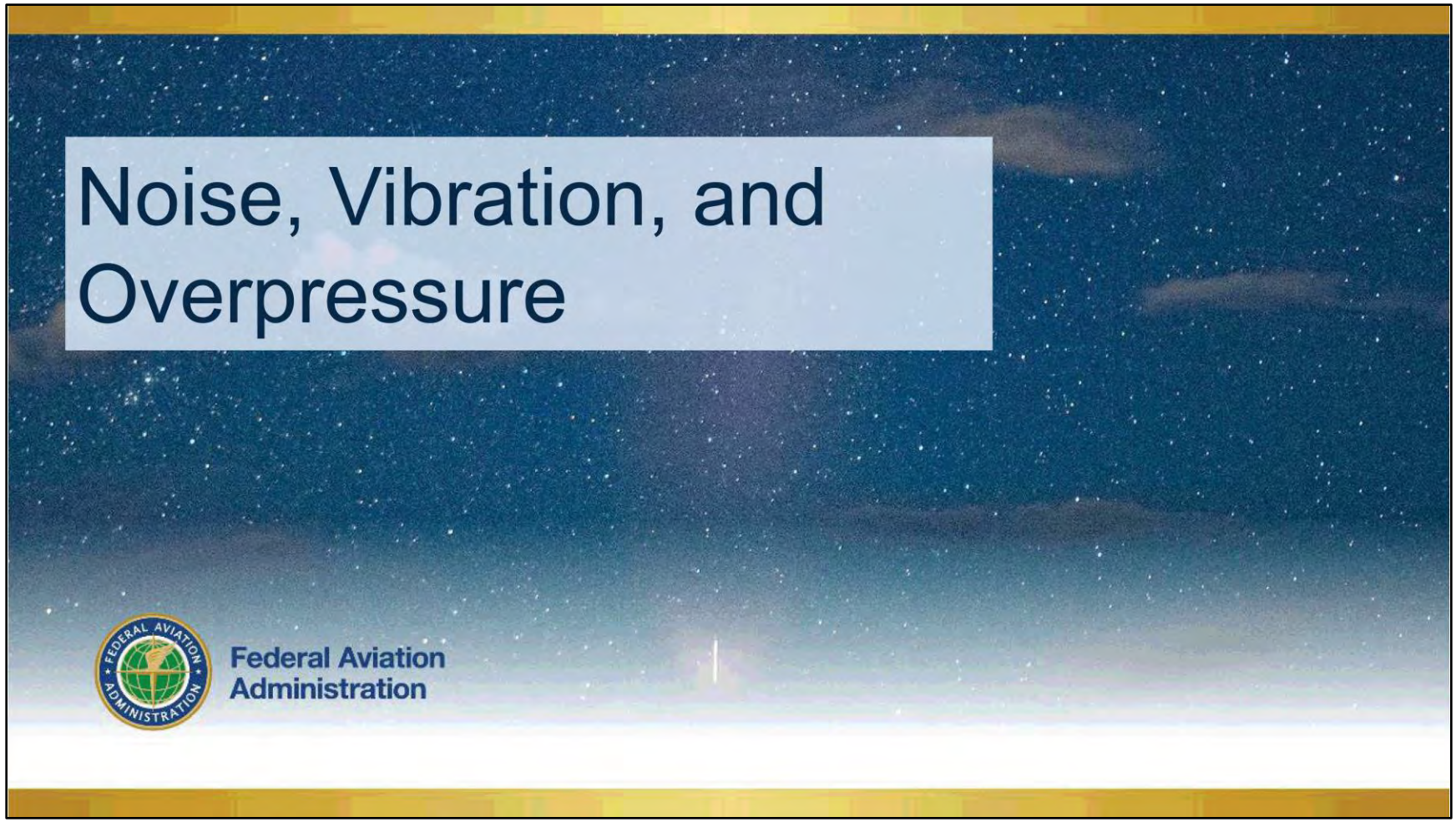
| Psf (Max) | Number of Sites |
|---|---|
| ≥20 psf | 6 |
| 10-20 psf | 32 |
| 6-10 psf | 70 |
| 4-6 psf | 157 |
| 2-4 psf | 89 |

# Archaeological Sites and dB (>130 dB)

Federal Aviation Administration

- Of the 354 archaeological sites recorded in APE;
  - 14 are within the 130 dB area
- Within the 130 dB area;
  - Ten sites were determined ineligible for the NRHP
  - Two sites were determined eligible for the NRHP
  - One site has insufficient information to determine NRHP-eligibility (8BR00206).
  - One site has not been evaluated for NRHP eligibility
  - No sites are flagged in FMSF as potentially containing human remains

| dB | Number of Sites |
|---|---|
| >130 dB | 14 |

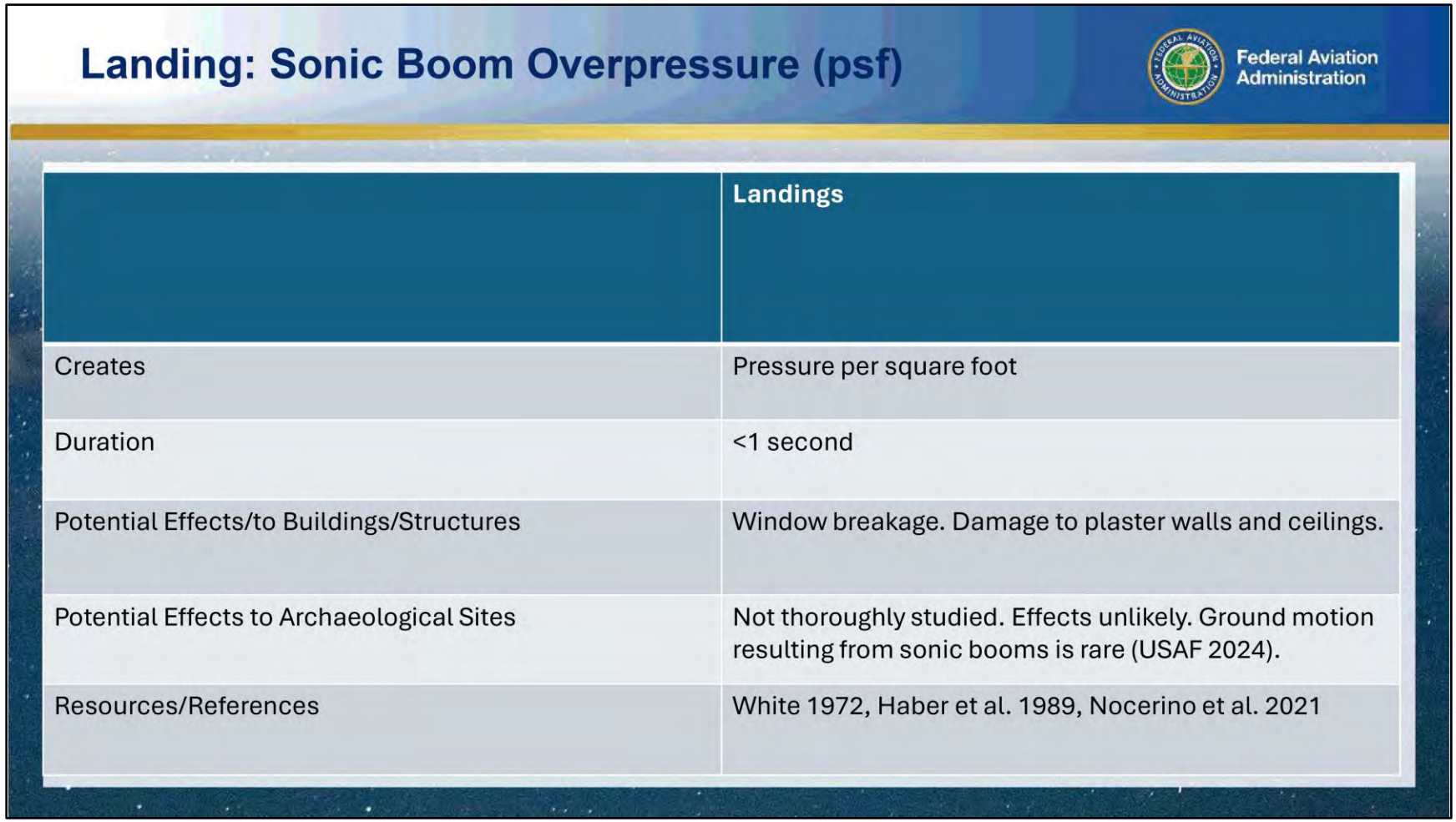

Noise, Vibration, and Overpressure
Federal Aviation Administration


| | Static Fire | Launch |
|---|---|---|
| Creates | Vibration and Noise | Vibration and Noise |
| Duration | Approximately 7-15 seconds | Approximately 3-5 minutes |

