



Underwriters Laboratories Inc.®

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December 7, 1994

Revision pages for

Standard for

Commercial Closed Circuit Television Equipment

UL 2044, First Edition

Attached to this transmittal notice is a reprinted title page for the first edition of UL 2044.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 2044-1994.

Revised and/or additional pages may be issued from time to time.

With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following checklist:

Page	Date
1	June 7, 1993 (Reprinted December 7, 1994)
2	—
3 – 109, A1 – A2, B1 – B2, C1 – C2	June 7, 1993

(Title Page Reprinted: December 7, 1994)

1

UL 2044

Standard for

Commercial Closed Circuit Television Equipment

First Edition

June 7, 1993

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Approved as ANSI/UL 2044-1994, September 22, 1994

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

ISBN 1-55989-347-8

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Subjects 3044 (2044)
 (In reply, refer to Subject 3044)

333 Pfingsten Road
 Northbrook, IL 60062
 June 13, 1994

TO: Burglary Protection Council of Underwriters Laboratories Inc.,
 Electrical Council of Underwriters Laboratories Inc.,
 Subscribers to UL's Standards Service for Commercial Closed Circuit Television
 Equipment

SUBJECT: Report of the Meeting of the Industry Advisory Group of UL for Closed Circuit Television
 Equipment; Request for Comments on Proposed Requirements for the Proposed First
 Edition of the Standard for Surveillance Commercial Closed Circuit Television
 Equipment, UL 3044; PROPOSED EFFECTIVE DATE

SUMMARY OF TOPICS

The following topics were discussed at the meeting:

1. Proposed requirements for the proposed first edition of the Standard for Surveillance Commercial Closed Circuit Television Equipment, UL 3044.
2. Future standards development activities for closed circuit television surveillance systems.

COMMENTS DUE: SEPTEMBER 12, 1994

A meeting of the Industry Advisory Group of UL for Closed Circuit Television Equipment was held on April 27, 1994 at UL's Northbrook Office. The purpose of the meeting was to discuss the proposed requirements for the proposed first edition of the Standard for Surveillance Commercial Closed Circuit Television Equipment, UL 3044.

Attached as Appendix A are proposed requirements for UL 3044. Attached as Appendix B is a list of those who attended the meeting. Questions regarding interpretation of requirements should be directed to the responsible UL Staff. Please see Appendix C of this bulletin regarding designated responsibility for the subject product category.

Please note that proposed requirements are of a tentative and early nature and are for review and comment only. Current requirements are to be used to judge a product until these requirements are published in final form.

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PROPOSED EFFECTIVE DATE

These proposed requirements will not necessitate a review or additional testing of currently Listed products. Therefore, UL proposes that the new requirements become effective upon publication.

* * * * *

The following report is not intended to be a verbatim transcript of the discussions at the meeting, but is intended to record the significant features of those discussions.

1. PROPOSED REQUIREMENTS FOR THE PROPOSED FIRST EDITION OF UL 3044**DISCUSSION**

As a result of input from representatives of industry at the October 28 and 29, 1992 meeting of the Industry Advisory Group (IAG) reported in UL's Subjects 2044 (983, 1409, 1410) bulletin dated November 19, 1992, and verification of the proposed test methods at an independent laboratory, UL provided for discussion at the April 27, 1994 IAG meeting proposed requirements for the proposed first edition of the Standard for Surveillance Commercial Closed Circuit Television Equipment, UL 3044. The representatives of industry commented as follows on the proposed test methods.

The representatives of industry noted that, as high definition television (HDTV) systems will be employed in the near future, definitions for the terms "TV resolution" and "IRE" that relate specifically to the presently used NTSC (National Television Systems Committee) television system need to be added to the Glossary, Section 2. UL indicated that these definitions will be added to the proposed standard.

The representatives of industry inquired as to the criteria UL used to choose which tests are to be applied to pan-and-tilt units. UL explained that the proposed first edition of the Standard for Surveillance Commercial Closed Circuit Television Equipment, UL 3044, was developed to evaluate individual equipment only. As a result, tests on individual equipment, the results of which are affected by associated equipment, such as the preset accuracy test for pan-and-tilt units that is affected by the drive unit, were omitted from proposed UL 3044. UL plans to include these system tests in a standard for closed circuit television (CCTV) surveillance systems.

The representatives noted that manufacturers rate their CCTV equipment, except for time-lapse video recorders, in lines of TV resolution to account for the NTSC aspect ratio of 3/4. Time-lapse video recorders are rated by manufacturers in lines of horizontal resolution. UL indicated that the proposed test methods for resolution would be modified to reflect this.

A representative of industry indicated that verification of color needs to be addressed. UL explained that proposed test methods for verification of color involve a CCTV system, and that UL plans to include this topic during the development of a standard for CCTV surveillance systems.

As a result of the discussion, UL incorporated the comments into the proposal attached as Appendix A for review and comment by industry and others interested.

RATIONALE

Prior to 1968, the Board of Governors of the United States Federal Reserve Bank conducted a study that was motivated by a large number of hold-ups that were occurring in banks across the country to determine the best method of establishing security in banking. Many security and banking experts participated in this study. The result of this study was the Bank Protection Act of 1968, also known as "Regulation P," which included requirements for the use of surveillance cameras in banks.

The Federal Reserve Bank subsequently requested that UL develop a standard for surveillance cameras that would meet the needs of the banking industry and the requirements of the Bank Protection Act of 1968. As a result with industry input, UL developed and subsequently published in 1972 the Standard for Surveillance Cameras, UL 983, which includes requirements for picture resolution for identification of persons.

The banking industry also relies on UL for third party certification of other security products, such as bank safes and vaults, bullet-resistant glass, burglar alarm systems, holdup alarm units and systems, and night depositories.

Recently, the Federal Reserve Bank, motivated by changing technology, reviewed the Bank Protection Act of 1968. The Federal Reserve Bank in its final ruling of March 29, 1991, mandated appointment of a bank officer charged with security. This officer is charged with employing whatever type of security system that is necessary to achieve the desired results. This places a significant new burden and liability on the bank officer for design and implementation of an effective security system, which often includes closed circuit television equipment.

In addition, the American Banking Association requires third party certification of all its security systems and equipment. UL has provided this third party certification for many of the banking industry's security products. Therefore, UL decided to offer the banking industry a means to obtain third party certification of closed circuit television equipment. To provide a basis for third party certification of closed circuit television equipment, UL invited the closed circuit television equipment industry and others interested to participate in the development of the first edition of the Standard for Commercial Closed Circuit Television Equipment, UL 2044. As a result, UL 2044, which covers the safety-related requirements for commercial closed circuit television equipment, was published by UL on June 7, 1993. Manufacturers that have products Listed in accordance with UL 2044 will be included in UL's Electrical Appliance and Utilization Equipment Directory under Commercial Closed Circuit Television Equipment (DROH).

To expand the service to cover commercial closed circuit television equipment that complies with UL 2044 and that is additionally intended for surveillance to provide a means of observing and/or recording activities in the surveyed area, UL proposes requirements for the first edition of the Standard for Commercial Surveillance Closed Circuit Television Equipment, UL 3044. These proposed requirements were developed as a result of UL's research, and input from industry and others interested. Manufacturers that have products Listed in accordance with proposed UL 3044 will be included in UL's Automotive, Burglary Protection, and Mechanical Equipment Directory under Burglary Protection.

IMPACT

If these proposals are adopted, no review or retest of presently Listed commercial closed circuit television equipment would be needed. However, if manufacturers desire to submit digital video products for an investigation in accordance with these proposed requirements, manufacturers may need to change the resolution rating on digital video products from pixels to lines of TV resolution.

