Root DNSSEC KSK Ceremony 46

Wednesday 17 August 2022

Root Zone KSK Operator Key Management Facility
1920 East Maple Avenue, El Segundo, CA 90245, USA

This ceremony is executed in accordance with the DNSSEC Practice Statement for the Root Zone KSK Operator 6th Edition (2020-11-04)

Abbreviations

AUD = Third Party Auditor
CA = Ceremony Administrator
CO = Crypto Officer
EW = External Witness
FD = Flash Drive
HSM = Hardware Security Module
IW = Internal Witness
KMF = Key Management Facility
KSR = Key Signing Request
OP = Operator
PTI = Public Technical Identifiers
RKSH = Recovery Key Share Holder
RKOS = RZ KSK Operations Security
RZM = Root Zone Maintainer
SA = System Administrator
SKR = Signed Key Response
SMK = Storage Master Key
SO = Security Officer
SSC = Safe Security Controller
SW = Staff Witness
TCR = Trusted Community Representative
TEB = Tamper Evident Bag (AMPAC: #GCS1013, #GCS0912, #GCS1216 or MMF Industries: #2362010N20, #2362011N20)

Participants

Key Ceremony roles are described on https://www.iana.org/help/key-ceremony-roles
Instructions: At the end of the ceremony, participants sign IW's script. IW records time of completion.

Title / Roles	Printed Name	Signature	Date	Time
CA	Francisco Arias / ICANN		2022 Aug —	
IW	Yuko Yokoyama / ICANN			
SSC1	Marilia Hirano / PTI			
SSC2	Anand Mishra / ICANN			
CO1	Arbogast Fabian			
CO3	João Damas			
CO6 Current	Nicolas Antoniello			
CO6 Successor	Jorge Etges			
CO7	Subramanian Moonesamy			
RZM	Trevor Davis / Verisign	Remote Participant		
RZM	Duane Wessels / Verisign	Remote Participant		
AUD	Emmanuel Nkereuwem / RSM	Remote Participant		
SA	Patrick Tudor / ICANN			
SA	Moises Cirilo / ICANN			
RKOS / CA Backup	Andres Pavez / PTI			
RKOS / IW Backup	Aaron Foley / PTI			

By signing this script, you are declaring that this document is a true and accurate record of the Root DNSSEC KSK ceremony to the best of your knowledge, and you agree that your personal data will be processed in accordance with the ICANN Privacy Policy available at https://www.icann.org/privacy/policy

Instructions for a Root DNSSEC KSK Ceremony

The Root DNSSEC Key Signing Key (KSK) Ceremony is a scripted meeting where individuals with specific roles generate or access the private key component of the root zone DNSSEC KSK. The process is audited by a third party firm for compliance with SOC 3 framework. The script and recordings are published online for the wider Internet community to review.

Ceremony Guidelines:

- The CA leads the ceremony
- Only a CA, IW, or SA can enter and escort other participants into Tier 4 (Key Ceremony Room)
- Dual Occupancy is enforced. IW with CA or SA must remain inside Tier 4 (Key Ceremony Room) if participants are present in the room
- During a ceremony a CA, IW, or SA may escort participants out of Tier 4 (Key Ceremony Room) at the CA's discretion if Tier 5 (Safe Room) is not occupied
- All participants are required to sign in and out of Tier 4 (Key Ceremony Room) using the visitor log located in Tier 3
- The SA starts filming before the majority of participants enter Tier 4 (Key Ceremony Room)
- Ceremony participants follow the script step by step in order to attest to the ceremony's proper performance
- The CA reads each step aloud prior to its performance
- Upon the successful completion of a step, the IW will announce and record its time of completion, and initials that step in their script
- A ceremony participant who has cause for concern or detects an issue is encouraged to interrupt the ceremony for discussion. The issue is brought to resolution before the ceremony resumes
- Questions and suggestions for improvement are welcome and can be discussed at any time or after the ceremony during the ceremony debrief

Unplanned events **(exceptions)** during the ceremony are evaluated, documented, and acted upon. It is the CA’s sole responsibility to decide on proper actions after consulting with the IW. In either case, an exception is regarded as an incident, and incident handling procedures are enacted.

Key Management Facility Tiers:

- Tiers 1-3: Consist of the facility areas between the outside environment and the Key Ceremony Room
- Tier 4: Consists of the Key Ceremony Room and is subject to Dual Occupancy
- Tier 5: Consists of the Safe Room (a cage only accessible from the Key Ceremony Room) and is subject to Dual Occupancy
- Tier 6: Consists of Safe #1 (Equipment Safe) and Safe #2 (Credentials Safe)
- Tier 7: Consists of the HSM stored in Safe #1 (Equipment Safe) and the safe deposit boxes installed in Safe #2 (Credentials Safe)

Some steps during the ceremony may require the participants to recite and/or confirm identifiers comprised of numbers and letters. When spelling identifiers, the phonetic alphabet shown below should be used:

Character	Code Word	Pronunciation
A	Alfa	AL-FAH
B	Bravo	BRAH-VOH
C	Charlie	CHAR-LEE
D	Delta	DELL-TAH
E	Echo	ECK-OH
F	Foxtrot	FOKS-TROT
G	Golf	GOLF
H	Hotel	HOH-TEL
I	India	IN-DEE-AH
J	Juliet	JEW-LEE-ETT
K	Kilo	KEY-LOH
L	Lima	LEE-MAH
M	Mike	MIKE
N	November	NO-VEM-BER
O	Oscar	OSS-CAH
P	Papa	PAH-PAH
Q	Quebec	KEH-BECK
R	Romeo	ROW-ME-OH
S	Sierra	SEE-AIR-RAH
T	Tango	TANG-GO
U	Uniform	YOU-NEE-FORM
V	Victor	VIK-TAH
W	Whiskey	WISS-KEY
X	Xray	ECKS-RAY
Y	Yankee	YANG-KEY
Z	Zulu	ZOO-LOO
1	One	WUN
2	Two	TOO
3	Three	TREE
4	Four	FOW-ER
5	Five	FIFE
6	Six	SIX
7	Seven	SEV-EN
8	Eight	AIT
9	Nine	NIN-ER
0	Zero	ZEE-RO

Act 1: Initiate Ceremony and Retrieve Materials

The CA initiates the ceremony by performing the steps below:

- Verify that the audit cameras are recording and the online video streaming is enabled
- Confirm that all of the ceremony attendees have signed in using the visitor log in Tier 3
- Review emergency evacuation procedures
- Explain the use of personal devices and the purpose of this ceremony
- Verify the time and date so that all entries into the script follow a common time source

The CA and IW will then escort the SSCs and COs into Tier 5 (Safe Room) to retrieve the following materials:

- Safe #1: HSM, laptop, OS DVD, etc
- Safe #2: The COs' smartcards required to operate the HSM

Sign into Tier 4 (Key Ceremony Room)

Step	Activity	Initials	Time
1	CA confirms with SA that all audit cameras are recording and online video streaming is enabled.		
2	CA confirms that all participants are signed into Tier 4 (Key Ceremony Room), then performs a roll call using the list of participants on page 2.		
3	CA asks that any first time ceremony participants in the room introduce themselves.		

Emergency Evacuation Procedures and Electronics Policy

Step	Activity	Initials	Time
4	CA reviews emergency evacuation procedures with onsite participants.		
5	CA explains the use of personal electronic devices during the ceremony.		
6	CA summarizes the purpose of the ceremony.		

Verify the Time and Date

Step	Activity	Initials	Time
7	IW enters UTC date (YYYY-MM-DD) and time (HH:MM) using a reasonably accurate clock visible to all in Tier 4 (Key Ceremony Room): Date and time:_____ **Note: All entries into this script or any logs should follow this common source of time.**		

Open Safe #2 (Tier 6, Credentials Safe)

Step	Activity	Initials	Time
8	CA transports the guard key and flashlight, and with IW escort SSC2 and the COs into Tier 5 (Safe Room.)		
9	SSC2 opens Safe #2 while shielding the combination from the camera. **Note: SSC begins by rapidly spinning the dial counter-clockwise 15-20 revolutions in order to charge it before stopping at the first number in the combination.**		
10	Perform the following steps to complete the safe log: a) SSC2 removes the existing safe log, then shows the most recent page to the audit camera. b) IW provides the pre-printed safe log to SSC2. c) SSC2 writes the date and time, then signs the safe log where **"Open Safe"** is indicated. d) IW verifies the entry then initials it.		

