Root DNSSEC KSK

Administrative Ceremony
HSM Acceptance Testing

Tuesday August 13, 2019

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

This ceremony is executed in accordance to the DNSSEC Practice Statement for the Root Zone KSK Operator Version 4th Edition (2016-10-01)

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 the time of completion.

Title / Roles	Printed Name	Signature	Date	Time
CA	Andres Pavez / PTI		2019 Aug 13	21:26
IW	Aaron Foley / PTI			
IW_Backup	Jonathan Denison / ~~RTN~~ ICANN			
SSC1	Anand Mishra / ICANN			
SA	Connor Barthold / ICANN			
SW	Anthony Bruneio / ICANN			
CO	Arbogast Fabian			
CO	Subramanian Moonesamy			
EW	Julian Macassey			

Note: 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 Root DNSSEC KSK Administrative Ceremony

The Root DNSSEC Key Signing Key (KSK) Administrative Ceremony is a scripted meeting where individuals with specific roles perform tasks related to support the operation of the Root Zone KSK. Administrative Ceremonies include all ceremonies that do not require use of the private key component of the root zone DNSSEC KSK, such as enrollment or replacement of a trusted role, media deposit or extraction, equipment acceptance testing or maintenance, etc. 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 CAs, IWs, or SAs can enter and escort other participants into the 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
- CAs, IWs, or SAs may escort participants out of Tier 4 (Key Ceremony Room) at the CA's discretion only if Tier 5 (Safe Room) is not occupied during the ceremony
- All participants are required to sign in and out of Tier 4 (Key Ceremony Room) using the visitor log
- The SA starts filming before the participants enter Tier 4 (Key Ceremony Room)
- Ceremony participants follow the script step by step
- CA reads each step aloud prior to its performance
- Upon completion of each step, IW announces the time of completion, records the completion time, and initials their copy of the script
- Ceremony participants who notice a problem or an error during the ceremony should interrupt the ceremony. Ceremony participants agree on a resolution before proceeding
- 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 inside 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 tell and/or confirm identifiers comprised of numbers and letters. When spelling identifiers, the phonetic alphabet shown below must 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

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

Sign into Tier 4 (Key Ceremony Room)

Step	Activity	Initials	Time
1	CA confirms with SA that all audit cameras are recording.		20:14
2	CA confirms that all participants are signed into Tier 4 (Key Ceremony Room) log, then performs a roll call using the participants list on page 2.		20:15
3	CA asks that any first time ceremony participants introduce themselves.		20:16

Emergency Evacuation Procedures and Electronics Policy

Step	Activity	Initials	Time
4	CA reviews the emergency evacuation procedure with onsite participants.		20:17
5	CA explains the use of personal electronic devices during the ceremony		20:17
6	CA briefly explains the purpose of the ceremony.		20:22

Verify the Time and Date

Step	Activity	Initials	Time
7	IW enters UTC date (year/month/day) and time using a reasonably accurate clock visible to all in Tier 4 (Key Ceremony Room): Date and time: 2019 08 13 20:22 All entries into this script or any logs should follow this common source of time.		20:22

Act 2. HSM Acceptance Testing

The CA performs the HSM Acceptance Testing by executing the following steps:

- Inspect the HSM's Tamper Evident Bag for tamper evidence
- Set up and configure the testing laptop, peripherals, and connections
- Power on HSM
- Issue Security Officer (SO) cards and set HSM to secure state
- Issue Crypto Officer (CO) and Operator (OP) cards
- Change and verify API settings
- Verify connectivity, activate, and initialize HSM
- Generate and verify a test key
- Erase / zeroize / unsecure HSM and power off
- Store the HSM inside of a Tamper Evident Bag
- Destroy credential cards
- Power off and disconnect remaining equipment
- Place HSM in Tier 6 (Equipment Safe #1)