2. FUTURE STANDARDS DEVELOPMENT ACTIVITIES

DISCUSSION

The representatives of industry inquired as to UL's future standards development activities for closed circuit television surveillance systems. UL indicated that, with the support from manufacturers of components, and installers and users of systems, UL intends to develop a standard that would cover installation and certification of CCTV surveillance systems. UL anticipates that the certification program would include:

- a) Qualifying a manufacturer or installer to do inspection of a system and to issue certificates;
- b) Auditing of these Certificated installations by a UL representative; and
- c) Reviewing of maintenance or service contracts for monitoring the performance of an installation.

REQUESTS FOR COMMENTS ON PROPOSALS

Please provide the following:

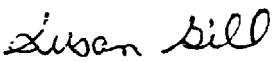
- 1. Your comments concerning the meeting report and the proposed requirements; and
- 2. Your comments concerning the proposed effective date, should the proposals be adopted.

Written comments should be sent to the attention of Susan Gill at UL's Northbrook office, 333 Pfingsten Road, Northbrook, IL 60062-2096. Please reference all correspondence to Subject 3044.

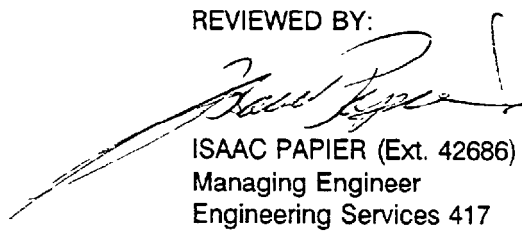
All comments should be sent by September 12, 1994.

Unless specifically requested to do otherwise, UL will not acknowledge comments indicating concurrence with these proposals.

UNDERWRITERS LABORATORIES INC.


 SUSAN GILL (Ext. 42090)
 Project Engineer
 Standards Department

REVIEWED BY:


 ISAAC PAPIER (Ext. 42686)
 Managing Engineer
 Engineering Services 417

SR:DES

E:\3044BUL.Q01

PROPOSED REQUIREMENTS ARE OF A TENTATIVE AND EARLY NATURE AND ARE FOR REVIEW AND COMMENT ONLY. CURRENT REQUIREMENTS ARE TO BE USED TO JUDGE A PRODUCT UNTIL THESE REQUIREMENTS ARE PUBLISHED IN FINAL FORM

APPENDIX A

PROPOSED REQUIREMENTS AND PROPOSED EFFECTIVE DATE FOR THE
FIRST EDITION OF THE STANDARD FOR
SURVEILLANCE COMMERCIAL CLOSED CIRCUIT TELEVISION EQUIPMENT,
UL 3044

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INTRODUCTION

1 Scope

1.1 These requirements cover commercial closed circuit television equipment that:

- a) Is intended to be used in a surveillance system to provide a means of observing and/or recording activities in the surveyed area;
- b) Is intended for commercial use and connection to supply circuits in accordance with the National Electrical Code, NFPA 70; and
- c) Complies with the Standard for Commercial Closed Circuit Television Equipment, UL 2044.

1.2 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involve a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 Glossary

2.1 For the purpose of these requirements the following definitions apply.

2.2 **ACTIVE VIDEO** – The portion of the video signal that carries the picture information – not the blanking portion of the signal.

2.3 **FLAT FIELD** – An overall gray image on the viewing area (blank screen) at 50 IRE.

2.4 **GRAY SCALE** – A series of 10 bars or lines varying in gray tones from black (7.5 IRE) to white (100 IRE).

2.5 **TV RESOLUTION** – The number of vertical lines that are produced by the video signal during the active horizontal scan time. The active horizontal scan time for an National Television Systems Committee (NTSC) television system is 52.5 microseconds. Vertical lines are defined as one-half of a cycle of a sinusoidal or square wave. TV resolution is determined as follows:

$$H_{TV} = (2) (F_c) (52.5 \mu s) (0.75)$$

or

$$H_{TV} = (78.75 \mu s) (F_c)$$

In which:

F_c is the frequency in MHz at which the signal amplitude is reduced to 25 percent (minus 12 db) of the amplitude of the signal at 0.5 MHz;

H_{TV} is the TV resolution;

52.5 μ s is the active horizontal scan time for an NTSC television system; and

0.75 is the aspect ratio of an NTSC television system.

2.6 IRE – A linear scale for measuring the the relative amplitudes of the various components of a television signal. For NTSC television systems 140 IRE equals 1 volt peak-to-peak.

2.7 UPDATE RATE – The number of times in each second that the information displayed on a video monitor is changed; number of fields per second.

3 Undated References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

TESTS

4 General

4.1 Unless otherwise indicated all tests shall be conducted with user adjustable controls set to the manufacturer's recommended settings, or to the factory preset points. The midpoint setting shall be used if manufacturer's recommendations or factory preset points are not provided.

4.2 The test pattern shall be the EIA Retna 1956 test pattern specified in the Electronic Industries Association, Electrical Performance Standards – Monochrome Television Studio Facilities, EIA-170, or the equivalent.

4.3 The test monitor with dc-restoration shall have a diagonal screen length of not less than 43 cm, and a TV resolution of not less than 1000 lines.

4.4 The signal generator shall electronically generate a test pattern, and shall provide a TV resolution of not less than 1000 lines.

4.5 The video noise meter shall be capable of measuring noise in the black-and-white mode, and of selecting the active video portion of the signal to be measured.

4.6 A waveform monitor is to be used to measure IRE.

4.7 The equipment under test and the test equipment are to be interconnected with 10 m of type RG-59/U coaxial cable that has the following characteristics:

- a) An impedance of 75 ohms;
- b) An outside diameter of 6.15 mm;
- c) A capacitance of 57 pf/m; and
- d) An attenuation of:
 - 1) 3.2 db/100 m at 10 MHz, and
 - 2) 11.2 db/m at 100 MHz.

4.8 All tests are to be conducted at the rated voltage of the equipment under test. If the equipment is rated in a range of voltages, it is to be tested at the highest voltage in the range.

5 Video Camera Tests

5.1 TV resolution

5.1.1 The results of the tests specified in 5.1.2 – 5.1.6 shall be consistent with the manufacturer's rated TV resolution as specified in a marking on the video camera or in the literature packaged with the video camera.

5.1.2 A video camera that is provided with an integral lens is to be mounted on an optical bench. A video camera that is not provided with an integral lens is to be tested while mounted to an optoliner. The camera is to be oriented as intended during normal use.

5.1.3 A tungsten-halogen light operating at 3200°K is to be used as a light source with the video output level of the camera adjusted to produce 100 IRE or maximum IRE (video output) without distortion while viewing a test pattern.

5.1.4 The video camera is to be connected to the video input of a test monitor as described in 4.3. The input impedance of the test monitor is to be matched to the output impedance of the camera.

5.1.5 With a gray scale displayed on the test monitor, the contrast and dc-bias (brightness) controls on the video camera are to be adjusted to produce the maximum number of distinguishable steps on the gray scale.

5.1.6 The TV resolution of the video camera is to be determined by a visual observation of the test pattern specified in 4.2 on the test monitor, and is to be measured at the lowest resolution point at which the resolution lines merge.

5.2 Signal-to-noise ratio

5.2.1 The signal-to-noise ratio determined as specified in 5.2.2 shall not be less than the manufacturer's signal-to-noise ratio specified in a marking on the product or in the literature packaged with the product.

5.2.2 Using a flat field, ND (neutral density) filters are to be used to reduce the video output level of the camera to 50 IRE with the automatic gain control (AGC), if provided, in the on position. A video noise meter as described in 4.5 is to be used. Using both a band pass filter (100 kHz to 4.2 MHz) and a weighted filter, the signal-to-noise ratio is to be read directly from the meter. A 3.58 MHz notch filter is to be used with color cameras only.