COs Access the Credentials in Safe Deposit Boxes (Tier 7)

Step	Activity	Initials	Time
11	COs perform the following steps sequentially to access the listed TEBs: a) After the CA operates the guard key in the bottom lock, CO uses their tenant key to operate the top lock and open their assigned safe deposit box. b) CO reads aloud the safe deposit box number, verifies its integrity, then removes the OP TEB and SO TEB. c) CO reads aloud the TEB numbers, then verifies integrity of TEBs while showing them to the audit camera above. d) CO retains the TEB(s) specified below, then locks the safe deposit box. **Note: The CO's key will remain inserted in their assigned safe deposit box lock when specified below.** e) CO writes the date and time, then signs the safe log. f) IW verifies the completed safe log entries, then initials it. **CO1: Arbogast Fabian** **Box # 1788** **OP TEB # BB91951351 (Retain)** **SO TEB # BB46584377 (Retain)** **CO3: João Damas** **Box # 1069** **OP TEB # BB91951353 (Retain)** **SO TEB # BB46584455 (Retain)** **CO6 Current: Nicolas Antoniello** **Box # 1073 (Key shall remain in lock)** **OP TEB # BB91951255 (Retain)** **SO TEB # BB91951252 (Retain)** **CO7: Subramanian Moonesamy** **Box # 1790** **OP TEB # BB91951355 (Retain)** **SO TEB # BB46584385 (Retain)**		

Close Safe #2 (Tier 6, Credentials Safe)

Step	Activity	Initials	Time
12	Once all safe deposit boxes are closed and locked, SSC2 writes the date and time, then signs the safe log where **"Close Safe"** is indicated. IW verifies the entry then initials it.		
13	SSC2 returns the safe log to Safe #2, closes the safe door, pulls up on the handle, and ensures it's locked by spinning the dial at least two full revolutions each way, counter-clockwise then clockwise. CA and IW verify that the safe is locked and the **"WAIT"** light indicator is off.		
14	CA, IW, SSC2, and COs leave Tier 5 (Safe Room) with TEBs, returning to Tier 4 (Key Ceremony Room).		

Open Safe #1 (Tier 6, Equipment Safe)

Step	Activity	Initials	Time
15	CA and IW transport a cart, and escort SSC1 into Tier 5 (Safe Room.)		
16	SSC1 opens Safe #1 while shielding the combination from the camera. **Note: SSC begins by rapidly spinning the dial counter-clockwise 15-20 revolutions in order to charge it before stopping at the first number in the combination.**		
17	Perform the following steps to complete the safe log: a) SSC1 removes the existing safe log, then shows the most recent page to the audit camera. b) IW provides the pre-printed safe log to SSC1. c) SSC1 writes the date and time, then signs the safe log where **"Open Safe"** is indicated. d) IW verifies the entry then initials it.		

Remove Equipment from Safe #1 (Tier 6, Equipment Safe)

Step	Activity	Initials	Time
18	CA performs the following steps to extract each piece of equipment from the safe: a) CAREFULLY remove each equipment TEB from the safe. b) Read aloud each TEB number, then verify its integrity while showing it to the audit camera. c) Place each equipment TEB on the cart as specified in the list below. d) Write the date and time, then signs the safe log. e) IW verifies the completed safe log entries, then initials it. **HSM3: TEB # BB51184234 (Place on Cart)** ***Last Verified: AC Ceremony 40-4 2020-02-16*** **HSM4: TEB # BB51184285 (Place on Cart)** ***Last Verified: KSK Ceremony 42 2021-02-11*** **HSM5W: TEB # BB51184290 (Place on Cart)** ***Last Verified: KSK Ceremony 44 2022-02-16*** **HSM6W: TEB # BB51184288 (Check and Return)** ***Last Verified: KSK Ceremony 44 2022-02-16*** **Laptop3: TEB # BB81420073 (Check and Return)** ***Last Verified: KSK Ceremony 44 2022-02-16*** **Laptop4: TEB # BB81420089 (Place on Cart)** ***Last Verified: KSK Ceremony 42 2021-02-11*** **OS DVD (release coen-0.4.0) + HSMFD: TEB # BB91951259 (Place on Cart)** ***Last Verified: KSK Ceremony 44 2022-02-16*** **KSK-2017: TEB # BB91951258 (Check and Return)** ***Last Verified: KSK Ceremony 44 2022-02-16*** **HSM3 Physical Keyboard Key: TEB # BB21907221 (Place on Cart)** ***Last Verified: AT Ceremony 22 2015-07-20*** **HSM4 Physical Keyboard Key: TEB # BB21907222 (Place on Cart)** ***Last Verified: AT Ceremony 22 2015-07-20*** **Note: *"Last verified"* indicates the last time a piece of equipment was placed in a new TEB during a ceremony. It is listed here for audit tracking purposes.**		

Close Safe #1 (Tier 6, Equipment Safe) Exit Tier 5 (Safe Room)

Step	Activity	Initials	Time
19	SSC1 writes the date and time, then signs the safe log where **"Close Safe"** is indicated. IW verifies the safe log entry then initials it.		
20	SSC1 returns the safe log to Safe #1, closes the safe door, pulls up on the handle, and ensures it's locked by spinning the dial at least two full revolutions each way, counter-clockwise then clockwise. CA and IW verify that the safe is locked and the **"WAIT"** light indicator is off.		
21	CA, IW, and SSC1 leave Tier 5 (Safe Room) with the cart, returning to Tier 4 (Key Ceremony Room).		

Act 2: Equipment Setup

The CA will set up the equipment by performing the following steps:

- Boot the laptop using the OS DVD (the laptop has no permanent storage device)
- Set up the printer
- Synchronize the laptop date and time
- Connect the HSMFD
- Start the log sessions
- Power ON the HSM (Tier 7)

Laptop Setup

Step	Activity	Initials	Time
1	CA performs the following steps to prepare the listed equipment: a) Remove all equipment TEBs from the cart and place them on the ceremony table. b) Inspect each equipment TEB for tamper evidence. c) Read aloud the TEB number and the serial number (if applicable) while IW verifies the information using the previous ceremony script where it was last used. d) Remove and discard the TEB, then place the equipment on its designated area of the ceremony table. **HSM5W: TEB # BB51184290 / Serial # H1903017** ***Last Verified: KSK Ceremony 44 2022-02-16*** **Laptop4: TEB # BB81420089 / Service Tag # F8SVSG2** ***Last Verified: KSK Ceremony 42 2021-02-11*** **OS DVD (release coen-0.4.0) + HSMFD: TEB # BB91951259** ***Last Verified: KSK Ceremony 44 2022-02-16*** **Note: *"Last verified"* indicates the last time a piece of equipment was placed in a new TEB during a ceremony. It is listed here for audit tracking purposes.**		
2	CA performs the following steps to confirm that no hard drive and battery are in the laptop: a) Open the latch on the right side of the laptop to confirm that the hard drive slot is empty. b) Open the latch on the left side of the laptop to confirm that the battery slot is empty.		
3	CA performs the following steps to boot the laptop: a) Connect the USB printer cable into the rear USB port of the laptop. b) Connect the null modem cable into the serial port of the laptop. c) Connect the external HDMI display cable. d) Connect the power supply. e) Immediately insert the **OS DVD release coen-0.4.0** after the laptop power is switched ON.		
4	CA verifies functionality of the external display and performs adjustments if necessary: To change the font size of the terminal: Click the **View** menu and select **Zoom In** or **Zoom Out** To change the resolution of each screen: Go to **Applications > Settings > Display**		

OS DVD Checksum Verification

Step	Activity	Initials	Time
5	CA uses the terminal window to executes the following steps: a) Calculate the SHA-256 hash by executing: **`sha2wordlist < /dev/sr0`** b) IW and participants confirm that the result matches the PGP Wordlist of the SHA-256 hash. **Note: CA assigns half of the participants to confirm the hash displayed on the TV screen while the other half confirm the hash from the ceremony script.** SHA-256 hash: **8105b885b176741d25ef9d391c6a302aed3f6c916093a621a865cb90d560774f** PGP Words: **minnow almighty select leprosy sailboat impetus indoors breakaway bombast unravel quadrant corporate befriend hamburger chairlift chambermaid tunnel customer glucose miracle facial molasses rematch Camelot retouch glossary spheroid millionaire sterling fortitude involve document** **Note: The SHA-256 hash of the OS DVD release coen-0.4.0 is also published on the IANA website https://www.iana.org/dnssec/ceremonies/46**		

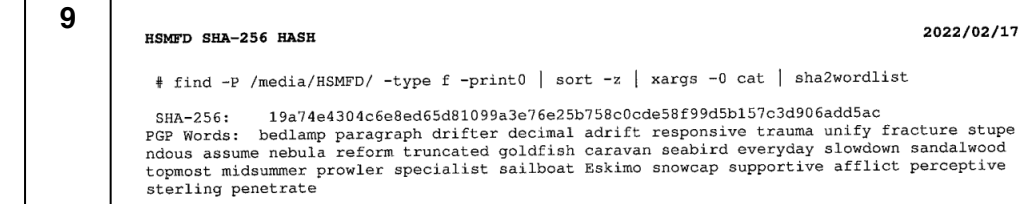
Printer Setup

Step	Activity	Initials	Time
6	CA confirms that the printer is switched ON, then executes the command below using the terminal window to configure the printer and print a test page: **`configure-printer`**		

Date Setup

Step	Activity	Initials	Time
7	CA executes **`date`** using the terminal window to verify if the date/time reasonably matches the ceremony clock. If the date/time do not match, perform the following steps: a) Execute **`date -s "20220817 HH:MM:00"`** to set the time. **where `HH` is two-digit hour, `MM` is two-digit minutes and `00` is zero seconds.** b) Execute **`date`** to confirm the date/time matches the clock.		

