ENERGY STAR® Program Requirements for Televisions

Eligibility Criteria
Draft 2 Version 9.0

Following is the Version 9.0 ENERGY STAR Product Specification for Televisions. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS[1]

A) Product Types:

1) Television (TV)[2]: A product designed to produce dynamic video, contains an internal TV tuner encased within the product housing, and that is capable of receiving dynamic visual content from wired or wireless sources including but not limited to:

a) Broadcast and similar services for terrestrial, cable, satellite, and/or broadband transmission of analog and/or digital signals; and/or

b) Display-specific data connections, such as HDMI, Component video, S-video, Composite video; and/or

c) Media storage devices such as a USB flash drive, a memory card, or a DVD; and/or

d) Network connections, usually using Internet Protocol, typically carried over Ethernet or Wi-Fi.

2) Home Theater Display (HTD): A product with diagonal viewable screen size greater than 25 inches, that is designed to produce dynamic video, that does not contain an internal TV tuner encased within the product housing, that is primarily marketed for use in home theater applications, and that is capable of receiving dynamic visual content from wired or wireless sources including but not limited to:

a) Display-specific data connections, such as HDMI, Component video, S-video, Composite video; and/or

b) Media storage devices such as a USB flash drive, a memory card, or a DVD; and/or

c) Network connections, usually using Internet Protocol, typically carried over Ethernet or Wi-Fi.

Home Theater Display does not include Computer Monitors or Signage Displays (defined in the ENERGY STAR Product Specification for Displays).

Note: EPA requests that stakeholders with information concerning whether HTDs are still relevant in the current market submit such for consideration.

3) Hospitality Television/Home Theater Display: A TV or HTD product which includes the following features:

a) A control port for bi-directional communication (DB-9, RJ11, RJ12, RJ45, coaxial cable, or HDMI-CEC); and

1 Where applicable, these definitions are based on definitions in 10 CFR 430. When in conflict, the definitions in the Federal Test Procedure in 10 CFR 430 take precedence, including any future updates to the test procedure.
2 10 CFR 430.2

b) Activated hospitality protocol software (e.g., SmartPort, Meeting Professionals International (MPI), Multiple Television Interface (MTI), Serial Protocol) to provide direct access to Video-On-Demand (VOD) systems, non-video hotel services or a digital media player designed for hospitality-specific applications.

4) Projector: A product that is a mains-powered, optical device, for processing analog or digital video image information, in any, broadcasting, storage or networking format to modulate a light source and project the resulting image onto an external screen[3].

B) Operational Modes:

1) On Mode[4]: The mode of operation in which the TV/HTD is connected to mains power and is capable of producing dynamic video.

2) Standby-Passive Mode[5]: The mode of operation in which the TV/HTD is connected to mains power, produces neither sound nor picture, and can be switched into another mode with only the remote control unit or an internal signal.

3) Standby-Active, Low Mode[6]: The mode of operation in which the TV/HTD is connected to mains power, produces neither sound nor picture, can be switched into another mode with the remote control unit or an internal signal, and can additionally be switched into another mode with an external signal.

4) Standby-Active, High Mode[7]: The mode of operation in which the TV/HTD is connected to mains power, produces neither sound nor picture, is exchanging/receiving data with/from an external source, and can be switched into another mode with the remote control unit, an internal signal, or an external signal.

Note: EPA has removed the definition for Download Acquisition Mode (DAM) as the testing and criteria concerning such is proposed to be removed for the Version 9.0 specification. Further discussion on this proposed removal is in Section 3.4.

5) Off Mode[8]: The mode of operation in which the TV/HTD is connected to mains power, produces neither sound nor picture, and cannot be switched into any other mode of operation with the remote control unit, an internal signal, or external signal.

C) Additional Functions[9]: Functions that are not required for the basic operation of the device.

Note: Additional functions include, but are not limited to, a VCR unit, a DVD unit, an HDD unit, a FM-radio unit, a memory card-reader unit, or an ambient lighting unit.

1) Thin Client Capability: The ability of the TV/HTD to receive, decrypt, and display encrypted content provided by a Multichannel Video Programming Distributor (MVPD) over the Local Area Network via a server device co-located on the customer premises without the need for a client device at the TV/HTD.

3 AEA, Building on the Eco-design Directive, EuP Group Analysis: ENTR Lot 3 Sound and Imaging Equipment Task 1-7 Report, http://ec.europa.eu/DocsRoom/documents/10198/attachments/1/translations/en/renditions/pdf.
4 10 CFR 430, Subpart B, Appendix H, Section 2.14
5 10 CFR 430, Subpart B, Appendix H, Section 2.18
6 10 CFR 430, Subpart B, Appendix H, Section 2.20
7 10 CFR 430, Subpart B, Appendix H, Section 2.19
8 10 CFR 430, Subpart B, Appendix H, Section 2.13
9 10 CFR 430, Subpart B, Appendix H, Section 2.1, which references International Electrotechnical Commission (IEC) Standard 62087 Ed. 3.

