TRICONEX

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June 26, 2001

Document Control Desk
United States Nuclear Regulatory Commission
Washington, DC 20555

Subject: Nuclear 1E Qualification of the TRICON TMR Programmable Logic Controller (PLC) – Change to Qualified Software Module

References: 1. Letter, T. Martel (Triconex) to NRC, March 20, 2001, subject; Nuclear 1E Qualification of the TRICON TMR Programmable Logic Controller (PLC) – Inclusion of Recent Upgrades in NRC Qualification Review

2. Project Number 709

Gentlemen:

In Reference 1, we transmitted document 7286-546, Revision 0, "Amendment 1 to Qualification Summary Report – Qualification Upgrade Evaluation." The purpose of that document was to provide information on the TRICON product upgrades from V9.3.1 to V9.5.3. The document contained a list of the TRICON hardware and software which we considered nuclear 1E qualified under our qualification program.

Triconex recently identified a potential problem with one of the software modules in our equipment under review by the NRC. The purpose of this letter is to inform you of this occurrence, describe actions taken, and provide an appropriate update to our previously submitted documentation which references this software.

During resolution of an internal discrepancy report, a potential problem was identified with the firmware used in our 3805E(N) analog output module. It was determined that, under certain conditions, the module diagnostics may improperly detect and handle the presence of a certain type of hardware fault. The potential for occurrence of the specific hardware fault was very rare. However, we viewed this a potential safety issue since we determined that it could result in an incorrect (unexpected) output signal on the affected point. For this reason, we took steps under our QA procedures to issue a Product Alert Notice (PAN #6), contact customers, and stop shipment



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of any modules with this firmware. It should be noted that, had this involved a module released for class 1E nuclear plant application, Triconex would have also filed a 10CFR Part 21 report in accordance with our reporting procedures.

A firmware fix eliminating the potential problem was developed and has been released. The analog output module firmware was revised, validated, and released in accordance with our QA procedures which have been reviewed by the NRC. A copy of Product Alert Notice #6 providing details of this condition is enclosed for your information.

Also enclosed is Revision 1 of document 7286-546, as referenced above. The list of qualified software in Table 1 of the document has been revised to replace the previous analog output firmware version number (meta number) with that of the current version which is free of the identified condition. This document revision also incorporated several editorial/typo corrections in the report (change areas are indicated by side bars). Please consider 7286-546, Revision 1 to fully supersede and replace Revision 0, transmitted earlier.

If you have any questions or wish further information, please contact me at (281) 360-6401 or Mr. Michael Phillips at (949) 885-0711.

Sincerely,

J. Troy Martel, P. E.
Triconex Nuclear Qualification Project Director

Enclosure
cc: L. Raynard Wharton, NRC
P. Loeser, NRC

TRICONEX

| | |
|---|---|
| Project: | NUCLEAR QUALIFICATION OF TRICON PLC SYSTEM |
| Purchase Order No.: | ST - 401734 |
| Project Sales Order: | 7286 |

# AMENDMENT 1 TO QUALIFICATION SUMMARY REPORT - Qualification Upgrade Evaluation

**Document No.: 7286-546**

**Revision 1**

**June 25, 2001**

| | Name | Signature | Title |
|---|---|---|---|
| Author: | Gary McDonald | | Sr. Nuclear QA Engineer |
| Reviewer: | Gary Hufton | | Director, Hardware Development |
| Reviewer: | Aad Faber | | Director, Product Assurance |
| Approvals: | Troy Martel | | Triconex Project Director |
| | Jerry McCann | 6/27/01 | VP, Development |
| | | | |

| Document Change History | | | |
|---|---|---|---|
| **Revision** | **Date** | **Change** | **Author** |
| 0 | 3/19/2001 | Initial Issue | G. McDonald |
| 1 | 6/25/01 | Revised to reflect recent EAO firmware revision per PAN #6 (see Attachment 1, page 9) and typos. Table 1 firmware list updated. Removed "pending" note 4 from Table 1. | G. McDonald |

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## 1.0 INTRODUCTION

Triconex has completed a Nuclear Qualification Program for its TRICON Triple Modular Redundant (TMR) PLC for safety related (1E) applications in nuclear power plants. The qualification program was performed and documented in accordance with NRC-approved EPRI TR-107330, "Generic Requirements Specification for Qualifying a Commercially Available PLC for Safety-Related Applications in Nuclear Power Plants." Triconex report 7286-545, "Qualification Summary Report," presented the final results of all testing and analyses performed in accordance with this EPRI specification and was provided to the NRC for review and issuance of a Safety Evaluation Report (SER).

The focus of the qualification effort was TRICON product version V9.3.1, which was the prevailing version being marketed at the time the qualification project was being organized. As with any high-tech product, during the extended period of qualification testing and evaluation, the TRICON products continued to evolve such that upgraded versions beyond V9.3.1 are now being manufactured and provided to industry. For business reasons, it is now desired to obtain NRC approval of the current TRICON product offering, specifically TRICON V9.5.3 and its associated support software.

## 2.0 PURPOSE

All data pertaining to testing and analysis of TRICON V9.3.1 have been provided to the NRC and are under review. The purpose of this report is to provide a listing of any pertinent differences between the product under review (V9.3.1) and the current product upgrades (represented by V9.5.3). A discussion of impact to qualification testing already completed is also provided. This additional information is provided for the NRC's consideration, with the express intent that the SER approval should be applied to the most recent TRICON product version specified herein.