Connect the HSMFD

Step	Activity	Initials	Time
8	CA plugs the **Ceremony 44 HSMFD** into the USB slot, then performs the steps below: a) Wait for the OS to recognize it. b) Display the HSMFD contents to all participants. c) Close the file system window.		
9	CA executes the command below using the terminal window to calculate the SHA-256 hash of the HSMFD: **`hsmfd-hash -c`** CA assigns half of the participants to confirm the hash displayed on the TV screen while the other half confirm the hash with the following image from the previous ceremony script.  HSMFD SHA-256 HASH 2022/02/17 # find -P /media/HSMFD/ -type f -print0 | sort -z | xargs -0 cat | sha2wordlist SHA-256: 19a74e4304c6e8ed65d81099a3e76e25b758c0cde58f99d5b157c3d906add5ac PGP Words: bedlamp paragraph drifter decimal adrift responsive trauma unify fracture stupendous assume nebula reform truncated goldfish caravan seabird everyday slowdown sandalwood topmost midsummer prowler specialist sailboat Eskimo snowcap supportive afflict perceptive sterling penetrate IW confirms that the result matches the SHA-256 hash of the HSMFD from the Ceremony 44 annotated script.		

Distribute Previous HSMFD

Step	Activity	Initials	Time
10	CA gives the unused **HSMFD 44** and the sheet of paper with the printed HSMFD hash to RKOS.		

Start the Terminal Session Logging

Step	Activity	Initials	Time
11	CA executes the command below using the terminal window to change the working directory to HSMFD: **`cd /media/HSMFD`**		
12	CA executes the command below to log activities of the **Commands** terminal window: **`script script-20220817.log`**		

Start the HSM Activity Logging

Step	Activity	Initials	Time
13	CA performs the following steps using the **HSM Output** terminal window to capture the activity logs of the HSM: a) Change the working directory to HSMFD by executing: **`cd /media/HSMFD`** b) Set the serial port baud rate by executing: **`stty -F /dev/ttyS0 115200`** c) Start logging the serial output by executing: **`ttyaudit /dev/ttyS0`** **Note: DO NOT unplug the null modem cable from the laptop as this will stop capturing activity logs from the serial port.**		

Power ON the HSM (Tier 7)

Step	Activity	Initials	Time
14	CA performs the following steps to prepare the HSM: a) Verify the label on the HSM reads **HSM5W** b) Plug the null modem cable into the serial port of the HSM. c) Connect the power to the HSM, then switch it ON. **Note: Status information should appear on the HSM activity logging screen.** d) Scroll up on the logging screen while IW verifies the displayed HSM serial number on the screen reads **H1903017**, then scroll back to the bottom. **HSM5W: Serial # H1903017** **Note: The date and time on the HSM is not used as a reference for logging and timestamp.**		

Act 3: Activate HSM (Tier 7) and Generate Signatures

Using the ksrsigner application the CA takes the Key Signing Requests (KSRs) and generates the Signed Key Responses (SKRs) by performing the steps below.

- The CA activates the HSM using the COs' smartcards
- After connectivity is confirmed the flash drive containing the KSRs is inserted into the laptop
- The ksrsigner application uses the private key stored in the HSM to generate the SKR containing the digital signatures of the ZSK slated for future use
- The CA then prints the signer log, backs up the newly created SKR, and deactivates the HSM

Crypto Officer Credentials Verification

Step	Activity	Initials	Time
1	The CA calls each of the COs listed below sequentially to perform the following steps: a) CO reads aloud the TEB number, then CA inspects it for tamper evidence. b) CO and CA open the TEB, then the CA removes the plastic case containing the card(s). c) CA opens the plastic case, then places the card(s) within on the designated card holder at the front of the ceremony table. CA retains the plastic case on the ceremony table. **CO1: Arbogast Fabian** **OP TEB # BB91951351** **SO TEB # BB46584377** **CO3: João Damas** **OP TEB # BB91951353** **SO TEB # BB46584455** **CO6 Current: Nicolas Antoniello** **OP TEB # BB91951255** **SO TEB # BB91951252** **CO7: Subramanian Moonesamy** **OP TEB # BB91951355** **SO TEB # BB46584385**		

Enable/Activate the HSM (Tier 7)

Step	Activity	Initials	Time
2	CA performs the following steps to activate the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"1.Set Online"**, press **ENT** to confirm. c) When **"Set Online?"** is displayed, press **ENT** to confirm. d) When **"Insert Card OP #X?"** is displayed, insert the OP card. e) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. f) When **"Remove Card?"** is displayed, remove the OP card. g) Repeat steps d) to f) for the 2nd and 3rd OP cards. Confirm the **"READY"** LED on the **HSM** is **ON.** IW records which cards were used below. Each card is returned to its designated card holder after use. 1st OP card ____ of 7 2nd OP card ____ of 7 3rd OP card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		

Check the Network Connectivity Between Laptop and HSM

Step	Activity	Initials	Time
3	CA connects the HSM to the laptop using an ethernet cable in the LAN ports.		

4	CA performs the following steps to test the network connectivity between laptop and HSM:
	a) Use the **Commands** terminal window
	b) Test connectivity by executing:
	`ping hsm`
	c) Wait for responses, then exit by pressing:
	`Ctrl + C`		

Insert the KSRFD

Step	Activity	Initials	Time
5	CA plugs the FD labeled **"KSR"** into an available USB port, then waits for it to be recognized by the OS. CA points out any KSR file that will be signed, then closes the file system window. **Note: The KSRFD was transferred to the facility by the RKOS. It contains 1 KSR.**		

Execute the KSR Signer for KSR 2022 Q4

Step	Activity	Initials	Time
6	CA executes the command below in the terminal window to sign the KSR file: `ksrsigner /media/KSR/KSK46/ksr-root-2022-q4-0.xml`		
7	When the KSR signer displays the prompt: `Activate HSM prior to accepting in the affirmative!! (y/N):` CA confirms that the HSM is online, then enters **"y"** to proceed.		

Verify the KSR Hash for KSR 2022 Q4

Step	Activity	Initials	Time
8	When the hash of the KSR is displayed in the terminal window, perform the following: a) CA asks the Root Zone Maintainer (RZM) representative to identify themselves. The IW verifies their employment documents and identification **off camera** for the purpose of authentication while maintaining privacy. **Note: If the RZM representative is not physically present in the room, write the representative's name and *"Remote Participant"* next to the name on the signature line.** b) IW retains the hash and PGP word list for the KSR(s), and employment verification letter provided by the RZM representative and writes their name on the following line: **Note: If the RZM representative is not physically present in the room, the documents will be provided to RKOS in advance to be included in the final annotated script and audit bundle.** _____ c) The CA asks some participants to compare the hash in the email sent by the RZM representative prior to the ceremony and some participants to compare the hash in the terminal window, then asks the RZM representative to read aloud the PGP word list SHA-256 hash of the KSR file being used.		
9	Participants confirm that the hash matches with the RZM representative's discourse, then CA asks **"are there any objections?"**		
10	CA enters **"y"** in response to `"Is this correct (y/N)?"` to complete the KSR signing operation. The SKR is located in: `/media/KSR/KSK46/skr-root-2022-q4-0.xml`		

Print Copies of the KSR Signer log

Step	Activity	Initials	Time
11	CA executes the commands below using the terminal window to print the KSR Signer log: a) `lpadmin -p HP -o copies-default=X` **Note: Replace "X" with the amount of copies needed for the participants.** b) `printlog ksrsigner-202208*.log`		
12	IW attaches a copy of the required ksrsigner log to their script.		