2) Full Network Connectivity: The ability of the TV/HTD to maintain network presence while in Standby-Active, Low mode. Presence of the TV/HTD, its network services, and its applications, is maintained even if some components of the TV/HTD are powered down. The TV/HTD can elect to change power states based on receipt of network data from remote network devices, but should otherwise stay in Standby-Active, Low mode absent a demand for services from a remote network device. Full network connectivity is not limited to a specific set of protocols. Also referred to as "network proxy" functionality and described in the Ecma-393 standard.

D) Special Functions[10]: Functions that are related to, but not required for, the basic operation of the device.

Note: Special functions include, but are not limited to, special sound processing, power saving functions (e.g., Automatic Brightness Control).

1) Automatic Brightness Control (ABC): A feature that senses ambient light conditions and changes display brightness accordingly, possibly reducing power consumption.

2) Motion-based Dynamic Dimming (MDD): A feature that adjusts luminance in response to the amount of motion in the displayed image.

3) High Contrast Ratio (HCR) Display: A display where pixels emit no light when displaying a pure black color, thus yielding a contrast ratio of infinity:1 when comparing these pixels against those that do emit light.

Note: EPA has consolidated the definitions of Special Functions to contain only those terms used in this document.

EPA also proposes the definition of an HCR Display. For the purposes of this specification, the definition encompasses the current (e.g., micro-LED and OLED) and anticipated display technologies that are understood to provide an exceptionally high contrast ratio.

E) TV/HTD Settings and Menus:

1) Preset Picture Setting[11](PPS): A preprogrammed factory setting obtained from the TV/HTD menu with pre-determined picture parameters such as brightness, contrast, color, sharpness, etc. Preset Picture Settings can be user-selected within the Home or Retail Configurations.

2) Default SDR Preset Picture Setting: The as-shipped Standard Dynamic Range (SDR) Preset Picture Setting that the TV/HTD enters immediately after making a selection from the Forced Menu. If the TV/HTD does not have a Forced Menu, this is the as-shipped SDR Preset Picture Setting. As referenced in this specification, default settings must be determined through direct observation of the as-shipped configuration.

3) Brightest SDR Preset Picture Setting: The user-selectable SDR Preset Picture Setting within the Home Configuration in which the TV/HTD produces the highest screen luminance.

4) Default HDR10 Preset Picture Setting: The as-shipped Preset Picture Setting when playing HDR10 content. This setting may not always be available for manual user selection and may instead be automatically entered when an HDR10 input signal is detected.

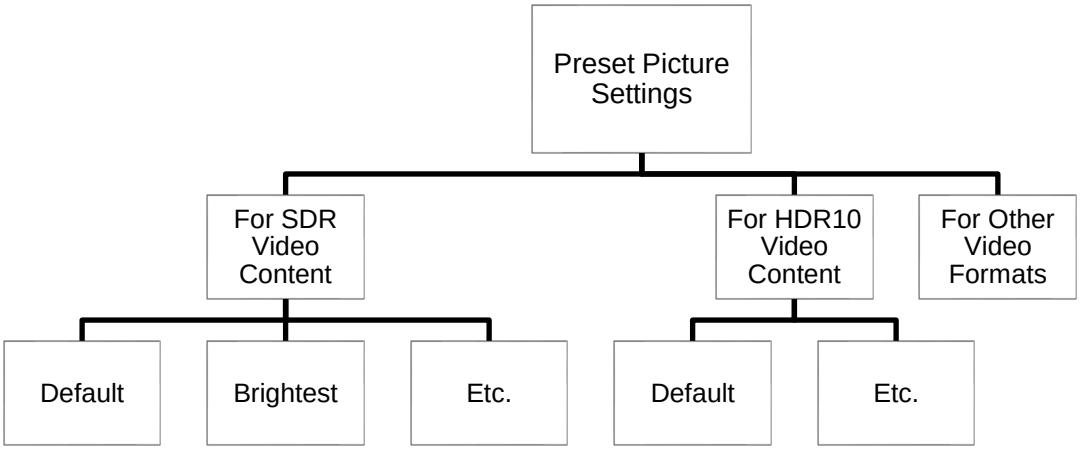
10 10 CFR 430, Subpart B, Appendix H, Section 2.17, which references IEC 62087 Ed. 3.
11 10 CFR 430, Subpart B, Appendix H, Section 2.15, with the exception of "Home or Retail Configurations"; Section 2.15 uses "home or retail mode" instead.

Note: The Default SDR, Brightest SDR, and Default HDR10 Preset Picture Settings referenced in this specification are equivalent to those identified through the current version of the forthcoming *CTA-2037-C: Determination of Television Set Power Consumption and Average Luminance.*

EPA has amended the definition of Brightest SDR Preset Picture Setting to clarify that this should be a user-selectable PPS.

The Agency has also amended the Default HDR10 Preset Picture Setting definition to clarify what the Agency considers to be an HDR PPS for the purpose of evaluating and testing products per this specification.

Figure 1: The Classification of Picture Setting Selection Options for TV/HTDs



5) Home Configuration[12]: The TV/HTD configuration selected from the Forced Menu which is designed for typical consumer viewing and is recommended by the manufacturer for home environments.

6) Retail Configuration[13]: The TV/HTD configuration selected from the Forced Menu which is designed to highlight the TV/HTD's features in a retail environment. This configuration may display demos, disable configurable settings, or increase screen brightness in a manner which is not desirable for typical consumer viewing.

