Re: Amendment to the International Traffic in Arms Regulations: Revision of U.S. Munitions List Category VIII (Federal Register Docket ID. 2011-28502, RIN 1400-AC96)

IPC — Association Connecting Electronics Industries welcomes the opportunity to comment on the proposed revision of United States Munitions List (“USML”) Category VIII as detailed by the Department of State’s Federal Register notice. As an organization with a long history of cooperation with and support of the agencies that develop and implement national security policy, IPC shares the Department of State’s concern that the proposed rule ensures appropriate USML coverage and fully protects U.S. national security. Therefore we would like to provide the following comments in response to the proposed amendment.

I. Executive Summary

IPC believes it is important that the Category VIII rule – and similar USML/CCL rules developed in the future – ensure clear treatment of printed boards and their designs as the Directorate of Defense Trade Controls (“DDTC”) transitions certain parts, components, accessories, and attachments from the USML to the Commerce Control List (“CCL”). Specifically, the rules should make clear that the design instructions for printed circuit boards will remain under International Traffic in Arms Regulation (“ITAR”) control when the end item for which the board was designed is included on the USML.

Printed circuit boards and their designs hold valuable and specific information about the workings of the underlying defense articles themselves. As examples, printed board designs can convey the following types of information: how sensitive an aircraft or its counter measure dispensing systems are to electronic disruption; the frequency range and range of operation for flight communications equipment; and design information for integrated avionics and vehicle management systems that may allow for reverse engineering of the technology.

Under the current ITAR, printed board designs for military aircraft and related defense articles are controlled by Category VIII(i) and/or Category XI (Military Electronics), because they reveal technical data regarding both the printed boards and the ultimate defense articles into which the printed boards are installed. IPC recommends that DDTC clarify the status of printed board designs in its final rule regarding Category VIII and has suggested one approach in Section IV.C., below. Further, IPC recommends that DDTC consider the issue of printed circuit board designs in the context of its ongoing revision of the USML, through steps such as (1) clarifying the scope of technical data in each USML Category, noting that printed board design coverage
follows the coverage of the end item itself, (2) amending the definition of “technical data” in 22 C.F.R. §120.10, to clarify this point across all categories, and (3) clarifying Category XI to refer expressly to printed board designs for defense articles.

II.  About IPC

IPC is a U.S.-headquartered global trade association, representing all facets of the electronic interconnect industry, including design, printed board manufacturing and printed board assembly. IPC has more than 3,000 member companies of which 1,900 members are located in the United States. IPC is the definitive authority on standards used by the global electronics industry and is the leading source for training, market research and public policy advocacy and other programs to meet the needs of an estimated $1.7 trillion global electronics industry.

Printed circuit boards (“PCBs”) and printed board assemblies provide the critical underpinnings of the operations and control of all modern military equipment, including unmanned vehicles, communications equipment, and missile defense systems: they are the “central nervous system” of military electronics. IPC’s standards, specifications, and guidelines developed for printed boards have replaced several U.S. military electronics standards. Fifteen IPC standards have been adopted for Department of Defense (“DoD”) use. Half of these specifically relate to the materials for PCBs as well as the design for critical high speed circuits. In addition, for over 20 years NASA has specified IPC standards for their PCB requirements. Nearly all tier-one military original equipment manufacturers (OEMs) are IPC members and active participants in IPC’s standards development. IPC standards are used by tier-one military OEMs and their suppliers in the design of defense electronics. As detailed in Appendix A, military and aerospace OEMs represent 75% of the top purchasers of IPC standards.