Back up the Newly Created SKR

Step	Activity	Initials	Time
13	CA executes the following commands using the terminal window: a) List the contents of the KSRFD by executing: **`ls -ltrR /media/KSR`** b) Copy the contents of the KSRFD to the HSMFD by executing: **`cp -pR /media/KSR/* .`** **Note: Confirm overwrite by entering "y" if prompted.** c) List the contents of the HSMFD to verify it has been copied successfully by executing: **`ls -ltrR`** d) Unmount the KSRFD by executing: **`umount /media/KSR`**		
14	CA removes the **KSRFD** containing the SKR files, then gives it to the RZM representative. **Note: If the RZM representative is participating remotely, RKOS will take custody of the KSRFD instead.**		

Disable/Deactivate the HSM (Tier 7)

Step	Activity	Initials	Time
15	CA deactivates the HSM by performing the following steps: **Note: CA will use OP cards not previously utilized in this ceremony if available.** a) CA displays the HSM activity logging terminal window b) Utilize the HSM's keyboard to scroll through the menu using < > c) Select **"2.Set Offline"**, press **ENT** to confirm. d) When **"Set Offline?"** is displayed, press **ENT** to confirm. e) When **"Insert Card OP #X?"** is displayed, insert the OP card from the card holder. f) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. g) When **"Remove Card?"** is displayed, remove the OP card. h) Repeat steps e) to g) for the 2nd and 3rd OP cards. Confirm the **"READY"** LED on the **HSM** is **OFF.** IW records which cards were used below. Each card is returned to its designated card holder after use. 1st OP card ____ of 7 2nd OP card ____ of 7 3rd OP card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		

Place the HSM (Tier 7) into a TEB

Step	Activity	Initials	Time
16	CA switches the HSM power to OFF, then disconnects the power, serial, and ethernet connections. **Note: DO NOT unplug the cable connections on the laptop.**		
17	CA places the HSM into a prepared TEB, then seals it.		
18	CA performs the following steps: a) Read aloud the TEB number and HSM serial number, then show it to the audit camera above for participants to see. b) Confirm with IW that the TEB number and HSM serial number match below. c) Initial the TEB along with IW using a ballpoint pen. d) Give IW the sealing strips for post-ceremony inventory. e) Place the HSM TEB on the cart. **HSM5W: TEB # BB51184248 / Serial # H1903017**		

Act 4: Zeroize and Dismantle Hardware Security Module

To conclude its period of service, the retiring HSM will be zeroized and have its critical components removed and securely destroyed.

- CA will remove all keys from the HSM
- CA will zeroize the HSM
- CA will intentionally tamper the HSM
- CA will dismantle the HSM and extract its critical components
- CA will place the components into a TEB in preparation of offsite secure destruction

Remove the HSM3 from TEB and Power On

Step	Activity	Initials	Time
1	CA selects the **HSM Output** terminal window.		
2	CA performs the following steps to prepare the HSM: a) Remove the TEB from the cart and place it on the ceremony table. b) Inspect the TEB for tamper evidence. c) Read aloud the TEB number and the serial number while IW verifies the information using the previous ceremony script where it was last used. d) Remove and discard the TEB, then place the equipment on its designated area of the ceremony table. e) Verify the label on the HSM reads **HSM3**. f) Plug the null modem cable into the serial port of the HSM. g) Connect the power to the HSM, then switch it ON. **Note: Status information should appear on the HSM activity logging screen.** h) Scroll up on the logging screen while IW verifies the displayed HSM serial number on the screen reads **H1403033**, then scroll back to the bottom. i) **If the HSM is tampered** (the **ALERT** LED light is **ON** and **IMK missing recovery mode** is displayed), disconnect the power and serial cables from the HSM, and proceed with the **step 10**. **HSM3: TEB # BB51184234 / Serial # H1403033** **Last Verified: AC Ceremony 40-4 2020-02-16** **Note: *"Last verified"* indicates the last time a piece of equipment was placed in a new TEB during a ceremony. It is listed here for audit tracking purposes.** **Note: The date and time on the HSM is not used as a reference for logging and timestamp.**		

List and Delete the KSK(s) present in the HSM3

Step	Activity	Initials	Time
3	CA ensure that three cards from only one of the two SO card sets are utilized to issue temporary Crypto Officer (CO) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"7.Role Mgmt"**, press **ENT** to confirm. c) When **"Insert Card SO #X?"** is displayed, insert the SO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the SO card. f) Repeat steps c) to e) for the 2nd and 3rd SO card. g) Select **"1.Issue Cards"**, press **ENT** to confirm. h) Select **"1.Issue CO Cards"**, press **ENT** to confirm. i) When **"Issue CO Cards?"** is displayed, press **ENT** to confirm. j) When **"Num Cards?"** is displayed, enter **"2"**, then press **ENT**. k) When **"Num Req Cards?"** is displayed, enter **"2"**, then press **ENT**. l) When **"Insert Card #X?"** is displayed, insert the required CO card. m) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. n) When **"Remove Card?"** is displayed, remove the CO card. o) Repeat steps l) to n) for the 2nd CO card. p) When **"CO Cards Issued"** is displayed, press **ENT** to confirm. q) Press **CLR twice** to return to the main menu **"Secured"**. IW records which cards were used below. Each card is returned to its designated card holder after use. Set # ____ 1st SO card ____ of 7 2nd SO card ____ of 7 3rd SO card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		
4	CA performs the following steps to list the KSK(s) present in the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"5.Key Mgmt"**, press **ENT** to confirm. c) When **"Insert CO Card #X?"** is displayed, insert the CO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the CO card. f) Repeat steps c) to e) for the 2nd CO card. g) Select **"2.Key Details"**, press **ENT** to confirm. h) When **"List Keys?"** is displayed, press **ENT**. i) Select **"1.Key Summary"**, press **ENT** to confirm. j) When **"Key Summary?"** is displayed, press **ENT**. **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		
5	CA matches the displayed KSK label(s) in the HSM Output terminal window. **KSK-2017: Klajeyz**		

Step	Activity	Initials	Time
6	CA performs the following steps to delete the KSK(s) from the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"3.App Keys"** from the same menu **"Key Mgmt"**, press **ENT** to confirm. c) Select **"7.Erase App Key"**, press **ENT** to confirm. d) When **"Erase App Keys?"** is displayed, press **ENT** to confirm. e) Select **"1.All Keys"**, press **ENT** to confirm. f) The **Klajeyz** key(s) will be selected in the HSM's display with a visible (*) asterisk. Press **ENT** to confirm. **There is no system confirmation prompt**. g) When **Done** is displayed, press **ENT** to return to the App Key Menu. h) Press **CLR** to return to the Key Mgmt menu.		
7	CA performs the following steps to list the KSK(s) from the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"2.Key Details"**, press **ENT** to confirm. c) When **"List Keys?"** is displayed, press **ENT**. d) Select **"1.Key Summary"**, press **ENT** to confirm. e) When **"Key Summary?"** is displayed, press **ENT**. f) Press **CLR** to return to the menu **"Secured"**. CA confirms that **KSK-2017: Klajeyz** has been deleted		

Unsecure the HSM3

Step	Activity	Initials	Time
8	CA performs the following steps to unsecure the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"6.HSM Mgmt"**, press **ENT** to confirm. c) When **"Insert Card SO #X?"** is displayed, insert the SO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the SO card. f) Repeat steps c) to e) for the 2nd and 3rd SO card. g) Select **"5.Unsecure"**, press **ENT** to confirm. h) When **"Unsecure?"** is displayed, then press **ENT**. i) When **"DONE"** is displayed, then press **ENT**. It may take a few minutes for the HSM to restart after the zeroization is complete. The HSM will reboot into the **"Unsecured State"** and after the completion of the HSM self test the display should show **"Important Read Manual"** indicating the HSM is in the initialized state. IW records which cards were used below. Each card is returned to its designated card holder after use. Set # ____ 1st SO card ____ of 7 2nd SO card ____ of 7 3rd SO card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		

Tamper the HSM3

Step	Activity	Initials	Time
9	CA performs the following steps to tamper the HSM equipment listed below: a) Using **Tool B**, press and hold the recessed button on the rear panel of the HSM located between the LAN and serial ports (remove the tamper sticker if necessary), then release it after 10 seconds to activate the tampering mechanism. **IMK missing recovery mode** will be displayed on the HSM. b) Turn **OFF** the HSM using the rocker switch on the rear panel. Turn **ON** the HSM with the same switch and wait until the **ALERT** LED light is **ON** and **IMK missing recovery mode** is displayed to verify the tampered state. c) Disconnect the power and serial cables from the HSM.		

