



AEROSPACE INFORMATION REPORT

AIR4964™

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Exposure Levels of UV Radiation in Nondestructive Inspection Processes

RATIONALE

AIR4964 has been reaffirmed to comply with the SAE five-year review policy.

INTRODUCTION

The UV-A lamps (also known as blacklights) contain mercury-gas plasma that emit radiation specific to the mercury atomic transition spectrum. There are several discrete lines in the ultraviolet section of the electromagnetic spectrum (between 180 to 400 nm). The irradiance output is dependent on the gas pressure and the amount of mercury content. Higher values of these parameters result in significant increase in its UV emission. Blacklights used for NDT employ appropriate filters (integral or external to the light source) to minimize the visible light output (between 400 to 760 nm) vital to the fluorescent inspection processes. Furthermore, these filters also block any harmful radiation below 320 nm. Medical data suggests that radiation between 180 to 319 nm (UV-B and UV-C) can cause severe skin and eye burns. The sensitivity of the skin to such radiation is a function of the incident UV wavelength and its dosage. Normally, the erythral effectiveness is strong between 180 to 300 nm, with rapid fall-off to 1% at 320 nm. Therefore, the filter characteristics and the lamp head construction play an important role in the radiation safety and suitability of blacklights for the NDT industry.

1. SCOPE:

Long wave ultraviolet or UV-A radiation (between 320 to 400 nm) is used for fluorescent inspections in magnetic particle and liquid penetrant examinations. The UV-A radiation is obtained from either fluorescent or high intensity discharge lamps that are stationary or portable. The commercially available UV-A lamps possess a large variation in intensity output that can cause a legitimate concern for possible health hazard. This draft reviews the nature of UV-A radiation emitted by these lights, blacklight equipment, acceptable UV dosage limits adopted by the American Conference of Governmental Industrial Hygienists (ACGIH) and the European Standards Committee for Nondestructive Testing, and recommendation of proper practices when working with UV-A radiation.

2. APPLICABLE DOCUMENTS:

There are no referenced publications specified herein.

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3. BLACKLIGHT EQUIPMENT:

The most commonly used blacklights are low, medium, or high-pressure mercury vapor discharge sources. The low pressure lamps are coated with special phosphor in order to maximize its UV-A output. The medium and high pressure lamps do not have phosphor coatings but operate at higher electrical power levels resulting in significantly higher UV-A output. Typically, the low pressure lamps are used in wash stations, whereas the medium or high pressure lamps are used in fluorescent inspection sites. Figures 1, 2, and 3 illustrate the emission profiles of such blacklights. A well-designed medium or high pressure blacklight should emit less than 0.25% and 1% of its total radiative output under 320 nm and above 400 nm, respectively. Spectroradiometric measurements conducted by the manufacturers of blacklight equipment must conform to the desirable emission characteristics.

4. UV-A AND VISIBLE LIGHT SPECIFICATIONS:

The AMS, Military, ASTM and other industrial NDT specifications in the United States require a minimum working UV-A irradiance level (measured with a suitable blacklight meter) of 1000 uW/cm^2 and a maximum permissible visible light level (measured with an illuminance meter with a CIE photopic spectral response) of 2 ft-c (20 lx) at the inspection surface. These values have also been adopted by the European NDT community. In addition, the European committee is working towards incorporating into their specification a maximum UV-A irradiance level of 5000 uW/cm^2 at the examination surface. The upper UV-A level was determined following penetrant indication experiments conducted on Nichrome test panels. The UV-A reflected from the examination part reduced the contrast level when working with irradiance in excess of 5000 uW/cm^2 . Also, saturation effects of the fluorescent material were perceived at high irradiance levels. Presently, none of the U.S. specifications denote a maximum UV-A level, although it may be useful to incorporate such a value. An upper limit could improve the inspection process and certainly pose less health-hazard.

5. THRESHOLD LIMIT VALUES FOR UV-A EXPOSURE:

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends threshold limit values (TLVs) for UV radiation in the spectral region between 180 to 400 nm. These values represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. For the long wave UV spectral region (UV-A), the total irradiance incident upon the unprotected eye should not exceed 1 mW/cm^2 (1000 uW/cm^2) for periods greater than 1000 s (approximately 16 min). For exposure times less than 1000 s, the total UV-A dosage should not exceed 1 J/cm^2 (Joule = Watts x seconds). However, these values do not apply to photosensitive individuals or to individuals concomitantly exposed to photosensitizing agents such as special medication. Such individuals must seek doctor's advice prior to further UV exposure. The TLV for occupational exposure to UV-A radiation within an 8-h period should be used as a guide and not be regarded as a fine line between safe and dangerous levels.