Verify Chain of Custody

Step	Activity	Initials	Time
1	CA performs the following steps to unbox the new HSM. a) Unpack the HSM box while leaving HSM enclosed in the vendor supplied TEB. b) Inspect the HSM vendor supplied TEB for tamper evidence. c) Match HSM serial number and vendor TEB to digitally signed email from the vendor (Appendix A). If these do not match, re-package HSMs, terminate the ceremony, and return HSMs. d) Remove and discard the TEB, then place the HSM on its designated area of the ceremony table. e) Affix a label on the HSM. **HSM5W: TEB # PS076811 / Serial # H1903017**		20:28
2	CA removes the small packet on top of the HSM containing the HSM physical key and performs the following steps: a) Verify the serial number on the packet matches with the HSM serial number. b) Verify the number in the key matches with the number in the packet. c) Return the physical key to the small packet, place it in a prepared TEB, and seal it. d) Read aloud the TEB number and show it to the participants and IW to confirm the TEB number below. e) Initial the TEB along with IW using a ballpoint pen. f) Give IW the sealing strips for post-ceremony inventory. g) Place the TEB on the cart. **HSM5W Physical Key: TEB # BB46584446** **Note: The HSM physical key is used to enable/disable the LCD display and the Keypad.**		20:31

Laptop Setup

Step	Activity	Initials	Time
3	CA performs the following steps to confirm that no hard drive and battery are in the testing laptop: a) Confirm that the hard drive slot is empty. b) Confirm that the battery slot is empty.		20:31
4	CA performs the following steps to boot the testing laptop: a) Connect the null modem cable into the serial port of the laptop. b) Connect the external HDMI display cable. c) Connect the power supply. d) Immediately insert the copy of the **OS DVD release coen-0.4.0**[1] after the laptop power is switched ON.		20:33
5	CA verifies whether the external display works, then 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**		20:34

OS DVD Checksum Verification

Step	Activity	Initials	Time
6	CA uses the terminal window to executes the following steps: a) Calculate the SHA-256 hash by executing: `sha2wordlist`[2] `< /dev/sr0` 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 confirms 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/38**		20:37

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 "20190813 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.		20:38

Format and label the blank FD

Step	Activity	Initials	Time
8	CA performs the following steps to format a new FD: a) Plug a new FD into an available USB port in the laptop and wait for it to be recognized. b) Close the file system popup window. CA uses the terminal window to perform the following steps: c) Confirm the drive letter by executing: **`df`** d) Unmount the drive by executing: **`umount /dev/sdb1`** e) Format and label the FD by executing: **`mkfs.vfat -n HSMFD -I /dev/sdb1`** f) CA removes the FD, then places it on the holder.		20:39
9	CA repeats step 8 for the 2nd blank FD.		20:39

Connect the HSMFD

Step	Activity	Initials	Time
10	CA plugs an empty **HSMFD** into the USB slot, then performs the steps below: a) Wait for the OS to recognize it. b) Close the file system window.		20:40

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`**		20:40
12	CA executes the command below to log activities of the **Commands** terminal window: **`script script-20190813.log`**		20:40

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[3] /dev/ttyS0`
	Note: DO NOT unplug the null modem cable from the laptop as this will stop capturing activity logs from the serial port.
			20:41

Power ON the HSM (Tier 7)

Step	Activity	Initials	Time
14	CA performs the following steps to prepare the HSM: a) Plug the null modem cable into the serial port of the HSM. b) Connect the power to the HSM, then switch it ON. **Note: Status information should appear on the HSM activity logging screen.** c) Scroll the logging screen up and look for the HSM serial number. d) IW matches the displayed HSM serial number on the screen with the information below. e) After the completion of the HSM self test the display should say **"Important Read Manual"** indicating the HSM is in the initialized state. **HSM5W: Serial # H1903017** **Note: The date and time on the HSM is not used as a reference for logging and timestamp.**		20:43

Issue Security Officer (SO) Cards

Step	Activity	Initials	Time
15	CA performs the following steps to issue Security Officer (SO) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"1.Issue SO Cards"**, press **ENT** to confirm. c) When **"Issue SO Cards?"** is displayed, press **ENT** to confirm. d) When **"Num Cards?"** is displayed, enter **"2"**, then press **ENT**. e) When **"Num Req Cards?"** is displayed, enter **"2"**, then press **ENT**. f) When **"Insert Card #X?"** is displayed, insert the required SO card. g) When **"Remove Card?"** is displayed, remove the SO card. h) Repeat steps f) to g) for the 2nd SO card. i) When **"SO Cards Issued"** is displayed, press **ENT** to confirm. **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		20:45