## Static Fire and Launch: Noise and Vibration

Federal Aviation Administration

| dB | Potential Effects to Buildings/Structures | Potential Effects to Archaeological Sites |
|---|---|---|
| 130 dB+ | Possible damage to glass and plaster (Fenton and Methold 2016). | Possible effects from repeated exposure. Post-launch studies of above-ground archaeological sites at Vandenberg SFB noted no effects, but effects to subsurface sites or site-types common in the APE are not thoroughly studied. |
| ≤130 dB | Glass/plaster damage unlikely, but not impossible. Possible wearing of joints/structural elements over repeated exposures (Fenton and Methold 2016, Nocerino et al. 2021, NCRHP 2012). | Effects considered unlikely. Post-launch studies of above-ground archaeological sites at Vandenberg SFB noted no effects, but effects to subsurface sites or site-types common in the APE are not thoroughly studied. |




| | Landings |
|---|---|
| Creates | Pressure per square foot |
| Duration | <1 second |
| Potential Effects/to Buildings/Structures | Window breakage. Damage to plaster walls and ceilings. |
| Potential Effects to Archaeological Sites | Not thoroughly studied. Effects unlikely. Ground motion resulting from sonic booms is rare (USAF 2024). |
| Resources/References | White 1972, Haber et al. 1989, Nocerino et al. 2021 |

# Structural Damage Potential

Federal Aviation Administration

## Propulsion Noise

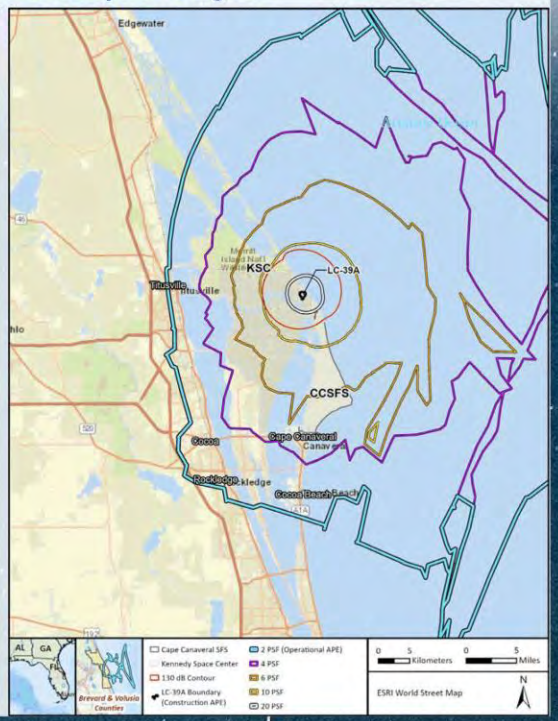
- >111 dB Lmax (1/1,000 risk of damage claim) large area off-installation
- >120 dB Lmax (1/100 risk of damage claim) very small off-installation area, multiple sensitive locations on KSC/CCSFS
- >130 dB Lmax (substantial risk) on-KSC within ~4 miles of LC-39A