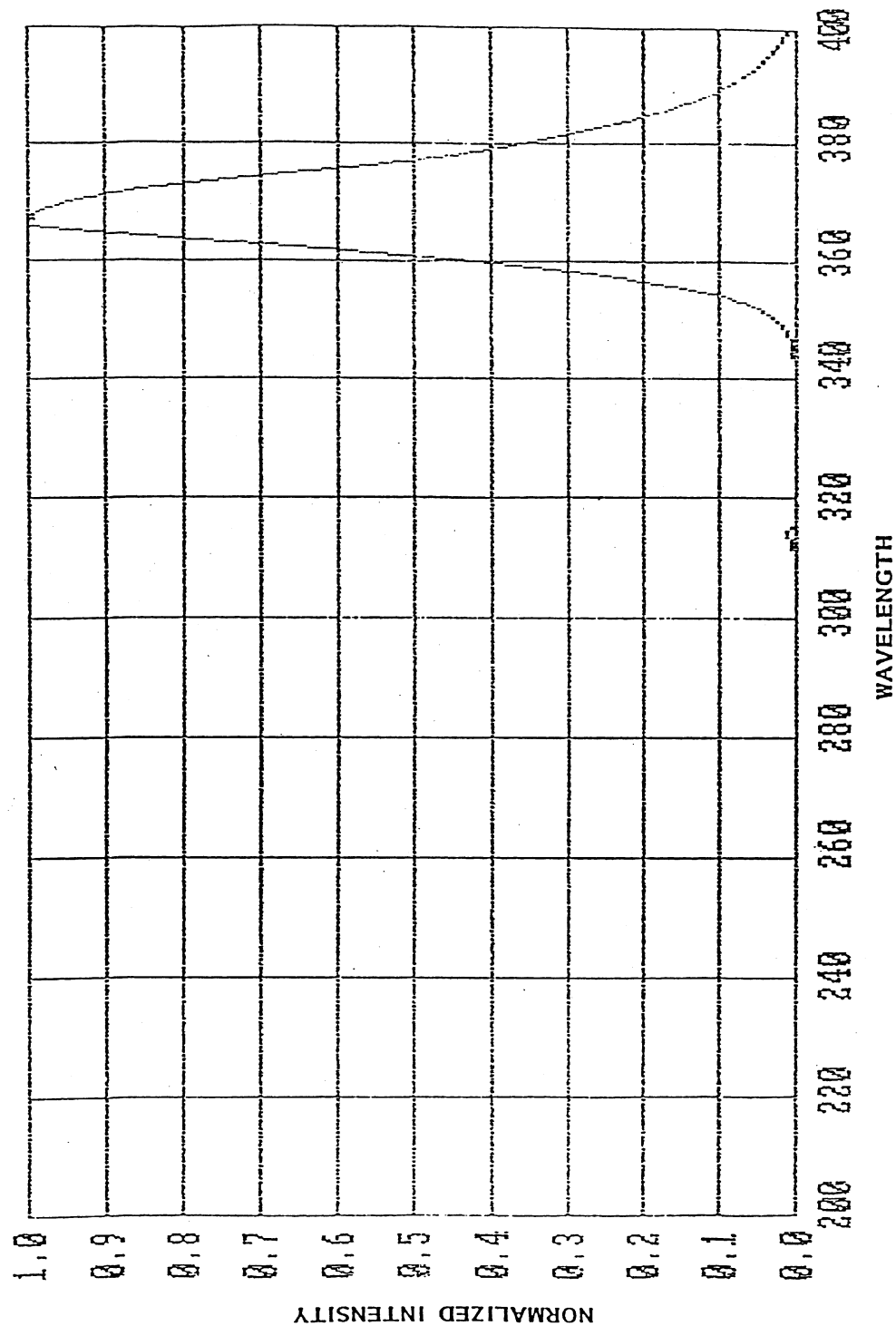


FIGURE 1 - Spectral Power Output of a Low-Pressure Mercury Vapor Blacklight