Configure the HSM to Secure State

Step	Activity	Initials	Time
16	CA performs the following steps to configure the HSM to secure state using Security Officer (SO) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"3.Secure"**, press **ENT** to confirm. c) When **"Secure?"** is displayed, press **ENT** to confirm. d) When **"Insert Card SO #X?"** is displayed, insert the SO card. e) When **"PIN?"** is displayed, enter **"11223344"**, then press **ENT**. f) When **"Remove Card?"** is displayed, remove the SO card. g) Repeat steps d) to f) for the 2nd SO card. h) When **"SMK AES Triple DES?"** is displayed, press **CLR** to skip. i) When **"SMK AES"** is displayed, press **ENT** to confirm. j) When **"LAN Port Number?"** is displayed, press **CLR** to skip. k) When **"Enable IPv4/IPv6?"** is displayed, press **CLR** to skip. l) When **"LAN IPv4 Address?"** is displayed, press **CLR** to skip. m) When **"LAN IPv4 Mask?"** is displayed, press **CLR** to skip. n) When **"Set IPv4 Gateway?"** is displayed, press **CLR** to skip. o) When **"LAN IPv6 Address?"** is displayed, press **CLR** to skip. p) When **"LAN IPv6 Mask?"** is displayed, press **CLR** to skip. q) When **"Set IPv6 Gateway?"** is displayed, press **CLR** to skip. r) When **"Remote Mgmt Off Enable?"** is displayed, press **CLR** to skip. s) When **"Remote Mgmt Off** is displayed, press **ENT** to confirm. t) When **"Change Clock?"** is displayed, press **CLR** to skip. u) When **"Import Config?"** is displayed, press **CLR** to skip. v) When **"FIPS Mode On Disable?"** is displayed, press **CLR** to skip. w) When **"FIPS Mode On"** is displayed, press **ENT** to confirm. x) When **"Global Key Export Enabled"** is displayed, press **CLR** to skip. **Done Rebooting Device** will be displayed. **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		20:49

Issue Crypto Officer (CO) and Operator (OP) Cards

Step	Activity	Initials	Time
17	CA performs the following steps to issue 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 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 **"Remove Card?"** is displayed, remove the CO card. n) Repeat steps l) to m) for the 2nd CO card. o) When **"CO Cards Issued"** is displayed, press **ENT** to confirm. **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		20:52
18	CA performs the following steps to issue Operator (OP) cards: a) Utilize the HSM's keyboard to scroll through the menu using < > b) Select **"2.Issue OP Cards"**, press **ENT** to confirm. c) When **"Issue OP Cards?"** is displayed, press **ENT** to confirm. d) When **"Num Cards?"** is displayed, enter **"2"**, then press **ENT**. e) When **"Num Req Cards?"** is displayed, enter **"2"**, then press **ENT**. f) When **"Insert Card #X?"** is displayed, insert the required OP card. g) When **"Remove Card?"** is displayed, remove the OP card. h) Repeat steps f) to g) for the 2nd OP card. i) When **"OP Cards Issued"** is displayed, press **ENT** to confirm. j) Press **CLR twice** to return to the main menu **"Secured"** **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		20:54

Change the API Settings

Step	Activity	Initials	Time
19	CA performs the following steps to change the API settings: 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 **"5. API Settings"**, press **ENT** to confirm. h) Select **"1.Key Import"**, press **ENT** to confirm. i) When **"Key Import On Disable?"** is displayed, press **ENT** to confirm. j) Select **"2.Key Export"**, press **ENT** to confirm. k) When **"Key Export On Disable?"** is displayed, press **ENT** to confirm. l) Select **"5.Sym Key Der"**, press **ENT** to confirm. m) When **"Sym Key Der On Disable?"** is displayed, press **ENT** to confirm. n) Press **CLR** to return to the menu **"Key Mgmt"** **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		20:55

Verify the API Settings

Step	Activity	Initials	Time

20	CA performs the following steps to dump the status of the HSM:
	a) Utilize the HSM's keyboard to scroll through the menu using < >
	b) Select **"8.HSM Info"** from the same menu **"Key Mgmt"**, press **ENT** to confirm.
	c) Select **"8.Output Info"**, press **ENT** to confirm.
	d) When **"Output Info?"** is displayed, press **ENT** to confirm.
	e) Press **CLR twice** to return to the main menu **"Secured"**
	