5.3 Sensitivity

5.3.1 The sensitivity (amount of light in lux or foot-candles required for the camera to produce a 50 IRE level) shall be consistent with the manufacturer's rated sensitivity as specified in a marking on the video camera or in the literature packaged with the video camera.

5.3.2 The illumination of the faceplate of the optoliner for cameras that are not provided with an integral lens, or the test pattern on the optical bench is to be measured with a photometer after the video output adjustment specified in 5.3.8. See Figure 5.1.

5.3.3 The test pattern specified in 4.2 is to be used for this test.

5.3.4 A video camera that is provided with an integral lens is to be mounted on an optical bench. A video camera that is not provided with an integral lens is to be tested while mounted to an optoliner. The camera is to be mounted in its normal orientation.

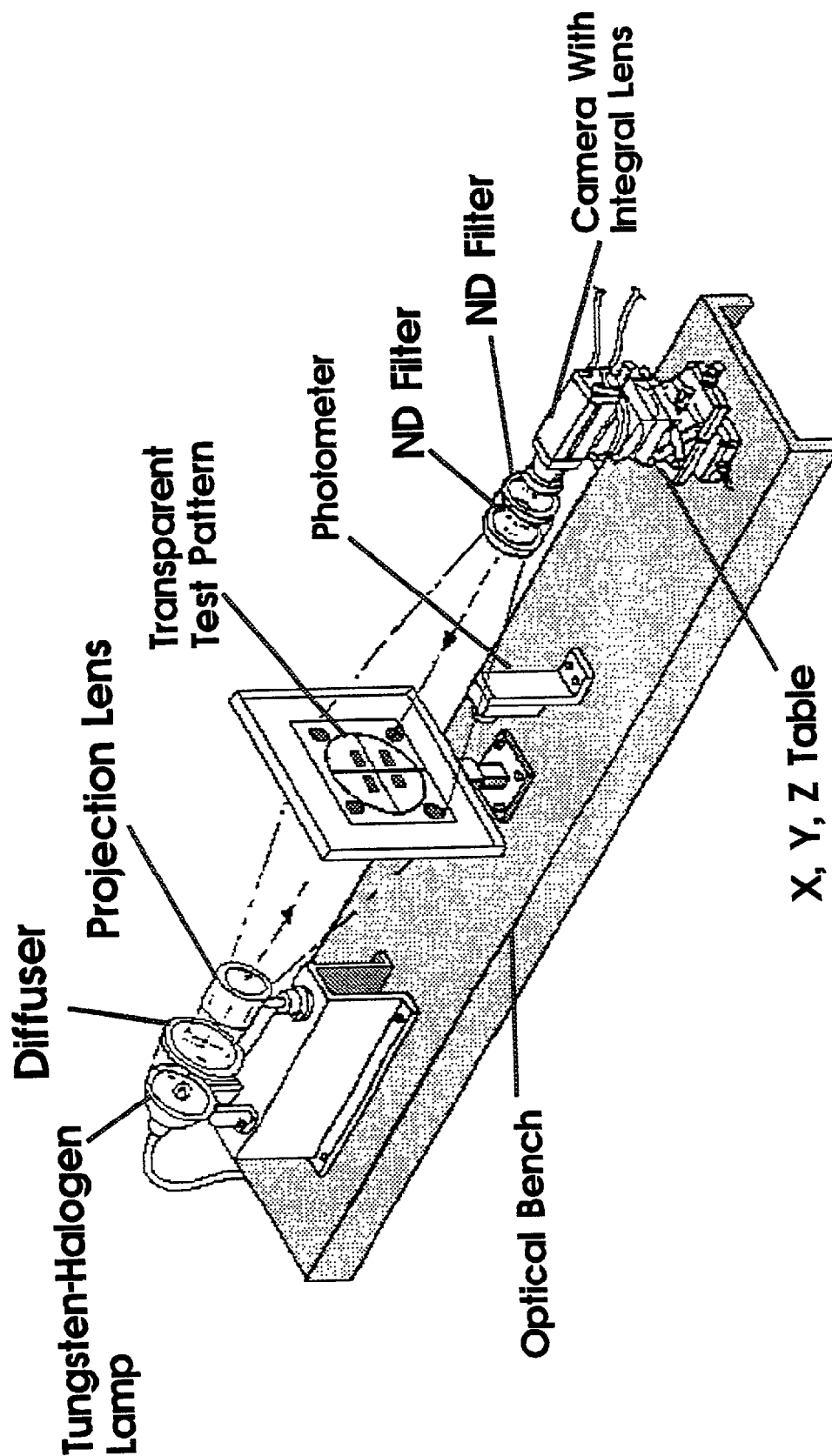
5.3.5 A tungsten-halogen light operating at 3200°K is to be used as a light source.

5.3.6 If the video camera is provided with a user-adjustable gain control, the control is to be set to maximum gain during the test. The test is to be repeated with the user-adjustable gain control set to minimum gain.

5.3.7 If the video camera is provided with an automatic iris control, the control is to be defeated.

5.3.8 The light level is to be reduced by means of one or more ND filters to reduce the video output level to 50 IRE. The light source may be adjusted to produce 50 IRE with the temperature remaining at 3200°K.

Figure 5.1
Optical bench



6 Monitor Tests

6.1 TV Resolution

6.1.1 The number of lines of TV resolution of a monitor shall be equal to or greater than the manufacturer's rated TV resolution as specified in a marking on the monitor or in the literature packaged with the monitor, when measured as specified in 6.1.2 – 6.1.5.

6.1.2 A signal generator, generating the test pattern specified in 4.2, is to be connected to the video input of the monitor under test. The output impedance of the generator is to be matched to the input impedance of the monitor under test.

6.1.3 With a gray scale displayed on the monitor under test, the contrast and dc-bias (brightness) controls of the monitor under test are to be adjusted to produce the maximum number of distinguishable steps on the gray scale.

6.1.4 For a color monitor, the color gain is to be adjusted to the minimum setting and the gray scale is to be adjusted as specified in 6.1.3. The color gain is then to be readjusted for hue using an NTSC (National Television Systems Committee) EIA RS-189A color bar test signal.

6.1.5 The resolution of the monitor under test is to be determined by a visual observation of the test pattern specified in 4.2, and is to be measured at the lowest resolution point at which the resolution lines merge, excluding artifacts caused by subcarrier frequencies.

7 Time-Lapse Video Recorder Tests

7.1 Horizontal resolution

7.1.1 The results of the tests specified in 7.1.2 – 7.1.5 shall be consistent with the manufacturer's rated horizontal resolution as specified in a marking on the time-lapse video recorder, or in the literature packaged with the recorder. The horizontal resolution is the TV resolution multiplied by 4/3 to correlate with the 4 to 3 aspect ratio of an NTSC television system viewing area.

7.1.2 A time-lapse video recorder is to be operated in any time-lapse mode in accordance with the manufacturer's settings. The recording tape used is to be that specified by the manufacturer.

7.1.3 The output of the signal generator is to be connected to the time-lapse video recorder input connections, and a multiburst signal is to be applied. The lowest frequency of the multiburst signal is to be 0.5 MHz. The color burst signal (3.58 MHz) is to be in the off mode. The signal is to be recorded for a length of time adequate to allow measurement in the playback mode.

7.1.4 The output of the recorder is to be connected to the input of an oscilloscope or waveform analyzer, and the recorded signal played back.

