The following Standard Development Report (SDR) is made in accordance with the Institute of Transportation Engineers (ITE) procedures for the Advanced Transportation Controller Cabinet Standard.
1 LATEST VERSION OF THE DRAFT PROPOSED STANDARD

Appendix I contains Recommended Standard (StdRS) ATC 5301 Advanced Transportation Controller Cabinet Standard Version 02.02 (V2) that is an update version to the prior Jointly Approved ITS Cabinet v01.02.17b (V1). Jointly Approved means that the standard had been formally balloted and approved separately by the following three standard development organizations (SDOs) cooperating under a signed Memorandum of Understanding (MOU) among:

- American Association of State Highway and Transportation Officials (AASHTO)
- Institute of Transportation Engineers (ITE)
- National Electrical Manufacturers Association (NEMA).

V1 was published on 9/26/2006 after successful ballot by AASHTO, ITE and NEMA. Adopted standards are either reaffirmed or revisited after five years. To inform this decision, the following End User organizations presented User Needs at the 2008 Workshop in Austin TX:

- Caltrans
- Harris County TX
- Minnesota DOT
- City of Houston TX
- Kentucky DOT
- New York City DOT
- Georgia DOT
- Los Angeles DOT
- San Francisco MTA

As a result, V1 was revisited due to significant additional User Needs identified in the workshop including:

- USDOE ban on the sale of incandescent bulbs
- EPA mercury waste regulations
- State legislation to eliminate shock hazard inside electrical cabinets
- State legislation to eliminate shock hazard of field wires
- State legislation to eliminate arc flash hazard under NFPA 70E
- Need to replace internal subassemblies while in flash for worker safety
- Low power features to facilitate alternate power sources such as solar

The objectives of the resulting V2 project are:

1) Develop ATC 5301 Advanced Transportation Controller Cabinet standard by assessing new issues and integrating lessons learned from current deployments of V1 into a Concept of Operation (ConOps), Requirements and Design. User Needs are considered, not limited to those of the User Needs Workshop. These items along with all others solicited were introduced into the Systems Engineering Process (SEP) that examines their relevancy.

2) Use an SEP to ensure the completeness and correctness of V2 standard and associated documents such that the standard is traceable and logically consistent.

3) Develop a detailed conformance statement that addresses backwards compatibility and provides clear and unambiguous instruction on how to extend the standard.

Resulting V2 takes guidance from Section 8.4.5 of “Systems Engineering Guidebook for ITS”, including:

- ConOps derived from the User Needs
- System Requirements derived from the ConOps
- High Level Design including major system elements and interfaces derived from Requirements
- Detailed Design of each major system element and interface derived from the High Level Design
- Validation and verification traceability from the resulting V2 back to original User Needs

2 SUMMARY STATUS

As part of the ATC standards maintenance efforts, V2 is being distributed to the members of ITE and other standard development organizations (SDOs) for formal review. This action is based on the July 25,
2018 required 2/3 plurality recommendation of the ATC Joint Committee (JC), which is the steering committee for the ATC program consisting of six members from each of the three MOU organizations. Comments from potential users of the standard are solicited. The standard contains the detailed design and requirements for ATC Cabinet devices. Following this comment period, the comments received are adjudicated by the ATC Cabinet Working Group (WG), V2 is updated accordingly and the standard is moved through the Recommended and Approved stages of the standards development process to Publication. Inquiries, comments or proposed changes to this standard should be submitted to:

ITS Standards Manager  
Institute of Transportation Engineers  
1627 I (eye) Street, NW, Suite 600  
Washington, DC 20006  
Voice: (202) 785-0060  
Fax: (202) 785-0609  
Email: standards@ite.org

Comments are requested using the fields described in Appendix III.

3 STATUS REPORT

Beginning in 2007, SEP commenced to develop V2 from the initial User Needs workshop in Austin TX. This effort resulted in the completion of User Needs, Concept of Operations, Requirements and High Level Design before the project was suspended at Project Task ID 50 (Develop Design Content) of the Project Management Plan (PMP).