## 3.0 DISCUSSION

Table 1 provides the current listing of Triconex products considered to be 1E qualified as a result of the EPRI specification (& IEEE-323) qualification program. This is basically identical to the hardware/software listing described in the Qualification Summary Report, with minor upgrades reflected. The routine product upgrades have not altered the critical characteristics of the product, i.e., current modules have the same functional and environmental characteristics as the V9.3.1 Test Specimen (or better).

A discussion of the software changes between V9.3.1 and V9.5.3 is provided in Attachment 1, "Evaluation of the differences between TRICON V9.3.1 and TRICON V9.5.3."

Routine component and board changes to maintain production needs are ongoing and are reviewed by the Configuration Control Board (CCB) in accordance with Triconex Appendix B QA procedures. This review confirms that no significant changes have been made to modules which would adversely affect performance specifications or qualification characteristics (seismic, environmental, electrical) as specified in the EPRI TR 107330. The most significant component change, replacement of the obsolete 80C451 microprocessor on most I/O boards, necessitated additional firmware upgrades and retesting as described in Attachment 1. Also, as indicated in paragraph 3.0 (2) below, component upgrades were made for four "T" (high voltage) modules; 3501TN, 3601TN, 3623TN, and 3636TN. These module upgrades significantly improved the surge and isolation capabilities of these modules.

In addition to evolutionary upgrades to the modules, Table 1 reflects other minor changes from the previous list of equipment described in the Qualification Summary Report. These equipment list changes fall into 3 categories:

**(1) Nuclear Model Numbers** - Unique model numbers have been assigned to the successfully qualified TRICON modules for marketing purposes. A trailing "N" has been added to each qualified module identified in 7286-545. Thus, the 3006 Main Processor will be identified in our product literature as 3006N if it is to be provided to a nuclear power plant for a 1E application (on a Safety Related customer purchase order). These modules will receive a special faceplate overlay with the N number in lieu of the base model number. Only the N module will receive a Triconex Certificate of Conformance attesting to its 1E qualification status. The commercial version of the same module will not receive this certification. The SER should therefore reflect the N model numbers exactly as indicated in the Table 1 list.

**(2) High Voltage (T) Models** - "T" modules have been substituted in place of four of the I/O modules in original test specimen. As described in paragraph 4.6 (4) of the Qualification Summary Report, the 3603E module was swapped out during surge testing and replaced with the 3603T module, which was functionally identical to the original module but provided a higher surge voltage withstand capability. Equivalent high voltage upgrades ("T" versions) to modules 3501E, 3601E, 3623, and 3636R are now available, and it is intended to offer these as the preferred nuclear versions. Even though the original versions of these modules passed the qualification tests, the T versions provide improved performance and are better suited to the nuclear industry.

The "T" modules were introduced to comply with the latest international (IEC) product safety and EMC standards. The high voltage modules were designed to be in compliance with the applicable US and Canadian national standards in effect at the time of their introduction. As the global world economy has matured, our customers are demanding

that all Triconex products fully comply with the latest IEC standards. The required changes were in 2 general categories:

a) Improve the module isolation from 1500VDC to 2500VDC for compliance with IEC 61010-1: 1990, Safety Requirements for electrical equipment for measurement, control, and laboratory use, Part 1: General requirements. This required improved voltage ratings on field de-coupling capacitors, and modification of the per unit acceptance test procedures.

b) Test and modify as required for compliance with IEC 61000-4-5, Surge Withstand. This required the installation of transient protection devices on selected modules and/or termination panels.

**(3) Generic Cable Lengths** - On the Table 1 equipment list, the part numbers for qualified connector cables have been generalized to indicate that, while specific lengths of certain cables were used in the test specimen, all of the varying lengths of the same base cable are considered qualified. Thus, while a 4000056-099 (dash number indicating 99 ft length) was tested, a 25 foot length (4000056-025) would also be considered qualified, as the base parts specification is the same. The list therefore identifies the qualified cable family part number as 4000056-xxx, consistent with our internal nomenclature standards.

## 4.0 CONCLUSION

The TRICON V9.5.3 products indicated in Table 1 continue to meet TR 107330 and IEEE requirements for 1E service and accurately represent the TRICON Qualification Test results as presented in Qualification Summary Report 7286-545. Changes made to the TRICON product since V9.3.1 are considered minor and evolutionary and have no adverse effect on qualification program results previously submitted for review.