7.1.5 The frequency (F_c) expressed in MHz of the multiburst signal that has an amplitude of 25 percent of the video signal at 0.5 MHz is to be measured. The horizontal resolution is to be determined using the following formula:

$$H_{res} = 2 (F_c) (52.5 \mu s)$$

or

$$H_{res} = (105 \mu s) (F_c)$$

In which:

F_c is the frequency in MHz at which the signal amplitude is reduced to 25 percent (minus 12 db) of the amplitude of the signal at 0.5 MHz;

H_{res} is the horizontal resolution; and

52.5 μs is the active horizontal scan time for an NTSC television system.

7.2 Signal-to-noise ratio

7.2.1 The signal-to-noise ratio determined as specified in 7.2.2 – 7.2.4 shall not be less than the manufacturer's signal-to-noise ratio specified in a marking on the product or in the literature packaged with the product.

7.2.2 A signal generator capable of providing a 100 IRE signal, and a video noise meter as described in 4.5 are to be used.

7.2.3 The signal generator is to be connected to the time-lapse video recorder. The test pattern specified in 4.2 is to be recorded on the time-lapse video recorder using the manufacturer's specified recording tape. The output signal of the recorder is to be 50 IRE.

7.2.4 The 50 IRE signal specified in 7.2.3 is to be played back through the video noise meter using a band pass filter (100 kHz to 4.2 MHz) and a weighted filter. The signal-to-noise ratio is to be read directly from the meter.

8 Video Signal Equipment and Video Switcher Tests

8.1 General

8.1.1 When tested as specified in 8.1.2, 8.2, 8.3, and 8.4, the ratings of a video signal product or video switcher shall be consistent with the manufacturer's rating as specified in a marking on the product or in the literature packaged with the product.

8.1.2 Unless otherwise noted, the tests specified in 8.2 – 8.4 are to be conducted under the following conditions:

- a) The signal source is to have an output impedance matching the input impedance of the device under test;
- b) The input signal is to be connected to the input ports of the device under test by a cable with matched characteristic impedance; and
- c) All unused input and output ports of the device under test are to be terminated with resistive loads matching the port impedance.

8.2 Frequency response and bandwidth

8.2.1 The input of the equipment under test is to be connected to the output of a sweep generator capable of sweeping over the manufacturer's specified frequency range. The amplitude of the output signal

of the equipment under test is to be measured over the rated bandwidth in 500 kHz increments, and shall be within the deviation specified by the manufacturer.

8.2.2 The bandwidth is to be measured between the 3db rolloff points. The bandwidth shall be the manufacturer's specified bandwidth.

8.3 Signal-to-noise ratio

8.3.1 A flat field video signal is to be applied to the input of the equipment. The signal-to-noise ratio is to be measured at the output using a band pass filter (100 kHz to 4.2 MHz) and a weighted filter with the video noise meter described in 4.5.

8.4 Crosstalk

8.4.1 A multiburst video signal, containing a 3.58 MHz burst, is to be applied to an input channel and switched to an output channel. Voltages are to be measured with an oscilloscope using a low pass filter as follows:

- a) At the input channel with the input signal,
- b) At all other input channels,
- c) At the switched on output channel, and
- d) At all other output channels.

8.4.2 Crosstalk is to be calculated as follows:

$$Crosstalk_{input} = 20Log_{10} \left[\frac{V_{other\ inputs}}{V_{input}} \right]$$

$$Crosstalk_{output} = 20Log_{10} \left[\frac{V_{other\ outputs}}{V_{output}} \right]$$

8.4.3 The test specified in 8.4.1 and 8.4.2 is to be repeated for at least one additional input channel.

9 Pan-and-Tilt Tests

9.1 General

9.1.1 A pan-and-tilt unit is to be mounted in accordance with the manufacturer's instructions. All mounting hardware provided by the manufacturer is to be used in the installation. If the installation instructions packaged with the product recommend certain hardware types, the recommended hardware is to be used.

9.1.2 A load equal to the manufacturer's specified maximum load is to be placed with the center of gravity of the load centered on the camera mounting platform.

9.1.3 A pan-and-tilt unit is to be subjected to the tests in the order in which they are presented.

9.2 Static weight load conditioning

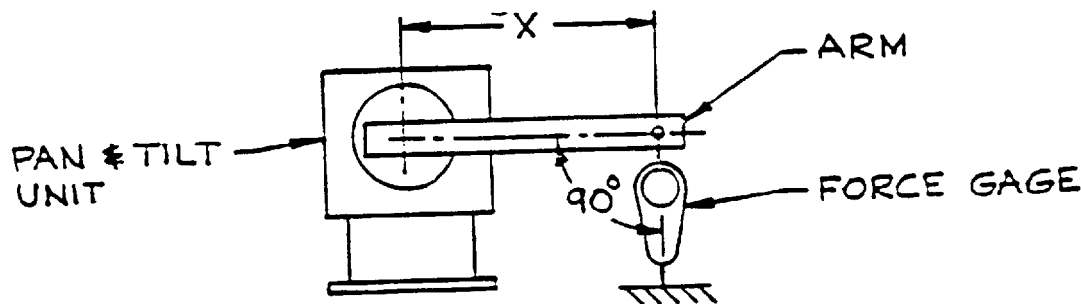
9.2.1 Before being subjected to the tests specified in 9.3 – 9.5, a pan-and-tilt unit is to be operated across its full range of motion in both the horizontal and vertical directions while mounted and loaded as specified in 9.1.1 and 9.1.2.

9.3 Torque

9.3.1 When determined as specified in 9.3.2 and 9.3.3, the maximum torque measured on a pan-and-tilt unit in any direction shall be equal to or greater than the manufacturer's specified maximum torque value.

9.3.2 With the pan-and-tilt unit mounted as described in 9.1.1, a rigid arm is to be attached to the camera mounting platform as shown in Figure 9.1. A force gauge is to be attached to the end of the arm, and the tilt is to be operated through the full tilting range. Following this operation, the force gauge is to be turned parallel to the horizontal, and the test repeated for the pan function.

Figure 9.1
Torque test set-up



X = The distance from the axis of rotation.

9.3.3 The maximum available torque is to be calculated as follows:

$$\text{Maximum torque} = (\text{Maximum measured force}) \times (\text{Distance from the axis of rotation})$$

9.4 Angular speed measurement

9.4.1 When tested as specified in 9.4.2, the measured angular speed of a pan-and-tilt unit shall be within ± 10 percent of the manufacturer's rated angular speed.

9.4.2 With the pan-and-tilt unit mounted as described in 9.1.1 and loaded as specified in 9.1.2, the unit is to be operated across its full range in both the horizontal and vertical directions. The angular speed rate is to be calculated as follows:

$$\text{Angular speed} = \frac{\text{Rotation angle (degrees)}}{\text{Time (Seconds)}}$$

9.5 Backlash measurement

9.5.1 When tested as specified in 9.5.2, the angular backlash of a pan-and tilt unit shall not exceed the manufacturer's specifications.

9.5.2 The pan-and-tilt platform is to be manually moved backwards and forwards in the horizontal direction, and up and down in the vertical direction. The amount of tangential linear motion is to be measured from the center of rotation, and the angular backlash is to be calculated as follows:

$$\text{Backlash} = \tan^{-1} \left(\frac{\text{Amount of tangential motion (inches)}}{\text{Distance from center of rotation}} \right)$$

10 Digital Video Equipment Tests

10.1 Update rate

10.1.1 The update rate of a digital video product is to be measured as specified in 10.1.2 – 10.1.4. The update rate shall not be less than the manufacturer's rating as specified in a marking on the product or in the literature packaged with the product.