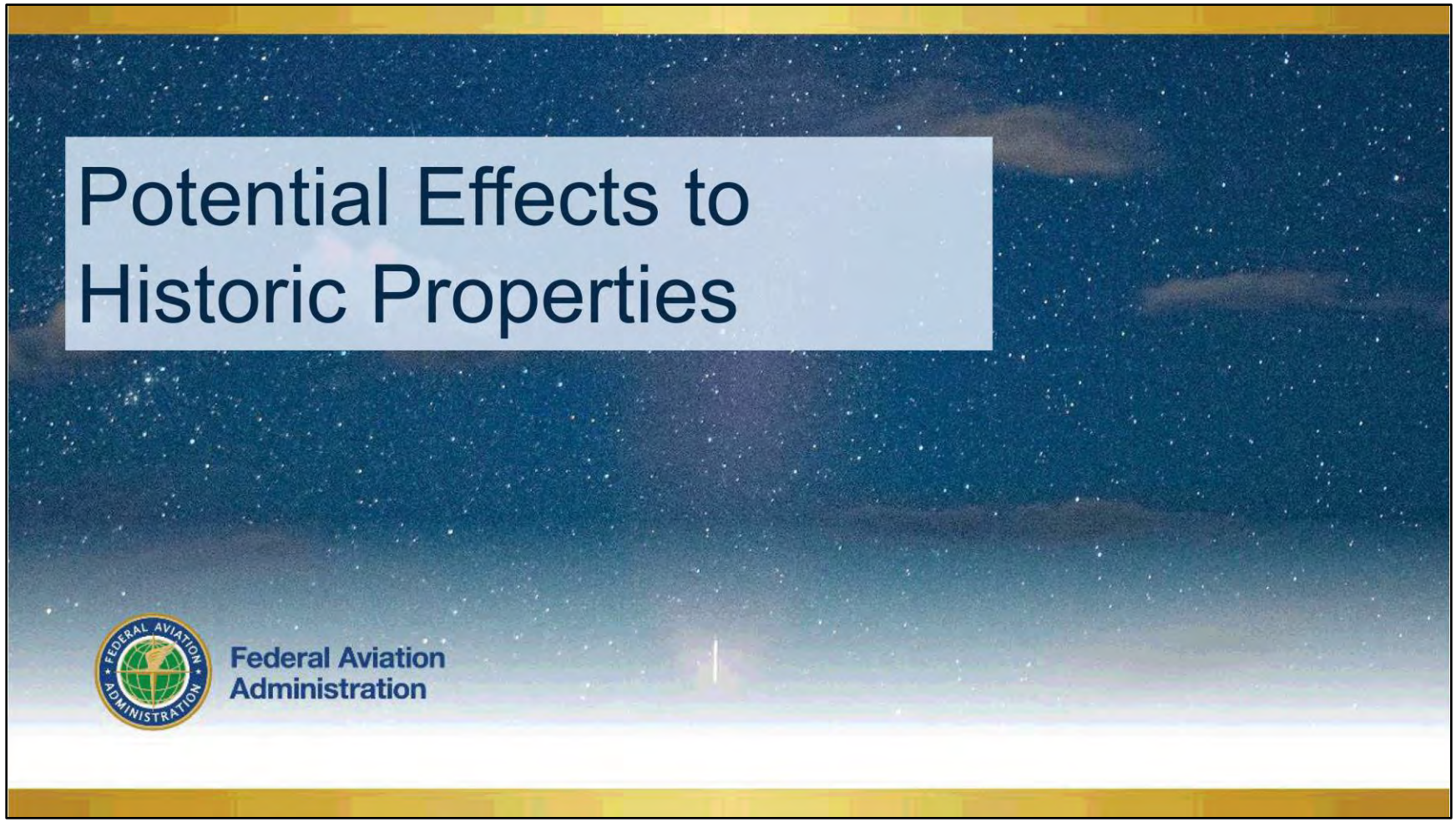
## Sonic Booms

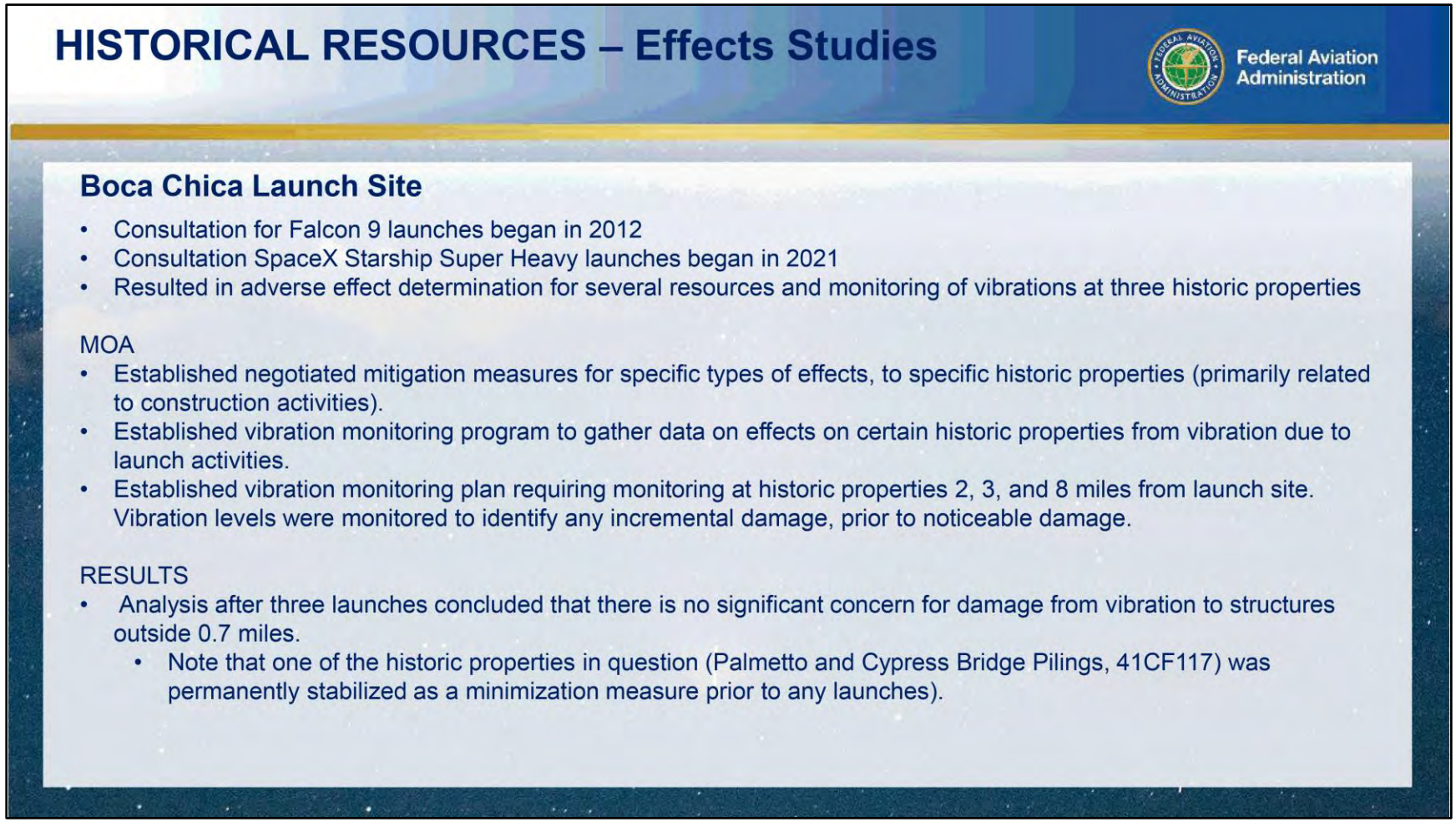
- >2 PSF (1/10,000 risk for large window breakage) in off-installation areas for booster landings (see map on previous slide)
- >4 PSF (1/10,000 risk for small windows) in portions of Merritt Island
- >10 PSF within ~5 miles of LC-39A (on KSC/CCSFS)
- <2 PSF for Starship landings all locations