7) Forced Menu: A series of menus which require the selection of initial settings before allowing the user to utilize primary functions. Within these menus, an option is often presented to allow a choice between setting-up the TV/HTD for use in either the Retail or Home Configurations.

F) Power Devices:

1) External Power Supply (EPS)[14]: Also referred to as External Power Adapter. An external power supply circuit that is used to convert household electric current into dc current or lower-voltage ac current to operate a consumer product.

2) Main Battery[15]: A battery capable of powering the TV/HTD to produce dynamic video without the support of mains power.

12 10 CFR 430, Subpart B, Appendix H, Section 2.6
13 10 CFR 430, Subpart B, Appendix H, Section 2.16
14 10 CFR 430.2
15 10 CFR 430, Subpart B, Appendix H, Section 2.12

G) Product Characteristics:

1) Luminance[16]: The photometric measure of the luminous intensity per unit area of light traveling in a given direction, expressed in units of candelas per square meter (cd/m^2).

2) Illuminance[17]: The photometric measure of the total luminous flux incident on a surface, per unit area, expressed in lux.

Note: EPA has added a definition for the term 'Illuminance' so that the term may be later referenced when discussing how ambient lighting conditions are set for and measured by TV/HTDs equipped with an ABC function and associated sensor. An 'illuminance condition,' as referred to in later sections, is akin to an ambient light level.

3) Dynamic Luminance (DL): The luminance averaged across the entire screen area as measured during dynamic video play.

4) Screen Area: The viewable screen area of the product, calculated by multiplying the viewable image width by the viewable image height. For curved screens, the measurements shall be made along the curvature on the face of the screen rather than along a straight line/chord.

5) Native Vertical Resolution**:** The number of visible physical lines along the vertical axis of the TV/HTD (e.g., a TV/HTD with a screen resolution of 1920 x 1080 (horizontal x vertical) would have a Native Vertical Resolution of 1080).

6) Horizontal Resolution: The number of visible physical lines along the horizontal axis of the TV/HTD (e.g., a TV/HTD with a screen resolution of 1920 x 1080 (horizontal x vertical) would have a Horizontal Resolution of 1920).

7) Contrast Ratio: The contrast ratio is the ratio between the luminance of the brightest white and the darkest black that a TV can produce, as measured by the method defined in Section 4.4 below.

8) HD Display: A display with a resolution of 1920x1080 pixels.

9) 4K Display: A display with a resolution of 3840x2160 pixels.

10) 8K Display: A display with a resolution of 7680x4320 pixels.

H) Basic Model[18]: All units of a given type of product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional characteristics that affect energy consumption and energy efficiency.

I) Multichannel Video Programming Distributor (MVPD)[19]: A person such as, but not limited to, a cable operator, a multichannel multipoint distribution service, a direct broadcast satellite service, or a television receive-only satellite program distributor, who makes available for purchase, by subscribers or customers, multiple channels of video programming.

J) High Definition Multimedia Interface (HDMI): An audio and video interface as defined by HDMI® Specification Informational Version 1.0 or greater. For reference, see HDMI specification[20].

16 10 CFR 430, Subpart B, Appendix H, Section 2.11
17 10 CFR 430, Subpart B, Appendix H, Section 2.10
18 10 CFR 430.2, with references to water consumption and other specific covered products removed.
19 As defined in 47 USC § 522(13)
20 10 CFR 430.2, https://www.hdmi.org/spec/index

Note: EPA has added a definition and associated specification footnote for 'HDMI' as the term is used to describe product capabilities and features.

K) Unit Under Test (UUT): The unit currently undergoing testing.

2 SCOPE

2.1 Included Products

2.1.1 Products that are: (1) marketed to the consumer as a TV/HTD (i.e., TV/HTD is the primary function); (2) capable of being powered from a wall outlet or with an external power supply; and (3) meet one of the following product type definitions, are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.2:

i. TVs
ii. Hospitality TV/HTDs
iii. Home Theater Displays

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/specifications.

2.2.2 Products that satisfy one or more of the following conditions are not eligible for ENERGY STAR certification under this specification:

i. Projectors.
ii. TV/HTDs with a Main Battery that enables operation without connected mains power.
iii. Products with a computer input port (e.g., VGA), that are marketed and sold primarily as computer monitors or other displays, and that do not contain an integrated TV tuner encased within the product housing.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values. Only the final result of a calculation shall be rounded.

3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

3.1.3 Annual Energy Consumption (AEC) values less than 100 kWh shall be rounded to the nearest tenth of a kWh; otherwise, they shall be rounded to the nearest kWh, as specified in Section 8.2 *Rounding* of the Federal Test Procedure, for reporting on the ENERGY STAR website.

3.1.4 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 General Requirements

3.2.1 External Power Supplies (EPSs): Single- and Multiple-voltage EPSs shall meet the Level VI or higher performance requirements under the International Efficiency Marking Protocol when tested according to the Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to Subpart B of 10 CFR Part 430.

i. Single- and Multiple-voltage EPSs shall include the Level VI or higher marking.
ii. Additional information on the Marking Protocol is available at http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218.