In September 2015, the project was restarted to complete the remaining tasks of the original PMP, but with updated milestone dates. The ITS Cabinet Working Group (WG), operating under the direction of the ATC Joint Committee, held WG meetings and teleconferences to complete this effort. Siemens Industry Inc. is retained under contract to ITE to provide consultant services to the WG for preparation of the V2 standard. This remaining effort picked up the prior work completed by ConSysTec (Bruce Eisenhart), Pillar Consulting (Ralph Boaz), and Adaptive Solutions, Inc. (James Kinnard) at Develop Design Content (Project Task ID 51) of the PMP, through the completion of the V2 standard.

During the time lapse while the project was suspended, volunteer efforts by several WG manufacturers resulted in the availability of Commercial Off-The-Shelf (COTS) subassemblies that were considered in the remaining standards development effort, and adopted when found to meet the project Requirements traceable to the original User Needs. In cases where multiple but differing COTS subassemblies met the requirements, each alternative was evaluated using a prior survey of ITS Owner/Operator Non-Functional Requirement (NFR) rankings, such as Reliability, Operational Safety, Modularity, etc. included as Section 15 of V2. COTS subassemblies with higher NFR rankings were adopted for standardization over differing COTS subassemblies that also met the Requirements, but with lower NFR rankings. This process provided the unique opportunity to review each Requirement in the context of existing COTS equipment developed independently via three manufacturer’s interpretation of the Requirements. This review resulted in critical clarifications of the wording and verification of key requirements for common understanding. These reviewed Requirements were captured as the Baseline in the Requirements Traceability Workbook that is included as Section 14 of V2. At that point, Requirements Management commenced, requiring a majority WG agreement and traceability to User Needs for changes to Requirements going forward. This process effectively eliminated differences in interpretation of the proposed standard before publication, instead of clarifications to the standard after V2 is published. Once establishing the Baseline, High Level Design (HLD) commenced, resulting in major system elements and interfaces included as V2 Figures 2 and 3 that pictorially depict the system elements controlled by V2. The HLD was unanimously accepted by WG vote, followed by Detailed Design captured as V2 Sections 6, 7, 8 and 9 plus added to Section 14 for end-to-end traceability from Needs to Requirements to Design.
### Figure 1: ATCC V2 Standard Development Major Milestones

The project timeline and major milestones for the tasks described above are depicted in Figure 1:

- **2007**: Working Group (WG) is formed including public agency end users and private sector manufacturers. The User Needs Workshop was conducted in Austin TX with presentations by end user Owner / Operators of signal control equipment and software.
- **2008**: Concept of Operation (ConOps) is developed to fulfill the User Needs. ConOps Workshop is conducted in Salt Lake City UT with end user Owner / Operators. Feedback from that workshop results in an updated ConOps document posted on the ITE website.
- **2009**: WG is developed Requirement based on User Needs and ConOps. After WG review, the Requirements document is posted on the ITE website.
- **2010**: WG conducts a week-long High Level Design workshop in Houston TX. A survey of end user, owner/operators is conducted to rank the importance of Non-Functional Requirements, such as product safety, cost, serviceability and others.
- **2011**: Project funding ends, but volunteer effort continued to update the Requirements document.
- **2012**: Volunteer effort continues to include field test of prototypes, such as field test of working systems operating off-grid on alternative power sources.
- **2013**: Volunteer effort continues to develop and test key missing subsystems, such as low voltage, high density switch packs.
- **2014**: First article manufacturing of commercially-available equipment by three private sector WG members is completed.
- **2015**: Funding is available to resume the standards development process. The High Level design is captured in High Level block diagrams that identify subassemblies and interfaces that are controlled by the standard versus those that are controlled by end user and manufacturer specifications.
- **2016**: Instead of the normal workflow to build prototypes based on the Requirements, the WG verified each requirement to the existing equipment developed voluntarily by three manufacturers. Conflicting designs were resolved by standardizing the design elements best meeting the Non-
Functional requirements, or by identifying design elements that should differ to meet differing local needs. Requirements management process enforces a Requirements update with approval of WG members. The Needs to Requirement Traceability Workbook is approved by WG, included as Section 14.