IPC has a long history of cooperation with and support of the DoD. IPC has been a leader in addressing issues of concern to the agency including counterfeit parts, intellectual property protection, and the direction of technology. IPC’s DoD Task Force, comprising senior level executives from leading North American printed board manufacturers and electronics manufacturing services (“EMS”) companies that supply the DoD with products and technology, provides industry expertise to Congress, the DoD, the Department of State and the Department of Commerce. Many IPC members supply electronics to the military and are experienced using ITAR and EAR as part of their daily business. Recently IPC and its members developed a Best Industry Practices for Intellectual Property (IP) Protection in Printed Board Manufacturing standard that is used by printed board manufacturers to better protect the IP embedded in printed boards manufactured for commercial, industrial, military and other high-reliability markets.

III.  National security significance of printed circuit boards and designs

IPC and its members recognize the value of establishing “a clearer line between the USML and the CCL regarding controls over military aircraft and related items.” 76 Fed. Reg. 68695. However, IPC believes it is important that the Category VIII rule – and similar USML/CCL rules developed in the future – ensure clear treatment of printed boards and their
designs as the DDTC transitions certain parts, components, accessories, and attachments from the USML to the CCL. In particular, the rules should make clear that the design instructions (known as “digital data” in the industry) for printed circuit boards will remain under ITAR control when the end item for which the board was designed is included on the USML. This clarification would ensure appropriate USML coverage and protect national security by controlling important technical data about ITAR controlled items.

A. Overview

Specialized printed board and printed board assemblies are custom-made and uniquely designed for the specific function of the electronic items in which they are incorporated. Each printed board is exclusively designed to hold and connect specific additional components and therefore contains a roadmap of the operation of the USML item for which it is custom-designed. The design and placement of the parts that constitute a printed board are dictated precisely by the nature and type of electronic components to be mounted on the board, which are in turn dictated by the specifications of the product into which the printed board assembly is to be incorporated. Manufacture of the printed board requires access to and use of all of the board’s design information. This access exposes a significant portion of the intellectual property for both the printed board and the item for which it is uniquely designed.

As military systems have become increasingly sophisticated, the design and production of their printed boards have become more complex and convey more information. Fundamental factors for printed boards in defense applications include reliability, ruggedness, speed, density, and frequency. For example, embedded within military electronics may be a mix of components capable of broadcasting analog and digital signals on a common substrate. In order to produce this technology, printed boards must be created with unique design configurations. Additionally, military electronics may also use new laminate materials with lower dielectric constants and better signal integrity. Further, the increasing complexity of military circuitry requires more functionality in less space, resulting in incorporating high density interconnect (“HDI”) technology into DoD specific electronics. Access to these types of parameters, which are outlined in the design of printed boards, provides critical insight to the capabilities, strengths, and weaknesses of the items for which the boards were designed.

The printed board layout – particularly the structure and pin count of large buffer gate arrays (“BGAs”), and the number and routing restrictions on the primary buses – provides critical information regarding the processor(s), field programmable gate arrays (“FPGAs”), memory system (i.e., DDR), input/output bus (i.e., 1394B) technology, and other parameters. This basic information provides technical insight into how the end item functions. Once a parent system for the printed board is identified, a readily achievable task given the amount of information in the public domain, the board design will provide a roadmap to its functionality, including dimensional specifics, radio frequency specifics, and control system speeds and logic. These parameters are often at the heart of classified information about our defense systems. Further, this knowledge would enable an adversary to determine the level and frequency of electro-magnetic pulse needed to disrupt the defense article’s electronic functioning.
The manufacture of any printed circuit board requires a complete data package. As demonstrated above, this data package contains a substantial amount of intellectual property. The drawings and digital data would include:

- Net list that contains all the points that are electrically connected and all the points that are electrically isolated
- Materials and number of layers which includes the type of insulating materials and the amount of copper used in the construction
- Physical size and shape of the final printed circuit board
- Footprints of all the components and connectors that will be connected (soldered, wire-bonded, etc.) to the printed circuit board, which identifies the components used in the assembly
- Key electrical connections including their impedance and timing
- Location and size of all the mechanical and laser drilled holes
- Layers that function as the power and ground layers for these key electrical connections
- Reliability requirements
- Special use testing requirements for example flight or space applications

Also included in many instances:
- Bill of Materials: A document identifying every component, the manufacturer and manufacturer part number, as well as the reference designator that identifies the physical location of the part.
- Schematic: Also known as the circuit diagram or logic diagram, this diagram maps out the way electrical components are connected together and is often supported by notes outlining the specifications of components. The schematic provides more precise detail as to the functionality of the circuitry of an end item.

