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ACRRF ☒	SPRF/CX ☒	AHCF ☐	GIF ☐	Other ☐

Title: ***Drone and Radar EMI Risk to ACRR Safety Channels***

Synopsis

This engineering evaluation concludes the Electro Magnetic Interference risk to reactor safety, from portable radar and drone electromagnetic interference, is negligible.

Free field calculations show we can limit programmatic risk exposure at ACRR and SPR by limiting field strength to less than 4 Volts/meter. This can easily be accomplished when transmitter power is less than 50 Watt, antenna gain is less than 6 and the standoff distance to SPR and ACRR is greater than 25 meters.

Affected SSC(s)	SSC Classification
• SPRCX SCRAM switch circuit • ACRR Instrumentation and Control System • ACRR Plant Protection System • ACRR Reactivity Control System	Safety Significant (active)

References

[1] ER-ACRR-ED-7310-01 PPS1 noise
[2] ER-ACRR-ED-7310-02 Revision 2 HV SCRAM on SS.
[3] ER-ACRR-ED-7360-03 PPS HV-NON_OP
[4] ER-ACRR-ED-7360-01 PPS2 HV Scram
[5] Kevin Staley, MS 1453 (2552) report of 18 Nov 2005 (Plant Protect System Drawer #2 High Voltage/Non-Operate Analysis)
[6] Documented Safety Analysis (DSA) for the Annular Core Research Reactor Facility (ACRRF), SAND2008-5636, CN6.1, 2013.
[7] Technical Safety Requirements (TSRs) for the Annular Core Research Reactor Facility (ACRRF), SAND2008-5637, CN6.1, 2013.
[8] ANSI/ANS-15.15-1978, *Criteria for Reactor Safety Systems of Research Reactors,* American Nuclear Society, La Grange Park, Illinois, November 8, 1978.
[9] U.S. Nuclear Regulatory Commission, Regulatory Guide 1.180 GUIDELINES FOR EVALUATING ELECTROMAGNETIC AND RADIO-FREQUENCY INTERFERENCE IN SAFETY-RELATED INSTRUMENTATION AND CONTROL SYSTEMS

Reviews and Approvals

Prepared by:	**Ken Mulder**	KRM	7/9/2015
	Plant Protection System Engineer	Initials	Date
Certification that distance and power assumptions meet org 6825 test needs.	**Dan Small**	DA	7/13/2015
	SNL Staff	Initials	Date
Peer Review	**R. Danny Beets**	RB	7/9/2015
	Reactivity Control System Eng	Initials	Date
Approved by:	**Paul Helmick**	MTS for P. Helmick	7/9/15
	Engineering Manager	Initials	Date

1.0 INTRODUCTION

The use of Electromagnetic Emitting Devices is an existing and anticipated condition in the DSAs of both SPR and ACRR. Emissions in the Radio Frequency, Microwave and Infrared spectrums are frequently found in and around TA-V, and have not been found to distract from the performance of ACRR system safety functions.

All ACRR systems have EMI vulnerabilities, some of which have been proven to cause an excessively safe reaction (in the form of inadvertent reactor shutdown, for example). ACRR safety system indications have also been proven vulnerable to Electro Magnetic Interference. However, when a failure of the PPS or RCS electromagnetic immunity properties occurs, these systems fail safe and put the reactor in a safe condition. References [1 through 5] substantiate the EMI vulnerability and, most importantly, provide objective quality evidence that noise intrusion will make safety circuit trips occur at lower temperature and lower power levels (a fail-safe design).

2.0 CONDITION UNDER EVALUATION

Several frequencies and radiated power levels were evaluated using the guidelines of Reference [9] to create an 8dB exclusion area designed to prevent exposure of ACCR or SPR equipment from exceeding 4 Volt per meter. An equation derived from the free space propagation model (provided in Reference [9] and shown below) was used to evaluate the EMI risk.

$$d = \frac{\sqrt{30 P_t G}}{E} (meters)$$

where:

P_t = the effective radiated power of the EMI/RFI emitter (in Watts);
G_t = the gain of the EMI/RFI emitter (dimensionless); and,
E = the allowable radiated electric field strength of the EMI/RFI emitter (in Volts/meter) at the point of installation.

3.0 REFERENCE DOCUMENTS

Documents referenced in this EE are listed by number on the front signature page.

4.0 AFFECTED STRUCTURES, SYSTEM, AND COMPONENTS (SSCs)

Systems affected in this EE are listed on the front signature page.

5.0 EVALUATION DISCUSSION

The author reviewed various vendor documents, provided by Org 6825, and selected a bounding power assumption of 50 Watts. A conservative estimate of the distance between the portable equipment and ACRR/SPR was estimated to be much greater than 25 meters. The highest typical gain of 6, provided by reference [9] was selected. Dan Small's signature certifies the actual equipment rating and equipment positioning are more conservative than my 50 Watt and 25 Meter bounding assumptions.