- 2017: User Comment Draft is created and reviewed by the wider transportation sector, resulting in disposition of 1,032 comments while tracing the design elements back to the Needs and Requirements. The User Comment Draft is updated to become the Recommended Standard document.
- 2018: The Needs to Requirements Traceability Workbook of Section 14 was updated to include traceability to Related Design Elements. The Recommended Standard is affirmed by the Joint Committee for ballot by AASHTO, ITE and NEMA under the terms of the MOU.

4 Comments Listing

A total of 1032 adjudicated user comments used in the creation of V2 are found in Appendix II. The comments of Appendix II are organized by the columns labeled A through AB as follows:

<table>
<thead>
<tr>
<th>Column</th>
<th>Description</th>
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<tbody>
<tr>
<td>A</td>
<td>Comment Identification Number</td>
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<td>B</td>
<td>Comment is OPEN (red) or CLOSED (green)</td>
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<td>C</td>
<td>Commentor Organization / Commentor Name</td>
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<td>D</td>
<td>Comment is minor Editorial or major Substantive that affects system operation</td>
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<tr>
<td>E</td>
<td>Reviewed document identification number and version number</td>
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<td>F</td>
<td>Document section relating to the comment</td>
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<td>G</td>
<td>Paragraph if text, Table number or Figure number</td>
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<td>H</td>
<td>Existing text relating to comment</td>
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<td>I</td>
<td>Proposed text replacing existing text</td>
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<tr>
<td>J</td>
<td>Reason or explanation of the proposed change / deletion / addition</td>
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<tr>
<td>K</td>
<td>WG response to adjudicate comment, color coded as:</td>
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<td></td>
<td>- Yellow: Reviewed and resolved during WG meetings</td>
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<td>- Green: Duplicate of other comments reviewed and resolved</td>
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<td>- Red: Future consideration, as not traceable to requirement or withdrawn</td>
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<td></td>
<td>- Blue: Staff closed as editorial / procedural not related to system operation</td>
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<td></td>
<td>- Orange: WG member review and vote between WG meetings</td>
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<td>L</td>
<td>Scott Evans review as subject matter expert for components per WG direction</td>
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<tr>
<td>M-AB</td>
<td>WG Voting Member vote on comments between WG meetings (orange column K, see Note 1)</td>
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Note 1:

Comments color-coded orange in column K were resolved between WG meetings according to the Cabinet WG Bylaws, Version 01 dated 06/2008, Section D.7.3 VOTING PROCEDURES, which allows:

- Balloting by Voting Members between meetings via electronic ballot vote on the questions. In this case, the questions consisted of instruction for each WG member to vote “Y” (yes), “N” (no) or “A” (abstain) to accept the proposed wording for each comment that is color coded orange.
- A simple majority of the Voting Members is required to adopt any individual comment, in this case at least 7 of the 13 WG Members voting “Y” is required to affirm the proposed comment wording.

The votes of each WG Voting Member are recorded in Columns M-AB of Appendix II. At the end of the voting period, none of the comments color-coded orange received the necessary seven “Y” votes and were thus not adopted, but archived for further consideration at the next standards review. This process workflow that was accepted by the WG to adjudicate the orange comments between WG meetings is shown below.
5 COMMITTEE OBJECTIVES

The objective of this project is to produce an updated version of cabinet standard that has addressed the additional User Needs identified above while retaining the key interfaces and protocols from V1 to protect the sunk cost of manufacturer’s software investment and training investment of the End Users. The distribution of V2 as a Recommended Standard is a step in this process by soliciting user comments from the members of the SDOs before publication of V2 on the ITE website for no-cost download.

