GRP Consulting Group, LLC
4915 Twin Lakes Rd
Suite 15
Boulder, Colorado 80301
tel: 303/249-0445

GRP Consulting Group, LLC

ALLEGHENY COUNTY PRE APRIL 26, 2016 GENERAL PRIMARY ELECTION

ES&S IVOTRONICS FIRMWARE VERIFICATION STUDY

FINAL REPORT

Developed for:

ALLEGHENY COUNTY

DIVISION OF ELECTIONS

STATE OF PENNSYLVANIA

Document Number GCG-AC-iVo-FRPT-000228

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1. Introduction: Allegheny County ES&S iVotronics Firmware Verification Study

The Allegheny County, Pennsylvania Division of Elections requested GRP Consulting Group to audit and verify the firmware source code on twenty (20) ES&S iVotronic DRE voting machines before conducting the April 26, 2016 General Primary Election. The devices to be audited were randomly selected from the counties 4700 devices. The purpose was to verify that the samples have in residence on the U1 designated Electronic Erasable Programmable Read Only Memory (EEPROM) chip the firmware version 9.1.4.1 and that all applied firmware versions are accurate and true to the State of Pennsylvania's Trusted Build as held in escrow by the Secretary of State's Office in Harrisburg. The study was accomplished by applying the *'Allegheny County iVotronic Firmware Verification Protocol'* process and was performed on location at the Allegheny County Division of Elections warehouse; located at 901 Pennsylvania Ave., Pittsburgh, Pennsylvania. GRP Consulting Group and Allegheny County staff performed this firmware audit on January 25, 2016.

It is the finding of GRP Consulting Group that the firmware verification audit applied to the resident code on the sample population was found to be unaltered versions of the 9.1.4.1 firmware.

1.1 Approach

1.1.1 Study's Focus

The focus of the exercise was:

1. Implementation of a fair and random selection process.
2. Deploy the verification protocol, known as the *'Allegheny County iVotronic Firmware Verification Protocol'*, to verify on twenty (20) randomly chosen ES&S iVotronics DRE voting devices that they hold in residence on the U1 designated EEPROM chip the exact, true and unaltered version of the 9.1.4.1 certified firmware source code as held in escrow at the Secretary of State's office.

1.1.2 Study's Concentration

The GRP Consulting Group has been tasked to independently apply a repeatable and validated verification protocol to verify that the ES&S firmware version 9.1.4.1 that resides in escrow by the Secretary of State's office and is resident on the Allegheny County iVotronic Direct-Recording Entry (DRE) - touch screen voting devices – are exact, true and unaltered versions of the certified firmware source code.

1.1.3 Study's Phases

GRP Consulting Group organized the project primary phases, each incorporating the flexibility to accommodate additional requirements, as they may have become known. The general strategy employed was comprised of the following aspects:

1. Setup and configure the verification environment and the parameters associated with each verification cycle;
2. Apply the protocol to verify that before the April 26, 2016 General Primary Election that the 9.1.4.1 firmware on the iVotronic DREs is the true and certified version of the firmware and has not been altered;
3. Execute twenty (20) verification cycles comprised of verification on performed one (1) ADA (American Disabilities Act) compliant iVotronic and nineteen (19) non-compliant DRE units;
4. Conduct reviews and analyses of all verification results and anomalies obtained during the twenty (20) verification execution cycles;
5. Advise the County on possible root cause(s) of any and all anomalies; and
6. Prepare and deliver reports of the verification activities, the results of all verification executions, and conclusions and recommendations in Executive Summary and Final Report formats.

1.2 Purpose

This document is the Allegheny County pre-April 26, 2016 General Primary Election ES&S iVotronic Firmware Verification Study Final Report. This report was developed as a review of the specific technical details, the project's results, and findings.

1.3 Statement of Independence

As an election validation and verification business practice, GRP Consulting Group is technically, managerially, and financially independent from all electronic voting systems vendors as specified in *IEEE 1012-2004* Annex C.