## TABLE 1: NUCLEAR 1E QUALIFIED EQUIPMENT LIST – (Hardware)

QUALIFIED TRICON SYSTEM VERSION: V9.5.3

| Model No. | Item Description | Triconex Part Number | Previous Model/PN (Referenced in 7286-545) | Comment |
|---|---|---|---|---|
| | | | | |
| | **(1. Module Assemblies)** | | | |
| 8110N | Main Chassis | 3000602-150 | 8110 7400101-100 | (1) |
| 8111N | Expansion Chassis | 3000603-150 | 8111 7400102-100 | (1) |
| 8112N | Remote Expansion Chassis | 3000604-150 | 8112 7400101-200 | (1) |
| | | | | |
| 8310N | High Density Power Module, 115 V | 3000600-150 | 8310 7400160-100 | (1) |
| 8311N | High Density Power Module, 24 VDC | 3000600-350 | 8311 7400160-300 | (1) |
| | | | | |
| 3006N | Enhanced Main Processor II, V9, 2 Mb | 3000348-650 | 3006 7400120-500 | (1) |
| | | | | |
| 4210N | Remote Extender Module | 3000611-350 | 4210 7400176-300 | (1) |
| 4211N | Remote Extender Module | 3000611-150 | 4211 7400176-100 | (1) |
| | | | | |
| 4119AN | EICM., V9, Isolated | 3000445-550 | 4119A 7400145-200 | (1) |
| 4329N | Network Communication Module, V9 | 3000336-850 | 4329 7400124-200 | (1) |
| 4609N | Advanced Communication Module | 3000612-150 | 4609 7400170-100 | (1) |
| | | | | |
| 3700AN | AI Module, 0-5 VDC, 6% Overrange | 3000041-065 | 3700A 7400069-015 | (1) |
| 3701N | AI Module, 0-10 VDC | 3000041-060 | 3701 7400069-010 | (1) |
| 3703EN | EAI Module, Isolated | 3000329-070 | 3703E 7400112-010 | (1) |
| 3704EN | HDAI Module, 0-5/0-10 VDC | 3000355-160 | 3704E 7400125-110 | (1) |
| | | | | |
| 3805EN | Analog Output Module, 4-20 mA | 3000316-160 | 3805E 7400097-110 | (1) |
| | | | | |
| | | | | |

| Model No. | Item Description | Triconex Part Number | Previous Model/PN (Referenced in 7286-545) | Comment |
|---|---|---|---|---|
| 3501TN | EDI Module, 115V AC/DC | 3000303-155 | 3501E 7400090-050 | (1) (2) |
| 3502EN | EDI Module, 48V AC/DC | 3000303-185 | 3502E 7400090-085 | (1) |
| 3503EN | EDI Module, 24V AC/DC | 3000303-175 | 3503E 7400090-025 | (1) |
| 3504EN | HDDI Module, 24/48 VDC (24V) | 3000354-170 | 3504E 7400125-120 | (1) |
| 3505EN | EDI Module, 24 VDC, Low Threshold | 3000303-225 | 3505E 7400090-125 | (1) |
| | | | | |
| 3601TN | EDO Module, 115 VAC | 3000307-155 | 3601E 7400091-050 | (1) (2) |
| 3603TN | EDO Module, 120 VDC | 3000608-185 | 3603T 7400157-085 | (1) |
| 3604EN | EDO Module, 24 VDC | 3000341-120 | 3604E 7400116-020 | (1) |
| 3607EN | EDO Module, 48 VDC | 3000341-180 | 3607E 7400116-080 | (1) |
| 3623TN | SDO Module, 120 VDC | 3000609-285 | 3623 7400157-180 | (1) (2) |
| 3624N | SDO Module, 24 VDC | 3000609-230 | 3624 7400174-130 | (1) |
| | | | | |
| 3510N | Pulse Input Module | 3000152-110 | 3510 7400068-010 | (1) |
| | | | | |
| 3706AN | NITC Input Module | 3000041-250 | 3706A 7400069-200 | (1) |
| 3708EN | ITC Thermocouple Input Module | 3000329-250 | 3708E 7400112-100 | (1) |
| | | | | |
| 3636TN | ERO Module, N.O., Simplex | 3000314-390 | 3636R 7400123-310 | (1) (2) |
| | | | | |
| 8105N | Blank Module Panel | 3000051-101 | 8105 3000051-001 | (1) |
| 8107N | Seismic Balance Module | 3000632-101 | 8107 3000632-001 | (1) |
| | | | | |
| --- | Standard Chassis Mounting Bracket (for Chassis rear) | 2000240-001 | (same) | |
| | | | | |
| | **(2. External Termination Assemblies - ETA)** | ---------- | ---------- | |
| 2551-1N | Term Panel (for use with DI 3501TN) | 3000568-110 | 2551-1 7400056-110 | (1) |
| 2552-6N | Term Panel (for use with DI 3502EN ) | 3000569-610 | 2552-6 7400056-260 | (1) |
| 2553-6N | Term Panel (for use with DI 3503EN, DI 3505EN) | 3000567-610 | 2553-6 7400056-360 | (1) |
| 2554-6N | Term Panel (for use with DI 3504EN) | 3000566-610 | 2554-6 7400126-380 | (1) |
| 2651-1N | Term Panel (for use with DO 3601TN) | 3000576-110 | 2651-1 7400058-110 | (1) |
| 2652-1N | Term Panel (for use with DO 3604EN) | 3000578-110 | 2652-1 7400058-310 | (1) |
| 2657-1N | Term Panel (for use with DO 3607EN) | 3000579-110 | 2657-1 7400058-210 | (1) |