In sum, printed circuit boards and their designs hold valuable and specific information about the workings of the underlying defense articles themselves. (Section III.B, below, provides some specific examples.) Companies with access to the designs of printed boards for defense articles thereby also have access to sensitive information about controlled technologies. This exposes these technologies to malicious intrusion that may undermine the reliability of U.S. weaponry and other critical equipment. Failure to properly secure the information embedded in printed boards that are custom-designed for defense articles could result in a breach of national security, theft of critical defense-related intellectual property and allow for reverse engineering of our critical defense systems.

B. Specific Examples

Following are several examples of printed board designs that convey technical data regarding the defense items for which the printed board was designed:

- Fly-by-wire flight controls: The design of the printed boards that are incorporated into flight controls can reveal the data buses used in the controls. Data buses are the communications channel between the flight computer and the aircraft control surfaces.
Understanding the data bus types can suggest potential weaknesses of the aircraft that may be exploited, including how sensitive the aircraft is to electronic disruption.

- **Counter Measures Dispensing Systems:** Integrated with missile warning systems and radar warning receivers, these self-defense chaff and flare dispensing systems are used on combat aircraft (including the F-15, F-16, F-22, and F-35), helicopters (including the AH-64, CH-53, UH-60, and AH-1), and transport aircraft (including the C-130). The design features of the printed circuit boards for these items can reveal means of electronic disruption on these basic aircraft defense systems. The use of this information to incorporate active suppression of chaff and flare dispensing systems into the next generation of surface-to-air and air-to-air missiles could pose a threat to aircraft and crew.

- **Electronic Warfare Systems:** Design instructions necessary for manufacturing the printed boards that are incorporated into phased-array systems and tactical radar and jamming systems outline the dimensions and placement of conductive and insulating patterns. Data of this type reveal specific frequency information about the systems themselves. Further, access to the printed board design imparts knowledge about the general system design, such as which components must be separately packaged and how the system may be countered or disrupted by external means.

- **Flight Communications:** The UHF/VHF radios designed for military aircraft incorporate printed circuit boards for receiver and transmitter components. Both of these board designs reveal the general frequency range in which the radio operates. Additionally, the transmitter board designs reveal the power level of the transmission, which equates to the range of operation for the device. Knowledge of these parameters could facilitate attempts to jam or intercept in-flight communications.

- **Integrated Avionics:** One of the key elements that gives fighter jets (such as the F-22) a tactical advantage against the threats of the future is the integration of its avionics. These systems require integration at many levels, including sensor control, sensor data fusion and the architectural components that support these functions. Displays within the aircraft are the primary means of communicating all of this information to the pilot. These functions are driven through complex electronic systems that are based on backplanes, which is a printed board that has additional modules of printed boards connected to it for increased functionality, such as accurate situational assessment and weapons fire control. This high speed computing system allows the pilot to focus on mission success rather than managing manual sensors. Design features of these boards could lead to reverse engineering of the key elements related to electronics involved in the avionics system.

- **Radar:** Radar is a primary sensor and is a long-range, rapid scan, and multi-functional system. The latest radar technology involves electronically scanned array antenna, which is composed of several thousand transmit/receive modules, circulators, radiators and manifolds assembled into sub-arrays and integrated into a complete array. The baseline design uses many different types of RF & Microwave assemblies that consist of many different printed boards. The intellectual property of the assemblies, *i.e.* the instructions
as to how to integrate these modules into a functioning radar system, resides primarily in the design of the printed board.