The consultants of GRP Consulting Group shall maintain an independent decisional relationship between its clients, affiliates, or other organizations so that GRP Consulting Group's capacity to perform services objectively and without bias is not adversely affected.

GRP Consulting Group shall maintain independence in fact and in appearance. The validation and verification environment, whether on-site at GRP Consulting Group facilities or partner organizations or at a client's site, shall be organized so that staff members are not subjected to undue pressure or inducement that might influence their judgment or the results of their work.

1.4 References

1. iVotronic Software Verification Protocols: Allegheny County Proposals; Collin Lynch, President, VoteAllegheny; 9/28/2008
2. Firmware vs. Uploaded Firmware Chip Data Comparison Procedure; Election Systems and Software, Inc.; 1/18/2008
3. Allegheny County iVotronic Firmware Verification Protocol; Geoffrey R. Pollich, SysTest Labs, 10/14/08

1.5 Systems Information

Items identified in Table 1 reflect firmware deployed at the Allegheny County Division of Elections warehouse on January 25, 2016:

Table 1 - Matrix of Firmware

Vendor	System	Description	Software/ Firmware Version
ES&S	iVotronic	Direct Record Entry	9.1.4.1
ES&S	iVotronic	ADA Compliant DRE	9.1.4.1

Equipment identified in Table 2 reflects iVotronic hardware selected at the Allegheny Division of Elections warehouse on January 25, 2016:

Table 2 - Matrix of Hardware

iVotronic Serial Number	Microchip Manufacturer	Microchip Part Number
-> V5178319	Spansion	0603FRC-G
-> V5184812	Spansion	0612FBE-G
-> V5182312	Spansion	0612EBA-G
-> V5184900	Spansion	0609BRB-G
-> V5180900	Spansion	0603FRC-G
-> V5185032	Spansion	0609BRB-G
-> V5186582	Spansion	0612FBE-G
-> V5186553	Spansion	0609BRB-G
-> V5185155	Spansion	0612GBA-G

iVotronic Serial Number	Microchip Manufacturer	Microchip Part Number
-> V5184019	Spansion	0612GBA-G
-> V5186162	Spansion	0603FRD-G
-> V5184044	Spansion	0609BRB-G
-> V5186478	Spansion	0612GBA-G
-> V5182938	Spansion	0612EBA-G
-> V5184661	Spansion	0609BRB-G
-> V5186976	Spansion	0609BRB-G
-> V5186241	Spansion	0612FBE-G
-> V5185206	Spansion	0612FBE-G
-> V5182212	Spansion	0603FRC-G
-> V5172646	Spansion	0446EBE-G

Table 3 - Matrix of Testing Hardware

Description	Manufacturer	Model
EEPROM Device Programmer	Logical Devices, Inc.	ChipMaster 6000XPu
Flash Module Programmer Adapter	Logical Devices, Inc.	Version 1
ESD Static Mat with wrist strap	N/A	N/A
#10 Tamper Proof Torx screwdriver	N/A	N/A
Small flathead screwdriver	N/A	N/A

Table 4 - Matrix of Testing Software

Description	Manufacturer	Software Version
Software- CHIPMASTER 6000 XPU for USB	Logical Devices, Inc	ChipMaster 6000Xpu for USB
WinLink2	Logical Devices, Inc	v. 01.51.00
Hex Editor	Xvi32	v. 2.5
Microsoft Visual C++, Binary Editor	Microsoft Corporation	Version 6.0
SHA_V Sha-1 and other SHA segments Hash Code Identification	Microsoft File Checksum Integrity Verifier (FCIV) http://support.microsoft.com/kb/841290	Version 2.05

2. ALLEGHENY COUNTY PRE APRIL 26, 2016 GENERAL PRIMARY iVOTRONIC FIRMWARE VERIFICATION PROCESS; PREFORMED JANUARY 25, 2016

To establish a best practice protocol and verification procedure, Geoffrey Pollich, consultant with GRP Consulting Group, reviewed and analyzed the *VoteAllegheny: iVotronic Software Verification Protocols: Allegheny County Proposals*, the ES&S *Firmware vs. Uploaded Firmware Chip Data Comparison Procedure*, and NIST Standard Lab Procedures best practices. It was from these primary sources that the 'Allegheny County iVotronic Firmware Verification Protocol' was established.