10.1.2 An input video source is to be provided with markers at sixty successive fields at 1/60 second intervals. Additional markers may be provided as needed. One example of a video source with markers is a video camera focused on a circle with 6 degree markers, and a sweep hand that makes one complete 360 degree revolution per second.

10.1.3 The output of the digital video product is to be connected to a video recorder and played back on a monitor so that the markers may be observed.

10.1.4 The markers are to be visually observed in the output signal, and the number of markers observed in one second recorded. The update rate is the number of markers observed per second.

10.2 Signal-to-noise ratio

10.2.1 The signal-to-noise ratio determined as specified in 10.2.2 and 10.2.3 shall not be less than the manufacturer's signal-to-noise ratio and operating mode specified in a marking on the product or in the literature packaged with the product.

10.2.2 A signal generator, generating a flat field, and the video noise meter described in 4.5 are to be used.

10.2.3 The signal generator is to be connected to the product under test, and a flat field is to be generated. Using a band pass filter (100 kHz to 4.2 MHz) and a weighted filter, the signal-to-noise ratio is to be read directly from the meter.

10.3 TV resolution

10.3.1 The number of lines of TV resolution of a product shall be equal to or greater than the manufacturer's rated TV resolution at the manufacturer's indicated mode or modes as specified in a marking on the product or in the literature packaged with the product, when measured as specified in 10.3.2 – 10.3.4.

10.3.2 A signal generator is to be connected to the input of a product. The output impedance of the generator is to be matched to the input impedance of the product.

10.3.3 The product is to be connected to the video input of a test monitor as described in 4.3. The input impedance of the test monitor is to be matched to the output impedance of the product.

10.3.4 The resolution of a product is to be determined by a visual observation of the test pattern specified in 4.2 on the test monitor, and is to be measured at the lowest resolution point at which the resolution lines merge.

11 Transmission Equipment Tests

11.1 TV resolution

11.1.1 The number of lines of TV resolution of a product shall be equal to or greater than the manufacturer's rated TV resolution with the manufacturer's specified line attenuation as specified in a marking on the product or in the literature packaged with the product, when measured as specified in 11.1.2 – 11.1.5.

11.1.2 A signal generator is to be connected to the input of the product. The output impedance of the generator is to be matched to the input impedance of the product.

11.1.3 The product output is to be connected to the video input of a test monitor as described in 4.3. The input impedance of the test monitor is to be matched to the output impedance of the product.

11.1.4 With a gray scale displayed on the test monitor, the contrast and dc-bias (brightness) controls on the test monitor are to be adjusted to produce the maximum number of distinguishable steps on the gray scale.

11.1.5 The TV resolution of the product is to be determined by a visual observation of the test pattern specified in 4.2 on the test monitor, and is to be measured at the lowest resolution point at which the resolution lines merge.

11.2. Signal-to-noise ratio

11.2.1 The signal-to-noise ratio determined as specified in 11.2.2 and 11.2.3 shall not be less than the manufacturer's rated signal-to-noise ratio specified in a marking on the product or in the literature packaged with the product.

11.2.2 A signal generator, generating a flat field, and the video noise meter described in 4.5 are to be used.

11.2.3 The signal generator is to be connected to the product, and a flat field is to be generated. Using a band pass filter (100 kHz to 4.2 MHz) and a weighted filter, the signal-to-noise ratio is to be read directly from the meter.

APPENDIX B

ATTENDANCE AT THE APRIL 27, 1994 MEETING OF THE IAG FOR CLOSED CIRCUIT TELEVISION EQUIPMENT

Industry Representatives

*A. Apo	American Insurance Services Group, Inc.
M. Bolte	Diamond Electronics
G. Carrick	Electronic Security
*E. Dean	D/A Technology
D. Epps	Gyyr Division of Odetics
J. Gels	Mosler, Inc.
*T. Glines	Pelco
N. Heller	Sanyo
V. Lee	Panasonic
*R. Leonhard	Videotec Corporation
*T. Marks	US JVC Corp.
L. Mecseri	Sony Electronics, Inc.
*B. Melninkoff	Wachovia Corp.
*J. Norris	Mosler Inc.
*J. O'Brien	Burle Industries
Y. Pshtissky	Vicon Industries, Inc.
*M. Scirica	American Dynamics
*T. Venlainen	CSA
*J. White	Jewelers Security Alliances

UL Staff

Isaac Papier, Chairman
Joe Stroder
Mark Granata
Al Gengler

*Not in attendance

A P P E N D I X CDESIGNATED RESPONSIBILITY FOR UL
PRODUCT CATEGORY
DRQH, CLOSED CIRCUIT TELEVISION EQUIPMENT

The individuals shown on the back side of this sheet are involved with the investigation of products covered under the subject category. The Primary Designated Engineer (**shown in UPPERCASE letters**) coordinates the establishment and uniform interpretation of UL requirements applicable to the product category. The Designated Engineers (**shown in lowercase letters**) work with the Primary Designated Engineer to interpret requirements and maintain standards.

Should you have questions regarding the interpretation of the requirements proposed in this bulletin or any adopted requirements that affect your product, you are encouraged to contact the individual at the office to which you normally submit your products.

The Industry Advisory Group (IAG) Chairman for the subject category is Isaac Papier at UL's Northbrook office. The IAG Chairman oversees the significant interpretations made by the Primary Designated Engineer and arbitrates any differences regarding interpretation of UL requirements.

Subjects 3044 (2044)

-C2-

June 13, 1994

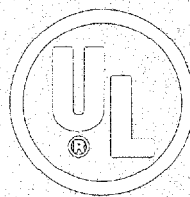
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	Santa Clara	Mike Faser	2201
	Japan	Larry Jungblut	

Standard for Safety

UL 2044

ISBN 1-55989-347-8

Commercial Closed Circuit Television Equipment



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Standard



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June 7, 1993

Standard for

Commercial Closed Circuit Television Equipment

UL 2044, First Edition

Accompanying this transmittal notice is a copy of the First edition of UL 2044.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

The requirements in this standard are substantially in accordance with UL's bulletins on this subject dated September 16, 1992 and November 19, 1992. These bulletins are now obsolete and may be discarded.

Revised and/or additional pages may be issued from time to time.



JUNE 7, 1993

1

UL 2044

Standard for

Commercial Closed Circuit Television Equipment

First Edition

June 7, 1993

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest published set of revision pages.

ISBN 1-55989-347-8

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(1- 06/07/93 - 06/07/93)

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufactures, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the test of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgement given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use of or in connection with the use, interpretation of or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conduction such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover closed circuit television equipment that:

- a) Are intended for commercial use on supply circuits as defined in the National Electrical Code, NFPA 70, and
- b) Receive their signals from a video-recorded medium or image-producing devices in a closed circuit television system.

1.2 These requirements cover closed circuit television equipment – such as video tape recorders; video-receiving, -processing, -recording, -producing, and -amplification equipment; video cameras; and the like.

1.3 These requirements also cover auxiliary equipment and accessories intended for use with closed circuit television systems.

1.4 These requirements also cover portable closed circuit television equipment of the types described in 1.2 that are intended for use with a vehicular, marine, or any other battery circuit as the power supply means.

1.5 These requirements do not cover video monitors, as these products are covered by the Standard for Television Receivers and High Voltage Video Products, UL 1410, the Standard for Audio-Video Products and Accessories, UL 1492, and the Standard for Safety of Information Technology Equipment Including Electrical Business Equipment, UL 1950.

1.6 These requirements do not cover video cameras with integral electronic viewfinders.

1.7 These requirements do not cover battery chargers and power supplies not intended for use with specific closed circuit television systems.