	CA switches to the **HSM Output** terminal window and scrolls up to confirm with IW the output of the HSM configuration matches with the list below:
	
	`Modes: (1=Enabled 0=Disabled)`
	`Global Key Export 1`
	`App Key Import 0`
	`App Key Export 0`
	`Asymmetric Key Gen 1`
	`Symmetric Key Gen 1`
	`Symmetric Key Derive 0`
	`Signing 1`
	`Signature Verify 1`
	`MAC Generation 1`
	`MAC Verification 1`
	`Encrypt / Decrypt 1`
	`Delete Asym Key 1`
	`Delete Sym Key 1`
	`Output Key Details 1`
	`Output Key Summary 1`
	`Suite B Algorithms 1`
	`Non Suite B Algs 1`
	`Auto Online 0`
	`Remote Management 0`
	`AES SMK`
	`Set Offline`
	`FIPS Mode`
			2058

Enable/Activate the HSM (Tier 7)

Step	Activity	Initials	Time
21	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 OP card. Confirm the **"READY"** LED on the **HSM** is **ON.** **Note: If the card is unreadable, gently wipe its metal contacts and try again.**		21:00

Check the Network Connectivity Between Laptop and HSM

Step	Activity	Initials	Time
22	CA connects the HSM to the laptop using an ethernet cable in the LAN ports.		21:01

23	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[4]`
	c) Wait for responses, then exit by pressing:
	`Ctrl + C`
			21:01

Initialize HSM

Step	Activity	Initials	Time

24	CA performs the following steps to initialize the HSM:
	a) Set environment variables
	`. /opt/dnssec/fixenv`
	b) Execute:
	`inittoken`
	c) For the slot number enter:
	`0`
	d) For the PKCS11 Token name enter:
	`ICANNTEST`
	e) For the User PIN enter and re-enter:
	`123456`
	f) For Security Officer PIN enter and re-enter:
	`123456`
	g) This should return
	"Token initialised OK"
			21:02

Generate New Test Key

Step	Activity	Initials	Time
25	CA executes the command below on the terminal window to generate new test key: `kskgen`[5] When `Activate HSM prior to accepting in the affirmative!! (y/N):` CA confirms that the HSM is online, then enters **"y"** to proceed. If `slot` is asked type `0`		21:04

Verify the Test KSK

Step	Activity	Initials	Time
26	CA checks the Test KSK by executing in to the terminal window: `keybackup`[6] `-l -P 123456` Verify the presence of the public and private keypair created previously by the `kskgen`[5] command.		21:05

Erase / Zeroize / Unsecure HSM

Step	Activity	Initials	Time
27	CA switches to the **HSM Output** terminal window. CA presses the **RESTART** button on the HSM to take **OFFLINE** and waits for *SELF TEST* to complete. Confirm the **READY** LED on the HSM is **OFF**.		21:06
28	CA performs the following steps to return the HSM to **Unsecure** factory default state. This will erase all keys, settings, and configuration. 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 SO card. g) Select **"5.Unsecure"**, press **ENT** to confirm. h) When **"Unsecure?"** is displayed, then press **ENT**. **Note: If the card is unreadable, gently wipe its metal contacts and try again.** It may take a few minutes for the HSM to restart after erasing all keys. The HSM will reboot into the **"Unsecured State"** and after the completion of the HSM self test the display should say **"Important Read Manual"** indicating the HSM is in the initialized state.		21:08
29	CA switches the HSM power to OFF, then disconnects the power, serial, and ethernet connections.		21:08

Place HSM in the TEB

Step	Activity	Initials	Time
30	CA places the HSM into a prepared TEB, then seals it.		21:10
31	CA performs the following steps to verify the TEB: a) Read aloud the TEB number and HSM serial number, then show the TEB to the audit camera above for participants to see. b) Confirm with IW that the TEB number and 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 HSM TEB on the cart. **HSM5W: TEB # BB51184509 / Serial # H1903017**		21:11