2.1 Present during the January 25, 2016 Verification Process:

GRP Consulting Group:

Geoffrey Pollich – GRP Consulting Group, Principle Consultant

Allegheny County Division of Elections:

Mark Wolosik – Elections Division Manager
John O'Brien – Manager of Voting Machines
Elizabeth Dell – Business Analyst, Division of Computer Services

Election Advocacy Observers:

Benjamin Cox – VoteAllegheny
Louise Cannon – League of Women Voters

2.2 Sample Size Randomization Procedure

The sample size must be carefully selected due to the need to open the warranty seal over the lower left chassis screw in order to conduct the firmware verification. When this seal is broken, the DRE should be inspected and tested by ES&S. If a larger sample of machines were inspected per election, the availability of certified election machines may not satisfy the needs of individual precincts for federal, state, county, municipal and special issue elections held over the calendar year. It is also doubtful if a larger sample sizes would yield a more valid result than the present sample size appropriately randomized.

Benjamin Cox of VoteAllegheny and Louise Cannon of the League of Women Voters along with Division of Election employees initiated the machine-selection effort to establish 20 randomly chosen iVotronic units for testing. The Observers walked the isles of DRE and randomly choose the test machines. Mark Wolosik, Elections Division Manager, John O'Brien, Manager of Voting Machines, Elizabeth Dell, Business Analyst, Division of Computer Services, and Geoffrey Pollich of the GRP Consulting Group believed the selection was consistent with a valid random selection process and was free of any and all mathematical bias.

3. Allegheny County Pre April 26, 2016 General Primary Election ES&S iVotronic Firmware Verification Study Results

3.1 January 25, 2016 Results

08:30 – 9:30 am GRP Consulting Group and observers arrive at the Allegheny County warehouse facility to set up the verification work area; the Observer launches their randomization process

1. GRP Consulting Group connected the CHIPMASTER 6000 XPU EEPROM Programmer; the analyst setup the device to a GRP Consulting Group laptop; County Employees, and the Observer brought 20 randomly picked iVotronics into the verification work area to begin the firmware verification procedure.

09:33 Verify firmware procedure for iVotronic DRE #1

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5178319 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:35 Verify firmware procedure for iVotronic DRE #2

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5184812 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display

09:38 Verify firmware procedure for iVotronic DRE #3

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5182312 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code:
   (F6A8D4570988E2D159398503144E64D48F0CC69F).
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:41 Verify firmware procedure for iVotronic DRE #4

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5184900 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code:
   (F6A8D4570988E2D159398503144E64D48F0CC69F).
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:44 Verify firmware procedure for iVotronic DRE #5

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5180900 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code:
   (F6A8D4570988E2D159398503144E64D48F0CC69F).
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display

09:49 Verify firmware procedure for iVotronic DRE #6

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5185032 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F).**
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:50 Verify firmware procedure for iVotronic DRE #7

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5186582 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F).**
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:53 Verify firmware procedure for iVotronic DRE #8

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5186553 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F).**
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:56 Verify firmware procedure for iVotronic DRE #9

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5185519 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

09:59 Verify firmware procedure for iVotronic DRE #10

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5184019 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:02 Verify firmware procedure for iVotronic DRE #11

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5186162 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:05 Verify firmware procedure for iVotronic DRE #12

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n V5184944 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:08 Verify firmware procedure for iVotronic DRE #13

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5186478 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was an Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The AMD firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:11 Verify firmware procedure for iVotronic DRE #14