| Model No. | Item Description | Triconex Part Number | Previous Model/PN (Referenced in 7286-545) | Comment |
|---|---|---|---|---|
| 2658-1N | Term Panel (for use with RO 3636TN) | 3000598-110 | 2658-1 7400110-010 | (1) |
| 2750-8N | Term Panel (for use with AI 3700AN, AI 3701N) | 3000586-810 | 2750-8 7400061-810 | (1) |
| 2752-2N | Term Panel (for use with AI 3703EN) | 3000587-210 | 2752-2 7400061-220 | (1) |
| 2755-6N | Term Panel (for use with TC 3708EN) | 3000589-610 | 2755-6 7400061-600 | (1) |
| 2756-2N | Term Panel (for use with TC 3706AN) | 3000588-710 | 2756-2 7400061-600 | (1) |
| 2760-2N | Term Panel (for use with AI 3704EN) | 3000588-110 | 2760-2 7400126-120 | (1) |
| 2790-310TN | Term Panel (for use with AI 3700AN/RTD) | 3000620-110 | 2790-310T 3000619-100 | (1) |
| 2852-1N | Term Panel (for use with AO 3805EN) | 3000596-110 | 2852-1 7400111-100 | (1) |
| 9661-910N | Term Panel (for use with DO 3603TN, DO 3623TN) | 3000525-810 | 9661-910 7400166-180 | (1) |
| 9662-610N | Term Panel (for use with DO 3624N) | 3000524-910 | 9662-610 7400166-390 | (1) |
| 9753-110N | Term Panel (for use with PI 3510N) | 3000406-110 | 9753-110 7400143-510 | (1) |
| | | | | |
| --- | Mounting Plate for V9 ETAs | 9420017-070 | (same) | |
| | | | | |
| | **(3. Signal Conditioners)** | ---------- | ---------- | |
| --- | Signal Conditioner (-100/+100) Pt | 1600024-010 | (same) | |
| --- | Signal Conditioner (0/+100) Pt | 1600024-020 | (same) | |
| --- | Signal Conditioner (0/+200) Pt | 1600024-030 | (same) | |
| --- | Signal Conditioner (0/+600) Pt | 1600024-040 | (same) | |
| | | | | |
| | **(4. Connector Cables)** | ---------- | ---------- | |
| --- | I/O Bus Cable Set (No. 9000, various lengths) | 4000056-xxx | 4000056-099 (100ft)<br>4000056-006 (6 ft) | (3) |
| --- | Ethernet Cable Assy (NCM, various lengths) | 1600010-xxx | 1600010-015 (50 ft) | (3) |
| | | | | |

COMMENTS:

(1) Nuclear Model Number. "N" added to base model number. Model part number encompasses the qualified (tested) board assembly. ETA Nuclear Model part number includes qualified connector cable assemblies.

(2) Indicates base module upgraded to "T" (high voltage) module.

(3) Part Number for generic cable lengths.

## TABLE 1: NUCLEAR 1E QUALIFIED EQUIPMENT LIST- (Software)

QUALIFIED TRICON SYSTEM VERSION: **V9.5.3**

| TYPE | | IDENTIFICATION | VERSION | USED IN |
|---|---|---|---|---|
| | | | | |
| **Application Program Development Software** | | TriStation 1131, Developer's Workbench Suite | **V3.1** | TriStation Workstation |
| | | | | |
| **Operating System Firmware** | Main Processors | TSX | **5211** | 3006N (MP) |
| | | IOC | **5212** | 3006N (MP) |
| | | COM | **5206** | 3006N (MP) |
| | Communication Modules | ICM | 4930 | 4119AN (EICM), 4329N (NCM), 4609 (ACM) |
| | | ACMX | **5203** | 4609N (ACM) |
| | | NCMX | 5028 | 4329N (NCM) |
| | | IICX | **5276** | 4119AN (EICM) |
| | | RXM | 3310 | 4210N (RXM), 4211N (RXM) |
| | I/O Modules | AI/NITC | 4873 | 3700AN (AI), 3701N (AI), 3706AN (TC) |
| | | EIAI/ITC | **5491** | 3703EN(AI), 3708EN (TC) |
| | | PI | 4559 | 3510N (PI) |
| | | EDI | **5490** | 3501TN (DI), 3502EN (DI), 3503EN (DI), 3505EN (DI) |
| | | HDI | **5499** | 3704EN (AI), 3504EN (DI) |
| | | EAO | **5595** | 3805EN (AO) |
| | | EDO | **5488** | 3601TN (DO), 3604EN (DO), 3607EN (DO) |
| | | ERO | **5497** | 3636TN (RO) |
| | | TSDO | **5502** | 3603TN (DO), 3623TN (DO), 3624N (DO) |

(Bolded versions = upgraded from V9.3.1)

**ATTACHMENT 1**

# An Evaluation of the Differences between TRICON V9.3.1 and TRICON V9.5.3

(Nuclear Qualified Modules only)

Aad Faber

March 2001
Revised June 2001

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# 1.0 Introduction

The TRICON Nuclear Qualification project resulted in a Qualification Summary Report (7286-545) that forms the basis for the generic qualification of the TRICON system for safety-related applications in nuclear power plants. The basis for qualification is compliance with EPRI TR-107330. The Qualification Summary Report as well as all testing and analysis described in that report is based on a TRICON V9.3.1 configuration. This document describes the differences between TRICON V9.3.1 and TRICON V9.5.3 and provides justification for the argument that the basic findings and results described in the Qualification Summary Report are also valid for TRICON Version 9.5.3.

In order to be able to properly market and track a Nuclear Qualified TRICON System, Triconex has decided to modify the model numbers of the qualified modules listed in Table 3-1 of the Qualification Summary Report. All Nuclear Qualified Model numbers will have an additional "N" suffix. Table 1 of this document includes a listing of the newly assigned model numbers.