Destroy SO, OP, and CO Cards

Step	Activity	Initials	Time
32	CA uses the shredder to destroy the SO, OP, and CO cards.		21:12

Stop logging the Serial Output and the Terminal Session

Step	Activity	Initials	Time
33	CA performs the following steps to stop logging: a) Perform the following steps using the **HSM Output** terminal window to stop logging the serial output **(ttyaudit)**: i) Press `Ctrl + C` ii) Execute `exit` b) 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.**		21:12

Back up the HSMFD Contents

Step	Activity	Initials	Time
34	CA executes the command below using the terminal window to enable copying of all content from the HSMFD: `shopt -s dotglob`		21:13
35	CA executes the command below using the terminal window to display the contents of the HSMFD: `ls -ltrR`		21:14
36	CA plugs a blank FD labeled HSMFD into a free USB slot on the laptop, then waits for the OS to recognize it as **HSMFD1**		21:14
37	CA closes the file system window, then executes the command below to back up the HSMFD: `cp -pR * /media/HSMFD1`		21:15
38	CA executes the command below using the terminal window to compare the SHA-256 hash between the original HSMFD and the HSMFD copy: `hsmfd-hash`[7] `-m`		21:15
39	CA executes the command below using the terminal window to unmount the HSMFD copy: `umount /media/HSMFD1`		21:15
40	CA removes the **HSMFD1**, then places it on the holder.		21:15

Power OFF the Laptop

Step	Activity	Initials	Time
41	CA performs the following steps: a) Executes the command below to unmount the HSMFD: i) `cd /tmp` ii) `umount /media/HSMFD` CA removes the HSMFD, then places it on the holder.		21:16
42	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 including power, printer, display, serial, and network.		21:16

Open Equipment Safe #1

Step	Activity	Initials	Time
43	CA and IW transport a cart and escort SSC1 into Tier 5 (Safe Room.)		21:11
44	SSC1 opens Safe #1 while shielding the combination from the camera.		21:18
45	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 this entry then initials it.		21:19
46	CA performs the following steps to place the HSM and HSM physical key into the Safe: a) CAREFULLY remove the equipment TEBs from the cart. b) Read aloud the TEB numbers while showing them to the audit camera above, then place them inside Safe #1 c) Write the date, time, and signature on the safe log where **"Place"** is indicated. d) IW verifies the safe log entry, then initials it. **HSM5W: TEB # BB51184509 / Serial # H1903017** **HSM5W Physical Key: TEB # BB46584446**		21:21

Close Equipment Safe #1

Step	Activity	Initials	Time
47	SSC1 writes the date and time, then signs the safe log where Close Safe is indicated. IW verifies the entry, then initials it.		21:21
48	SSC1 returns the safe log back to Safe #1 and locks it (spin dial at least two full revolutions each way, counter clock wise then clock wise). CA and IW verify that the safe is locked and the "WAIT" light indicator is off.		21:22
49	CA, IW, and SSC1 leave the safe room with the cart, closing the door behind them.		21:22

Act 3. Close the Administrative Ceremony

The CA will finish the ceremony by:

- Reading all exceptions that occurred during the ceremony
- Calling the ceremony participants to sign the IW's script
- Stopping the video recording
- Ensuring that all participants are signed out of Tier 4 (Key Ceremony Room) log and escorted out of Tier 4 (Key Ceremony Room)
- Preparing the audit bundle materials

Participants Signing of IW's Script

Step	Activity	Initials	Time
1	CA reads all exceptions that occurred during the ceremony.		21:23
2	CA calls each attendee on the participants list to proceed to the ceremony table and sign IW's participants list. **All signatures declare that this script is a true and accurate record of the ceremony.**		21:25
3	CA reviews IW's script, then signs the participants list.		21:26
4	IW signs the list and records the completion time once all participants have completed.		21:26

Stop Video Recording and Sign Out of Tier 4 (Key Ceremony Room)

