

**Basis of Defining "Not Normally Occupied Area" for Personal
Criticality Detector Application per ANS 8.3 at SRS.**

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INTRODUCTION

DOE Order 420.1A, *Facility Safety*¹, requires the installation of Criticality Accident Alarm System (CAAS) to detect the radiation from an unplanned and uncontrolled nuclear reaction and to notify building occupants of such an event if the expected dose exceeds 12 rads in free air. DOE Order 420.1A requires that the Nuclear Criticality Safety Program be based on the requirements in ANSI/ANS-8.3-1997². This standard permits the use of portable criticality detection instruments "in areas that are not normally occupied." It is proposed to replace the present engineered CAAS system requirement in areas that are not normally occupied with alarming personal criticality detectors (APCDs) that are controlled by an administrative program. These APCDs fulfill the ANSI/ANS-8.3-1997 requirements for portable instruments and respond to radiation in essentially the same manner as a standard CAAS instrument.

In permitting limited use of portable criticality detection instrument, ANSI/ANS-8.3-1997 does not define the term "*not normally occupied*." This paper provides a basis for a working definition of the term "*not normally occupied*" for the application of APCDs at the Savannah River Site (SRS).

Two alternate approaches were used to establish this definition: (1) a review of the National Fire Protection Association (NFPA) requirements associated with areas that are not normally occupied and a risk-based evaluation of the criticality protection at SRS for areas that are not normally occupied.

EVALUATION BASED ON NFPA REQUIREMENTS

The NFPA publishes more than 275 codes, standards, guides and recommended practices. A

search of the May 2002 set identified eleven NFPA documents that used the term "not normally occupied." Two of these provided insight in defining the term "not normally occupied."

NFPA 101³, *Life Safety Code*, establishes the requirements for building egress. These requirements include exit arrangements, detection capability, automatic suppression capability, fire compartmentalization, emergency lighting and means of egress components. There are three uses of the term "*not normally occupied*", two of which apply to the criticality question.

- Elimination of emergency lighting in storage occupancies that are not normally occupied [NFPA 101:42.2.9].
- Alternate design provisions for stories used exclusively for mechanical equipment rooms, elevator penthouses, and etc. [NFPA 101:3.3.194.1].

NFPA 101 defines occupied as "any time a building is open to the public, or at any other time it is occupied by more than 10 persons" [NFPA 101:7.2.1.1.3]. Under such conditions the egress doors may be locked such that occupants require keys to exit the building. The intent is to permit small security and cleaning crews during off-hours. The code also permits reduced egress capability in Industrial Occupancies for equipment access locations if the location is occupied by 20 or fewer persons [NFPA 101:40.2.5.6]. The NFPA 101 definition of occupied (i.e., > 10 occupants) suggests an upper limit for the number of workers that could use an area that is designated as "not normally occupied" at any given time. While an occupancy limit of 20 is used for modifications to the egress requirements in an Industrial Facility, the requirement relaxations are very minimal in terms of actual safety, but sometimes

considerable in construction costs. Thus, the 10-person limit is more defensible.

NFPA 301⁴, *Code for Safety to Life from Fire on Merchant Vessels* defines the terms Manned Space, Restricted Access Space and Unmanned Space. Different levels of safety requirements exist for each space. Restricted Access Space is defined as “Spaces that are not normally occupied by the crew during the course of normal working or watchstanding but that can be periodically checked during the course of their rounds” [NFPA 301:3.4.5]. Examples of such space “are cargo holds, fuel tanks, and cargo tanks”[NFPA 301:A.3.4.5]. Unmanned Space is defined as “A space that is occasionally occupied”[NFPA 301:3.4.7]. The appendix material explains that “unmanned spaces are not normally occupied while a vessel is underway or in port. However, they are at times occupied and the occasional manning of the space can correspond to maintenance, inspection, response to abnormal condition alarms, or other situations”[NFPA 301:A.3.4.7].