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5182938 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:14 Verify firmware procedure for iVotronic DRE #15

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5184661 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: `(F6A8D4570988E2D159398503144E64D48F0CC69F).`
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:17 Verify firmware procedure for iVotronic DRE #16

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->5186976 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: `(F6A8D4570988E2D159398503144E64D48F0CC69F).`
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:20 Verify firmware procedure for iVotronic DRE #17

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5186241 was selected.
2. Perform iVotronic Firmware Verify Procedure.
3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: `(F6A8D4570988E2D159398503144E64D48F0CC69F).`
5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:24 Verify firmware procedure for iVotronic DRE #18

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5185206 was selected.

2. Perform iVotronic Firmware Verify Procedure.

3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.

4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.

5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:27 Verify firmware procedure for iVotronic DRE #19

1. Randomly select an iVotronic DRE from the warehouse for the firmware verification procedure; s/n ->V5182212 was selected. Perform iVotronic Firmware Verify Procedure.

2. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.

3. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.

4. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

10:36 Verify firmware procedure for iVotronic DRE #20

1. Randomly select an iVotronic ADA equipped DRE from the warehouse for the firmware verification procedure; s/n V5172646 was selected. (*ADA Device*)

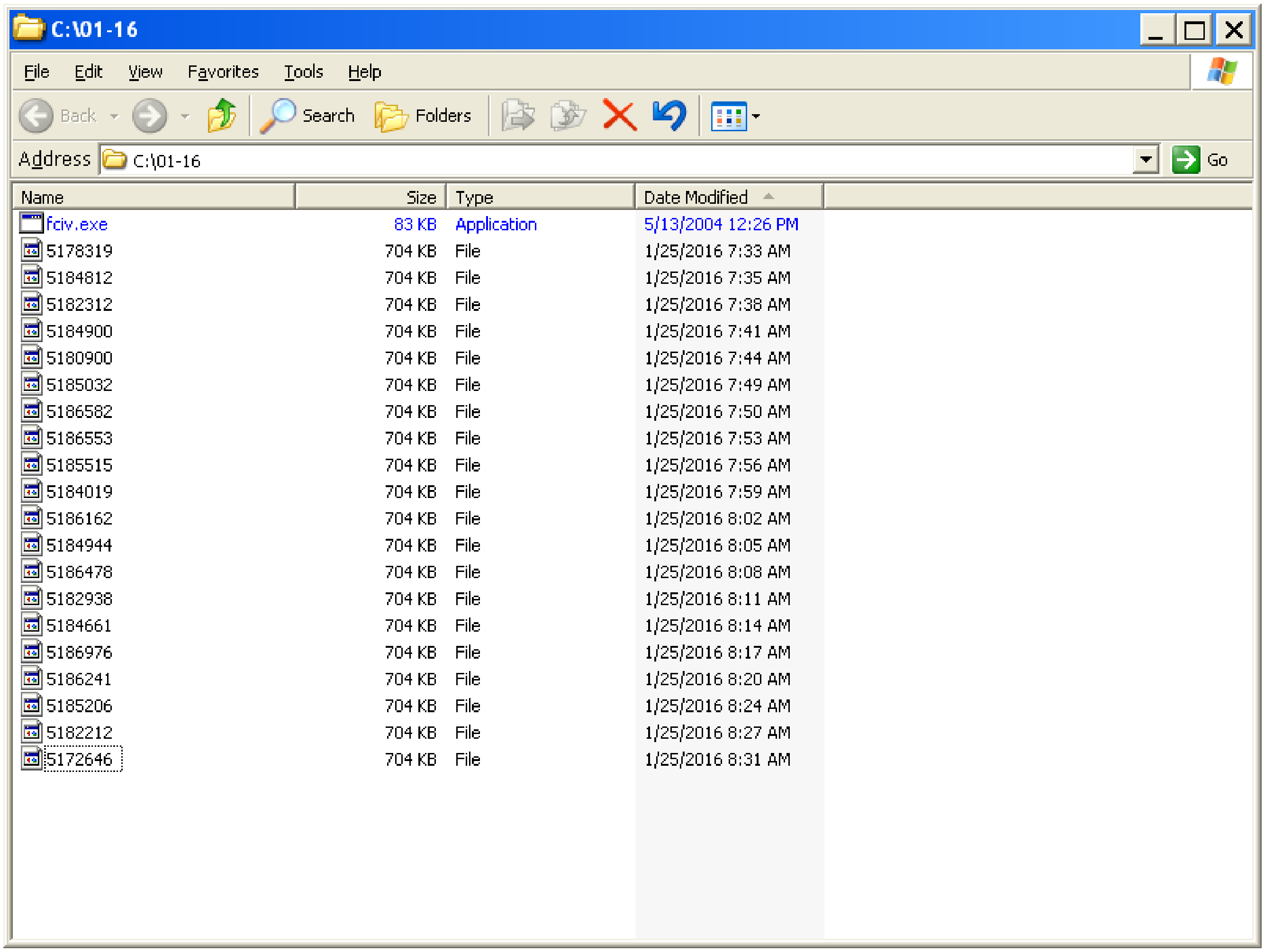
2. Perform iVotronic Firmware Verify Procedure.