Following V9.3.1 TRICON Firmware and application software that were listed in the Qualification Summary Report were changed in the V9.5.3 release.

| Firmware Module / PC Application | V9.3.1 | V9.5.3 |
|---|---|---|
| TSX | 5124 | 5211 |
| IOC | 5106 | 5212 |
| COM | 4931 | 5206 |
| ACM | 5141 | 5203 |
| IICX | 5148 | 5276 |
| ERO | 3568 | 5497 |
| EDO | 4621 | 5488 |
| EDI | 4299 | 5490 |
| EIAI/ITC | 5087 | 5491 |
| HDI | 4843 | 5499 |
| TSDO | 5066 | 5502 |
| EAO | 4532 | **5595** |
| TS1131 | V1.1SP1 | V3.1 |

Note: TS1131 V2.0 was referenced in the qualification report.

Detailed descriptions of the changes and an evaluation of the changes are provided in section 3 through 9 of this document.

# 2.0 Summary and Conclusions

- No changes to basic functionality were made. Updates were primarily to accommodate a new processor, recognize new module/model numbers, and bug fixes identified in Product Discrepancy Reports (PDRs).
- All changes described in this document were validated and released in accordance with current Triconex Quality Assurance procedures.
- Triconex has no reason to believe that any of the changes made from V9.3.1 to V9.5.3 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330.

# 3.0 TSX Changes

## 3.1 TSX 5124

This version of TSX was used in the V9.3.1 qualification system.

## 3.2 TSX 5211

TSX 5211 was released in version 9.5.0 (12/21/99).

Supporting Documentation for this change:

(1) Software Release Definition (SRD), 6200003-111, 12/21/1999 (E3319)
(2) V9.5 SQA Validation Plan rev 1.1, 12/9/1999
(3) SQA Tricon V9.5 Test Report, 3/20/2000

### 3.2.1 Description of the change

The TSX firmware was changed to support a new Pulse Totalizer module (Model number 3515). The nuclear qualification does not include this new module. The differences in the firmware are described in detail in the SRD appendix A. This description includes a source code diff., an assembly code and a binary image diff.

### 3.2.2 V&V activity to support the change

Verification of the change in TSX firmware was carried out by review of the code differences documented in the SRD. The code differences were prepared by the responsible design Engineer and reviewed by issuer of the SRD (Director of real time software Triconex QA, and TUV).

TSX 5211 was validated in accordance with the V9.5 SQA Validation Plan. This plan included the requirement to execute a number of applicable sections in the QA Validation Procedures 9600047-001 and 9600038-001. The Director of Product Assurance issued a TRICON V9.5 Test Report. This report documents the recommendation to release V9.5.0 as specified in the SRD. TSX 5211 was released as part of V9.5.0.

### 3.2.3 Evaluation of the change

Triconex has no reason to believe that any of the changes made from TSX 5124 to TSX 5211 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes made to TSX were minor and only affect the support of a new module. This new module is not part of the Qualified TRICON Module listing. The changes were fully validated both by Triconex SQA and TUV.

# 4.0 IOC Changes

## 4.1 IOC 5106

This version of IOC was used in the V9.3.1 qualification system.

## 4.2 IOC 5212

IOC 5212 was released in version 9.5.0 (12/21/99).

Supporting Documentation for this change:

(1) Software Release Definition (SRD), 6200003-111, 12/21/1999 (E3319)
(2) V9.5 SQA Validation Plan rev 1.1, 12/9/1999
(3) SQA Tricon V9.5 Test Report, 3/20/2000

### 4.2.1 Description of the change

The IOC firmware was changed to support a new Pulse Totalizer module (Model number 3515). The nuclear qualification does not include this new module. The differences in the firmware are described in detail in the SRD appendix A. This description includes a source code diff., an assembly code and a binary image diff.

### 4.2.2 V&V activity to support the change

Verification of the change in IOC firmware was carried out by review of the code differences documented in the SRD. The code differences were prepared by the responsible design Engineer and reviewed by issuer of the SRD (Director of real time software Triconex QA, and TUV).

IOC 5212 was validated in accordance with the V9.5 SQA Validation Plan. This plan included the requirement to execute a number of applicable sections in the QA Validation Procedures 9600047-001 and 9600038-001. The Director of Product Assurance issued a TRICON V9.5 Test Report. This report documents the recommendation to release V9.5.0 as specified in the SRD. IOC 5212 was released as part of V9.5.0.

### 4.2.3 Evaluation of the change

Triconex has no reason to believe that any of the changes made from IOC 5106 to IOC 5212 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes made to the IOC firmware were minor and only affect the support of a new module. This new module is not part of the Qualified TRICON Module listing. The changes were fully validated both by Triconex SQA and TUV.

# 5.0 COM Changes

## 5.1 COM 4931

This version of IOC was used in the V9.3.1 qualification system.

## 5.2 COM 5206

COM 5206 was released in version 9.5.0 (12/21/99).

Supporting Documentation for this change:

(1) Software Release Definition (SRD), 6200003-111, 12/21/1999 (E3319)
(2) V9.5 SQA Validation Plan rev 1.1, 12/9/1999
(3) SQA Tricon V9.5 Test Report, 3/20/2000
(4) Product Discrepancy Report (PDR) 2446, 11/20/1998
(5) Technical Advisory Bulletin (TAB) 96, 1/27/1999

### 5.2.1 Description of the change

The COM firmware was modified to fix PDR 2446 / TAB 96.