1.8 These requirements do not cover tape-head demagnetizers or bulk tape erasers intended for use with video products and do not cover general-purpose tape-head demagnetizers or bulk tape erasers, as those products are covered by the requirements for household and commercial tape recorders in the Standard for Radio and Audio Equipment, UL 1270, the Standard for Audio-Video Products and Accessories, UL 1492, and the Standard for Commercial Audio Equipment, UL 813.

1.9 Commercial video products provided with a means for receiving commercially broadcasted video signals and household video products are covered by the Standard for Low-Voltage Video Products Without Cathode-Ray-Tube Displays, UL 1409, the Standard for Television Receivers and High-Voltage Video Products, UL 1410, and the Standard for Audio-Video Products and Accessories, UL 1492.

1.10 A cart or stand that is not intended to be used with a specific product is covered by the Standard for Tall Institutional Carts for Use With Audio-, Video-, and Television-Type Equipment, UL 1667, and the requirements for household, commercial, and professional-use carts and stands in UL 1678.

1.11 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the Standard was developed, and that involves a risk of fire, electric shock, or injury to persons, shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix C for a list of standards covering components generally used in the products covered by this standard.

2.1.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.1.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use.

2.1.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits and shall be used only under those specific conditions for which they have been recognized.

2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.3 Terminology

2.3.1 The term "product" as used in this standard refers to all types of closed circuit television products.

3 Glossary

3.1 For the purpose of these requirements the following definitions apply.

3.2 **ACCESSIBLE PART** – A part so located that it can be contacted by means of a probe (see Figure 16.1) or that is not recessed the required distance behind an opening (see 16.9).

3.3 **ADJUSTABLE CONTROL** – A control provided for making adjustments necessary to render the product capable of performing its intended functions.

3.4 **BRANCH CIRCUIT** – A branch circuit is that portion of the building wiring system beyond the final overcurrent device on the power-distribution panel protecting the circuit to the field-wiring terminals in a permanently connected unit or to the receptacle outlet for cord-connected units.

3.5 **CART** – A stand (see 3.21) provided with casters, wheels, or rollers to make it mobile.

3.6 **CASTER** – Any roller or swiveled wheel attached to a cart, stand, or product that makes the cart, stand, or product mobile.

3.7 **ELECTRONIC DEVICE** – A part, or an assembly of parts, that employs electron or hole conduction in a vacuum, in a gaseous atmosphere, or in semiconductors.

3.8 ENCLOSURE – A material intended to limit access to uninsulated live parts, and live parts insulated with materials not intended to be subjected to user contact.

3.9 FIBER – The term "fiber" is used in place of "vulcanized fiber" to denote a material usually used as electrical insulation. Vulcanized fiber is made by combining layers of chemically gelled paper. The chemical compound used in gelling the paper is subsequently removed by leaching, and the resulting product, after being dried and finished by calendering, is a dense material of partially regenerated cellulose in which the fibrous structure is retained in varying degrees, depending upon the grade of fiber. Cellulose fiberboard, pressboard, fullerboard, or cardboard are not accepted as the equivalent of fiber. Fishpaper is a designation commonly used in the trade to refer to thin sheets of electrical grade vulcanized fiber.

3.10 FIELD-WIRING TERMINAL – Any terminal to which a supply or other wire can be connected by an installer in the field is a field-wiring terminal unless the wire is provided as part of the unit and a connector, soldering lug, soldering loop, crimped eyelet, pressure terminal, or other means for making the connection is factory-assembled to the wire.

3.11 GROUND – Earth ground, unless otherwise specified.

3.12 HAZARDOUS CIRCUIT – A circuit that is not supplied by a low voltage, limited energy circuit as described in Low Voltage, Limited Energy Circuits, Section 14.

3.13 HOSPITAL PRODUCT – A product intended for use in a hospital, a nursing home, a medical-care center, or a similar health-care facility where installation is limited to a nonhazardous area in accordance with the National Electrical Code, NFPA 70. It is not intended for use in a critical-care area where a patient may be treated with an externalized electrical conductor, such as a probe, a catheter, or other electrode, connected to the heart.

3.14 HOUSING – A material intended to reduce the risk of unintentional contact with parts the user is expected to contact.

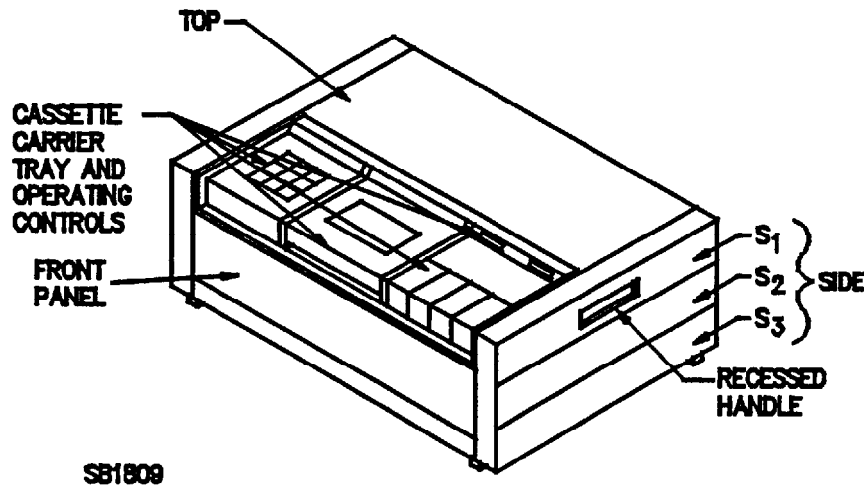
3.15 INTERLOCK – A mechanism that de-energizes parts involving a risk of electric shock or that stops moving parts involving a risk of injury to persons before they become accessible to the user when the enclosure of the part is opened or a cover is removed.

3.16 MAJOR ENCLOSURE PART – A part of an enclosure that:

- a) Forms more than 50 percent of the area of any surface, such as the front, back, top, bottom, or either side; and
- b) Is required to comply with the requirements for protection against risks of fire, electric shock, and injury to persons, or protection against mechanical damage to internal parts.

The surface area of a part is to be computed based on the surface area encompassed by the perimeter of the part, including the area composed of holes, perforations, and deletions within the boundaries of the part. If an enclosure surface is formed by separate sections, those sections that perform the same enclosure function are to be considered together; and both evaluation of the part and the computation of the surface area are to be based on the composite surface. See Figure 3.1.

Figure 3.1
Examples of some major enclosure parts



FRONT – The front surface is composed of a single panel of material plus the overlap from other surfaces. Since the panel comprises more than 100 percent of the surface and is considered to be a required part of the enclosure, it is a major enclosure part.

TOP – The top surface is composed of several parts and materials including the top panel, several dial windows, the cassette carrier tray, and operator controls. The dial windows, cassette carrier tray, and operator controls are not major enclosure parts, even though they are required parts of the enclosure, because they do not form more than 50 percent of the top surface. The top panel is a major enclosure part because when computing the surface area encompassed by the perimeter of the part – including the area composed of openings for the dial windows, cassette carrier tray, and operator controls – the resulting area comprises more than 50 percent of the surface.

SIDE – The side surface is composed of several parts and materials, including the recessed handle and three panels (S1, S2 and S3). The recessed handle is not a major enclosure part, even though it is a required part of the enclosure, because it does not form more than 50 percent of the side surface. The panels S1, S2 and S3 are major enclosure parts, even though each panel by itself does not form more than 50 percent of the side surface, because the three parts perform the same enclosure function, and when taken together, they form more than 50 percent of the side surface involved.

3.17 MINOR DIMENSION OF OPENING – The minor dimension of an opening is the diameter of the largest sphere that can pass through the opening.