- Vehicle Management System (VMS): The VMS provides integrated flight and propulsion control and enables the pilot to aggressively and safely maneuver the aircraft to its maximum capabilities. The system includes a control stick, throttle, rudder pedals and actuators, air data probes, accelerometers, leading edge flap drive actuators, and the primary flight control actuators. This system comprises devices that are all assembled with printed boards. The design of these boards could compromise information related to the devices being used, such as computing speed and other operating parameters.

IV. Applicability of ITAR to Printed Circuit Boards and Their Designs

A. Current Rule

1. Printed Boards

Printed circuit boards designed for defense articles are generally within the scope of the USML’s controls on “components” that are specifically designed or modified for defense articles. Of relevance here, printed boards that are designed for military aircraft or other Category VIII items may be generally considered as subject to USML control as Category VIII(h) components. IPC recognizes that certain printed boards may also, or alternatively, come within the controls of Category XI(c) Military Electronics, as components specifically designed or modified for military electronic systems or equipment. IPC intends to comment on any proposed rule that DDTC publishes regarding Category XI; however, given the potential application of Category VIII, and the relevance of IPC’s comments to other USML Categories including Category XI, IPC considers that it may be useful for DDTC to receive these comments regarding Category VIII at this time. ¹

Moreover, due to their unique characteristics, printed boards may also be considered as “technical data” related to the defense articles into which they are incorporated, such as military aircraft. The definition of “defense article” includes “technical data recorded or stored in any physical form, models, mockups or other items that reveal technical data directly relating to

¹ IPC recognizes that there will be many printed boards installed on a military aircraft that are not specifically designed for a USML item. For instance, a printed board may be designed for a dual-use computer used on the aircraft. IPC understands and agrees that such printed boards are not subject to the USML. IPC’s comments only address printed boards that are designed for USML items.

In addition, the Missile Technology Control Regime (“MTCR”) Annex to the ITAR, 22 C.F.R. §121.16, Item 14, provides that certain printed circuit boards with specific technical parameters are controlled on the MTCR Annex and are subject to the ITAR. IPC assumes that such printed boards will remain subject to the ITAR, although it is unclear whether this provision may require an amendment to the proposed rule in order to specify that such boards remain covered in Category VIII or whether another Category would apply.
items designated in § 121.1.” 22 CFR § 120.6. Printed boards may be considered as technical data stored in a physical form, given that the boards reveal important information about the defense articles into which they are incorporated. Therefore, printed boards designed for military aircraft and aircraft components may also be considered as Category VIII(i) technical data under the current ITAR.

2. Printed Board Designs

Under the current ITAR, technical data directly related to enumerated defense articles are generally included in the USML. Technical data, as currently defined, include “[i]nformation, other than software . . ., which is required for the design, development, production, manufacture, assembly, operation, repair, testing, maintenance or modification of defense articles.” 22 CFR § 121.10(a). Further, the regulations specify that “[t]his includes information in the form of blueprints, drawings, photographs, plans, instructions, or documentation.” Id.

Printed board designs reveal information about the design of printed boards, by definition. However, as described in Section III above, these designs reveal technical data regarding the defense articles for which the printed boards are designed as well. Thus, under the current rule, the printed board designs are controlled because they reveal technical data regarding both the printed boards and the ultimate defense articles into which printed boards are installed. Therefore, the designs for military aircraft printed boards are generally included in the USML, under Category VIII(i).

B. Proposed Rule

1. Printed Boards

Under the proposed rule, it is unclear whether printed boards would be transferred to the jurisdiction of the CCL. The proposed rule generally transfers to the CCL all components specifically designed for military aircraft, with the exception of certain listed components as well as components that are specially designed for certain stealth aircraft. See Proposed Rule, 76 Fed. Reg. 68694, 68695. On the other hand, the proposed rule retains on the USML all “technical data … directly related to the defense articles enumerated in paragraphs (a) through (h) of this category.” Id., 76 Fed. Reg. at 68697. As noted above, printed boards may be considered as “technical data” related to the defense articles into which they are incorporated, such as military aircraft. Accordingly, it is possible that printed boards would remain on the USML as technical data (in physical form) related to defense articles.