Open the HSM Case and Remove the Logic Board from HSM3

Step	Activity	Initials	Time
10	IW reads steps 11 to 14 aloud while the CA dismantles **HSM3: Serial # H1403033**.		
11	CA performs the following steps to access the HSM's critical components: a) Using **Tool A+Bit 2**, remove the two screws securing the serial port to the rear panel. b) Using **Tool A+Bit 1**, remove the four screws from the rear panel of the case securing the shell. c) Using **Tool A+Bit 1**, remove the four screws from the bottom of the case securing the shell. d) Using **Tool C**, slice the tamper stickers on the bottom of the case along the seam with the shell. e) Slide the shell toward the back of the case to remove it and place it in the **HSM Parts** bin on the ceremony table. f) Using **Tool A+Bit 3**, remove the two logic board screws nearest to the front panel securing the plastic logic board cover. g) Remove the plastic logic board cover and place it in the **HSM Parts** bin on the ceremony table. h) Using **Tool A+Bit 3**, remove the two remaining screws securing the logic board near the rear panel. i) Detach the four cables from the front of the logic board. Open the latches outward to release each of the ribbon cables. j) Using **Tool A+Bit 4**, remove the nut from the cryptographic module securing the ring terminal of the green/yellow wire and slide the ring terminal off of the threaded stud. k) Detach the cable from each side of the cryptographic module connecting it to the logic board.		
12	CA performs the following steps to remove the logic board and batteries: a) Separate the logic board from the HSM case by pulling the logic board up then toward the front of the case. b) Using **Tool D**, cut and remove the zip ties securing the batteries if they are present, then cut the battery terminals that connect the batteries to the logic board. c) Pry the batteries from the logic board by placing the logic board flat on the table and rolling each battery back and forth with sufficient force to break the adhesive bond. d) Place the batteries in the **HSM Parts** bin on the ceremony table. e) Place the logic board in the **Critical Parts** bin on the ceremony table.		

Remove Cryptographic Module and Card Reader from HSM3

Step	Activity	Initials	Time
13	CA performs the following steps to remove the cryptographic module: a) Using **Tool A+Bit 4**, remove the 4 nuts securing the cryptographic module to the case. b) Lift the cryptographic module up to separate it from the case. c) Using **Tool C**, remove both connectors from the cryptographic module as flush with the case as possible. d) Place the cryptographic module in the **Critical Parts** bin, and the connectors in the **HSM Parts** bin on the ceremony table.		
14	CA performs the following steps to remove the front panel and card reader: a) Using **Tool A+Bit 4**, remove the 4 nuts securing the front panel to the bottom of the case. b) Place the front panel in the **HSM Parts** bin on the ceremony table. c) Using **Tool A+Bit 4**, remove the nut securing the card reader. d) Using **Tool A+Bit 3**, remove the 3 screws securing the card reader. e) Lift the card reader up to separate it from the case and place it with the ribbon cable in the **Critical Parts** bin on the ceremony table. f) Place the HSM case in the **HSM Parts** bin on the ceremony table.		

Place the Critical HSM3 parts into a TEB

Step	Activity	Initials	Time
15	CA places the container with the following critical parts into a prepared TEB, then seals it. a) Cryptographic Module b) Logic Board c) Card Reader **Note: The HSM case will not be destroyed.**		
16	CA performs the following steps: a) Read aloud the TEB number, then show it to the audit camera above for participants to see. b) Confirm with IW that the TEB number matches below. c) Initial the TEB along with IW using a ballpoint pen. d) Give IW the sealing strips for post-ceremony inventory. e) Give RKOS the TEB for destruction. **HSM3: TEB # BB81420087**		

Remove the HSM4 from TEB and Power On

Step	Activity	Initials	Time
17	CA performs the following steps to prepare the HSM: a) Remove the TEB from the cart and place it on the ceremony table. b) Inspect the TEB for tamper evidence. c) Read aloud the TEB number and the serial number while IW verifies the information using the previous ceremony script where it was last used. d) Remove and discard the TEB, then place the equipment on its designated area of the ceremony table. e) Verify the label on the HSM reads **HSM4**. f) Plug the null modem cable into the serial port of the HSM. g) Connect the power to the HSM, then switch it ON. **Note: Status information should appear on the HSM activity logging screen.** h) Scroll up on the logging screen while IW verifies the displayed HSM serial number on the screen reads **H1411006**, then scroll back to the bottom. i) **If the HSM is tampered** (the **ALERT** LED light is **ON** and **IMK missing recovery mode** is displayed), disconnect the power and serial cables from the HSM, and proceed with the **step 26**. **HSM4: TEB # BB51184285 / Serial # H1411006** **Last Verified: KSK Ceremony 42 2021-02-11** **Note: *"Last verified"* indicates the last time a piece of equipment was placed in a new TEB during a ceremony. It is listed here for audit tracking purposes.** **Note: The date and time on the HSM is not used as a reference for logging and timestamp.**		

List and Delete the KSK(s) present in the HSM4

Step	Activity	Initials	Time
18	CA performs the following steps to issue temporary Crypto Officer (CO) cards if they were not previously generated during this ceremony. If the cards were generated, proceed with the step 19. CA ensure that three cards from only one of the two SO card sets are utilized to issue temporary Crypto Officer (CO) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"7.Role Mgmt"**, press **ENT** to confirm. c) When **"Insert Card SO #X?"** is displayed, insert the SO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the SO card. f) Repeat steps c) to e) for the 2nd and 3rd SO card. g) Select **"1.Issue Cards"**, press **ENT** to confirm. h) Select **"1.Issue CO Cards"**, press **ENT** to confirm. i) When **"Issue CO Cards?"** is displayed, press **ENT** to confirm. j) When **"Num Cards?"** is displayed, enter **"2"**, then press **ENT**. k) When **"Num Req Cards?"** is displayed, enter **"2"**, then press **ENT**. l) When **"Insert Card #X?"** is displayed, insert the required CO card. m) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. n) When **"Remove Card?"** is displayed, remove the CO card. o) Repeat steps l) to n) for the 2nd CO card. p) When **"CO Cards Issued"** is displayed, press **ENT** to confirm. q) Press **CLR twice** to return to the main menu **"Secured"**. IW records which cards were used below. Each card is returned to its designated card holder after use. Set # ____ 1st SO card ____ of 7 2nd SO card ____ of 7 3rd SO card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		
19	CA performs the following steps to list the KSK(s) present in the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"5.Key Mgmt"**, press **ENT** to confirm. c) When **"Insert CO Card #X?"** is displayed, insert the CO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the CO card. f) Repeat steps c) to e) for the 2nd CO card. g) Select **"2.Key Details"**, press **ENT** to confirm. h) When **"List Keys?"** is displayed, press **ENT**. i) Select **"1.Key Summary"**, press **ENT** to confirm. j) When **"Key Summary?"** is displayed, press **ENT**. **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		
20	CA matches the displayed KSK label(s) in the HSM Output terminal window. **KSK-2017: Klajeyz**		

Step	Activity	Initials	Time
21	CA performs the following steps to delete the KSK(s) from the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"3.App Keys"** from the same menu **"Key Mgmt"**, press **ENT** to confirm. c) Select **"7.Erase App Key"**, press **ENT** to confirm. d) When **"Erase App Keys?"** is displayed, press **ENT** to confirm. e) Select **"1.All Keys"**, press **ENT** to confirm. f) The **Klajeyz** key(s) will be selected in the HSM's display with a visible (*) asterisk. Press **ENT** to confirm. **There is no system confirmation prompt**. g) When **Done** is displayed, press **ENT** to return to the App Key Menu. h) Press **CLR** to return to the Key Mgmt menu.		
22	CA performs the following steps to list the KSK(s) from the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"2.Key Details"**, press **ENT** to confirm. c) When **"List Keys?"** is displayed, press **ENT**. d) Select **"1.Key Summary"**, press **ENT** to confirm. e) When **"Key Summary?"** is displayed, press **ENT**. f) Press **CLR** to return to the menu **"Secured"**. CA confirms that **KSK-2017: Klajeyz** has been deleted		

Clear Temporary Crypto Officer (CO) Cards

Step	Activity	Initials	Time
23	CA performs the following steps, ensuring that three cards from only one of the two SO card sets are utilized to clear the temporary Crypto Officer (CO) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"7.Role Mgmt"**, press **ENT** to confirm. c) When **"Insert Card SO #X?"** is displayed, insert the SO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the SO card. f) Repeat steps c) to e) for the 2nd and 3rd SO card. g) Select **"4.Clear RoleCard"**, press **ENT** to confirm. h) When **"Clear Card?"** is displayed, press **ENT** to confirm. i) When **"Num Cards?"** is displayed, enter **"2"**, then press **ENT**. j) When **"Insert Card #X?"** is displayed, take the required **CO #X** card from the cardholder, show the **CO #X** card to the audit camera and then insert the **CO #X** card into the HSM's card reader. k) When **"Are you sure?"** is displayed, press **ENT** to confirm. l) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. m) When **"Remove Card?"** is displayed, remove the CO card. n) Repeat steps j) to m) for the 2nd CO card. IW records which cards were used below. Each card is returned to its designated card holder after use. Set # ____ 1st SO card ____ of 7 2nd SO card ____ of 7 3rd SO card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		