3.2.2 General User Information: The product shall ship with consumer informational materials located in either (1) the hard copy or online electronic user manual, or (2) a package or box insert. These materials shall include:

i. Information about the ENERGY STAR program;
ii. Information on the energy consumption implications of changes to as-shipped TV/HTD configurations and settings, including the implications of software or firmware updates; and
iii. Notification that enabling certain optional features and functionalities (e.g., instant-on), may increase energy consumption beyond the limits required for ENERGY STAR certification, as applicable.

3.2.3 Energy Saving Features: A TV/HTD may not be certified with any detectable or undetectable energy saving features that are enabled when tested unless that feature provides comparable energy savings during typical viewing experiences (i.e., the duration of a variety of common or prevalent programming). This prohibition applies irrespective of whether the function's primary or intended purpose is energy savings. Further, this applies to features that may be downloaded in the future.

3.2.4 Forced Menu: For any product that includes a Forced Menu where consumers are provided a choice of Home Configuration or Retail Configuration at initial start-up:

i. Upon selection of Retail Configuration, the product must either (1) display a second prompt requiring the user to confirm the choice of Retail Configuration, or (2) display information on the start-up menu that the Home Configuration is the setting in which the product qualifies for ENERGY STAR. If option (2) is selected, additional detail about ENERGY STAR certification and energy consumption expectations shall be included in printed product literature and on the product information page on the Partner's website.
ii. Partners may use alternative terminology if approved by the U.S. Environmental Protection Agency (EPA).

3.2.5 Standby-Active, High Mode Capability: TV/HTDs with Standby-Active, High Mode shall automatically return to the as-tested Standby-Active, Low Mode or Standby-Passive Mode following a manufacturer firmware update or other maintenance operation in Standby Active, High Mode within a period less than or equal to 15 minutes from the completion of said update/maintenance operation.

3.3 On Mode Requirements

The following On Mode requirements are based on measurements taken per the *CTA-2037C*: *Determination of Television Set Power Consumption and Average Luminance*.

3.3.1 For all TV/HTDs, On Mode Power (P_{OA}) metrics shall be determined through the following process:

i. For PPSs **without** ABC enabled by default: The metrics gathered while testing with ABC disabled shall represent P_{OA} and the DL for the PPS.

ii. For PPSs **with** ABC enabled by default: Measurements at different illuminance conditions are thus taken (at 3, 12, 35, and 100 lux) per the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance*:

a) To calculate DL for the PPS: The value of DL used to represent the PPS for the purpose of calculating $P_{OA\_Average\_Limit}$ per Equation 5 shall be the calculated average of the DL measurements taken at each illuminance condition, as outlined by Equation 1.

b) To calculate P_{OA} for the PPS: The value of P_{OA} that represents the PPS for the purpose of calculating $P_{OA\_Average}$ per Equation 4 shall be the calculated average of the P_{OA} measurements for the PPS taken at each illuminance condition, as outlined by Equation 2.

iii. If the value for the DL used to represent an SDR PPS is measured or calculated to be less than 20 cd/m^2, then 20 cd/m^2 shall be the DL value used to represent the PPS for the purpose of determining certification, and the value of P_{OA} used to represent the PPS shall be the interpolated P_{OA} value of the PPS when the TV/HTD is set to a DL of 20 cd/m^2. Likewise, if the value of the DL for an HDR PPS is less than 10 cd/m^2, then 10 cd/m^2 shall be used as the DL representing the PPS for the purpose of determining certification, and the value of P_{OA} used to represent the PPS shall be the interpolated P_{OA} value of the PPS when the TV/HTD is set to a DL of 10 cd/m^2.

a) For PPSs **without** ABC enabled by default: The P_{OA} values of a PPS correlating to a projected DL of 20 cd/m^2 or 10 cd/m^2 shall be calculated through interpolation of the linear trendline created by plotting the PPS's measured P_{OA} values at its default and minimum backlight setting (or brightness if no backlight-specific control is available) against the measured DL values at the same points.

b) For PPSs **with** ABC enabled by default: The P_{OA} values of a PPS correlating to a projected DL of 20 cd/m^2 or 10 cd/m^2 shall be calculated through interpolation of the 2nd order polynomial trendline created by plotting the PPS's measured P_{OA} values at 3 lux, 12 lux, 35 lux, 100 lux, and the ABC-disabled datapoints against the measured DL values at the same points.

Equation 1: Calculation of Dynamic Luminance for Preset Picture Settings Where ABC is Enabled by Default

$$DL = \frac{DL_3 + DL_{12} + DL_{35} + DL_{100}}{4}$$

Where:

- DL is the Dynamic Luminance for a Preset Picture Setting where ABC is enabled by default, in cd/m^2; and
- DL_3, DL_{12}, DL_{35}, and DL_{100} are the dynamic luminance measurements taken per the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance* when illuminance conditions are configured to 3 lux, 12 lux, 35 lux, and 100 lux, respectively.

Equation 2: Calculation of P_{OA} for Preset Picture Settings Where ABC is Enabled by Default

$$P_{OA} = \frac{P_{OA\_3} + P_{OA\_12} + P_{OA\_35} + P_{OA\_100}}{4}$$

Where:

- P_{OA} is the On Mode Power for a Preset Picture Settings where ABC is enabled by default, in watts; and
- P_{OA_3}, P_{OA_12}, P_{OA_35}, and P_{OA_100} are the On Mode Power measurements taken per the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance* when illuminance conditions are configured to 3 lux, 12 lux, 35 lux, and 100 lux, respectively.