6 COMMITTEE MEMBERS

This standard has been developed under the oversight of the ATC Joint Committee (JC) which is made up of representatives from the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA). The work in developing this standard was performed by the ATC Controller Working Group (WG), a technical subcommittee of the ATC JC.
Cabinet Working Group Voting Members

<table>
<thead>
<tr>
<th>Public Sector Member</th>
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<tr>
<td>Richard Dickinson</td>
<td>Harris County (Houston) TX</td>
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<tr>
<td>Peter Skweres</td>
<td>Minnesota DOT</td>
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<tr>
<td>Mohamad Talas</td>
<td>New York City DOT</td>
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<tr>
<td>John Thai</td>
<td>City of Anaheim, CA</td>
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<tr>
<td>Herasmo Iniquez</td>
<td>Caltrans</td>
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<td>Jeffrey Hayes</td>
<td>Oregon DOT</td>
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<td>Robert Rausch</td>
<td>TransCore</td>
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<tr>
<td>Douglas Acker</td>
<td>McCain</td>
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<td>Robin Harrison</td>
<td>Peek Traffic</td>
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<td>Ben Luke</td>
<td>Eberle Design</td>
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<td>Craig Gardner</td>
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<td>Brent Katauskas</td>
<td>Mobotrex</td>
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<td>Jim Rose</td>
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ATC Joint Committee Voting Members

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<tr>
<td>Andy Mao</td>
<td>Texas DOT</td>
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<tr>
<td>Derek Vollmer</td>
<td>Florida DOT</td>
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<tr>
<td>Lei Wang</td>
<td>Louisiana DOT</td>
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<tr>
<td>Daniel Farley</td>
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<tr>
<td>Matt Luker</td>
<td>Utah DOT</td>
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<td>Alan Davis</td>
<td>Georgia DOT</td>
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<tr>
<td>Edward Seymour</td>
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<tr>
<td>Robert Rausch</td>
<td>Transcore</td>
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<td>John Thai</td>
<td>City of Anaheim CA</td>
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<td>Jon Wyatt</td>
<td>Parsons</td>
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<td>Gary Duncan</td>
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<th>NEMA Member</th>
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<tr>
<td>Dave Miller (Chair)</td>
<td>Siemens</td>
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<td>Luis Silva</td>
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<td>Ray Deer</td>
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<td>Kleinjan Deetlefs</td>
<td>Applied Information</td>
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<td>Doug Crawford</td>
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<td>Vacant</td>
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Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC) v02.17, ATC JC, 1 September 2011. Available from the Institute of Transportation Engineers.

Model 2070 Controller Standard Version 3, ATC JC, August 2012. Available from the Institute of Transportation Engineers.

Caltrans Transportation Electrical Equipment Specifications (TEES), California Department of Transportation, 12 March 2009. Available from the California Department of Transportation.


NEMA Standards Publication TS 2-2003 v02.06 Traffic Controller Assemblies with NTCIP Requirements. Available from the National Electrical Manufacturers Association.

8 DECLARATION REGARDING OTHER KNOWN NATIONAL AND INTERNATIONAL STANDARDS

This statement confirms that other known national and international standards have been examined with regard to harmonization and duplication of content, and no significant conflicts with other known standards have been identified.

9 ABSTRACT OF THE STANDARD

Purpose

V2 is one of the Advanced Transportation Controller (ATC) standards that are intended to provide open architecture hardware and software platform to support a wide variety of Intelligent Transportation Systems (ITS) applications including traffic management, safety, security and other applications.

This V2 standard defines a transportation field device known as an Advanced Transportation Controller Cabinet (ATCC). It has been prepared by the Cabinet Working Group (WG), a technical subcommittee of the ATC JC. It establishes a common understanding of the specifications for an ATCC for:

a) Local, state and federal transportation agencies who specify and use ATCC equipment;

b) Manufacturers who produce ATCC equipment;

c) Software developers who develop application programs for ATCC equipment; and

d) The public who benefit from the application programs that run on ATCC equipment and who directly or indirectly pays for these products.

Overview

V2 defines two versions:

- High Voltage (HV) version fulfills the need for operation on traditional 120 VAC service voltage to control 120 VAC low power (non-incandescent) signal heads.

- Low Voltage (LV) version fulfills the need for operation on 48 VDC alternate power sources, such as battery and solar, to control low voltage DC signal heads.

V2 reserves attributes for a future version:
• Very High Voltage (VHV) version fulfills the need for operation on 240 VAC service voltages to control 240 VAC low power (non-incandescent) signal heads, typically used outside of the USA and Canada.

