DEVELOPMENT OF AN ADAPTIVE CONTROL SYSTEM FOR NUCLEAR THERMAL TESTS USING A HIGH POWER XENON ARC LAMP

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ABSTRACT

For the evaluation of nuclear thermal irradiation effects on material surfaces, different kinds of simulation facilities are available today. A decision has always to be made whether the accuracy of the pulse shape, the thermal energy level or the spectrum are most important for the test scenario. It has also to be considered if small scale tests are sufficient or if full scale tests for materials or equipment need to be performed.

At the Armed Forces Scientific Institute for Protection Technologies – NBC Protection in Munster, Germany, a high power xenon arc lamp is used for small scale thermal irradiation tests. The characteristics of this device are high thermal flux levels of up to 1,000 W/cm^2 and a spectral distribution very close to that of a real nuclear weapon. Since the xenon arc lamp is capable of high speed operations, nearly arbitrary pulse shapes and pulses with durations shorter than 1 ms can be realized.

A major challenge for this kind of simulator lies in the control of the electric arc current to preserve the desired pulse shape, energy level and therefore the thermal irradiance resulting on the surface of the test object. For this purpose, a new control system has been developed and an adaptive control algorithm was implemented. Nonlinearities between arc current and resulting thermal flux and other influencing factors are taken into account. Tests on the spectral and spatial distribution of the thermal irradiation pulse were conducted and included in the examination to validate the operation of the control system.