Note: Throughout this specification, DL and P_{OA} metrics are often referred to as "representative of" or "as representing" the PPS. In these cases, "representative" metrics are those determined through the steps outlined in Section 3.3.1.

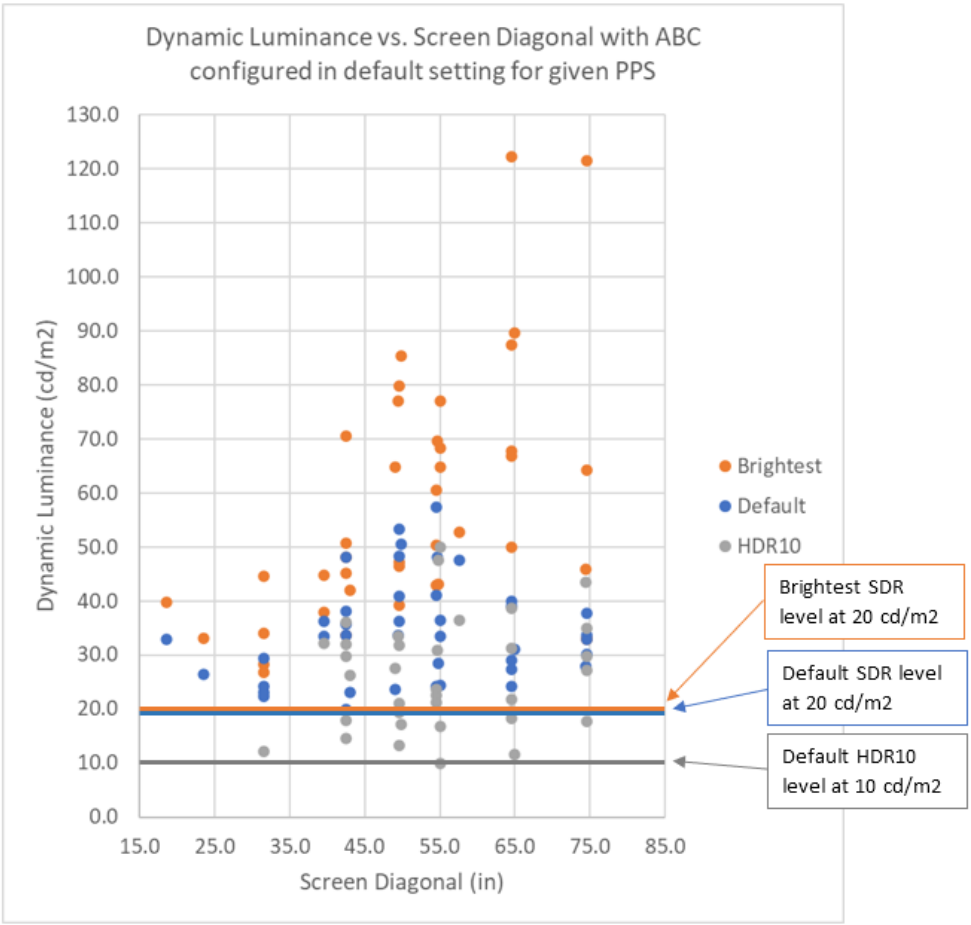
EPA has used an updated dataset consisting of 41 2020-2021 TV models from 10 different manufacturers to evaluate the criteria levels presented in Draft 1. This variety of TVs includes models with several different resolutions, sizes, and display technologies. Furthermore, the dataset was obtained by testing these TVs per the current iteration of the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance* test procedure, which includes provisions for testing TVs with ABC enabled by default. Use of this dataset has led to the Agency proposing the following for determining P_{OA} and DL, as outlined in Section 3.3.1:

(1) For PPSs where ABC is enabled by default, EPA proposes using metrics that are the average DL and P_{OA} taken at several illuminance conditions to represent the PPS in calculating $P_{OA\_Average\_Limit}$ and $_{POA\_Average}$ metrics, respectively. As mentioned in the Draft 1 cover memo, EPA continues to monitor the development of an updated approach towards ABC testing. At this time, the approach as presented in the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance* has been developed to the extent that the Agency feels it appropriate to include ABC-based metrics in the Version 9.0 criteria levels as proposed in this Draft 2 specification.

Recent testing has shown that many manufacturers configure their TVs to have ABC functionality enabled by default in the Default SDR PPS, among others. A 2019 NEEA study of consumer behavior regarding changing TV settings indicates that a majority of consumers do not change the default settings of the TV (although they may change PPSs), EPA believes that incorporating ABC-enabled metrics for PPSs that have it enabled by default, as outlined in Section 3.3.1.ii, leads to criteria that are more representative of how the TV is likely to perform in the home. Also, testing has illustrated the extent to which an ABC feature can provide energy savings to the consumer and the Agency wishes to encourage persistence of the feature.

(2) If the DL used to represent a PPS is below a certain luminance, 20 cd/m^2 for SDR PPSs and 10 cd/m^2 for HDR PPSs, use interpolated values for P_{OA} at these specific DL values to represent the PPS in calculating $P_{OA\_Average}$. The goal of including these lower luminance thresholds (as presented in Section 3.3.1.iii) to determine certification is to ensure that there is no incentive to overly dim TVs in order to meet ENERGY STAR criteria levels.