IPC recommends that DDTC clarify the proper treatment of printed boards, to ensure that the industry understands the U.S. government’s position regarding the proper export control jurisdiction of these important products.

2. Printed Board Designs

If printed boards themselves are retained on the USML as “technical data” in physical form, then printed board designs necessarily must be retained on the USML also. The printed
board designs convey the same information as do the printed boards about the defense items into which printed boards are incorporated, just in a different format.

Moreover, even if DDTC determines that printed boards for defense articles are not subject to USML jurisdiction, DDTC should determine that printed board designs are subject to the USML as “technical data”. Plainly, printed board designs are not “components”, and therefore – unlike printed boards themselves – the treatment of board designs is not directly affected by the transfer to the CCL of most components specially designed for USML items. Instead, printed board designs must remain on the USML because, as discussed above, they convey technical data regarding the defense items into which printed boards are incorporated.

Therefore, control of printed circuit board digital data and related designs should follow the categorization of the end item itself, whether or not the physical printed circuit board remains an ITAR controlled item. Accordingly, if an end item is not on the USML, then the design data for any of its printed circuit boards would be under EAR/CCL control. However, if the end item is on the USML, the design data for its printed circuit boards must remain under ITAR control as USML technical data.

C. Recommendation

For these reasons, IPC recommends that DDTC clarify the status of printed board designs in its final rule regarding Category VIII. For instance, DDTC could state the following in the Final Rule when it responds to public comments:

One commenter requested that DDTC confirm that the design and digital instructions for printed circuit boards specifically designed for military aircraft and other Category VIII items are “technical data” within the meaning of Category VIII(i). DDTC confirms that these designs and digital data fall within the standard definition of “technical data,” to the extent that they contain technical data directly relating to Category VIII items. Accordingly, such printed board designs and digital instructions are subject to the USML when the end item for which the printed circuit board is designed is identified in Category VIII.

IPC recognizes that there could be a number of ways to address this issue.

V. Overall Export Control Reform

The issue of printed circuit board designs is not unique to the Category VIII military aircraft context. Every category of USML items includes the technical data directly related to those items. These printed circuit board designs and digital data constitute technical data relating to the various end-items and USML components identified in each category because they contain information required for the design, development, manufacture, etc. of those defense articles.

2 See 22 C.F.R. § 121.1 Category I(i), II(k), III(e), IV(i), V(h), VI(g), VII(h), IX(e), X(e), XI(d), XII(f), XIII(l), XIV(m), XV(f), XVI(e), XVII(a), XVIII(f), XX(d), XXI(b).
Examples of the type of technical data printed circuit board designs may contain about end-items in other USML categories include:

- **Space-Based Radar:** Currently, the use of ceramics (LTCC) is carefully controlled in recognition of the importance of the intellectual property of this process to the function of the radar system. However, absent clarification that board designs remain covered as technical data, the move from LTCC to printed circuit boards – a move now underway to improve the performance of these systems – will allow this information to escape ITAR control. The process of moving to printed boards has been a key development in advancing the capabilities of space-based radar. If the designs for printed board for space-based radar are not tightly controlled, there is a significant risk that key elements of the radar system design will be released, compromising U.S. national security interests.

- **Small Caliber (80mm – 120 mm) Smart Munitions Fuze:** The smart munitions fuze has been used extensively by U.S. forces in both Iraq and Afghanistan. There is no fuze this sophisticated anywhere in the world for this caliber of munitions, i.e. portable mortar rounds. A flexible printed circuit board is the heart of this fuze. It supports and interconnects all of the electronics in this state-of-the-art proximity fuze. The design of the fuze, while not necessarily exposing the frequencies at which the antenna operates, exposes the operation of the fuze which then could easily be replicated and/or neutralized.