Unsecure the HSM4

Step	Activity	Initials	Time
24	CA performs the following steps to unsecure the HSM: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"6.HSM Mgmt"**, press **ENT** to confirm. c) When **"Insert Card SO #X?"** is displayed, insert the SO card. d) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. e) When **"Remove Card?"** is displayed, remove the SO card. f) Repeat steps c) to e) for the 2nd and 3rd SO card. g) Select **"5.Unsecure"**, press **ENT** to confirm. h) When **"Unsecure?"** is displayed, then press **ENT**. i) When **"DONE"** is displayed, then press **ENT**. It may take a few minutes for the HSM to restart after the zeroization is complete. The HSM will reboot into the **"Unsecured State"** and after the completion of the HSM self test the display should show **"Important Read Manual"** indicating the HSM is in the initialized state. IW records which cards were used below. Each card is returned to its designated card holder after use. Set # ____ 1st SO card ____ of 7 2nd SO card ____ of 7 3rd SO card ____ of 7 **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		

Tamper the HSM4

Step	Activity	Initials	Time
25	CA performs the following steps to tamper the HSM equipment listed below: a) Using **Tool B**, press and hold the recessed button on the rear panel of the HSM located between the LAN and serial ports (remove the tamper sticker if necessary), then release it after 10 seconds to activate the tampering mechanism. **IMK missing recovery mode** will be displayed on the HSM. b) Turn **OFF** the HSM using the rocker switch on the rear panel. Turn **ON** the HSM with the same switch and wait until the **ALERT** LED light is **ON** and **IMK missing recovery mode** is displayed to verify the tampered state. c) Disconnect the power and serial cables from the HSM.		

Open the HSM Case and Remove the Logic Board from HSM4

Step	Activity	Initials	Time
26	IW reads steps 27 to 30 aloud while the CA dismantles **HSM4: Serial # H1411006**.		
27	CA performs the following steps to access the HSM's critical components: a) Using **Tool A+Bit 2**, remove the two screws securing the serial port to the rear panel. b) Using **Tool A+Bit 1**, remove the four screws from the rear panel of the case securing the shell. c) Using **Tool A+Bit 1**, remove the four screws from the bottom of the case securing the shell. d) Using **Tool C**, slice the tamper stickers on the bottom of the case along the seam with the shell. e) Slide the shell toward the back of the case to remove it and place it in the **HSM Parts** bin on the ceremony table. f) Using **Tool A+Bit 3**, remove the two logic board screws nearest to the front panel securing the plastic logic board cover. g) Remove the plastic logic board cover and place it in the **HSM Parts** bin on the ceremony table. h) Using **Tool A+Bit 3**, remove the two remaining screws securing the logic board near the rear panel. i) Detach the four cables from the front of the logic board. Open the latches outward to release each of the ribbon cables. j) Using **Tool A+Bit 4**, remove the nut from the cryptographic module securing the ring terminal of the green/yellow wire and slide the ring terminal off of the threaded stud. k) Detach the cable from each side of the cryptographic module connecting it to the logic board.		
28	CA performs the following steps to remove the logic board and batteries: a) Separate the logic board from the HSM case by pulling the logic board up then toward the front of the case. b) Using **Tool D**, cut and remove the zip ties securing the batteries if they are present, then cut the battery terminals that connect the batteries to the logic board. c) Pry the batteries from the logic board by placing the logic board flat on the table and rolling each battery back and forth with sufficient force to break the adhesive bond. d) Place the batteries in the **HSM Parts** bin on the ceremony table. e) Place the logic board in the **Critical Parts** bin on the ceremony table.		

Remove Cryptographic Module and Card Reader from HSM4

Step	Activity	Initials	Time
29	CA performs the following steps to remove the cryptographic module: a) Using **Tool A+Bit 4**, remove the 4 nuts securing the cryptographic module to the case. b) Lift the cryptographic module up to separate it from the case. c) Using **Tool C**, remove both connectors from the cryptographic module as flush with the case as possible. d) Place the cryptographic module in the **Critical Parts** bin, and the connectors in the **HSM Parts** bin on the ceremony table.		
30	CA performs the following steps to remove the front panel and card reader: a) Using **Tool A+Bit 4**, remove the 4 nuts securing the front panel to the bottom of the case. b) Place the front panel in the **HSM Parts** bin on the ceremony table. c) Using **Tool A+Bit 4**, remove the nut securing the card reader. d) Using **Tool A+Bit 3**, remove the 3 screws securing the card reader. e) Lift the card reader up to separate it from the case and place it with the ribbon cable in the **Critical Parts** bin on the ceremony table. f) Place the HSM case in the **HSM Parts** bin on the ceremony table.		

Place the Critical HSM4 parts into a TEB

Step	Activity	Initials	Time
31	CA places the container with the following critical parts into a prepared TEB, then seals it. a) Cryptographic Module b) Logic Board c) Card Reader **Note: The HSM case will not be destroyed.**		
32	CA performs the following steps: a) Read aloud the TEB number, then show it to the audit camera above for participants to see. b) Confirm with IW that the TEB number matches below. c) Initial the TEB along with IW using a ballpoint pen. d) Give IW the sealing strips for post-ceremony inventory. e) Give RKOS the TEB for destruction. **HSM4: TEB # BB81420075**		

Destroy Temporary Crypto Officer (CO) Cards

Step	Activity	Initials	Time
33	CA uses the shredder to destroy the temporary Crypto Officer (CO) cards. Use scissors to slice through the center of the chip before inserting cards into the shredder.		

Retire HSM Physical Keyboard Key

Step	Activity	Initials	Time
34	CA performs the following steps to retire the listed HSM Physical Keyboard Key: a) Remove the TEB from the cart. b) Inspect TEB for tamper evidence. c) Read aloud the TEB number while IW verifies the information using the previous ceremony script where it was last used. d) Remove and discard the TEB. e) RKOS will take possession of the HSM Physical Keyboard Key and place in its designated area. **HSM3 Physical Keyboard Key: TEB # BB21907221** **Last Verified: AT Ceremony 22 2015-07-20** **HSM4 Physical Keyboard Key: TEB # BB21907222** **Last Verified: AT Ceremony 22 2015-07-20** **Note: *"Last verified"* indicates the last time a piece of equipment was placed in a new TEB during a ceremony. It is listed here for audit tracking purposes.**		

Act 5: Secure Hardware

The CA will secure the ceremony hardware by performing the steps below:

- Back up the HSMFD contents
- Print log information
- Place the equipment and CO credentials inside of TEBs
- Along with IW, escort SSC1 and equipment cart into Tier 5 (Safe Room) to return equipment to Safe #1
- Along with IW, escort SSC2 and COs into Tier 5 (Safe Room) to return COs' smartcards to Safe #2.

Stop logging the Serial Output and the Terminal Session

Step	Activity	Initials	Time
1	CA performs the following steps to stop logging: a) Disconnect the null modem and ethernet cables from the laptop. b) Perform the following steps using the **HSM Output** terminal window to stop logging the serial output **(ttyaudit)**: i) Press **`Ctrl + C`** ii) Execute **`exit`** c) Execute the command below using the **Commands** terminal window to stop logging the terminal session: **`exit`** **Note: The Commands terminal session window will remain open.**		