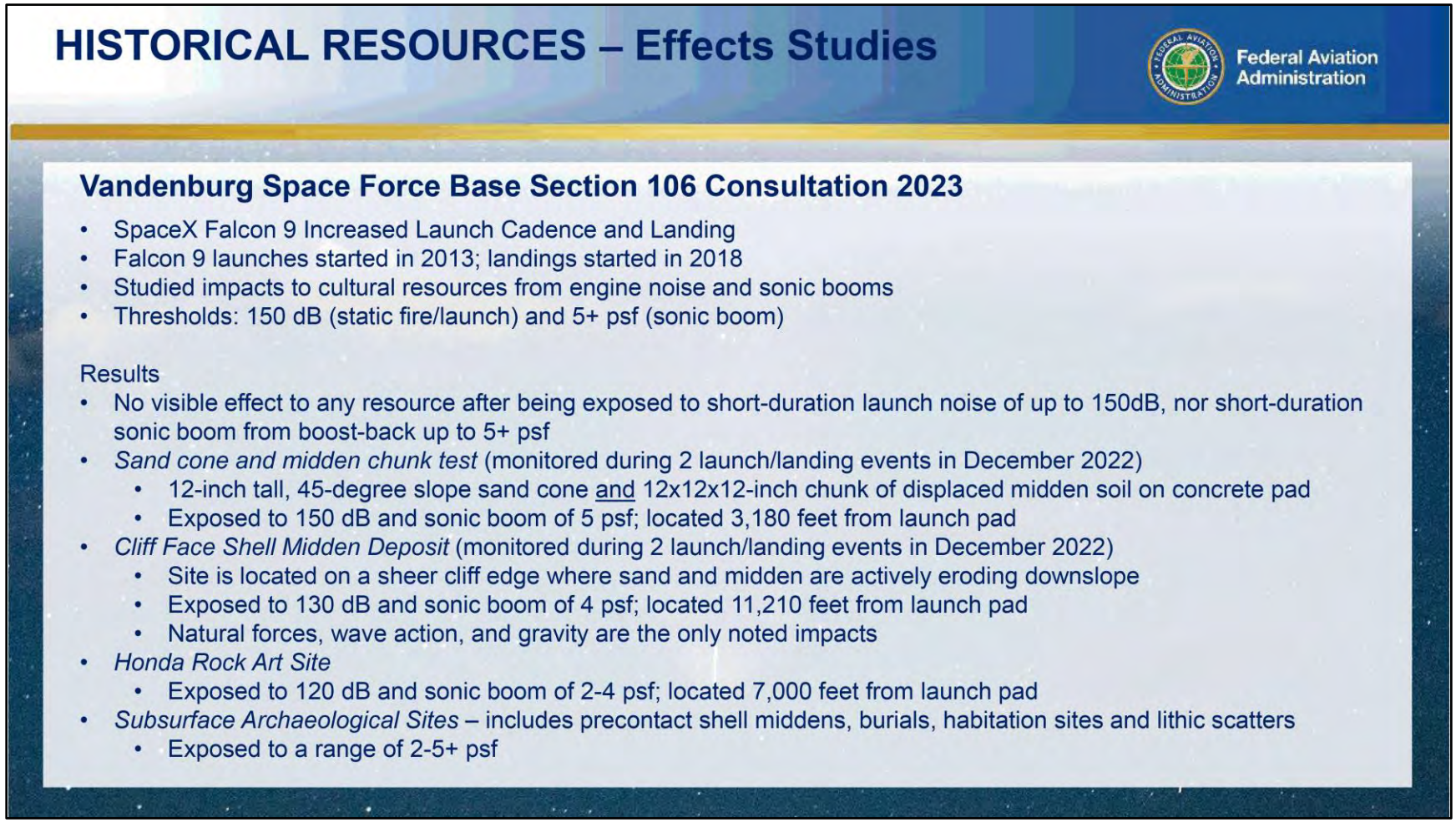
***Launch Lmax***

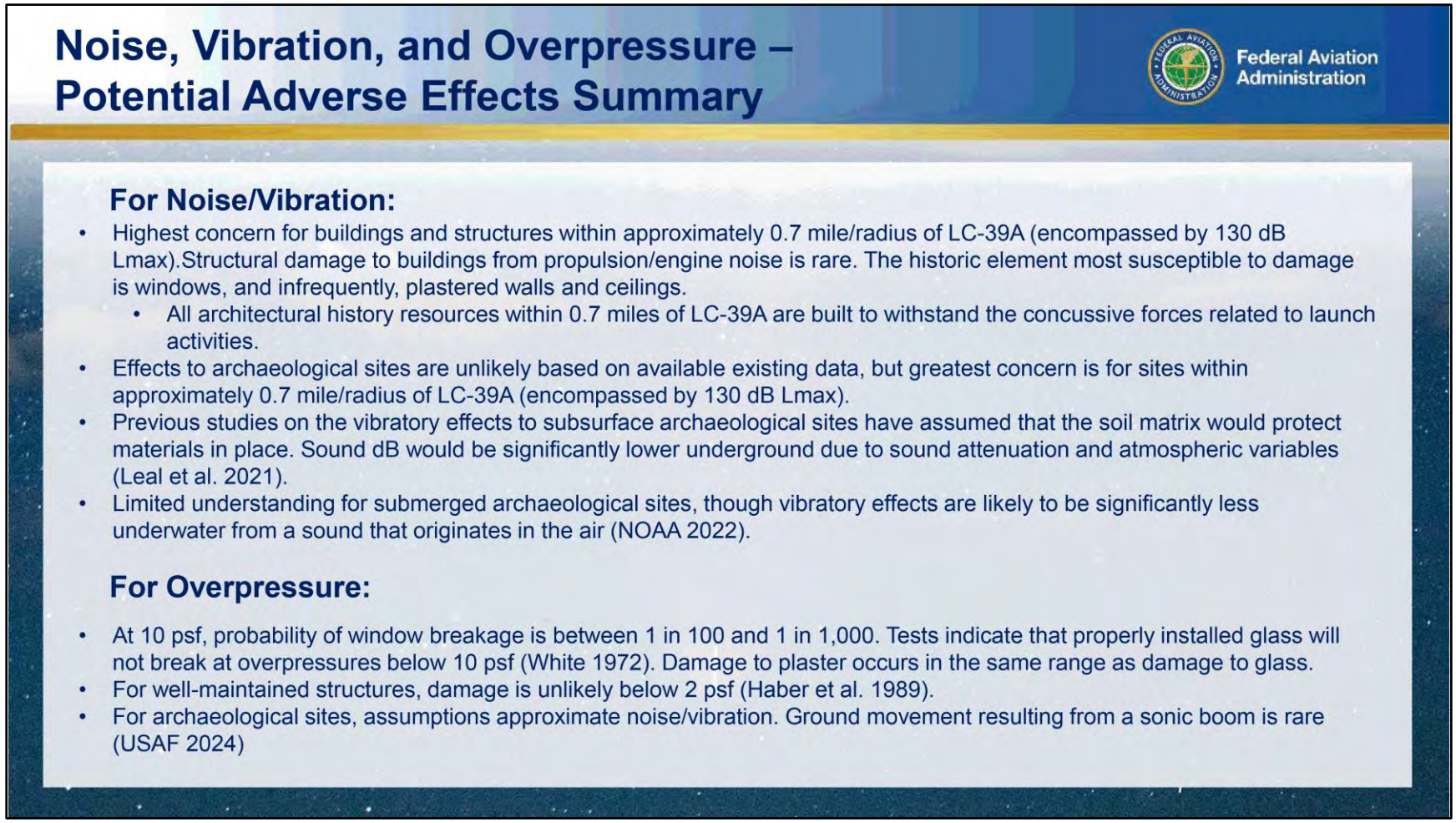

***Starship Landing PSF***

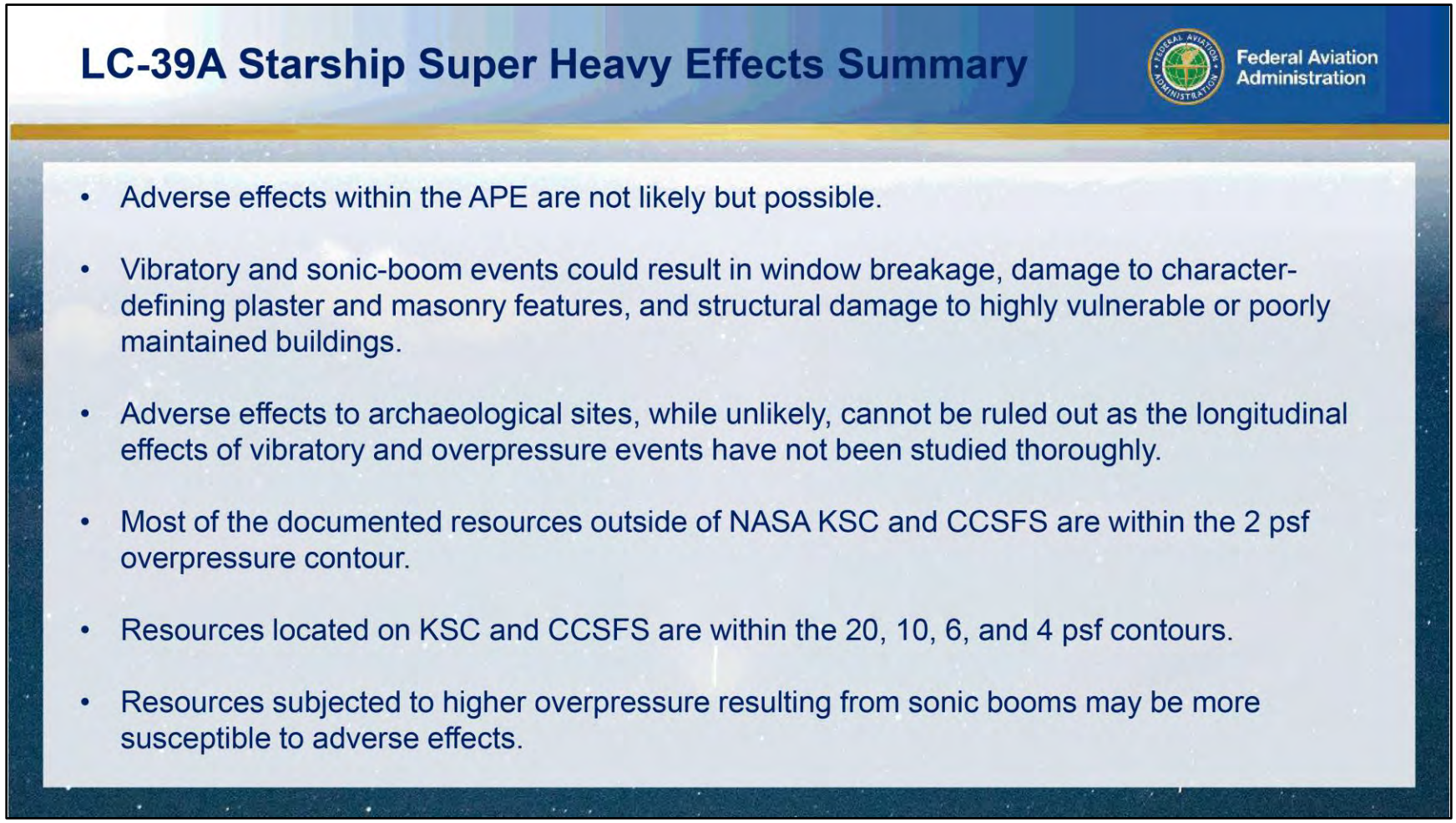



Potential Effects to
Historic Properties
Federal Aviation
Administration


HISTORICAL RESOURCES – Effects Studies
Federal Aviation Administration
Boca Chica Launch Site
• Consultation for Falcon 9 launches began in 2012
• Consultation SpaceX Starship Super Heavy launches began in 2021
• Resulted in adverse effect determination for several resources and monitoring of vibrations at three historic properties
MOA
• Established negotiated mitigation measures for specific types of effects, to specific historic properties (primarily related to construction activities).
• Established vibration monitoring program to gather data on effects on certain historic properties from vibration due to launch activities.
• Established vibration monitoring plan requiring monitoring at historic properties 2, 3, and 8 miles from launch site. Vibration levels were monitored to identify any incremental damage, prior to noticeable damage.
RESULTS
• Analysis after three launches concluded that there is no significant concern for damage from vibration to structures outside 0.7 miles.
• Note that one of the historic properties in question (Palmetto and Cypress Bridge Pilings, 41CF117) was permanently stabilized as a minimization measure prior to any launches).