### 5.2.2 V&V activity to support the change

The validation of changes to the COM firmware as a result of the PDR 2446 fix are documented in the SQA Validation report in section 6.2.16.

### 5.2.3 Evaluation of the change

Triconex has no reason to believe that any of the changes made from COM 4931 to COM 5206 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The change made to the COM firmware was a fix for a problem that was discovered during Triconex Internal Validation testing. The changes were fully validated both by Triconex SQA and TUV.

# 6.0 ACM Changes

## 6.1 ACM 5141

This version of ACM was used in the V9.3.1 qualification system.

## 6.2 ACM 5203

ACM 5203 was released in version 9.4.0 (1/15/99).

Supporting Documentation for this change:

(1) Software Release Definition (SRD), 6200003-104, 1/15/1999 (E3179)
(2) V9.4 SQA Test Plan
(3) SQA Tricon V9.4 Test Report, 3/20/2000
(4) Product Discrepancy Report (PDR) 728

### 6.2.1 Description of the change

The ACM Firmware was modified to improve fault insertion behavior of the module. This change was triggered by TRICON PDR 728.

### 6.2.3 V&V activity to support the change

The ACM 5203 Firmware was validated as part the V9.4 validation effort. This validation included a full functional validation of the V9.4 TRICON system including a validation and manual fault insertion of the ACM module. The results of this validation are reported in the V9.4 SQA validation report.

### 6.2.3 Evaluation of the change

Triconex has no reason to believe that any of the changes made from ACM 5141 to ACM 5203 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes were fully validated both by Triconex SQA and TUV.

# 7.0 IICX Changes

## 7.1 IICX 5148

This version of IOC was used in the V9.3.1 qualification system.

## 7.2 IICX 5276

IICX 5276 was released in version 9.5.2 (8/8/2000).

Supporting Documentation for this change:

(1) Software Release Definition (SRD), 6200003-118, 8/8/2000 (E3445 & E3471)
(2) V9.5.2 SQA Validation Plan rev 1.0, 3/17/2000
(3) SQA Tricon V9.5.2 Test Report
(4) Product Discrepancy Reports (PDRs) 2418, 688, 689, 690

**7.2.1 Description of the change**

As a result of an investigation into a problem report from one customer, a number of PDRs were generated (PDR 2418, 688, 689, 690). The IICX Firmware was modified to correct the these problems.

**7.2.2 V&V activity to support the change**

The changes to the IICX firmware were validated as part of the V9.5.2 release. The results of the validation are documented in the SQA V9.5.2 Validation report.

**7.2.3 Evaluation of the change**

Triconex has no reason to believe that any of the changes made from IICX 5148 to IICX 5276 invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes were fully validated both by Triconex SQA and TUV.

## 8.0 I/O Firmware changes

TRICON Version 9.5.3 includes changes to most of the I/O firmware modules. The following table summarizes the Firmware Meta numbers for each I/O module that was affected by this change.

| Firmware Module Acronym | Used on Model # | V9.3.1 Firmware Meta# | V9.5.3 Firmware Meta# | Changes made other then required to support the new processor |
|---|---|---|---|---|
| ERO | 3636R, 3636TN | 3568 | 5497 | None |
| EDO | 3601E, 3601T, 3601TN, 3604E, 3604EN, 3607E, 3607EN | 4621 | 5488 | Yes, PDR 742, 716 |
| EDI | 3501E, 3501T, 3501TN 3502E, 3502EN 3503E, 3503EN 3505E, 3505EN | 4299 | 5490 | None |
| EIAI/ITC | 3703E, 3703EN 3708E, 3708EN | 5087 | 5491 | None |
| HDI | 3504E, 3504EN 3704E, 3704EN | 4843 | 5499 | None |

| | | | | |
|---|---|---|---|---|
| TSDO | 3603E, 3603T, 3603TN 3623, 3623T,3623TN 3624, 3624N | 5066 | 5502 | None |
| EAO | 3805E, 3805EN | 4532 | 5595 | Yes, PDR 833, 849 |

### 8.1 Description of the change

The 80C451 chip used in the I/O boards went out of production, necessitating replacement. The firmware changes that were required to replace the 80C451 microprocessor with the 80C515 microprocessor were very localized in the code. The only change required between the new and old firmware was identified as a change in the port assignments (constants) that are used at multiple locations in the code. The port assignments are done in code header files.

### 8.2 Additional changes made

In addition to the changes made to support the new microprocessor, the EAO firmware and the EDO firmware were modified to fix several outstanding PDRs. PDRs 716 and 742 were fixed in EDO 5488 firmware. PDRs 833 and 849 were fixed in EAO 5595 firmware. A recent Product Alert Notice (PAN #6, issued 3/27/01) identified a potentially safety-significant problem with EAO firmware as a result of PDR 833. This condition was fixed in a firmware upgrade to EAO 5595, which was incorporated into the V9.5.3 SRD, 6200003-120.