These thresholds were developed by looking at the measured DL data of 18 4K LCD TVs with ABC functionality from four different manufacturers. Because there is no current policy incentive to set a TV's ABC algorithm in any particular way, EPA considers these datapoints to be representative of the backlight levels that manufacturers believe consumers find desirable. As such, the proposed DL thresholds for SDR and HDR PPSs are slightly below the DL that would be calculated per 3.3.1.ii for all but the dimmest tested TVs. **The proposed thresholds are not minimum luminance requirements and for any current or future TV model with a representative DL below the threshold, there is no penalty, only a lack of incentive to dim further to meet criteria levels. In other words, manufacturers may still set their TV default settings to have a representative DL below this threshold, but compliance for ENERGY STAR will be determined no lower than these thresholds.** EPA believes that this proposal will give manufacturers the freedom to program their backlight settings for however they believe will deliver the best viewing experience while ensuring that ENERGY STAR is not providing an incentive to do otherwise. A chart showing the distribution of default DL values used to create these thresholds is below:



For PPSs with a representative DL value below its corresponding threshold, the datapoints gathered through testing will be used to determine P_{OA} as outlined in Section 3.3.1.iii. When ABC is not enabled by default, the relationship between DL and power is observed through a linear trendline that passes through the datapoints of the PPS's default DL and the manually-adjusted-dimmest backlight setting. However, the current dataset illustrates that this linear relationship between DL and power is not always present for PPSs where ABC is enabled by default. As such, when a PPS has a representative DL below its corresponding threshold, the trendline used to interpolate P_{OA} values shall be a 2nd order polynomial that passes through the DL datapoints taken at the four illuminance conditions and the DL when ABC is disabled. A higher order equation such as this has been observed to accurately interpolate P_{OA} for all TVs with ABC enabled by default in the current dataset.

3.3.2 Products shall meet the On Mode Power Requirement as outlined by Equation 3:

i. Should a TV not be capable of displaying HDR10 content in an HDR format, it will not be subject to that test and P_{OA} metrics associated with the HDR10 picture setting shall be omitted from calculations as presented by Equations 4 and 5.

ii. Should a TV have a Default SDR Preset Picture Setting that is also the Brightest Selectable SDR Preset Picture Setting, then the same test result can be used for $P_{OA\_Default}$ and $P_{OA\_Brightest}$ (i.e., $P_{OA\_Brightest} = P_{OA\_Default}$).

Equation 3: On Mode Power Requirement

$$P_{OA\_Average} \leq P_{OA\_Average\_Limit} \text{x } AF$$

Where:

- $P_{OA\_Average}$ is the average of the On Mode Power in each applicable preset picture setting as calculated per Equation 4, in watts;
- $P_{OA\_Average\_Limit}$ is the average limit of On Mode Power in each applicable preset picture setting as calculated per Equation 5, in watts; and
- AF is the Adjustment Factor, dependent on the TV/HTD, calculated from the corresponding equations in Table 2.

Equation 4: Average On Mode Power, $P_{OA\_Average}$

$$P_{OA\_Average} = \frac{P_{OA\_Default} + P_{OA\_Brightest} + P_{OA\_HDR}}{n}$$

Where:

- $P_{OA\_Average}$ is the average of the On Mode Power in each applicable preset picture setting as calculated per Equation 4, in watts;
- $P_{OA\_Default}$ is the On Mode Power for the Default SDR Preset Picture Setting, as determined by Section 3.3.1, in watts;
- $P_{OA\_Brightest}$ is the On Mode Power for the Brightest SDR Preset Picture Setting, as determined by Section 3.3.1, in watts;
- P_{OA_HDR} is the On Mode Power for the Default HDR Preset Picture Setting, as determined by Section 3.3.1, in watts; and
- *n* is the number of PPSs for which DL and P_{OA} metrics have been gathered (i.e., n equals 2 if the TV/HTD is not capable of displaying HDR10 content in an HDR format and 3 if it is).

Equation 5: Average Limit of On Mode Power, $P_{OA\_Average\_Limit}$

$$P_{OA\_Average\_Limit} = \frac{P_{OA\_Default\_Limit} + P_{OA\_Brightest\_Limit} + P_{OA\_HDR\_Limit}}{n}$$

Where:

- $P_{OA\_Average\_Limit}$ is the average limit of On Mode Power in each applicable preset picture setting as calculated per Equation 5, in watts;
- $P_{OA\_Default\_Limit}$ is the limit for On Mode Power of the Default SDR Preset Picture Setting, as determined by Table 1, in watts;
- $P_{OA\_Brightest\_Limit}$ is the limit for On Mode Power of the Brightest SDR Preset Picture Setting, as determined by Table 1, in watts;
- $P_{OA\_HDR\_Limit}$ is the limit for On Mode Power of the Default HDR Preset Picture Setting, as determined by Table 1, in watts; and
- *n* is the number of PPSs for which DL and P_{OA} metrics have been gathered (i.e., n equals 2 if the TV/HTD is not capable of displaying HDR10 content in an HDR format and 3 if it is).