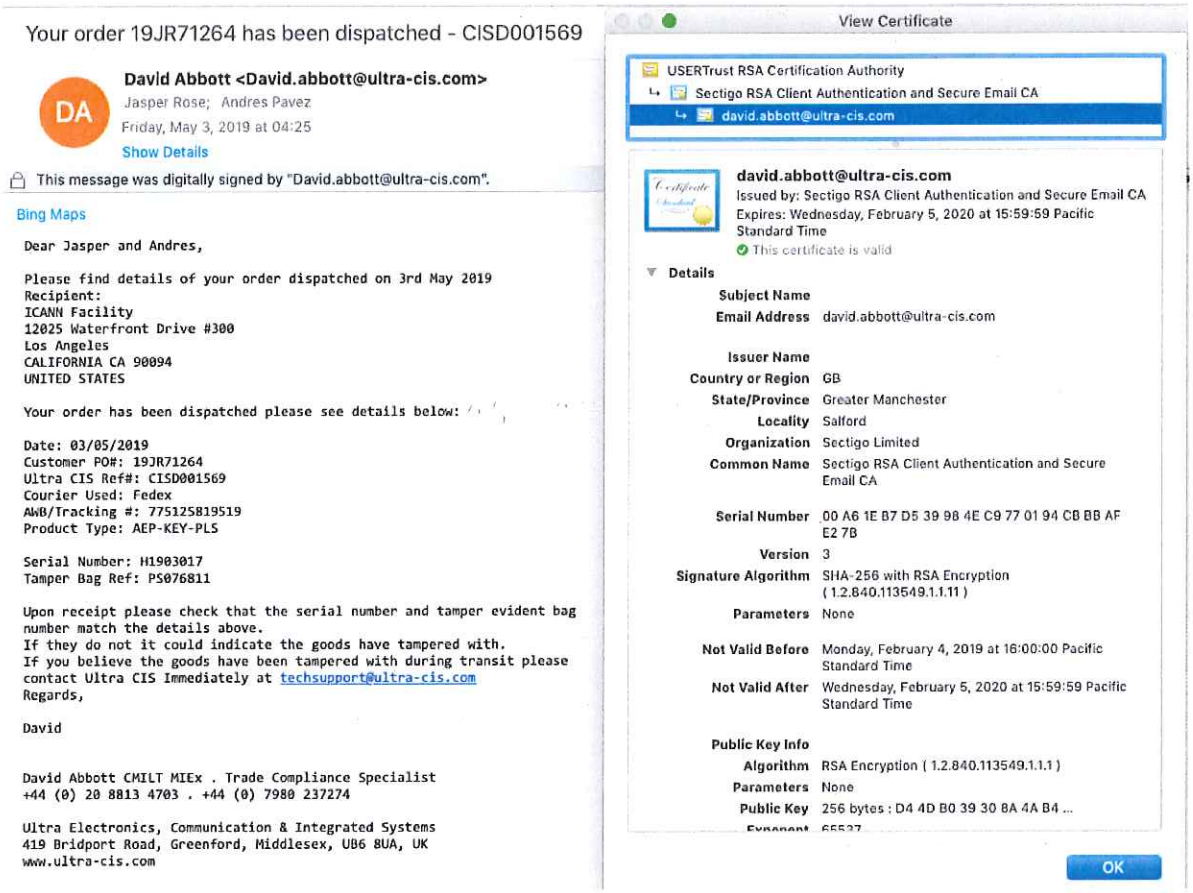
Step	Activity	Initials	Time
5	CA requests that an SA stop the audit camera video recording.		21:26
6	CA and IW ensure that all participants are signed out of Tier 4 (Key Ceremony Room) log and escorted out of Tier 4 (Key Ceremony Room).		21:36

Bundle Audit Materials

Step	Activity	Initials	Time
7	IW makes 1 copy of their script for off-site audit bundle. Each Audit bundle contains: a) Copy of IW's administrative ceremony script. b) Audio-visual recording. c) IW's attestation (Appendix D). All TEBs are labeled **Root DNSSEC Administrative Ceremony HSM Acceptance Testing**, dated and signed by IW and CA. An off-site audit bundle is delivered to an off-site storage.		21:37

Appendix A. HSM Chain of Custody

The following digitally signed email contains the HSM serial number and TEB number dispatched from the vendor.



Your order 19JR71264 has been dispatched - CISD001569

DA

David Abbott <David.abbott@ultra-cis.com>
Jasper Rose; Andres Pavez
Friday, May 3, 2019 at 04:25
Show Details

This message was digitally signed by "David.abbott@ultra-cis.com".