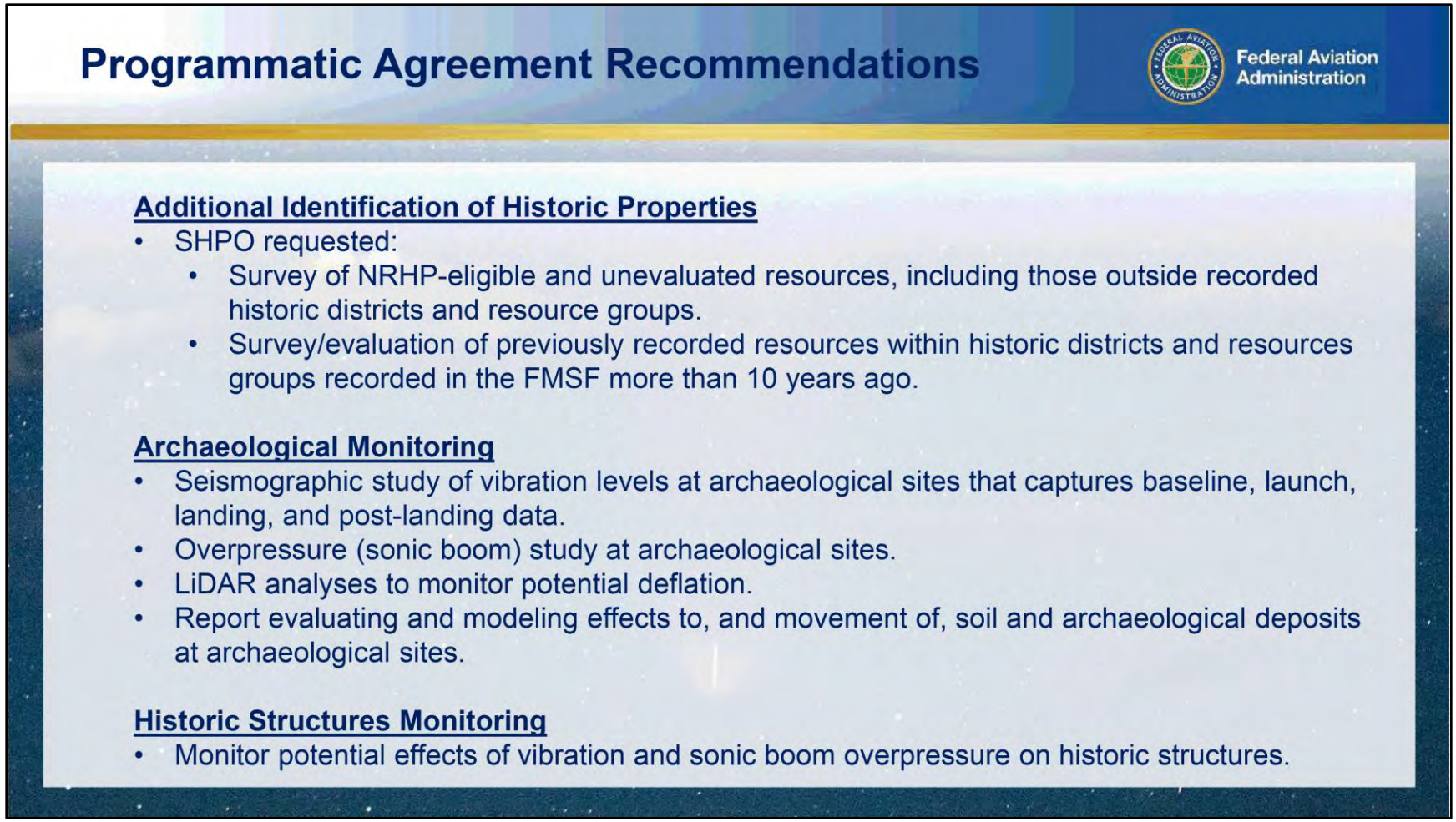

HISTORICAL RESOURCES – Effects Studies
Federal Aviation Administration
Vandenburg Space Force Base Section 106 Consultation 2023
• SpaceX Falcon 9 Increased Launch Cadence and Landing
• Falcon 9 launches started in 2013; landings started in 2018
• Studied impacts to cultural resources from engine noise and sonic booms
• Thresholds: 150 dB (static fire/launch) and 5+ psf (sonic boom)
Results
• No visible effect to any resource after being exposed to short-duration launch noise of up to 150dB, nor short-duration sonic boom from boost-back up to 5+ psf
• Sand cone and midden chunk test (monitored during 2 launch/landing events in December 2022)
• 12-inch tall, 45-degree slope sand cone and 12x12x12-inch chunk of displaced midden soil on concrete pad
• Exposed to 150 dB and sonic boom of 5 psf; located 3,180 feet from launch pad
• Cliff Face Shell Midden Deposit (monitored during 2 launch/landing events in December 2022)
• Site is located on a sheer cliff edge where sand and midden are actively eroding downslope
• Exposed to 130 dB and sonic boom of 4 psf; located 11,210 feet from launch pad
• Natural forces, wave action, and gravity are the only noted impacts
• Honda Rock Art Site
• Exposed to 120 dB and sonic boom of 2-4 psf; located 7,000 feet from launch pad
• Subsurface Archaeological Sites – includes precontact shell middens, burials, habitation sites and lithic scatters
• Exposed to a range of 2-5+ psf