Table 1: On Mode Power Limits

Preset Picture Setting	Functions:	
	Limit 1: Performance-based efficiency limit	Limit 2: Power cap
Default ($P_{OA\_Default\_Limit}$)	0.94 x ((0.0007 x A + 0.5736) x DL + (0.0055 x A + 18.9667))	1.15 x ((0.0249 x A) + 46.5902)
Brightest ($P_{OA\_Brightest\_Limit}$)	0.94 x ((0.0007 x A + 0.5424) x DL + (0.005 x A + 19.8365))	1.15 x ((0.057 x A) + 40.7037)
HDR10 ($P_{OA\_HDR\_Limit}$)	0.94 x ((0.0013 x A + 1.866) x DL + (0.0069 x A + 17.1106))	1.15 x ((0.0576 x A) + 31.6067)

Where:

- DL is the dynamic luminance for the Preset Picture setting, as determined in Section 3.3.1;
- A is the viewable Screen Area of the product in square inches; and
- The lesser of the two limit values calculated for a Preset Picture Setting is to be used in the $P_{OA\_Average\_Limit}$ calculation.

Table 2: Average Limit of On Mode Power, $P_{OA\_Average\_Limit}$, Adjustment Factors

P_{OA_MAX} Adjustment Factor (AF)	Value
AF_{HCR}	$0.4588 \times A^{0.138}$
$AF_{Resolution}$	$(0.0469 \times P^{0.1946})/1.041$

Where:

- A is the viewable Screen Area of the product in square inches;
- P is the pixel count of the TV/HTD, calculated by multiplying the TV/HTD's vertical resolution by its horizontal resolution;
- The AF_Resolution adjustment factor applies to all TV/HTDs; and
- The AF_HCR adjustment factor applies to TV/HTDs that are determined by the Certification Body, through review of manufacturer-supplied technical materials, to meet the definition of an HCR Display.

Note: EPA has replaced the On Mode Power requirements prescribed for **each** PPS as proposed in Draft 1 with an ***average*** On Mode Power requirement (Equation 4). The Agency believes that combining this requirement with the Average On Mode Power Limit (Equation 5) approach allows manufacturers more flexibility in designing their TVs for efficiency – a model that would not meet power requirements for all three PPSs may still be certifiable if the efficiency of the model's PPSs meets requirements on average.

The On Mode Power Limits, as outlined in Table 1, have been updated to apply even stringency across variations in product type (e.g., resolutions, display technology, size bins, etc.), as evident through analysis of the current, 2020-2021 model dataset.

The Average On Mode Power Adjustment Factors, as outlined in Table 2, have been updated in two ways: (1) the three, resolution-based AFs presented in Draft 1 have been replaced by the single $AF_{Resolution}$ in order to eliminate the need to determine which AF applies to the TV/HTD and better apply an even stringency across both common and atypical resolution categories and (2) the HCR AF that was exclusive to 4K resolution models in Draft 1 has been replaced with AF_{HCR}, which relates pixel count to efficiency in order to account for future models that may combine HCR-capable display technology with other resolutions.

EPA proposes to remove the requirement to verify contrast ratio through testing to determine AF_{HCR} applicability. This is due to the lack of a standardized testing approach for measuring contrast ratio and the innate difficulty in arranging a test environment so that the light projected by a pixel does not influence the measured luminance of an adjacent pixel. Because there is common understanding that some current and anticipated TV technologies can precisely turn on/off individual pixels to provide an exceptionally high contrast ratio, the Agency believes that Certification Bodies will be able to determine applicability of AF_{HCR} when reviewing the manufacturer-provided specification manuals during certification testing.

Analyzing the current dataset, approximately 39% of TVs meet these On Mode Power requirements. This percentage does not incorporate the effect of Standby requirements on pass rates.

3.4 Standby Mode Requirements

The following Standby Mode Requirements are based on measurements from the Federal Test Procedure Standby-Passive Mode Test as well as the series of additional Standby-Active, Low Mode tests outlined in the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance*, that are designed to measure standby power in a more typical network environment (e.g., multicast traffic on the network).

3.4.1 Standby-Passive Mode Power ($P_{STANDBY-PASSIVE}$), as measured per Section 7.3.*2 Standby-Passive Mode* of the Federal Test Procedure, shall be less than or equal to 0.5 W.

3.4.2 For TVs capable of network connectivity, Standby-Active, Low Mode Power ($P_{ADDITIONAL-STANDBY-ACTIVE-LOW}$), as measured per *CTA-2037C*, shall be less than or equal to 1.0 W.

Note: EPA proposes to reduce the number of Additional Standby-Active, Low Mode Power tests required in Draft 1 by only requiring the information gathered through testing Standby-Active, Low Mode after powering down from the Default SDR PPS for certification evaluation. Additional research has shown that there is no significant correlation between the PPS selected for On Mode and energy usage while in Standby Mode.

The Agency proposes to remove the requirement for Standby-Active, Low Mode Power as measured per the Federal Test Procedure because the requirement set for this mode as measured per *CTA-2037C* is of equal stringency (1 W). This proposed removal follows EPA's understanding that the standby-active mode power as measured per *CTA-2037C* will always be higher than that measured per the Federal Test Procedure because it requires the configuration of wake-by-voice and wake-by-cast capabilities if available, which the Federal Test Procedure does not. As a result, a requirement based on measurements taken per the Federal Test Procedure would be redundant because the TV must already meet an identical requirement for a higher power consuming version of the same mode.