Prepare blank FDs and back up the HSMFD Contents

Step	Activity	Initials	Time
2	CA executes the command below using the terminal window to enable copying of all content from the HSMFD: **`shopt –s dotglob`**		
3	CA executes the following commands using the terminal window to print 2 copies of the hash for the HSMFD content: a) **`lpadmin -p HP -o copies-default=2`** b) **`hsmfd-hash –p`** **Note: One copy for audit bundle and one copy for HSMFD package.**		
4	CA executes the command below using the terminal window to display the contents of the HSMFD: **`ls –ltrR`**		
5	CA executes the command below using the terminal window to create the mount point that will be used for the backup HSMFDs: **`mkdir /media/HSMFD1`**		
6	CA plugs a blank FD labeled HSMFD into an available USB slot on the laptop, then waits for the OS to recognize it.		
7	CA closes the file system window, then executes the command below to verify the device name of the blank HSMFD: **`df`**		
8	CA executes the commands below to unmount, format, mount, and back up the HSMFD contents to the blank HSMFD: a) **`umount /dev/sdc1`** b) **`mkfs.vfat -n HSMFD -I /dev/sdc1`** c) **`mount /dev/sdc1 /media/HSMFD1`** d) **`cp -pR * /media/HSMFD1`**		
9	CA executes the commands below using the terminal window to compare the SHA-256 hash between the original HSMFD and the HSMFD copy, then unmounts the flash drive before removal: a) **`hsmfd-hash -m`** b) **`umount /media/HSMFD1`**		
10	CA removes the **HSMFD copy**, then places it on the holder. **Wait for the activity light on the backup HSMFD to stop flashing before removal.**		
11	CA repeats step 6 to 10 for the 2nd copy. **Wait for the activity light on the backup HSMFD to stop flashing before executing each step.**		
12	CA repeats step 6 to 10 for the 3rd copy. **Wait for the activity light on the backup HSMFD to stop flashing before executing each step.**		
13	CA repeats step 6 to 10 for the 4th copy. **Wait for the activity light on the backup HSMFD to stop flashing before executing each step.**		
14	CA repeats step 6 to 10 for the 5th copy. **Wait for the activity light on the backup HSMFD to stop flashing before executing each step.**		

Print Logging Information

Step	Activity	Initials	Time
15	CA executes the following commands using the terminal window to print a copy of the logging information: a) **`lpadmin -p HP -o copies-default=1 -o fit-to-page-default=true`** b) **`enscript -2Gr script-202208*.log`** c) **`enscript –Gr --font="Courier8" ttyaudit-tty*-202208*.log`** Attach the printed copies to IW script. **Note: Ignore the error regarding non-printable characters if prompted.**		

Place HSMFDs and OS DVDs into a TEB

Step	Activity	Initials	Time
16	CA executes the following commands using the terminal window to unmount the HSMFD: a) **`cd /tmp`** b) **`umount /media/HSMFD`** CA removes the HSMFD, then places it on the holder.		
17	CA performs the following steps to switch OFF the laptop and remove the OS DVD: a) Remove the OS DVD from the laptop. b) Turn OFF the laptop by pressing the power button. c) Disconnect all connections from the laptop.		
18	CA places 2 HSMFDs, 2 OS DVDs, and 1 sheet of paper with the printed HSMFD hash into a prepared TEB, then seals it.		
19	CA performs the following steps to verify the TEB: a) Read aloud the TEB number, then show it to the audit camera above for participants to see. b) Confirm with IW that the TEB number matches with the information below. c) Initial the TEB along with IW using a ballpoint pen. d) Give IW the sealing strips for post-ceremony inventory. e) Place the OS DVD TEB on the cart. **OS DVD (release coen-0.4.0) + HSMFD: TEB # BB91951311**		
20	CA distributes the remaining HSMFDs: 2 for IW (for audit bundles). 2 for RKOS (for SKR exchange with RZM and process review).		

Place the Laptop into a TEB

Step	Activity	Initials	Time
21	CA places the laptop into a prepared TEB, then seals it.		
22	CA performs the following steps: a) Read aloud the TEB number and laptop serial number, then show it to the audit camera above for participants to see. b) Confirm with IW that the TEB number and laptop serial number matches with the information below. c) Initial the TEB along with IW using a ballpoint pen. d) Give IW the sealing strips for post-ceremony inventory. e) Place the laptop TEB on the cart. **Laptop4: TEB # BB81420086 / Service Tag # F8SVSG2**		

Trusted Community Representative Declaration

Step	Activity	Initials	Time
23	CA confirms that the **Trusted Community Representative Declaration** form is signed by the CO Successor. IW retains the original copy. **CO6 Successor: Jorge Etges**		

Place Crypto Officers' Credentials into TEBs

Step	Activity	Initials	Time
24	The CA calls each of the COs listed below sequentially to the ceremony table to perform the following steps: a) CA takes the TEB and plastic case prepared for the CO. b) CO takes their cards from the card holder and places it inside the plastic case. c) CO gives the plastic case containing the cards to the CA. d) CA places the plastic case into the prepared TEB, reads aloud the TEB number and description, then seals it. e) CA initials the TEB with a ballpoint pen, then IW keeps the sealing strips for post-ceremony inventory. f) IW inspects the TEB, confirms the TEB number with the list below, then initials it with a ballpoint pen. g) CA gives the TEB containing the cards to the CO. h) CO inspects the TEB, verifies its contents, then initials it with a ballpoint pen. i) CO writes the date and time, then signs the table of IW's script, then IW initials the entry. j) CO returns to their seat with their TEBs, being especially careful not to compromise any TEB. k) Repeat steps for all the remaining COs' credentials on the list. **CO1: Arbogast Fabian** **OP TEB # BB91951310** **SO TEB # BB91951309** **CO3: João Damas** **OP TEB # BB91951308** **SO TEB # BB91951307** **CO6 Successor: Jorge Etges** **OP TEB # BB91951306** **SO TEB # BB91951305** **CO7: Subramanian Moonesamy** **OP TEB # BB91951304** **SO TEB # BB91951303**		

CO	TEB #	Printed Name	Signature	Date	Time	IW Initials
CO1	OP TEB # **BB91951310** SO TEB # **BB91951309**	**Arbogast Fabian**		**2022 Aug __**		
CO3	OP TEB # **BB91951308** SO TEB # **BB91951307**	**João Damas**		**2022 Aug __**		
CO6	OP TEB # **BB91951306** SO TEB # **BB91951305**	**Jorge Etges**		**2022 Aug __**		
CO7	OP TEB # **BB91951304** SO TEB # **BB91951303**	**Subramanian Moonesamy**		**2022 Aug __**		

Return the Equipment to Safe #1 (Tier 6, Equipment Safe)

Step	Activity	Initials	Time
25	CA and IW transport a cart and escort SSC1 into Tier 5 (Safe Room.)		
26	SSC1 opens Safe #1 while shielding the combination from the camera. **Note: SSC begins by rapidly spinning the dial counter-clockwise 15-20 revolutions in order to charge it before stopping at the first number in the combination.**		
27	SSC1 removes the safe log, then writes the date and time, then signs the safe log where **"Open Safe"** is indicated. IW verifies this entry, then initials it. **Note: If log entry is pre-printed, verify the entry, record time of completion and sign.**		
28	CA performs the following steps to return each piece of equipment to the safe: a) CAREFULLY remove the equipment TEB from the cart. b) Read aloud the TEB number while showing it to the audit camera above, then place it inside Safe #1 c) Write the date, time, and signature on the safe log where **"Return"** is indicated. d) IW verifies the safe log entry, then initials it. **HSM5W: TEB # BB51184248** **Laptop4: TEB # BB81420086** **OS DVD (release coen-0.4.0) + HSMFD: TEB # BB91951311**		

Close Safe #1 (Tier 6, Equipment Safe)

Step	Activity	Initials	Time
29	SSC1 writes the date and time, then signs the safe log where **"Close Safe"** is indicated. IW verifies the entry, then initials it.		
30	SSC1 returns the safe log to Safe #1, closes the safe door, pulls up on the handle, and ensures it's locked by spinning the dial at least two full revolutions each way, counter-clockwise then clockwise. CA and IW verify that the safe is locked and the **"WAIT"** light indicator is off.		
31	CA, SSC1, and IW leave Tier 5 (Safe Room) transporting the cart and returning to Tier 4 (Key Ceremony Room).		