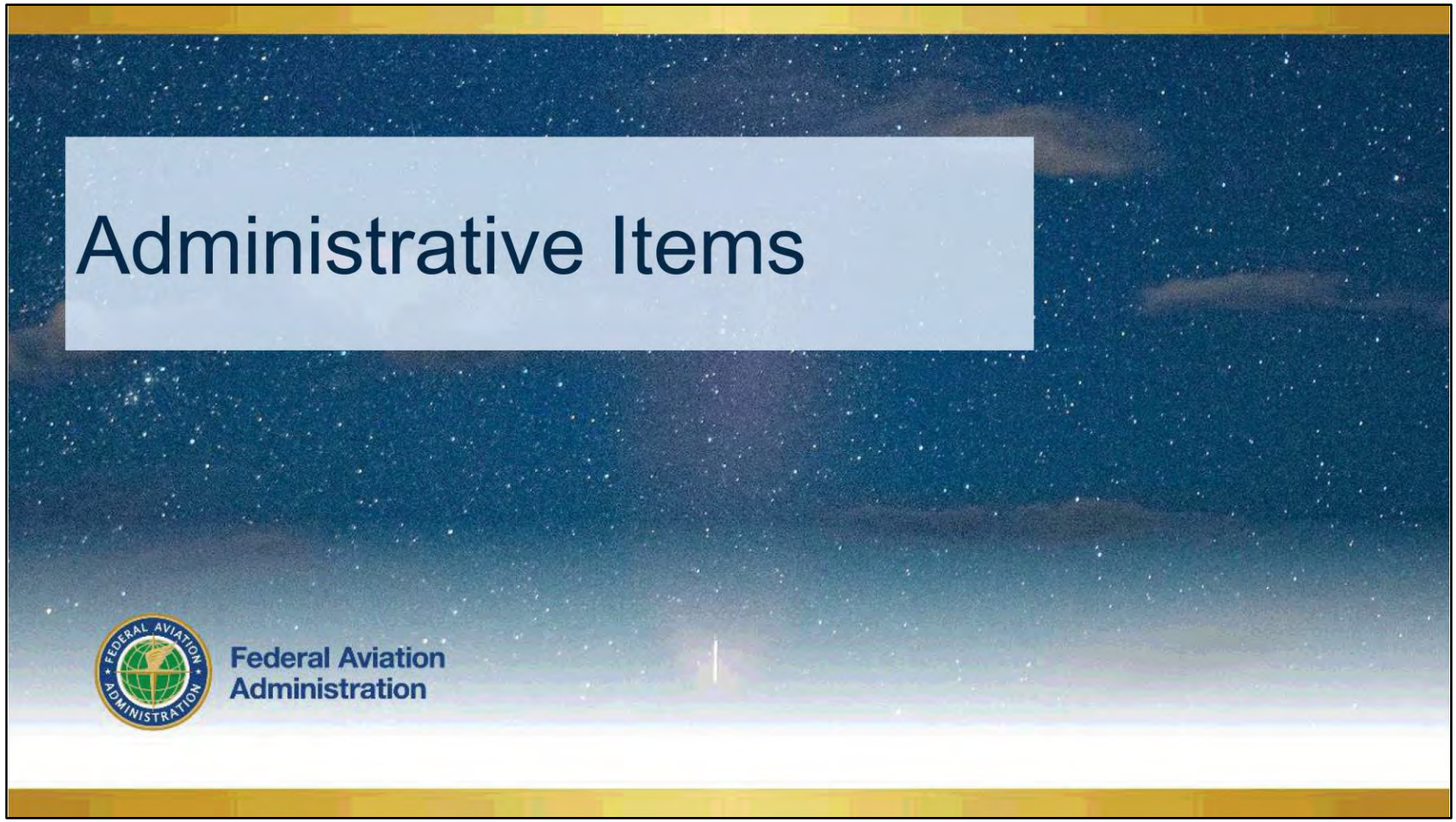

Noise, Vibration, and Overpressure –
Potential Adverse Effects Summary
Federal Aviation Administration
For Noise/Vibration:
• Highest concern for buildings and structures within approximately 0.7 mile/radius of LC-39A (encompassed by 130 dB Lmax).Structural damage to buildings from propulsion/engine noise is rare. The historic element most susceptible to damage is windows, and infrequently, plastered walls and ceilings.
• All architectural history resources within 0.7 miles of LC-39A are built to withstand the concussive forces related to launch activities.
• Effects to archaeological sites are unlikely based on available existing data, but greatest concern is for sites within approximately 0.7 mile/radius of LC-39A (encompassed by 130 dB Lmax).
• Previous studies on the vibratory effects to subsurface archaeological sites have assumed that the soil matrix would protect materials in place. Sound dB would be significantly lower underground due to sound attenuation and atmospheric variables (Leal et al. 2021).
• Limited understanding for submerged archaeological sites, though vibratory effects are likely to be significantly less underwater from a sound that originates in the air (NOAA 2022).
For Overpressure:
• At 10 psf, probability of window breakage is between 1 in 100 and 1 in 1,000. Tests indicate that properly installed glass will not break at overpressures below 10 psf (White 1972). Damage to plaster occurs in the same range as damage to glass.
• For well-maintained structures, damage is unlikely below 2 psf (Haber et al. 1989).
• For archaeological sites, assumptions approximate noise/vibration. Ground movement resulting from a sonic boom is rare (USAF 2024)

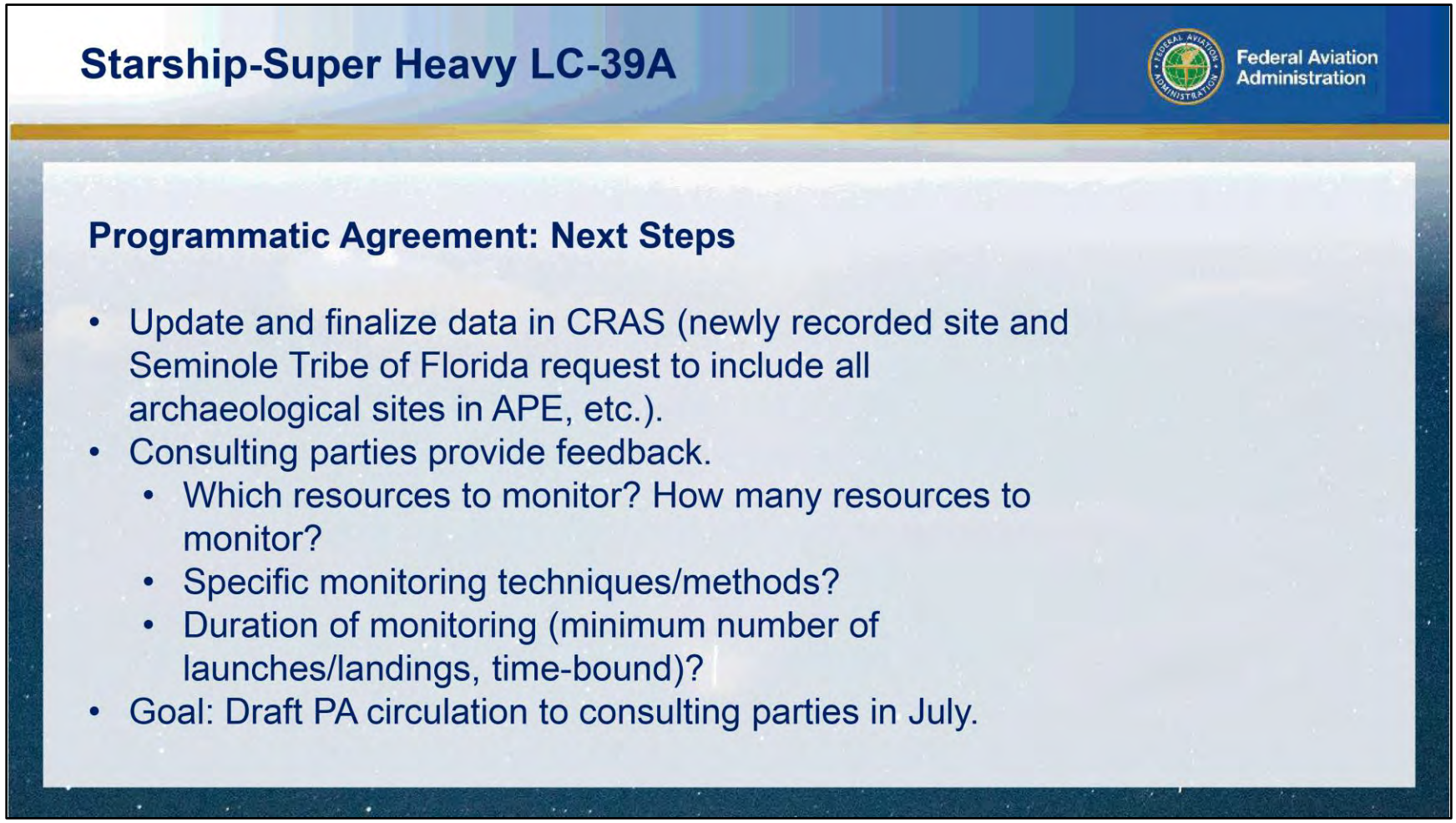

LC-39A Starship Super Heavy Effects Summary
Federal Aviation Administration
• Adverse effects within the APE are not likely but possible.
• Vibratory and sonic-boom events could result in window breakage, damage to character-defining plaster and masonry features, and structural damage to highly vulnerable or poorly maintained buildings.
• Adverse effects to archaeological sites, while unlikely, cannot be ruled out as the longitudinal effects of vibratory and overpressure events have not been studied thoroughly.
• Most of the documented resources outside of NASA KSC and CCSFS are within the 2 psf overpressure contour.
• Resources located on KSC and CCSFS are within the 20, 10, 6, and 4 psf contours.
• Resources subjected to higher overpressure resulting from sonic booms may be more susceptible to adverse effects.