EPA also proposes to lower the Standby-Active, Low Mode requirements from 2 W to 1 W. The current, 2020-2021 model dataset shows that several manufacturers have been able to configure their smart TV lineups to have Standby-Active, Low Mode Power values of well below 1 W, despite the industry average being much higher. The overall pass rate of TVs meeting both On Mode and Standby requirements, as calculated for the current dataset, is 20%.

The Agency proposes to delete power requirements and associated testing for Download Acquisition Mode (DAM). Looking at the products certified to ENERGY STAR since 2016, the Agency has seen a decline in the hospitality-specific models that employ a DAM function and as such, believes that the availability of these models in general has declined in recent years (as smart TVs have grown in market share). EPA would appreciate stakeholder feedback and associated data regarding whether DAM requirements are still relevant.

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR Program Requirements for Televisions: Partner Commitments for details.

4 TESTING

4.1 Applicable Test Procedures

To the extent that the U.S. Department of Energy (DOE) requires use of the Federal Test Procedure, Annual Energy Consumption (AEC) and other values as measured according to the Federal Test Procedure and certified to DOE, may be reported to EPA for presentation in the ENERGY STAR Product Finder.

Table 3: Test Method for All TV/HTDs

Test Method	Requirements	Applicability
Uniform Test Method for Measuring the Energy Consumption of Television Sets incorporated in Appendix H to Subpart B of 10 CFR Part 430	Report measured AEC and power consumption in On, Standby-Active, Low, and Off Modes	Reporting requirement
	Test and report Standby-Passive Mode (3.4.1)	Test to determine ENERGY STAR Certification*
CTA-2037C: Determination of Television Set Power Consumption and Average Luminance	Test and report On Mode (Section 3.3) and Standby-Active, Low (Section 3.4.2) Power	

*Only data used to determine compliance with ENERGY STAR requirements must be measured in an EPA-Recognized Laboratory through the Third-Party Certification process.

Note: Since publishing the Draft 1, EPA has begun to work with stakeholders in the Consumer Technology Association (CTA) R4 Working Group 13 to develop the *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance* test procedure that is based on the same approach to measuring TV power and projected luminance as the additional test procedures outlined in Draft 1. As such, and so long as the working group continues to make timely progress towards the finalization of *CTA-2037C*, the Agency intends to reference it for use in testing to determine compliance with this specification. This will allow for ENERGY STAR to align with the industry accepted approach to measuring TV efficiency and reduce the test burden that having an additional test method would put on manufacturers looking to certify products under the program.

EPA developed the specification levels based on a dataset of TVs tested in accordance with the NEEA test method being used as the starting point for developing *CTA-2037C*. EPA understands that as the *CTA-2037C* test procedure continues to be developed, some changes are likely to be made to the test method that may impact power measurements. As changes are made, the Agency will reevaluate the criteria presented in this specification to determine whether corresponding modifications to the specification levels are necessary.

4.2 Software Update

4.2.1 All TV/HTDs shall execute a software update before performing any testing per the forthcoming *CTA-2037C: Determination of Television Set Power Consumption and Average Luminance*:

i. Download and install any available software updates either by acknowledging a prompt or by requesting an update through a menu selection.
ii. Wait until all software updates have been installed.

Note: EPA acknowledges that the current version of the *CTA-2084* test procedure includes instructions for performing a software update. If the final version of this procedure retains these instructions, the Agency will consider removing the Section 4.2 as presented in this draft.

4.3 Number of Units Required for Testing

4.3.1 One of the following sampling plans shall be used to test for ENERGY STAR certification:

i. A single representative unit shall be selected for testing the Basic Model;
ii. Units shall be selected for testing per the sampling requirements defined in 10 CFR 429.25, which references 10 CFR 429.11.

4.4 International Market Certification

4.4.1 Products shall be tested for certification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

5 USER INTERFACE

5.1.1 Partners are encouraged to design products in accordance with the user interface standard IEEE 1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see http://eetd.LBL.gov/Controls.

6 EFFECTIVE DATE

6.1.1 Effective Date: The Version 9.0 ENERGY STAR Televisions specification shall take effect on **TBD**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

Note: The effective date is tentative until the date of final publication of the ENERGY STAR Televisions Version 9.0 Specification. The Version 9.0 specification will take effect 9 months after that date.

6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.

7 CONSIDERATIONS FOR FUTURE REVISIONS

7.1.1 Backlight Control Accessibility and ABC Persistence: EPA seeks to understand if more accessible backlight controls would increase ABC persistence.

7.1.2 Implementation of Filmmaker Mode and Performance: EPA is interested to see if the increased implementation of a “Filmmaker Mode” Preset Picture Setting by manufacturers is followed by a tendency to apply the setting by consumers and how the characteristics unique to this setting affect energy efficiency.

7.1.3 Color Quality and Energy Efficiency: EPA looks to explore the relationship between image quality, with respect to color (viewing angle, gamut size, etc.), and energy efficiency.