

November 9, 1979

Estimation Of Service Life
Of EA170-XX302 Limit Switches
For Class 1E Use, Outside Of The
Containment Area Of Nuclear Power Plants

Qualification Report Dated 3/17/78 & 7/24/78
Switch P/No. EA170-11302 Rev. E Through G.

The purpose of this presentation is to show that the service life of the EA170 series limit switch exceeds 20 years, under normal service conditions.

The Nanco Controls' Qualification Test Procedure included three types of aging; thermal aging, mechanical aging and radiation aging.

As a result of an Engineering study the components of the switch were classified into three groups: elastomeric seals, other non-metallic components and metallic components.

The metallic components, such as, zinc alloy housings, steel alloy covers, steel alloy shafts and fasteners are not affected by the thermal conditions of service or test.

Non-metallic components; the contact carriers and blocks are made from thermoset plastics which has been supplied, by our vendor, to the industry for over fifteen years. This thermoset plastic is listed by UL with an index of 130 C, the average endurance time being 100,000 hours (12 years) for this temperature. Extrapolation of the regression curve provides an estimated life of greater than 50 years. The lubricant manufacturer was unable to provide thermal aging characteristics for the synthetic lubricants used, however; our experience indicates the proper application of the proper amount is more critical than the thermal aging characteristics of the lubricant.

Relubrication of the switch on a five year cycle would extend the life of the switch beyond the 20 year estimate.

Elastomeric seals, the cover gasket material is a methyl vinyl (VMQ) type silicone rubber, generic aging information for this type of material indicates that minimal physical changes occur after exposure to temperatures of 150 C (320 F) for less than one year (1) (2). Catalog data from the two leading manufacturers of silicone rubber states a service life of from 10 to 20 years at 150 C and when conservatively projected indicates a service life of greater than 90 years at 90 C (3).

The shaft seal is a viton o'ring, generic aging information on this type of material indicates that no change in durometer occurs after 11 months at 148 C and other physical characteristics actually improved (the o'ring is considered as a static seal). Indefinite service life is obtained under these conditions (4).

The EA170-XX302 series switches have a maximum rated temperature of 90 C. Service temperatures for outside the containment area (as proposed in IEEE 382 Drafts) range from 40 C to 60 C.

It is impractical to thermally age the switch assembly at a high enough temperature or long enough duration of time to cause a significant change in the three groups of materials and still simulate the long service life at low temperature without causing unusual outgassing and physical changes.

Therefore, the switch was heat soaked at 200 F for 200 hours to stabilize all the components.

The data search also disclosed that the radiation threshold of damage for viton and silicone rubber is as low as 1×10^7 Rads for some compounds (1) (4). The radiation aging, of the qualification test procedure, is 20.4×10^7 Rads. \triangle

Therefore, it can be concluded that the elastomeric seals were at or beyond the condition of "end of life", as required by IEEE 323 (5). Before the switch was subjected to seismic conditions.

Based upon the above data we can consider the estimated service life of the EA170-XX302 series switches to be approximately 20 years, assuming the contacts are cleaned every two years and relubrication is carried out every five years.

References:

- (1) General Electric Company
Technical Data Book S-1E
Silicone Rubber Technical Information
- (2) Dow Corning Corporation
Designing with Silastic Silicone Rubber
Bulletin 17-158, Date: 10/72
- (3) E. I. DuPont De Nemours & Co. (Inc.)
Elastomer Chemical Department
Wilmington, Delaware
- Upgrading Seal Performance with DuPont Viton
Catalog A98591

\triangle 40 YEARS OF RADIATION 4×10^6 RADS
 ACCIDENT RADIATION 20×10^6 RADS
 GRS 5/1/80

- (4) E. I. DuPont De Nemours & Co. (Inc.)
Elastomer Chemical Department
Wilmington, Delaware
The Engineering Properties of Viton
Catalog A65053, 4/69

- (5) IEEE 323-1974, Section 6.3.3 Aging
Std. For Qualifying Class IE Equipment for
Nuclear Power Generating Stations