### 8.3 V&V activity to support the change

All changes to the I/O firmware listed in the table above were validated as part of the TRICON V9.5.3 validation effort. In addition, the differences between the old firmware and the new firmware were analyzed by Engineering to ensure that only the port assignment numbers were changed. The validation was carried out in accordance with the TRICON I/O processor replacement validation plan (rev 1.0). The plan included a full functional validation per the I/O Modules Functional Validation Procedure (9600038-001). The plan also included fault insertion testing of the 3805E Module. PDRs 849, 716, 742, and 833 were fixed and validated in TRICON V9.5.3. The results of the validation are documented in the SQA V9.5.3 Validation report. Due to the significance of PDR 833 and PAN #6 issuance, a special PAN 6 Validation Plan (9600085-001) was prepared, and the validation of PDR 833 is documented in a special PAN 6 Validation Report.

### 8.4 Evaluation of the change

Triconex has no reason to believe that any of the changes made to the I/O Firmware invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes were fully validated both by Triconex SQA and TUV.

## 9.0 TS1131 Changes

### 9.1 Version 2.0

This version of TS1131 was used in the qualification system.

### 9.2 Version 2.0 SP1

This version of TS1131 was superseded by TS1131 Version 2.0 SP2. TS1131 Version 2.0 SP1 was never shipped to the customer base. All changes made in SP1 were incorporated in SP2.

## 9.3 Version 2.0 SP2

TS1131 Version 2.0 SP2 was released as part of the TRICON V9.4.1 release.

### 9.3.1 Description of the change

TS1131 V2.0 SP2 includes the following fixes and modification the TS1131 Application Software:

- In order to change MIN and MAX settings on Memory Real R/W variables, the project state had to change to Download All (PDR 1921 / TAB97)
- The TS1131 Emulator could not maintain a DDE conversation with a client like Excel (PDR 1980)
- The PI 3511 Module uses the wrong Board ID (PDR 2441 / TAB 98)

### 9.3.2 V&V activity to support the change

TRICONEX SQA validated this version of TS1131 in accordance with the SQA TS1131V2.0SP2 Validation Plan revision 1.1. The results of this validation are documented in the SQA Test report.

## 9.4 Version 2.0 SP3

This version of TS1131 was released as part of TRICON V9.5 (12/21/99).

### 9.4.1 Description of the change

TS1131 V2.0 SP2 includes TS1131 support for the PT3515 Pulse Totalizer module (The PT3515 is not part of the nuclear qualification). No other changes were made to TS1131.

### 9.4.2 V&V activity to support the change

Triconex SQA validated this version of TS1131 in accordance with the SQA TRICON V9.5 Validation Plan revision 1.0. The results of this validation are documented in the SQA Test report.

## 9.5 Version 3.0

This version of TS1131 was released as part of Trident Release 1.0 only. This version does not support the TRICON hardware platform.

## 9.6 Version 3.0.1

This version of TS1131 was released as part of the TRICON V9.5.2 release (8/8/2000).

### 9.6.1 Description of the change

TS1131 Version 3.0.1 supports both TRICON and Trident hardware platforms. TS1131 V3.0.1 includes the following major functional enhancements:

- Support for Cut and Paste in CEM
- A new option in the CEM Editor for an AND or an OR matrix.
- A new auto save / back-up function for project files

In addition to these enhancements, PDRs 2336, 2367, 2398, 2693, and 2697 were fixed.

#### 9.6.2 V&V activity to support the change

Because of the extent of the changes between Version 2.0SP3 and Version 3.0.1 it was decided to complete a full functional validation of TS1131 for the V3.0.1 release. The validation was carried out in accordance with SQA V9.5.2 Validation Plan (3/17/2000). The results of the validation are documented in the SQA Validation report. The validation included execution of the System Functional Validation Procedure (9600047-001), execution of all available TS1131 Compiler and Standard Library test vectors (35000+) and all TS1131 GUI test scripts.

## 9.7 Version 3.1

#### 9.7.1 Description of the change

Tristation Version 3.1 includes support for the new 3008 Main Processor Module and for future Trident Analog Output, Pulse Input and Communication modules. None of these modules are being considered for Nuclear Qualification currently. Furthermore TS1131 V3.1 includes some user-requested enhancements to the CEM editor and monitor functions in Tristation. Configuration libraries were also revised to recognize the new Nuclear "N" model numbers for all 1E qualified modules. In addition to the mentioned enhancements, a number of outstanding PDRs were fixed in this Tristation release. The Tristation software release definition includes a listing of all PDRs that were fixed in this release. Tristation V3.1 has been released for use with TRICON V9.6 and TRICON V9.5.

#### 9.7.2 V&V activity to support the change

Tristation Version 3.1 was validated as part of the TRICON V9.6 / TRICON V9.5.3 validation effort. The validation of TS1131 V3.1 was carried out in accordance with the SQA TRICON V9.6/V9.5.x Validation Plan. The results of the validation are documented in the SQA Validation report. The validation included execution of the System Functional Validation Procedure (9600047-001), execution of all available TS1131 Compiler and Standard Library test vectors (35000+) and all TS1131 GUI test scripts.

## 9.8 Evaluation of the TS1131 changes from V2.0 to V3.1

Triconex has no reason to believe that any of the changes made to Tristation invalidate the findings and results of the generic qualification of the TRICON in accordance with EPRI TR-107330. The changes were fully validated by Triconex SQA and TUV.

