

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
APPENDIX G Photovoltaic (PV) Modules	Appx. G gen.	<p>From a macroscopic perspective, draft Appendix G for Photovoltaic (PV) Modules (Draft Appendix G) seems poised to create a situation for EOL PV modules at this time that is rather similar to the situation for CRTs and CRT glass since the mid-2010s. At this moment in time, end-of-life (EOL) PV modules do not have a robust downstream infrastructure for recycling of their solar-active material (“Solar Cells”). This would require markets for the recycled solar cell material(s). Core Requirement 2(b)(3)(A) seems to require the recycling of “solar cells”, a Focus Material (FM) in Draft Appendix G, even though there is not much recycling capacity. It seem likely that most (if not all) R2 recyclers certified to Appendix G (among other appendices) will document in the near term “extreme and rare circumstances beyond [their] control [that] disrupts” their ability to recycle (normal management?) solar cells, allowing their disposal. This likelihood suggests that finalizing Appendix G now is premature.</p>	<p>Appendix G should not be finalized and adopted at this time.</p>	<p>There are facilities recycling solar cells and there are existing markets for recycled solar cell material. However, R2 Facilities would have until 2027 before they would be required to add Appendix G to their R2 Certification.</p>	<p>Require R2 Certified facilities that manage PV modules to add Appendix G to their R2 Certification in the 2027 calendar year.</p>

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
APPENDIX G Photovoltaic (PV) Modules	Appx. G gen.	Please see the recommendation above that Appendix G should not be finalized and adopted at this time.	In the alternative, it makes sense to run pilots of the requirements of Draft Appendix G to understand the real-world challenges and opportunities for recycling PV modules under R2v3. Such an approach was used in the development of the first version of R2.	In order to give the PV industry time to develop a robust downstream infrastructure for the management of end of life PV modules, R2 Certified facilities that manage PV modules would not be required to add Appendix G to their R2 Certification until the 2027 calendar year.	Those that chose to add Appendix G to their R2 Certification prior to the required timeline can show leadership in PV modules processing and recycling.

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
APPENDIX G Photovoltaic (PV) Modules	Core Reqt. (1)- (10)	<p>Clauses (1)-(10) under the General Principle do not appear to follow an order of operations for PV modules and their control. For instance, clause (7) for PV module evaluation should probably have a lower number because it is one of the first operations to be conducted on newly received PV modules. The evaluation process could result in functional PV modules that “are exempt from controls of equipment and components containing Focus Materials in the R2 Standard because of their functioning status.” This possibility suggests that clause (7) should precede clause (4) for “includ[ing] PV modules in its FM Management Plan.” This is similar to Core Requirement 6 (Sorting, Categorization, and Processing) preceding Core Requirement 8 (Focus Materials) in R2v3.</p>	<p>The order of clauses (1)-(10) should be reviewed in light of the order of the Core Reqt. in R2v3.</p>	<p>Requirements 1-2 make PV modules applicable to R2 standard’s Core requirement by making PV modules the same as electronic equipment and an R2 controlled stream. Requirments 3-6 are processes for proper management of PV modules such as a risk assessment, adding PV modules to the FM Management Plan, assessing electrical risks during processing, storage, and transportation, and assessing risks of outdoor processing. Requirements 7-10 are about specific processing strategies covering applicable Agencies such as reuse, materials recovery and/or brokering. In Core Requirement 8, the FM Management Plan shall state the planned methods and demonstrated capacity needed to process each type of electronic equipment containing an FM, this is required whether the equipment is for reuse or materials recovery. Requirement 1 in Appendix G makes this requirement applicable to PV modules. If PV modules are received that are evaluated as being capable of reuse, those PV modules would be tested and shown to be functional equipment in accordance with Table 5 of the REC for functional PV modules. If they are evaluated and determined to not be capable of reuse, they are either processed by the R2 Facility in accordance with Appendix E for materials recovery or sent to a downstream vendor qualified in accordance with the requirements of Appendix G.</p>	<p>No change</p>

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
DEFINITIONS - Photovoltaic Modules	No answer given	<p>The proposed definition of “Photovoltaic Module” is much broader than the “common” notion of PV modules (i.e., solar panels) that are used on rooftops and in solar farms. Because a PV module is “a standalone device designed to convert solar radiation into electrical energy”, the definition would include much smaller portable “panels”, including those attached to a battery for storing the solar electricity produced. The proposed definition would also arguably include a PV module that was formerly integrated into a device as a power source and has since been separated from the device. This broad scope is not necessarily a problem, unless the intent was to limit the definition of PV module to solar panels of a particular size, power, and/or other attribute (e.g., non-portable solar panels, which is not necessarily non-stationary, such as those used to power wheel-mounted variable highway signage).</p>	<p>The scope of the definition of PV module requires greater clarity or specificity.</p>	<p>The intent of removing the language "for use in residential, commercial, industrial, and utility applications" from the definition of PV modules after the first round of public comments was to include the smaller portable panels, including the portable panels attached to a battery for storing electricity. The portable panels were intended to be included because the composition of these portable panels is essential the same as the composition of the common notion of PV modules used on rooftops and in solar farms. However, since the definition of PV modules specifically calls out the distinct quality that the PV module is a standalone device, those PV modules formerly integrated into a device would not be included.</p>	<p>Definition of PV modules clarified by moving the solar cells definition to the third sentence of the PV modules definition.</p>
DEFINITIONS - Photovoltaic Modules	Conn. to Focus Material "Solar Cells"	<p>The proposed Focus Material “Solar Cells” should probably be tied more formally to the definition of “Photovoltaic Module”. While its proposed Description/Note offers that “[s]olar cells are components of the PV module that convert light to electricity,” the definition of “Photovoltaic Module” (i.e., PV module) does not mention “solar cells” at all.</p>	<p>The definition of “Photovoltaic Module” should be revised to mention “solar cells”.</p>	<p>The definition of solar cells currently in the Description/Note column of the FM table will be moved to the third sentence of the definition for PV modules for clarity and to tie solar cells into the definition of PV modules. The description/note for solar cells will still remain in the FM table. "Solar cells are components of the PV module that convert light to electricity."</p>	<p>Move "solar cell" definition in the FM Description/ Note column to the third sentence of the definition of PV modules for clarity.</p>