3. Upon opening of iVotronic DRE, the removable CMOS was a Spansion CMOS part S29AL016D90TF101, and the CHIPMASTER 6000 XPU EEPROM programmer was used to read and save the binary firmware code.

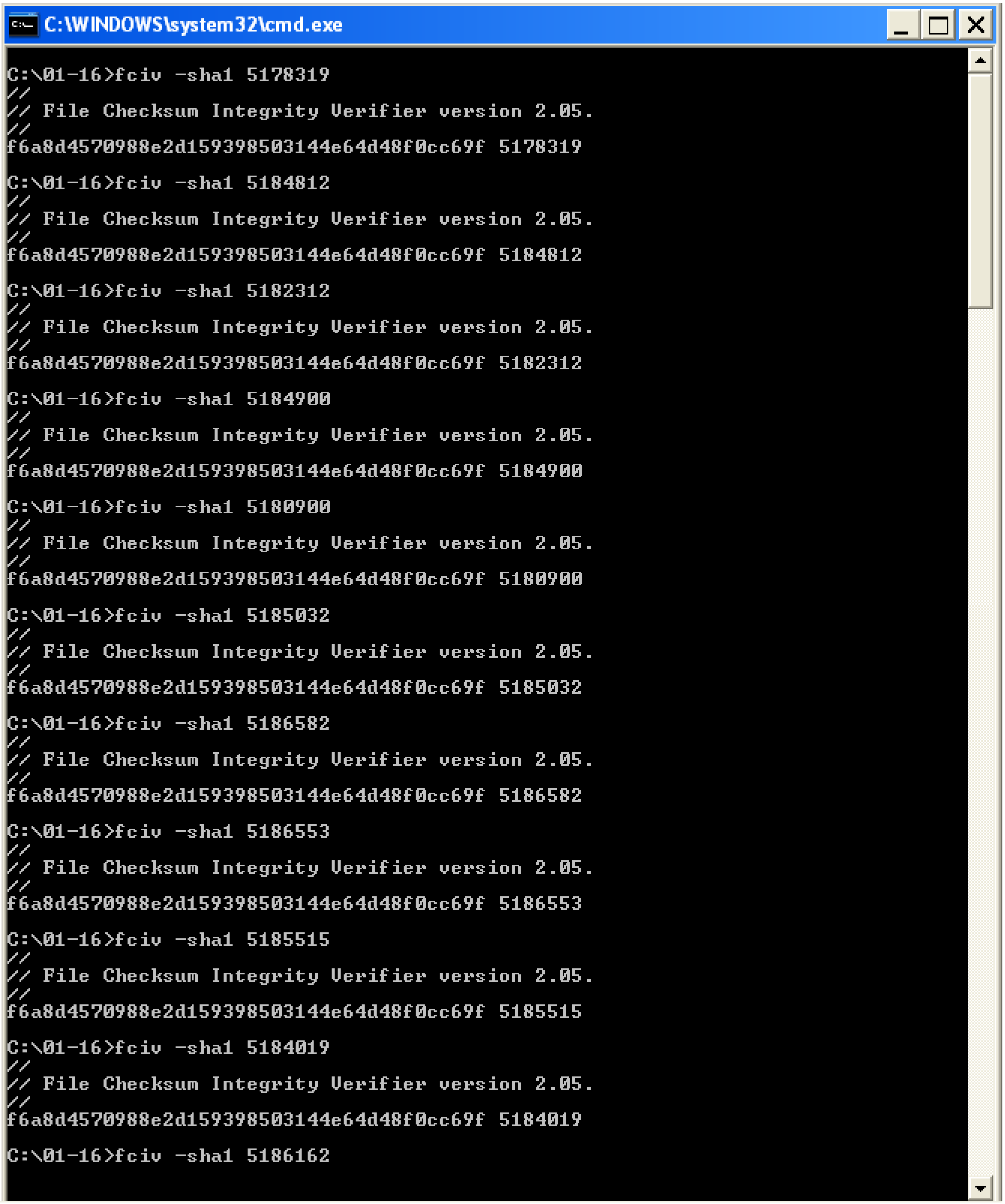
4. The Spansion firmware chip was successfully read into the PC and the hash code generated did match the trusted build hash code: **(F6A8D4570988E2D159398503144E64D48F0CC69F)**.