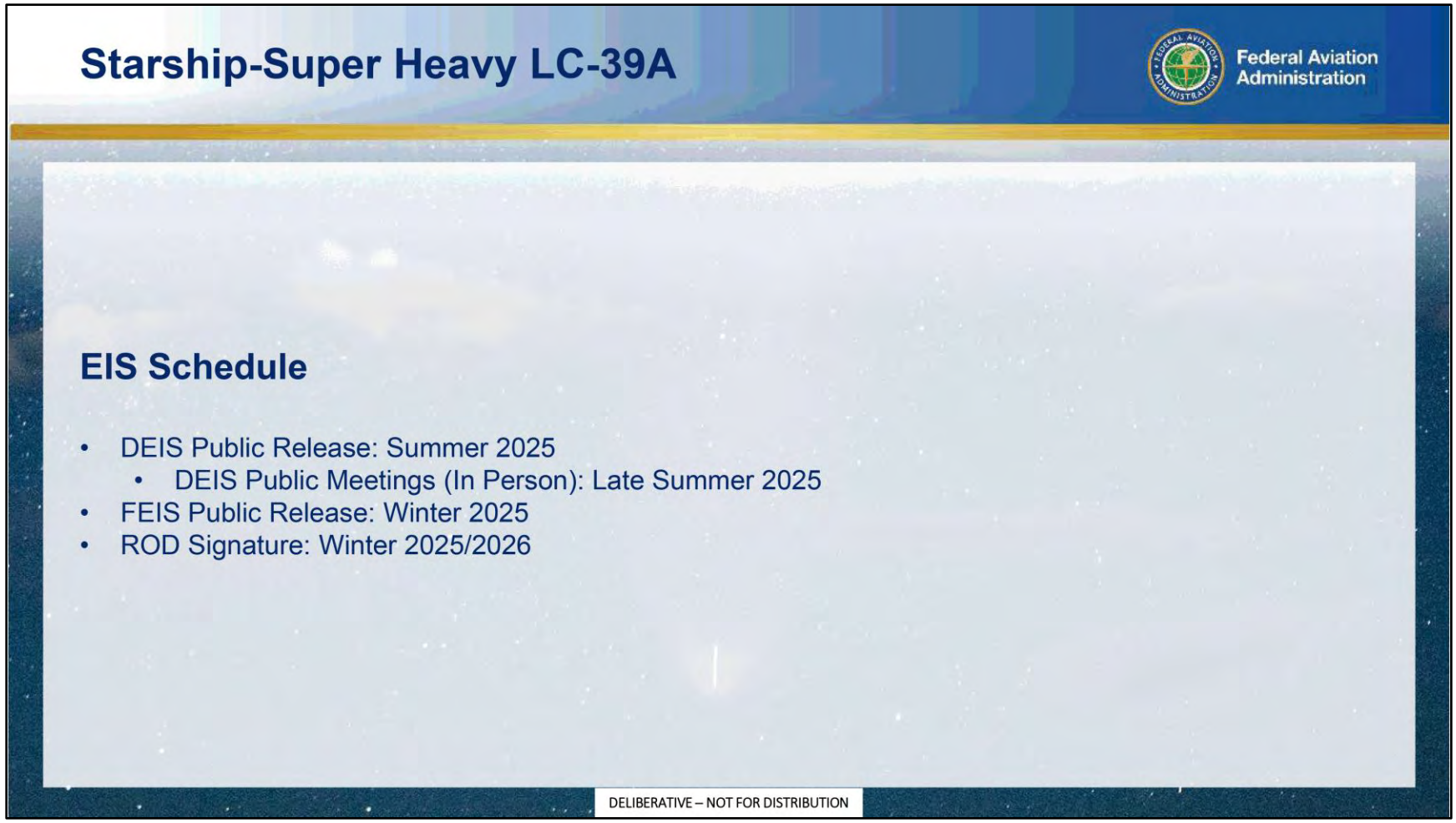

Programmatic
Agreement
Federal Aviation
Administration

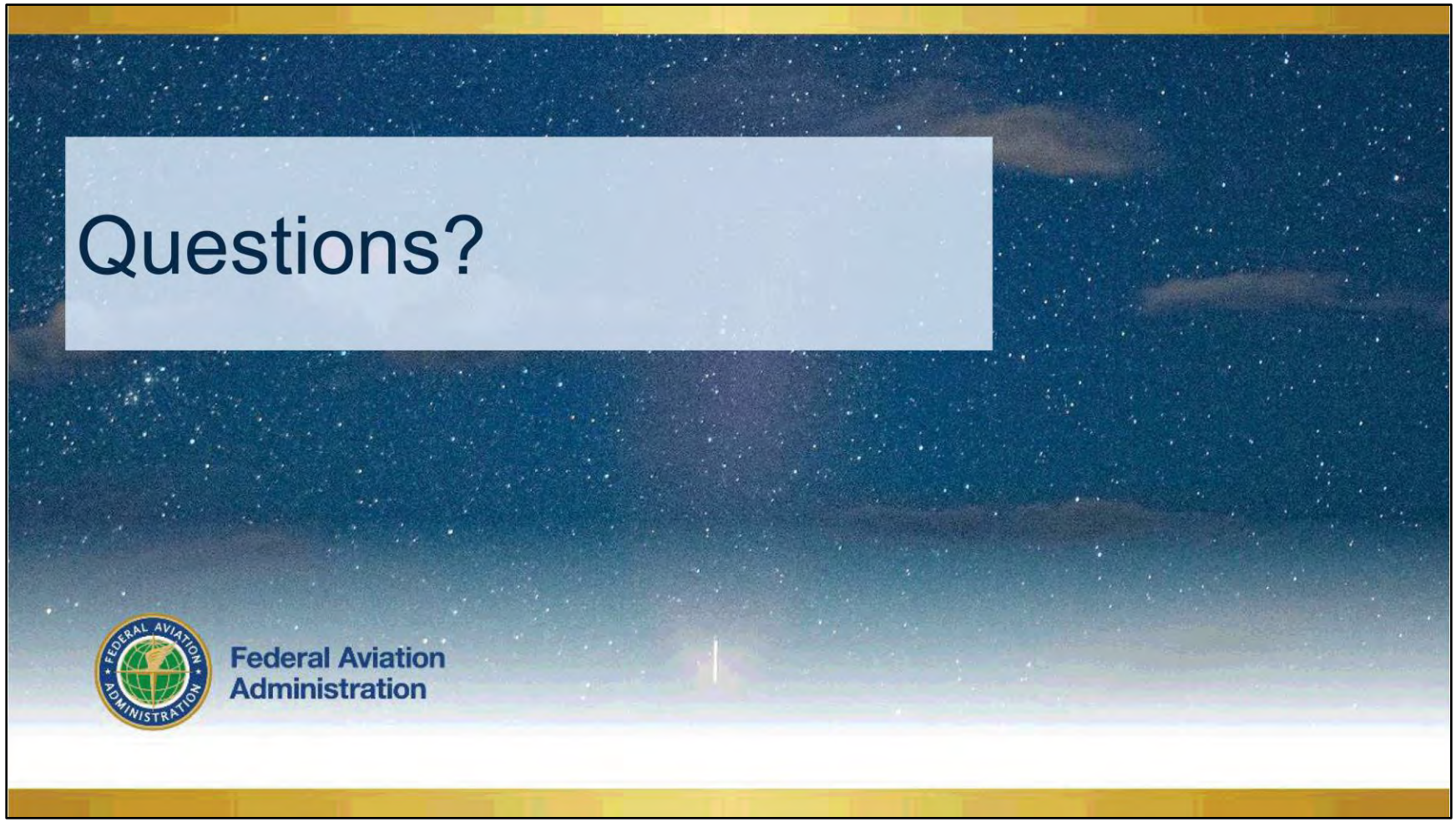

Programmatic Agreement Overview
Federal Aviation Administration
• Because a final determination of how SSH launch and landing activities will affect historic properties is not possible at this time, a programmatic agreement is necessary.
• PA will be developed pursuant to 36 CFR § 800.14(b), to govern the implementation of a program for the assessment of effects on historic properties and the resolution of adverse effects on historic properties.
• PA will be modelled on the agreement executed for resolution of adverse effects and monitoring of historic properties for the operation of the SpaceX Boca Chica launch site in Cameron County, Texas.
• PA will require the development of plans for monitoring architectural history and archaeological resources, the additional identification of historic properties within the APE, and an inadvertent discoveries plan.
• Any adverse effects identified through monitoring will be resolved through the execution of a Memorandum of Agreement, or through pre-negotiated mitigations.


Programmatic Agreement Recommendations
Federal Aviation Administration
Additional Identification of Historic Properties
• SHPO requested:
• Survey of NRHP-eligible and unevaluated resources, including those outside recorded historic districts and resource groups.
• Survey/evaluation of previously recorded resources within historic districts and resources groups recorded in the FMSF more than 10 years ago.
Archaeological Monitoring
• Seismographic study of vibration levels at archaeological sites that captures baseline, launch, landing, and post-landing data.
• Overpressure (sonic boom) study at archaeological sites.
• LiDAR analyses to monitor potential deflation.
• Report evaluating and modeling effects to, and movement of, soil and archaeological deposits at archaeological sites.
Historic Structures Monitoring
• Monitor potential effects of vibration and sonic boom overpressure on historic structures.


Administrative Items
Federal Aviation
Administration


Starship-Super Heavy LC-39A
Federal Aviation Administration
Programmatic Agreement: Next Steps
• Update and finalize data in CRAS (newly recorded site and Seminole Tribe of Florida request to include all archaeological sites in APE, etc.).
• Consulting parties provide feedback.
• Which resources to monitor? How many resources to monitor?
• Specific monitoring techniques/methods?
• Duration of monitoring (minimum number of launches/landings, time-bound)?
• Goal: Draft PA circulation to consulting parties in July.