Open Safe #2 (Tier 6, Credentials Safe)

Step	Activity	Initials	Time
32	CA transports the guard key and a flashlight, and with IW escort SSC2 and the COs into Tier 5 (Safe Room.)		
33	SSC2 opens Safe #2 while shielding the combination from the camera. **Note: SSC begins by rapidly spinning the dial counter-clockwise 15-20 revolutions in order to charge it before stopping at the first number in the combination.**		
34	SSC2 removes the safe log, then writes the date and time, then signs the safe log where **"Open Safe"** is indicated. IW verifies this entry, then initials it. **Note: If log entry is pre-printed, verify the entry, record time of completion and sign.**		

COs Return the Credentials to Safe Deposit Boxes (Tier 7)

Step	Activity	Initials	Time
35	COs perform the following steps sequentially to return the listed TEBs: a) CO reads aloud the TEB number(s), then verifies integrity while showing the TEB(s) to the audit camera above b) After the CA operates the guard key in the bottom lock, CO uses their tenant key to operate the top lock and opens their safe deposit box. c) CO reads aloud the safe deposit box number, places their TEB(s) inside, then closes and locks the safe deposit box. **Note: The COs will retrieve their new safe deposit box keys when specified below.** d) CO writes the date and time, then signs the safe log where **"Return"** is indicated. e) IW verifies the completed safe log entry, then initials it. **CO1: Arbogast Fabian** **Box # 1788** **OP TEB # BB91951310** **SO TEB # BB91951309** **CO3: João Damas** **Box # 1069** **OP TEB # BB91951308** **SO TEB # BB91951307** **CO6 Successor: Jorge Etges** **Box # 1072 (Retrieve keys from lock)** **OP TEB # BB91951306** **SO TEB # BB91951305** **CO7: Subramanian Moonesamy** **Box # 1790** **OP TEB # BB91951304** **SO TEB # BB91951303**		

Close Safe #2 (Tier 6, Credentials Safe)

Step	Activity	Initials	Time
36	Once all safe deposit boxes are closed and locked, SSC2 writes the date and time, then signs the safe log where **"Close Safe"** is indicated. IW verifies the safe log entry, then initials it.		
37	SSC2 returns the safe log to Safe #2, closes the safe door, pulls up on the handle, and ensures it's locked by spinning the dial at least two full revolutions each way, counter-clockwise then clockwise. CA and IW verify that the safe is locked and the **"WAIT"** light indicator is off.		
38	CA, IW, SSC2, and COs leave Tier 5 (Safe Room) returning to Tier 4 (Key Ceremony Room).		

Act 6: Close the Key Signing Ceremony

The CA will finish the ceremony by performing the following steps:

- Read any exceptions that occurred during the ceremony
- Call the ceremony participants to sign the IW's script
- Stop the online streaming and video recording
- Ensure that all participants are signed out of Tier 4 (Key Ceremony Room) log and escorted out
- Prepare the audit bundle materials

Participants Sign IW's Script

Step	Activity	Initials	Time
1	CA reads all exceptions that occurred during the ceremony.		
2	CA calls each attendee on the participants list to proceed to the ceremony table and sign IW's participants list. **All signatories declare that this script is a true and accurate record of the ceremony.**		
3	CA reviews IW's script, then signs the participants list.		
4	IW signs the list and records the completion time.		

Retiring Crypto Officers

Step	Activity	Initials	Time
5	CA acknowledges the retiring Crypto Officer and presents them with a token of our appreciation. **Nicolas Antoniello**		

Stop Online Streaming and Recording

Step	Activity	Initials	Time
6	CA acknowledges the participation of the online participants, then notifies the SA to stop the online streaming.		
7	CA requests that an SA stop the audit camera video recording.		
8	CA informs onsite participants of post ceremony activities.		
9	Ceremony participants take a group photo.		

Sign Out of Tier 4 (Key Ceremony Room)

Step	Activity	Initials	Time
10	RKOS ensure that all participants are signed out of Tier 4 (Key Ceremony Room) log and escorted out of Tier 4 (Key Ceremony Room.) SA, IW, and CA must remain in Tier 4 (Key Ceremony Room.)		

Bundle Audit Materials

Step	Activity	Initials	Time
11	IW makes a copy of their script for off-site audit bundle containing: a) Output of signer system – HSMFD. b) Copy of IW's key ceremony script. c) Audio-visual recording from the audit cameras. d) Logs from the Physical Access Control System and Intrusion Detection System: Range: **20220216 00:00:00 to 20220818 00:00:00 UTC** e) IW's attestation (See Appendix C on page 42). f) SA's attestation (See Appendix D on page 43 and Appendix E on page 44). All TEBs are labeled **Root DNSSEC KSK Ceremony 46**, dated and initialed by IW and CA. An off-site audit bundle is delivered to an off-site storage.		

Appendix A: References

The numeric items listed below has been referenced in the script.

[1] **coen:** The Ceremony Operating ENvironment (COEN) is a *Reproducible* ISO image consisting of a live operating system.
More information and the OS image source code can be found at https://github.com/iana-org/coen

[2] **sha2wordlist:** Is an application written in C by Kirei AB, which digests STDIN and output a SHA-256 checksum displayed as PGP words.
The source code is available at https://github.com/kirei/sha2wordlist

[3] **configure-printer:** Is a bash script used to install the HP LaserJet printer from the command line instead using system-config-printer.
The source code is available at https://github.com/iana-org/coen/blob/master/tools/packages/ksk-tools-0.1.0coen_amd64.deb*

[4] **hsmfd-hash:** Is a bash script used to calculate, print and compare SHA-256 checksums for the HSMFD flash drives. It has the following options:

a) **-c Calculate the HSMFD SHA-256 hash and PGP Word List**

b) **-p Print the calculated HSMFD SHA-256 hash and PGP Word List using the default printer**

c) **-m Compare the calculated SHA-256 hashes between HSMFDs**

The following is the main command invoked by this script:
find -P */media/HSMFD/* -type f -print0 | sort -z | xargs -0 cat | sha2wordlist

Note: The sort command has a different behavior depending on the locale settings specified in environment variables. Current OS locale setting is `LC_COLLATE="POSIX"`

The source code is available at https://github.com/iana-org/coen/blob/master/tools/packages/ksk-tools-0.1.0coen_amd64.deb*

[5] **ttyaudit:** Is a perl script use to capture and logging the *HSM* output.
The source code is available at https://github.com/iana-org/coen/blob/master/tools/packages/ksk-tools-0.1.0coen_amd64.deb*

[6] **ping hsm:** The HSM static IP address **192.168.0.2** has been included in the **/etc/hosts** file.

[7] **ksrsigner:** Is an application written in C by Dr. Richard Lamb, which uses the KSK private key stored in the HSM to generate digital signatures for the ZSK.
The source code is available at https://github.com/iana-org/dnssec-keytools

[8] **printlog:** Is a bash script use to print the *Key Signing Log* output from **ksrsigner** application.
The source code is available at https://github.com/iana-org/coen/blob/master/tools/packages/ksk-tools-0.1.0coen_amd64.deb*

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* A debian package is an **ar** archive. To extract data from a deb package, use the command **ar -x ksk-tools-0.1.0coen_amd64.deb**
Then extract the files with **tar -xvf data.tar.xz**
The file will be located in the directory: **./opt/icann/bin/**

Appendix B: Audit Bundle Checklist

1. Output of Signer System (by CA)

Each audit bundle will contain one HSMFD. All bundles will be placed inside TEBs that are pre-labeled Audit Original and Audit Copy

2. Key Ceremony Script (by IW)

Hard copies of the IW's key ceremony script, notes during the ceremony and attestation. See Appendix C on page 42.

3. Audio-Visual Recordings from the KSK Ceremony (by SA)

Two sets of the audit camera footage - One for the original audit bundle and the other for the duplicate audit bundle.

4. Logs from the Physical Access Control System and Intrusion Detection System (by SA)

Two electronic copies of the following:

1. Firewall configuration
2. Configuration reports
3. Personnel/cardholder reports
4. Activity and audit log reports

These files will be placed inside two separate Flash Drives that are labeled "Audit".

The contents of the Flash Drive will be confirmed by the IW before placing each of them inside the original and the duplicate audit bundles.

5. Configuration review of the Physical Access Control System and Intrusion Detection System (by SA)

SA's attestation and hard copies of the screen shots and configuration audit log from the review process. See Appendix D on page 43.

6. Configuration review of the Firewall System (by SA)

SA's attestation and hard copies of the firewall configuration from the review process. See Appendix E on page 44. Ensure the scrambled passwords are eliminated from the configuration before publishing it.

7. Other items

If applicable.

Appendix C: Key Ceremony Script (by IW)

I hereby attest that the Key Ceremony was conducted in accordance with this script.
Any exceptions that occurred were accurately and properly documented.

IW: **Yuko Yokoyama**

Signature: _____

Date: 2022 Aug __

Appendix D: Access Control System Configuration Review (by SA)

In my review of the KMF's Access Control System, I attest that the following are true and correct to the best of my knowledge:

a) There were NO discrepancies found in the system configurations, assigned authorizations and audit logs.
b) Aside from the date filter that is applicable to some reports, there were NO other filters applied.

Below are the reports that were generated from the access control system:

1. List of Personnel with assigned Access Group.
2. Configuration of Areas and Access Groups.
3. Logs for Access Event activities and Configuration activities.

Range: **20220216 00:00:00 to 20220818 00:00:00 UTC.**

SA: _____

Signature: _____

Date: 2022 Aug __

Appendix E: Firewall Configuration Review (by SA)

I have reviewed and confirmed that the firewall configuration satisfies the requirements of the DNSSEC Practice Statement with version 6th Edition (2020-11-04). No part of the signer system making use of the Hardware Security Module (HSM) is connected to any communication network.

SA:

Signature:

Date: 2022 Aug __