5. The iVotronic DRE was closed and powered by County employees to verify that the DRE was working properly with the correct firmware date, time, and version number showing on the initial display.

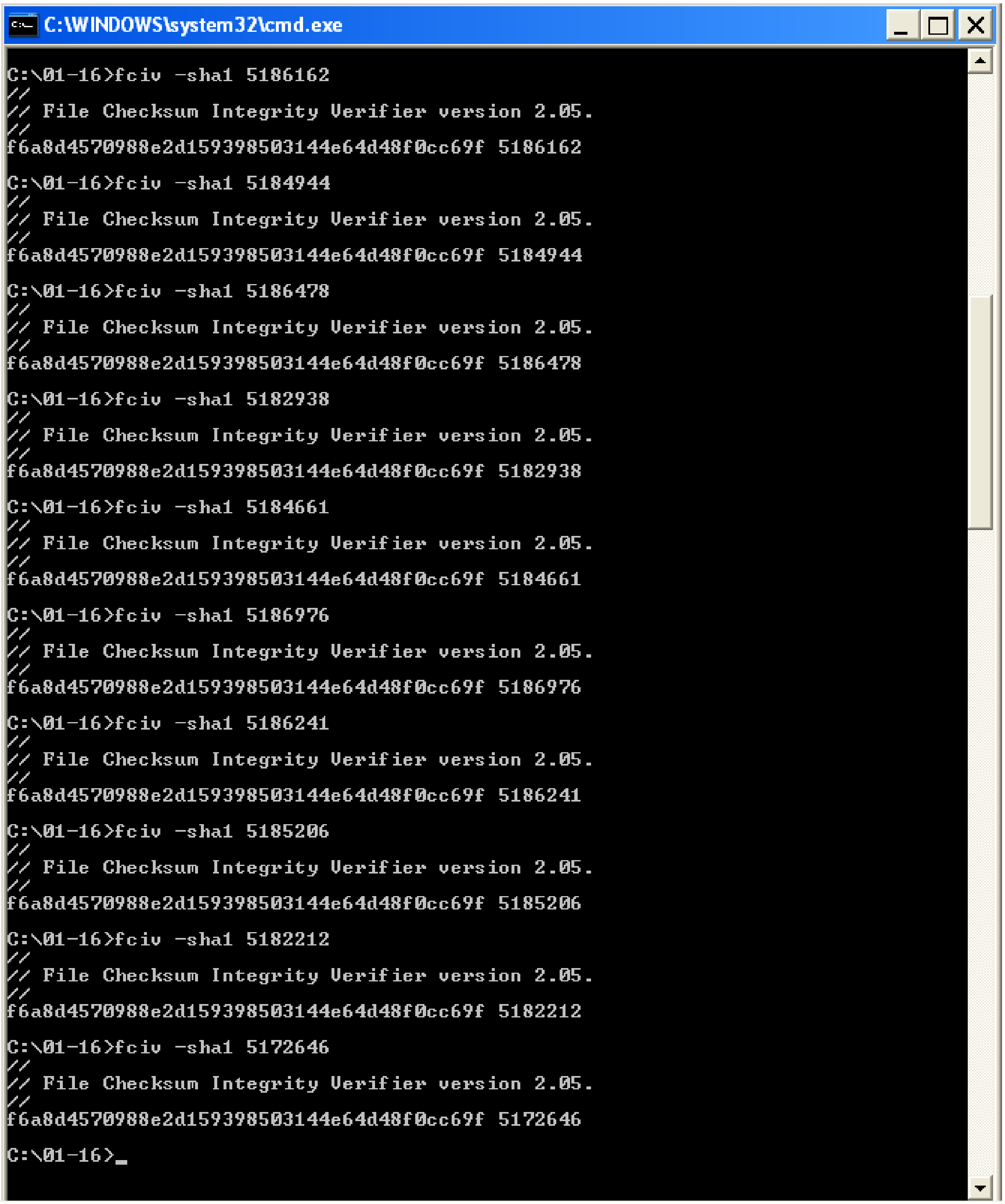
3.2 January 25, 2016 Collective Firmware Files (Date Modified in Mountain Standard Time)



Name	Size	Type	Date Modified
fciv.exe	83 KB	Application	5/13/2004 12:26 PM
5178319	704 KB	File	1/25/2016 7:33 AM
5184812	704 KB	File	1/25/2016 7:35 AM
5182312	704 KB	File	1/25/2016 7:38 AM
5184900	704 KB	File	1/25/2016 7:41 AM
5180900	704 KB	File	1/25/2016 7:44 AM
5185032	704 KB	File	1/25/2016 7:49 AM
5186582	704 KB	File	1/25/2016 7:50 AM
5186553	704 KB	File	1/25/2016 7:53 AM
5185515	704 KB	File	1/25/2016 7:56 AM
5184019	704 KB	File	1/25/2016 7:59 AM
5186162	704 KB	File	1/25/2016 8:02 AM
5184944	704 KB	File	1/25/2016 8:05 AM
5186478	704 KB	File	1/25/2016 8:08 AM
5182938	704 KB	File	1/25/2016 8:11 AM
5184661	704 KB	File	1/25/2016 8:14 AM
5186976	704 KB	File	1/25/2016 8:17 AM
5186241	704 KB	File	1/25/2016 8:20 AM
5185206	704 KB	File	1/25/2016 8:24 AM
5182212	704 KB	File	1/25/2016 8:27 AM
5172646	704 KB	File	1/25/2016 8:31 AM



```
C:\01-16>fciv -sha1 5178319
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5178319

C:\01-16>fciv -sha1 5184812
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5184812

C:\01-16>fciv -sha1 5182312
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5182312

C:\01-16>fciv -sha1 5184900
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5184900

C:\01-16>fciv -sha1 5180900
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5180900

C:\01-16>fciv -sha1 5185032
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5185032

C:\01-16>fciv -sha1 5186582
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186582

C:\01-16>fciv -sha1 5186553
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186553

C:\01-16>fciv -sha1 5185515
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5185515

C:\01-16>fciv -sha1 5184019
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5184019

C:\01-16>fciv -sha1 5186162
```



```
C:\01-16>fciv -sha1 5186162
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186162

C:\01-16>fciv -sha1 5184944
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5184944

C:\01-16>fciv -sha1 5186478
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186478

C:\01-16>fciv -sha1 5182938
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5182938

C:\01-16>fciv -sha1 5184661
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5184661

C:\01-16>fciv -sha1 5186976
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186976

C:\01-16>fciv -sha1 5186241
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5186241

C:\01-16>fciv -sha1 5185206
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5185206

C:\01-16>fciv -sha1 5182212
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5182212

C:\01-16>fciv -sha1 5172646
//
// File Checksum Integrity Verifier version 2.05.
//
f6a8d4570988e2d159398503144e64d48f0cc69f 5172646

C:\01-16>_
```