The NFPA 301 definition for Unmanned Space best fits the concept of “not normally occupied” as used in ANSI/ANS-8.3-1997. These spaces would only be occupied for limited periods, on the order of 7 days per year. The occupiable story concept introduced in NFPA 101 is similar; stories, which are dedicated to mechanical equipment, which might require a maintenance presence every couple of months (~7 days per year).

ANALYTICAL EVALUATION

In addition to the literature approach, an analytical approach derived from two existing SRS criticality frequencies analyses^{5,6} was developed. The respective frequencies for a criticality in these facilities was reported to be 1.3E-03 and 6.9E-04 per year. In both these facilities the criticality is expected to occur in a storage basin, thus there will be some event mitigation. These analyses can be compared with the 1995 occupational fatality rate in the United States for machine operators, assemblers, and inspectors, which is the category that best fits SRS operators and mechanics was 3 per 100,000 workers⁷. These values are nominally based on a 40-hour work week. Thus, normalized to constant exposure time, the fatality rate would be:

$$F_n = \frac{168 \frac{\text{hrs}}{\text{wk}}}{40 \frac{\text{hrs}}{\text{wk}}} \left(3E-5 \frac{\text{fatalities}}{\text{year}} \right) = 1.3E-4 \frac{\text{fatality}}{\text{year}}$$

The log average criticality frequency for the two SRS facilities discussed above is 9.5E-04 criticalities per year. When combined with the fatality rate of 1.3E-4 per year and an assumption that each criticality where no fixed CAAS exists results in one fatality, the time at risk factor would be:

$$P = \frac{1.3E-4 \frac{\text{fatality}}{\text{year}}}{\left(9.5E-4 \frac{\text{criticality}}{\text{year}} \right) \left(1 \frac{\text{fatality}}{\text{criticality}} \right)} = 0.14$$

This corresponds to a time at risk of 51 days per year. The time at risk is based on the existence of a single hazard (i.e., a criticality). It neglects the potential for a fatality from other causes. In addition, it does not account for multiple death scenarios. To account for these, it is recommended that not normally occupied be defined as 7 days per year, unless a facility-specific analysis is prepared and that entry to the areas defined as not normally occupied be limited to 2 or fewer persons at a time.

Where the entry of 3 to 10 persons into an area that is not normally occupied, the time at risk should be lower. A graded protective approach is recommended. This approach should limit the time at risk for 3 to 6 persons to 2 days per year. This limit keeps the per person risk approximately constant (i.e. risk for 1 person is 1x7=7, the risk for 3 persons is 3x2=6). For 7 to 10 persons the time at risk should be 1 day per year.

If a temporary control is implemented to reduce the likelihood of a criticality, then the graded approach may be waived and the 7 days time at risk would apply to any occupant load up to 10 persons.

RESULTS AND CONCLUSION

Based on a review of the NFPA codes and standards the definition of “not normally occupied” may be modified to be less restrictive. The characteristics of an area that may be designated as “not normally occupied” should be:

- The total occupied time does not exceed 168 hours (7 days) in a 1-year period
- The total occupied time does not exceed 40 hours in a 30-day period
- Access is administratively controlled as part of a safety program
- The area is occupied by no more than 10 persons at any given time.

Portable criticality instruments used in areas that are designated as “not normally occupied” should meet the intent of ANSI/ANS-8.3-1997, paragraph 4.4.2.

It has been shown that in areas that are not normally occupied, which are not equipped with a CAAS alarm, a reasonable level of safety could be achieved by providing personnel CAAS alarms and limiting the time at risk. For areas that are not normally occupied, but occupancy is limited to 2 persons an acceptable time at risk is 7 days per year. For locations with occupancy of 3 to 6 persons the time at risk should be 2 days per year, and for locations with 7 to 10 persons the time at risk should be 1 day per year.

The following definition of “not normally occupied areas” has been accepted and implemented at SRS for limited usage of APCDs.

Not Normally Occupied – An area for which entry is controlled and recommended occupancy is limited to 168 hours per year, not to exceed forty hours per month, and the number of occupants is limited to 10 at any given time. Facility management may request an extension of occupancy time and/or number of occupants, subject to local Criticality Safety Committee concurrence.

REFERENCES

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