Bing Maps

Dear Jasper and Andres,

Please find details of your order dispatched on 3rd May 2019
Recipient:
ICANN Facility
12025 Waterfront Drive #300
Los Angeles
CALIFORNIA CA 90094
UNITED STATES

Your order has been dispatched please see details below:

Date: 03/05/2019
Customer PO#: 19JR71264
Ultra CIS Ref#: CISD001569
Courier Used: Fedex
AWB/Tracking #: 775125819519
Product Type: AEP-KEY-PLS

Serial Number: H1903017
Tamper Bag Ref: PS076811

Upon receipt please check that the serial number and tamper evident bag number match the details above.
If they do not it could indicate the goods have tampered with.
If you believe the goods have been tampered with during transit please contact Ultra CIS Immediately at techsupport@ultra-cis.com
Regards,

David

David Abbott CMILT MIEx . Trade Compliance Specialist
+44 (0) 20 8813 4703 . +44 (0) 7980 237274

Ultra Electronics, Communication & Integrated Systems
419 Bridport Road, Greenford, Middlesex, UB6 8UA, UK
www.ultra-cis.com

View Certificate

USERTrust RSA Certification Authority
Sectigo RSA Client Authentication and Secure Email CA
david.abbott@ultra-cis.com

david.abbott@ultra-cis.com
Issued by: Sectigo RSA Client Authentication and Secure Email CA
Expires: Wednesday, February 5, 2020 at 15:59:59 Pacific Standard Time
This certificate is valid

Details

Subject Name	
Email Address	david.abbott@ultra-cis.com
Issuer Name	
Country or Region	GB
State/Province	Greater Manchester
Locality	Salford
Organization	Sectigo Limited
Common Name	Sectigo RSA Client Authentication and Secure Email CA
Serial Number	00 A6 1E B7 D5 39 98 4E C9 77 01 94 CB BB AF E2 7B
Version	3
Signature Algorithm	SHA-256 with RSA Encryption (1.2.840.113549.1.1.11)
Parameters	None
Not Valid Before	Monday, February 4, 2019 at 16:00:00 Pacific Standard Time
Not Valid After	Wednesday, February 5, 2020 at 15:59:59 Pacific Standard Time
Public Key Info	
Algorithm	RSA Encryption (1.2.840.113549.1.1.1)
Parameters	None
Public Key	256 bytes : D4 4D B0 39 30 8A 4A B4 ...
Exponent	65537

OK

Appendix B. 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] **`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*

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

[5] **`kskgen:`** Is an application written in C by Dr. Richard Lamb, which create a KSK stored in the HSM.
The source code is available at https://github.com/iana-org/dnssec-keytools

[6] **`keybackup:`** Is an application written in C by Dr. Richard Lamb, which list, delete, and backup keys.
The source code is available at https://github.com/iana-org/dnssec-keytools

[7] **`hsmfd-hash:`** Is a bash script used to calculate, print and compare SHA-255 checksums for the HSMFD flash drives. It has the following options:

a) **`-h Show this help message`**
b) **`-c Calculate the HSMFD SHA-256 hash and PGP Word List`**
c) **`-p Print the calculated HSMFD SHA-256 hash and PGP Word List using the default printer`**
d) **`-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`[2]
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*

* 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 -zxvf data.tar.xz`**
The file will be located in the directory: **`./opt/icann/bin/`**

Appendix C. Audit Bundle Checklist

1. Administrative Ceremony Script (by IW)

Hard copies of the IW's administrative ceremony script, including notes and attestation. See Appendix D.

2. Audio-Visual Recordings from the Administrative Ceremony (by SA)

One set of the audit camera footages.

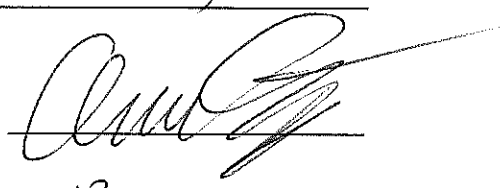
3. Other items

If applicable.

Appendix D. Administrative Ceremony Script (by IW)

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

IW: Aaron Foley

Signature: 

Date: 2019 Aug 13