3.18 ORDINARY TOOLS – Flat-bladed and cross-head screwdrivers, nut drivers, pliers, and the like.

3.19 POWER-SUPPLY CORD – The flexible cord and attachment plug provided to connect a product to the supply circuit.

3.20 RAIN SHIELD ENCLOSURE – A structural part of an outdoor-use wet location product relied upon to reduce the likelihood of contact with live parts, and the entrance of water into the product or onto current-carrying parts.

3.21 **STAND** – A structure intended to support a product.

3.22 **STANDBY CONDITION** – The ready-to-operate condition. The condition which exists prior to being tripped or operated by the manual actuation of an initiating device.

3.23 **SUPPLY CIRCUIT** – The branch circuit supplying electrical energy to the product.

3.24 **UNINSULATED PART** – A part that is bare (being without insulation) or has insulation that is not acceptable for the operating conditions (such as potential and temperature).

3.25 **USER SERVICING** – The replacing, cleaning, adjusting, and similar maintenance operations intended to be accomplished by the user (see User Servicing and Replacement of Parts, Section 17), for example:

- a) Removing a cover;
- b) Opening a door;
- c) Adjusting a control;
- d) Setting a supply-circuit voltage mechanism; and
- e) Replacing a fuse.

CONSTRUCTION

4 General

4.1 The requirements in this section apply to all products within the scope of this standard. They are supplemented by requirements in separate sections that apply to a specific product.

4.2 The construction of the product shall be such that the product complies with each of the following:

- a) The operation and user servicing of the product does not result in a risk of fire, electric shock, or injury to persons;
- b) The materials and components are used within their electrical, mechanical, and temperature limits; and
- c) The assembly protects the components and wiring from being displaced or damaged.

4.3 The materials, components, and wiring referred to in 4.2 and elsewhere in this standard, are to be those involving risk of fire, electric shock, or injury to persons.

Exception: Other materials, components, and wiring shall comply with 4.2 if specifically indicated.

5 Corrosion Protection

5.1 A metal part shall be protected against corrosion if corrosion of that part can increase the risk of fire, electric shock, or injury to persons.

Exception: Metals that are inherently corrosion resistant need not be additionally protected.

6 Outdoor-Use Products

6.1 A product intended for outdoor use shall be:

- a) Provided with a Type SJ power-supply cord or the equivalent that is acceptable for outdoor-use,
- b) Provided with an enclosure that complies with the applicable requirements in the Standard for Enclosures for Electrical Equipment, UL 50, and marked with an appropriate designation, and
- c) Subjected to the Outdoor-Use Wetting Test, Section 65.

6.2 A product is considered to be intended for outdoor-use if it complies with one or more of the following:

- a) It is provided with a means (handles, wheels, rollers, or similar manipulatory devices) making it portable;
- b) It has a total mass of less than 35 kg;
- c) It can be operated from a battery power-supply source; or
- d) The product-manufacturer's literature (instruction manual, use-and-care information, advertising, or promotional material) indicates or implies outdoor-use of the product.

Exception: A product that is marked as specified in 73.11 need not be considered outdoor use.

7 Multiple-Supply-Circuit-Voltage Products

7.1 A product employing a supply-circuit-voltage selector shall be tested in accordance with the Multiple-Voltage Equipment Test, Section 58, without resulting in a risk of fire or electric shock. The product shall be provided with instructions and marked in accordance with 72.11 and 72.12.

7.2 A product that can be set to different rated supply-circuit voltages shall be so constructed that the indication of voltage to which the product is set is externally visible and preferably in the area adjacent to the rating information. See 72.12.

7.3 If the product is provided with more than one voltage-setting device or selector, it shall be indicated, either on the product or in the instructions that accompany the product from the factory, as to how all devices or selectors are to be set.

7.4 The construction of the supply-circuit-voltage selector shall be such that the supply-circuit-voltage setting cannot be unintentionally changed.

7.5 If the product is so constructed that the supply-circuit-voltage-selector setting can be changed by the user, the action of changing the voltage-selector setting shall also change the supply-circuit-voltage indication.

8 Material Flammability Classifications

8.1 A material shall have a minimum flammability rating as shown in Table 8.1. Cellulose nitrate or any comparably flammable material shall not be used for any part regardless of location, application, or function.

8.2 A recording or playback medium (for example tapes or discs) provided with or recommended for use with a recording or playback product shall not be formed of, nor coated with, cellulose nitrate or any comparably flammable material. The risk of fire for recording or playback media in storage shall not be greater than that of common newsprint in the same general form and quantity.

8.3 Accessory parts — such as lens caps, eyeshields, sunshades, shoulder pads, shoulder straps and separable lens systems, including lens, filters, and the like — that are external to a product need not comply with the requirements in Table 8.1, but shall not be formed or coated with cellulose nitrate or any comparably flammable material.

8.4 The flammability requirements in Table 8.1 do not apply to small parts. For the purpose of these requirements, a small part is defined as one that complies with each of the following items:

- a) Its volume does not exceed 2 cubic centimeters;
- b) Its maximum dimension does not exceed 3 centimeters; and
- c) Its location is such that it cannot propagate flame from one area to another or act as a bridge between a possible source of ignition and other ignitable parts.

Table 8.1
Material flammability requirements^a

Material and application	Flammability classifications ^{b,c}
A. Enclosures	
1. Polymeric	94V-2, 94V-1, 94V-0
2. Pressed wood or similar materials ^d	None
B. Polymeric and fiber materials in contact with hazardous parts ^{e,f}	94V-2, 94V-1, 94V-0, 94HF-2, 94HF-1, 94VTM-2, 94VTM-1, 94VTM-0
C. Sound-deadening and shock absorption material	
1. In contact with live parts	
a. specific gravity less than 0.6	94HF-1, 94HF-0
b. specific gravity equal to or more than 0.6	94HB, 94V-2, 94V-1, 94V-0
2. Not in contact with live parts	
a. specific gravity less than 0.6	94HBF, 94HF-1, 94HF-0
b. specific gravity equal to or more than 0.6	94HB, 94V-2, 94V-1, 94V-0
D. Grille covering material, cloth, and reticulated foam	Tablet ^g
E. Materials used in applications other than those specified in A–D	94HB, 94V-2, 94V-1, 94V-0 94HBF, 94HF-2, 94HF-1, 94VTM-2, 94VTM-1, 94VTM-0

^a Covers insulation properties and stability. Mechanical strength is investigated in the application. For enclosures see, Strength of Enclosure Tests, Section 61.

^b Flammability Classification – Determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. For testing a material, the samples are to be flat stock – bar samples – sized in accordance with UL 94; for an assembly, the samples can consist of the assembly. High voltage transformers, deflection yokes, printed-wiring boards, terminal strips, and the like can be tested as finished parts, or test samples can be cut from finished parts. In the case of small parts that might be consumed before the test is completed, larger samples of the same material can be tested provided they represent the same or lesser thickness than the part in question. None of the larger samples is to be entirely consumed. Samples that consist of an assembly or a section of an assembly that are not flat stock samples are to be positioned in what is considered to be the worst position in the application. A material having a higher flammability classification than that specified in Table 8.1 is acceptable. See footnote c.

^c The parts evaluated by Table 8.1 and classified using 1.6 mm thick bar specimens may be accepted in lesser thicknesses in the end product. For polymeric enclosures, a material classified using 3.2 mm thick bar specimens may be accepted in lesser thicknesses in the end product.

^d Must be spaced at least 3.0 mm from uninsulated live parts.

^e Does not apply to the internal insulating systems of components or where component requirements exist (see 2.1.1 – 2.1.4).

^f See 3.12.