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# Product Alert Notice

PAN#: 6 Release Date: Mar. 27, 2001

Revision: 0 Part No.: 9791010-006



Subject: **Improperly Diagnosed Fault on Analog Output Module**

## Affected Product(s):

Model #3805E Enhanced Analog Output Module, V6.x, V7.x, V8.x, V9.5.x and earlier
Model #3806 High Current Analog Output Module, V9.5.x and earlier
Model #3800 Analog Input Output Module 0-5VDC, V6.x and earlier
Model #3801 Analog Input Output Module 0-10VDC, V6.x and earlier
Model #6810 TriconLite Analog Output / Pulse Input Module, V2.x and earlier

## Problem Description:

Triconex has recently identified a rare type of hardware fault within the family of Analog Output Modules. It has been found that the module diagnostics may improperly detect and handle the presence of a faulty hardware component. If this fault should occur, the following behavior will be observed:

The fault only affects the point it is associated with. The affected output point will be at the correct programmed value for 20 seconds, and an incorrect value, 0.0ma, for 10 seconds. This pattern will repeat every 30 seconds for several minutes. After several minutes, the Analog Output module will turn its FAULT light ON, and the output will cease toggling and follow the correct programmed value.

## Problem Background:

The Analog Output module utilizes "a selected leg" architecture. One and only one leg is allowed to actually drive the outputs at a time. The selected leg is chosen via a 2oo3-voting algorithm. Each leg independently verifies the health state of itself and all other legs to determine its vote for the selected leg. The selected leg is rotated between the healthy legs on the module every 10 seconds; a complete rotation takes 30 seconds. If an actual fault affecting the outputs of the selected leg is detected, a leg switch will be forced, typically in less than 2 milliseconds, and the module will be FAULT'ed. The affected leg will not be selected again as the driving leg.

Also, the Analog Output module is designed to detect open load conditions, and set a LOAD alarm for the module. Each leg checks for an open load condition independently. The LOAD alarms generated by each leg are OR'd before being reported to the control program. LOAD

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|---|---|
| DIRECTOR, PRODUCT ASSURANCE | PRESIDENT, TRICONEX |

alarms are processed as low priority background tasks in the Tricon. In the smallest systems with the fastest scan times it will take at least 2 seconds for the LOAD alarm to be reported to the control program. In the largest systems with the slowest scan times it can take up to 10 seconds. The alarm update rate can be calculated for a specific system configuration with the following formula:

*LOAD_Alarm_Update = 2 seconds + (# of Chassis installed in the system + 1) * Program_Scan_Time*

The LOAD alarms generated by each leg are compared. If one leg detects an open load condition and the others do not, that leg is presumed to be bad and the module is FAULT'ed. In addition, the affected leg will not be selected again to be the driving leg. The diagnostic that checks for this type of fault runs as a background task and may take several minutes to execute.

Analog modules with firmware earlier than what is specified under "Affected Products" section of this PAN, do not correctly handle the case when one leg has a valid open fault. The fault is handled as a low-priority bad-detector problem, instead of as a high-priority bad-output problem. The affected leg is not prevented from being voted as the selected leg until the module is FAULT'ed by the low priority background task. This type of fault should be detected and acted upon as any other output fault in less than 2 milliseconds.

This type of fault is very rare and has only been seen once in over 10 years of service in hundreds of applications. Per traditional Mil Spec 217 reliability calculations, the probability of the "at risk" components in the output circuit failing in the open state are, for the Model #3805E, approximately once every 2 million hours, for the Model #3806, once every million hours.

However rare this problem may be, the cyclic ON and OFF nature of this fault could seriously de-stabilize a critical process under control and/or a large piece of rotating machinery.

## Operational Restrictions/Recommended Actions:

Each Tricon system using Analog Output modules should perform a hazard and operability study (HAZOP) or other hazard assessment study. If the fault behavior described is found to present an unacceptable risk, then one or more of the following actions must be taken.

- Contact your local Triconex Customer Service Representative for availability of the latest Analog Output firmware that includes a fix for this problem. Until this firmware can be installed in your system, modify the process or machinery operating instructions and restrictions as required to ensure safe operation.

- If spare Analog Input points are available, consider monitoring the actual analog output current of each point at risk, and modifying the control program to detect this condition and react according to the safety requirements of the system. The response time of the system from analog input to control program should be calculated, and used as part of the HAZOP. For details on how this might be accomplished, refer to the Tricon user documentation supplied with your system, or contact your local Triconex Customer Service Representative. After installation of the updated firmware, continued operation with the modified control program must be re-evaluated.

- Modify the Tricon control program to monitor the LOAD alarm from each Analog Output Module, and react according to the safety requirements of your system. Since it may take up to 10 seconds for a LOAD alarm to be detected, it is impossible to guarantee a clean transition to the OFF (0.0 ma) state in all applications. For details on how this might be accomplished refer to the Tricon user documentation supplied with your system, or contact your local Triconex Customer Service Representative. After installation of the updated firmware, continued operation with the modified control program must be re-evaluated.

In all applications, continued safe operation of the system must be assured during all types of load faults, including load shorts and opens. The control algorithms employed should be selected to mitigate the effects of intermittent load problems. Field wiring problems can result in random ON and OFF, and/or cyclic behaviors. The problem discussed in this PAN reflects a serious but limited subset of potential field related problems that should be considered as part of the overall system design.

For further information regarding this Product Alert Notice (PAN), please contact your local area Triconex Support Office or contact the Irvine Customer Satisfaction Group at 1-949-885-0700 or 1-800-325-2128.