4. FINDINGS

GRP Consulting Group was engaged by the Allegheny Division of Elections on site at 901 Pennsylvania Ave., Pittsburgh, PA on January 25, 2016; the purpose of the engagement was to apply the '*Allegheny County iVotronic Firmware Verification Protocol'* to verify the ES&S iVotronic firmware version 9.1.4.1 is resident on the Allegheny County iVotronic population.

On January 25, 2016, the GRP Consulting Group analyst completed the verification process of the firmware residing on twenty (20) Allegheny County ES&S iVotronics Direct-Recording Entry electronic voting machines chosen at random from the population of approximately 4700 iVotronic Direct-Recording Entry (DRE) electronic voting machines. It is the findings of GRP Consulting Group that the firmware version 9.1.4.1 residing on the twenty (20) randomly chosen DRE electronic voting machines, do represent the population, and furthermore; the firmware version as resident on the U1 designated Electronic Erasable Programmable Read Only Memory (EEPROM) chip is an exact, true, and unaltered version of the NVLAP federally certified trusted build as held in archive at SysTest Labs in Denver, Colorado and in escrow by the Pennsylvania Secretary of State in Harrisburg, PA.

5. Appendix A - Terms and Abbreviations

These terms and abbreviations will be used throughout this document:

Table 2 - Matrix of Terms & Abbreviations

Terms & Abbreviation	Description
Binary	The system of representing text or computer processor instructions by the use of a two digit number system. This system is composed of only the number zero, representing the off state, and the number one, representing the on state, combined in groups of 8. These groups of 8 bits can represent up to 256 different values and can correspond to a variety of different symbols, letters or instructions.
DOE	Division of Elections
DRE	Direct-Recording Entry - touch screen voting device
Firmware	Firmware is the programmable content of a hardware device, which can consist of machine language instructions for a processor or configuration settings for a fixed-function device, gate array or programmable logic device. A common feature of firmware is that it can be updated post-manufacturing, either electronically, or by replacing a storage medium such as a socketed memory chip.
Hardware	Hardware refers to the physical artifacts of a technology such as the physical components of a computer system
Hash Code	A hash function is a well-defined procedure or mathematical function for turning binary code into a relatively small integer that serves as a unique mathematical footprint.
ITA	Independent Test Authority
iVotronic	ES&S touch screen voting terminal
Protocol	Rules governing process conduct to a written instruction.
Trusted Build	Unaltered, true, and certified complied binary code.
SHA-1	Algorithm used to define the hash code value.
Software	Computer software is human interfacing computer programs, procedures and documentation that perform defined task on a computer system. The term includes application software that performs productive tasks for users, system software such as operating systems, which interface with hardware to provide the necessary services for application software.
Voting System Components	The units of equipment (server platform, DRE voting terminal, ballot scan device) when used together create a voting system.
Verification	The act of reviewing, inspecting, and/or testing to establish and document

Terms & Abbreviation	Description
	that a product, service, or system meets the regulatory, standard, or specification requirements.

End of Report