^g The flammability test using a hexamethylene-tetramine tablet is described in Section 67, Tablet Flammability Test.

9 Spacings

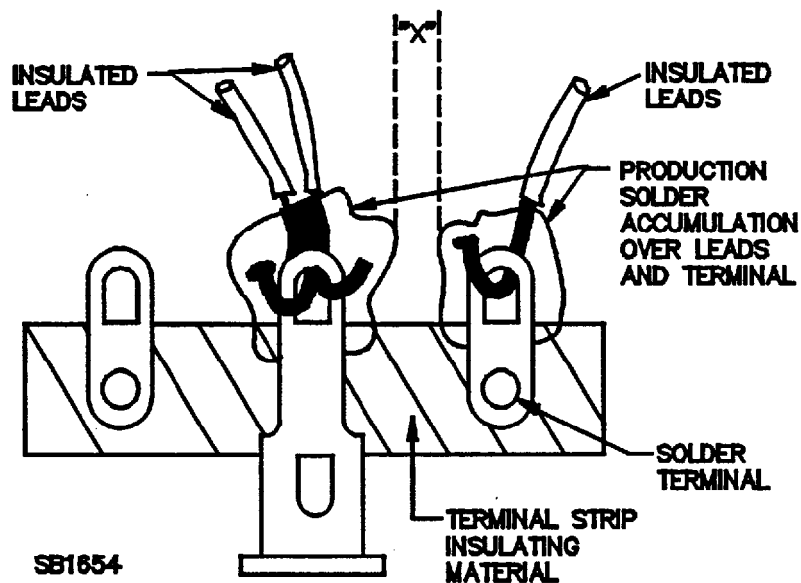
9.1 A minimum spacing of 3.0 mm over surface and through air shall be maintained between uninsulated live parts conductively connected to the supply circuit (for example, the primary circuit) and each of the following:

- a) Uninsulated live parts of opposite polarity; and
- b) Accessible conductive parts.

Exception: The spacing requirements in 9.1 do not apply if the location and relative arrangement of parts are such that acceptable permanent separation is provided. See Section 45, Dielectric Voltage-Withstand Test.

9.2 When measuring spacings through air or over surface between parts where hand soldering is involved, the spacing may need to be measured assuming production accumulation of solder on parts and lead connections as illustrated in Figure 9.1.

Figure 9.1
Measurements of spacings between parts
where hand-soldering is involved
(example only to illustrate 9.2)



X = Spacing to be maintained between hand-soldered parts assuming production solder accumulation.

9.3 A barrier or liner of polymeric, fiber, or similar material (other than the enclosure), employed where spacings would otherwise be unacceptable between uninsulated live parts of opposite polarity or between such parts and accessible conductive parts, according to 9.1 and 9.2, shall comply with each of the following:

- a) It shall be of a material complying with the requirements for insulating materials;
- b) It shall be of a material as defined by Table 8.1;
- c) It shall comply with the applicable tests specified in Strength of Enclosure Tests, Section 61, if it is likely to be handled during use or user servicing of the product;
- d) It shall be held in place by a means other than friction between surfaces;
- e) It shall be so located that it is not likely to be damaged by operation of the product; and
- f) It shall have a minimum thickness of 0.70 mm; 0.35 mm when used in conjunction with an air space.

Exception: Insulation that is built into a component need not comply with 9.3 (a)–(f).

9.4 A minimum spacing of 3.0 mm over surface and through air shall be maintained between the uninsulated live parts of a fuse and fuse clip that involve risk of electric shock and each of the following:

- a) Uninsulated live parts of opposite polarity; and
- b) Accessible conductive parts.

The spacing shall be measured with the fuse in place.

Exception: If a barrier according to 9.3 is provided the minimum spacing need not be maintained.

10 Product and Accessory Assembly

10.1 User-mechanical assembly (addition of legs, casters, decorative parts, and the like) of a product or accessory shall be such that all of the following requirements are met:

- a) Assembly shall require one or more of the following:
 - 1) No tools,
 - 2) Only ordinary tools (see 3.18), or
 - 3) Tools supplied with the assembly by the manufacturer;
- b) All required parts shall be provided;
- c) Assembly instructions shall be provided (see Installation, Operation, and Other Instructions, Section 75); and
- d) Assembly instructions shall not cause the user to commit an act that in itself might result in a risk of fire, electric shock, or injury to persons.

10.2 Products or accessories intended to be installed by qualified service personnel, need not comply with 10.1 (a) and (d). Such products or accessories shall be provided with the installation instructions required in 75.1 and 75.4.

11 Adhesive Backed Conductive Parts and Labels

11.1 A part or label of conductive material secured in place by an adhesive shall comply with the test in Adhesive-Backed-Parts Peel Test, Section 64, if, when dislodged, the part or label can act as a bridging agent and result in a risk of fire or electric shock.

12 Injury to Persons

12.1 The risk of injury to persons is considered to exist if one or more of the following conditions are present:

- a) Power-operated moving parts, such as gears and linkages, are accessible during normal operation (see 12.2);
- b) Sharp edges, burrs, or projections are present that can cause injury to persons during user assembly, operation of the product, or user-servicing; or
- c) The product, or the product on a cart or stand used with it, is unstable (see Section 60, Injury to Persons Tests).

12.2 In applying the requirement specified in 12.1 (a), accessibility of power-operated moving parts such as gears and linkages shall be evaluated using the accessibility requirements specified in 16.8 and 16.9, and Table 16.2. Accessibility shall be determined after the installation or assembly of parts provided by the manufacturer has been completed according to the instructions packed with the product.

Exception: This requirement does not apply to tape-reel or tape-drive mechanisms that must be exposed for operation of the product. However, gears, linkages, and similar mechanisms shall be evaluated for accessibility if the construction is such that those parts can move with a tape reel, cartridge, or cassette removed from its operating position.

12.3 To determine compliance with the requirements specified in 12.1 (b), the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, shall be used.

13 Fire

13.1 For the purpose of evaluating the internal circuitry of products to the requirements of this standard, risk of fire is not considered to exist when the circuitry is determined to be low voltage, limited energy as described in Section 14 and as evaluated according to Section 56, Low Voltage, Limited Energy Circuit Test.

14 Low Voltage, Limited Energy Circuits

14.1 There are no specifications for spacings in a low voltage, limited energy circuit, other than as may be required to reduce the risk of contact with an uninsulated live part of another circuit.

Table 14.1
Low voltage, limited energy circuit^a

	Inherently Limited transformer (Overcurrent protection not required)			Not-inherently-limited transformer (Overcurrent protection required)			
	0 – 20 volts ac or dc	Over 20 volts but no more than 30 volts ac or dc	Over 30 volts but no more than 60 volts dc	0 – 15 volts ac or dc	Over 15 volts but no more than 20 volts ac or dc	Over 20 volts but no more than 30 volts ac or dc	Over 30 volts but no more than 60 volts dc
Circuit voltage (volts) ^b							
Power limitation (volt-amperes) ^c	–	–	–	350	250	250	250
Current limitation (amperes) ^d	8	8	150/V ^b	1000/V ^b	1000/V ^b	1000/V ^b	1000/V ^b
Maximum overcurrent protection (Amperes)	–	–	–	5	5	100/V ^b	100/V ^b

^a In all cases the applied primary voltage shall be as indicated in Table 38.1.

^b Maximum output voltage, regardless of load, with applied voltage as specified in Table 38.1.

^c Maximum volt-ampere output regardless of load, and overcurrent protection (if provided) bypassed.

^d Maximum output after 1 minute of operation under any noncapacitive load, including short circuit, and with overcurrent protection (if provided) bypassed.