Starship-Super Heavy LC-39A
Federal Aviation Administration
EIS Schedule
• DEIS Public Release: Summer 2025
• DEIS Public Meetings (In Person): Late Summer 2025
• FEIS Public Release: Winter 2025
• ROD Signature: Winter 2025/2026
DELIBERATIVE – NOT FOR DISTRIBUTION


Questions?
Federal Aviation Administration

# Buildings/Structures – Monitoring and Mitigation

Federal Aviation Administration

## Potential Monitoring Approach

- Collection of baseline structural information, vibratory and overpressure data over multiple launches and landings.
- A report assessing and evaluating changes or damage to structures beyond baseline condition.
- Report will include effects assessments.
- Structures to monitor will be included in monitoring plan developed through consultation with PA signatories.

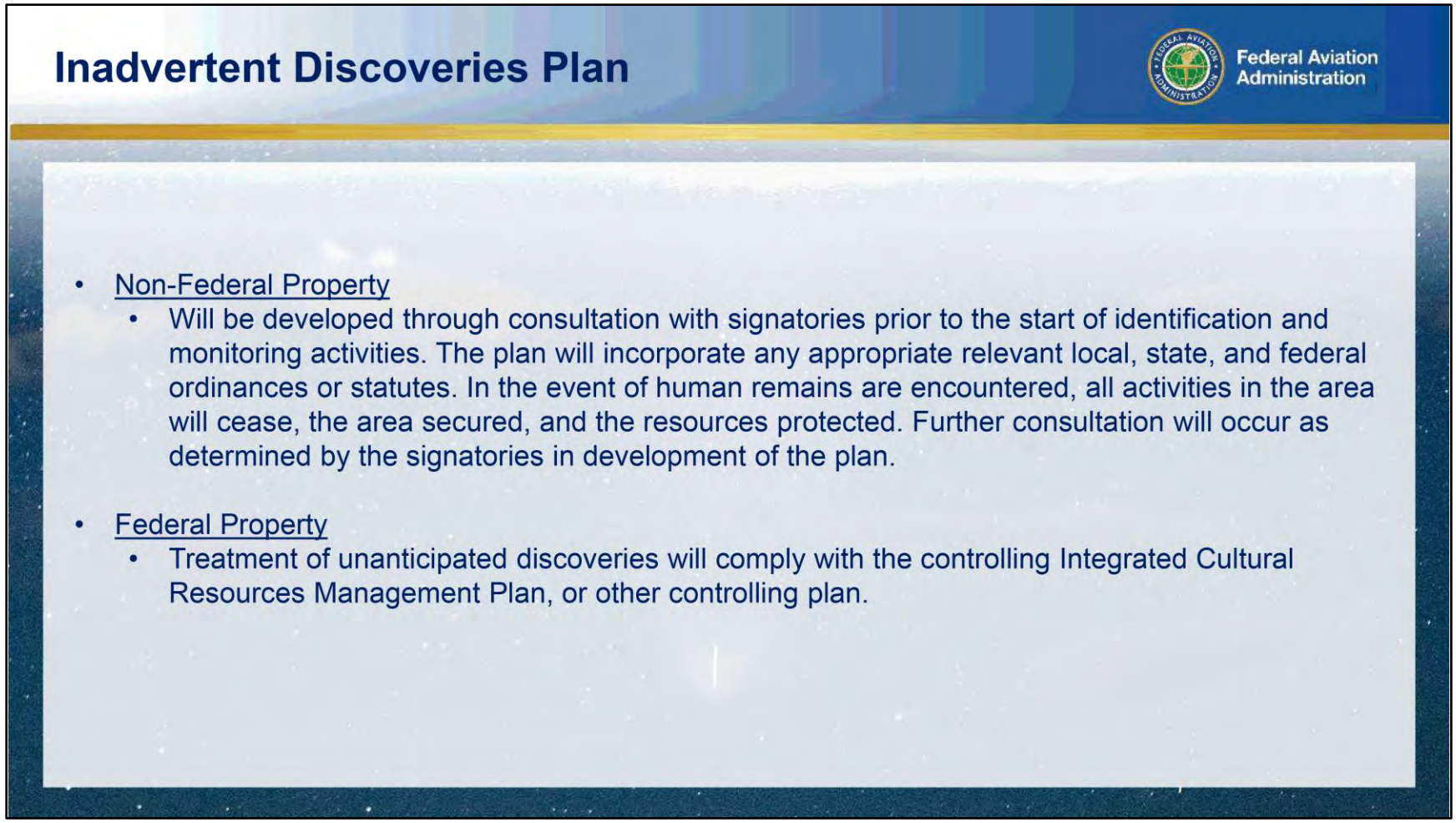
# Archaeological Resources – Monitoring and Mitigation

Federal Aviation Administration

## Potential Monitoring Approaches

Longitudinal, minimally intrusive monitoring

- Seismographic data collection of vibration levels at three or more sites that captures baseline, launch, landing, and post-landing data.
- Collection of overpressure data generated during landing activities at three or more sites.
- A report evaluating and modeling effects to, and movement of, soil and archaeological deposits at each archaeological site.
- Report will include effects assessments.
- Sites to monitor will be included in monitoring plan developed through consultation with PA signatories.


Inadvertent Discoveries Plan
Federal Aviation Administration
• Non-Federal Property
• Will be developed through consultation with signatories prior to the start of identification and monitoring activities. The plan will incorporate any appropriate relevant local, state, and federal ordinances or statutes. In the event of human remains are encountered, all activities in the area will cease, the area secured, and the resources protected. Further consultation will occur as determined by the signatories in development of the plan.
• Federal Property
• Treatment of unanticipated discoveries will comply with the controlling Integrated Cultural Resources Management Plan, or other controlling plan.

# Noise – Contingency Landing Scenario

Federal Aviation Administration

## Propulsion Noise

- Booster contingency landing noise levels generally less than nominal landing levels on land
- Booster contingency landing area: Minimum 5 NM offshore in area bounded by 40- and 115-degree launch trajectories
- Starship contingency landing noise levels analysis is still under development
- Starship contingency landing area: minimum 1 NM off-shore (purple and yellow shaded areas in the figure to the right)

## Sonic Booms

- Booster contingency landing boom overpressures less than for nominal landing
- Starship contingency landing booms could hypothetically exceed 1 psf but would not exceed 1.7 psf in land areas bounded by blue dashed line in figure to the right
- Less than 5 contingency landings per year are expected
- Contingency landing area extends more than 1,000 miles - landings in portions that are far from shore would not be audible on shore
- Booms exceeding 1 psf on shore in blue-dashed are would be extremely rare

***Land Areas Hypothetically Affected by 1 to 1.7 PSF***

**SpaceX Starship Superheavy**
**Consulting Party Feedback for the Historic Property Monitoring Plan**

Please use the following questions to provide feedback to NASA regarding the development of a historic preservation monitoring plan for SpaceX's Starship Superheavy launch and landing activities at LC-39A. These inputs will help us formulate the Programmatic Agreement.

**What Should Be Monitored?**

1. Are there specific historic properties you recommend for monitoring? Please list them by Florida Master Site File Number or address.
2. What specific historic property types and/or characteristics are you concerned about?

**Where Should Monitoring Occur?**

1. Which dB or psf levels are of most concern to you?
2. Should monitoring sites be concentrated within specific dB or psf levels? Or should monitoring sites be distributed evenly across the entire Area of Potential Effects (APE)?

**How Should Monitoring Be Accomplished?**

1. Do you have any suggested methods or approaches for monitoring?
2. What specifically do you want to be monitored?
3. Should there be variability in monitoring approaches depending upon location of the historic property within the APE?
4. Is your organization willing to actively assist with monitoring activities (e.g. site inspections, measurements, photography)?

**How Long Should Monitoring Last?**

1. Should the monitoring plan be based on a time interval (e.g. 3 months), the number of events (e.g. 6 static fire/launch/landing events), or a combination of both?
2. How often do you think reporting should occur?

**Do you have any other comments, concerns, or recommendations?**