V2 controls the following cabinet elements:
• Standardized communications interfaces to the ATC 5201 controller for software compatibility
• Standardized plug-in component assemblies for interchangeability among ATCC manufacturers:
  o Sensor inputs
  o Load switch outputs
  o Cabinet Monitor Unit
  o Cabinet Flasher Unit
  o Serial Interface Unit
• Standardized electrical signal characteristics
• Standardized electrical signal naming convention
• Overall maximum mechanical size

V2 does not control the following cabinet elements, which are specified by the end user or manufacturer:
• Details of housing mechanical design and dimensions within standardized overall maximum size
• Component locations within the cabinet housing
• Field termination mechanical connector types and cabling

This deliniation is depicted in the following conventions used in the V2 High Level Block diagrams.
Document Organization

ATC 5201 v06.31 is made up of sixteen sections.

- Section 1, “Purpose of the Document,” provides a background and history of the standard, including the earlier V1 plus the review process of V1 that uncovered additional User Needs leading to the development of V2.

- Section 2, “Scope of Project,” describes the project organization and development process, the collection of User Needs and the overall project timeline.

- Section 3, “Reference Documents” identifies related documents referenced in V2.

- Section 4, “Conventions Used in this Document”, describes the pictorial icons and the normative reference indicators to related documents.

- Section 5, “High Level Block Diagram” describes the major system elements and the interfaces between elements. This section also describes the ATCC versions: High Voltage, Low Voltage and a reserved placeholder for Very High Voltage for future consideration. Section 5 also describes the Traceability support.

- Section 6, “Components” describes the plug-in components that are controlled by V2, including connector type, pin assignments, interfaces and mechanical dimensions.

- Section 7, “Slots” describes the recepticals for the interchangeable components of Section 6.

- Section 8, “Interfaces” describes the signal names and electrical characteristics of the interfaces between major elements.

- Section 9, “Protocols” describes the serial communications that are controlled by V2, both between internal system elements and external devices, such as ATC 5201 controller devices.

- Section 10, “Product Safety and Reliability” describes requirements for safe and reliable design, plus the identification of banned materials.

- Section 11, “Environmental and Testing Requirements’ describes the Diagnostic Acceptance Tests (DAT) required for first article evaluation to demonstrate conformance to V2, plus additional requirements for routine inspection of ongoing ATCC production and incoming acceptance.

- Section 12, “Wire Requirements” describes minimal acceptable conductor sizes for current carrying capacities, plus insulation and splicing methods.

- Section 13, “Acronyms” lists the abbreviations used in V2 along with their definitions.

- Section 14, “Needs to Requirements to Design Traceability” consists of the traceability workbook compiled during the SEP, which includes:
  - Requirement ID
  - Requirement Title
  - Requirement Text
  - Justification for Requirement
  - User Need traceable source
  - Comments / Changes and Guidance recorded during the requirements review discussion
  - Related design elements in the V2 sections
  - Requirement Criteria to validate the requirement using unambiguous text

- Section 16, “ATCC Power Signal Naming Conventions” with graphical representations depicting the point-to-point signal connections and signal names.
Appendix I

Recommended Standard ATC 5301 v02.02
Appendix II

Adjudicated User Comments for ATC 5301 v02.02
Appendix III

Comment Submission Requirements

Comments should be submitted using the fields as shown below.

- **Document Name/Ver:** ATC 5301 v02.02
- **Reviewer Name:** First and last name.
- **Reviewer Organization:** Current employer or “self” if representing only as an individual.
- **Comment Date:** Submission date for the set of comments.
- **CID#:** A numerical value unique for the commenter’s comments. (e.g. 1, 2, 3).
- **CType:** Type of comment one of Technical/Editorial/Other.
- **Page:** Page # or #s for which the comment applies. “General” can be used if pertains to entire document.
- **Section/Paragraph:** Section # for which the comment applies. May add paragraph # or leave field blank as appropriate.
- **Comment:** State the issue or concern.
- **Suggested Resolution:** If possible please state a proposed solution to the issue or concern. Comments with proposed solutions can help the working group address the issue more effectively even if it is not resolved in the exact way as proposed.

Comments may also be submitted in a tabular form as shown below (column widths can be adjusted):

<table>
<thead>
<tr>
<th>CID#</th>
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