- **IED Jammers and Detectors:** Improvised explosive devices, also known as IEDs, roadside bombs, and suicide car bombs, have caused over 65% of all American combat casualties in Iraq and over 60% of casualties in Afghanistan, both killed and wounded. Prevention of the remote detonation of these devices has been accomplished through jammer systems called Joint Counter Radio-Controlled Improvised Explosive Device (“RCIED”) Electronic Warfare (“JCREW”). These systems, such as the CREW 2.1, are high-power, modular, programmable, multiband radio frequency jammers that deny enemy use of selected portions of the radio frequency spectrum. Three state-of-the-art printed circuit boards help determine the frequency and range capability of JCREW systems. Access to the design of these boards could lead to an understanding the system architecture and how to circumvent the jammers, thus allowing for increased remote detonation of IEDs in the field of combat.

For this reason, IPC recommends that DDTC consider the issue of printed circuit board designs in the context of its overall revision of the USML, not just Category VIII. For instance, in each rule, DDTC could explicitly clarify the scope of technical data and note that the digital data and instructions for the manufacture of printed circuit boards is a USML item when the end

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item for which the board has been designed is included on the USML. Alternatively, DDTC may wish to amend the definition of “technical data” in 22 C.F.R. §120.10, to clarify this point. Another approach would be to address the issue clearly in Category XI (Military Electronics), to explicitly cover all printed board designs related to defense articles.

VI. Conclusion

IPC supports the State Department’s goal of reforming the USML to clearly describe what items it covers. However, in order to prevent the unintentional release of detailed design information about these items, the State Department should clarify that printed circuit board designs remain under the jurisdiction of ITAR when the end item for which the board is designed is a USML item.

Thank you again for the opportunity to comment on the proposed amendments to USML Category VIII. If IPC can offer additional information or assistance, please contact Tony Hilvers at AnthonyHilversw@ipc.org or (847) 597-2837 or Fern Abrams at FernAbrams@ipc.org or (703) 522-0225.

Sincerely,

for
Anthony Hilvers
Vice President, Industry Programs
### APPENDIX A

**Table 1**

Top 20 Purchasers of IPC Standards

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<thead>
<tr>
<th>Customer</th>
<th>Market Segment</th>
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<tr>
<td>1. Honeywell</td>
<td>Military / Aerospace</td>
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<td>2. BAE</td>
<td>Military / Aerospace</td>
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<tr>
<td>3. Lockheed Martin</td>
<td>Military / Aerospace</td>
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<td>4. General Dynamics</td>
<td>Military / Aerospace</td>
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<tr>
<td>5. NASA Marshall</td>
<td>Military / Aerospace</td>
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<td>6. Flextronics</td>
<td>EMS</td>
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<td>7. Jabil</td>
<td>EMS</td>
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<tr>
<td>8. Sony Ericsson</td>
<td>Communication</td>
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<tr>
<td>9. Northrop Grumman</td>
<td>Military / Aerospace</td>
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<td>10. Boeing</td>
<td>Military / Aerospace</td>
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<td>11. Textron</td>
<td>Military / Aerospace</td>
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<td>12. MSSD</td>
<td>Military / Aerospace</td>
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<td>13. EADS</td>
<td>Military / Aerospace</td>
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<td>14. UTC</td>
<td>Military / Aerospace</td>
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<td>15. Plexus</td>
<td>EMS</td>
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<td>16. MSUG/GBMUAA</td>
<td>Military / Aerospace</td>
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<td>17. Raytheon Co</td>
<td>Military / Aerospace</td>
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<td>18. Sanmina-SCI</td>
<td>EMS</td>
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<tr>
<td>19. Dell Computer</td>
<td>Computer</td>
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<tr>
<td>20. Rockwell Collins</td>
<td>Military / Aerospace</td>
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