Section	Clause	Comment	Recommended Change	Response	Action Taken
DEFINITIONS - Photovoltaic Modules	Focus Material "Solar Cells"	The proposed FM Description/Note suggests, as do external references, that Solar Cells are functional (i.e., convert light to electricity). At the extreme, it seems doubtful that shredding FM Solar Cells should cause the resulting solar cell material to cease to be a FM because it is not functional.	FM "Solar Cells" should be clarified with respect to functionality and physical integrity.	The proposed FM description/note was included to describe the function of a solar cell in a PV module. Describing the function of a solar cell to make a PV module work is not intended to create a requirement that the tracking of the FM solar cells would cease when the FM solar cells are no longer functional. In fact, the next column, "When Tracking Stops" defines what processing needs to occur for when the FM is no longer required to be tracked. There are four different options, none of which discuss functionality, but processing techniques for recovery, use, and/or depollution.	No change

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
DEFINITIONS - Photovoltaic Modules	Focus Material "Solar Cells"	<p>With regard to FM “Solar Cells”, the proposed threshold of 100 mg/kg for Cd, Se, and Pb in Condition 3 for cessation of the tracking requirement seems potentially problematic. This assertion is based on the idea that the proposed concentration threshold is intended to define (at least in the U.S.) the lowest concentration of Cd, Se, and Pb that makes the material hazardous waste based on the characteristic of toxicity. Materials with concentrations that are below this threshold cannot be hazardous waste. This is a good approach for defining when material no longer requires tracking, as it cannot trigger regulations for hazardous waste. In the U.S., the Toxicity Characteristic Leaching Procedure (TCLP) is used to determine whether a material is federally toxic and thus hazardous waste. To determine the proper concentration threshold, the TCLP threshold value (in mg/L) of a hazardous constituent (e.g., Cd, Se, and Pb) is multiplied by 20 and rendered in “mg/kg”. The TCLP threshold values for Cd, Se, and Pb are 1.0, 1.0, and 5.0 mg/L, respectively. These values result in concentration thresholds of 20, 20, and 100 mg/kg for Cd, Se, and Pb, respectively. Proposed use of 100 mg/kg as the threshold for each of Cd, Se, and Pb would not guarantee that the material could not be hazardous waste for Cd and Se in the U.S. (this may or may not be the case in other countries). This result for Cd and Se would seem to defeat the purpose of the proposed threshold of 100 mg/kg and thus be problematic in the U.S. To alleviate this problem in the U.S., each of Cd and Se should have a concentration threshold of 20 mg/kg. It is worth noting that silver (Ag) is a U.S. hazardous constituent, as are Cd, Se, and Pb. The corresponding concentration threshold of Ag is 100 mg/kg, given its TCLP threshold value of 5.0 mg/L.</p>	<p>The proposed threshold of 100 mg/kg should be revisited to understand better its relevance to toxicity thresholds in the U.S. and abroad and be adjusted accordingly if necessary (e.g., retained or split into metal-specific values).</p>	<p>Although the TCLP threshold values are used in the United States (US) to determine whether a material is hazardous waste based on the characteristic of toxicity, this sampling method is not widely used outside of the US. The values denoted in the column "When tracking stops" are based on the Total Threshold Limit Concentration (TTLC), and why the section states "total concentration thresholds." California (CA), a state in the US with some of the most stringent regulations that often go beyond what US EPA requires, have TTLC limits for the metals as follows: Cadmium 100 mg/kg, Lead 1000 mg/kg, and selenium 100 mg/kg. Finally, the TTLC is a test that measures total concentrations rather than the leachability of the hazardous substances like TCLP. Therefore, using TTLC to analyze PV modules is likely a better representation of what is in the PV module than using TCLP to analyze leachability from PV modules. Under the TTLC criteria in CA, silver has a limit of 500 mg/kg. However, silver was considered by the R2 TAC, and not included as part of the criteria because silver has value, and is likely be extracted in limits that are above what makes the material a hazardous waste. Therefore, since the TTLC is more commonly adopted around the world, and might be more representative of the actual characteristics of a PV module, the TTLC limits were used. However, for clarity a note will be added that explains the R2 facility must adhere to the local legal requirements for managing the PV modules.</p>	<p>Clarifying note about adhering to local legal reqts.</p>

R2v3, Appendix G -Second Round of Public Comments -10/6-11/20/2023

Section	Clause	Comment	Recommended Change	Response	Action Taken
DEFINITIONS - Photovoltaic Modules	Def.	This is improved, but still does not address when there is a portable solar panel. Such as a power bank with the solar panels connected. Having two different definitions could it makes it very clear what is going, and may have a bit better direction for when a battery may be direction connected.	Have two different definitions: Independent Photovoltaic Module, Integrated Photovoltaic Module.	Removing the language "for use in residential, commercial, industrial, and utility applications" was done as a result of the first round of public comments in order to include portable solar panels in the definition of PV modules. Additionally, the definition currently states, " any integrated equipment or components physically attached to the panel" which would include power banks directly connected to a portable solar panel.	No change