TO: All Interested Parties

FROM: Jessica Schultz, Deputy Director, National Weather Service (NWS) Radar Operations Center SCHULTZ.JESSICA.ANN.1365868456 Digitally signed by SCHULTZ.JESSICA.ANN.1365868456 Date: 2022.02.01 16:42:38 -06'00'

SUBJECT: Lowering the Minimum Scan Angle of the KSGF Weather Surveillance Radar - Model 1988 Doppler (WSR-88D) serving the Springfield, MO, area

DATE: February 1, 2022

In accordance with provisions of the National Environmental Policy Act of 1969, the National Weather Service (NWS) prepared a Draft Environmental Assessment (EA) analyzing the potential environmental effects of lowering the minimum scan angle of the KSGF WSR-88D serving the Springfield, MO, area. The Draft Environmental Assessment is available for public review and comment. The Draft EA may be obtained at:

https://www.roc.noaa.gov/WSR88D/SafetyandEnv/EAReports.aspx

The KSGF WSR-88D is an existing radar facility located at Springfield Branson National Airport in Springfield, Greene County, MO. The radar is in located about 6.2 miles west-northwest of downtown Springfield, MO. The KSGF WSR-88D, commissioned in September 1995, is one of 159 WSR-88Ds in the nationwide network. The KSGF WSR-88D antenna transmits a narrow focused main beam with a width of 1 degree. In normal operation, the radar antenna rotates horizontally to cover all directions (i.e., azimuths). The radar antenna also varies the scan angle at which it points with respect to the horizon. Currently, the WSR-88D operates at a minimum of scan angle of +0.5 degrees (deg) above the horizon. NWS proposes to reduce the minimum scan angle of the KSGF WSR-88D from the current minimum of +0.5 deg to +0.2 deg (i.e., 0.3 deg lower than existing) to provide enhanced coverage of the lower portions of the atmosphere. No construction activities or physical modification of the KSGF WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

NWS will accept written comments on the Draft EA until March 9, 2022. Please submit comments via either email or regular mail to:

James Manitakos
Sensor Environmental LLC
296 West Arbor Avenue
Sunnyvale, CA 94085-3602

Email: jmanitakos@sensorenvirollc.com

Comments sent by regular mail must be postmarked March 9, 2022. After the end of the Draft EA review period, NWS will prepare a Final EA containing responses to all comments. NWS will not make any decision on implementing the proposed action until completion of the environmental review. Thank you for your interest in this important project.

SENSOR ENVIRONMENTAL LLC
www.sensorenvirollc.com

Draft Environmental Assessment Report • January 2022

ENVIRONMENTAL ASSESSMENT (EA)

LOWERING THE MINIMUM SCAN ANGLE OF THE WEATHER SURVEILLANCE RADAR - MODEL 1988, DOPPLER (WSR-88D) SERVING THE SPRINGFIELD, MISSOURI, AREA

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Executive Summary

The National Weather Service (NWS) owns and operates the existing Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) serving the Springfield, MO, area. The International Civil Aviation Organization designator for the radar is KSGF and the radar is located at Springfield Branson National Airport in Greene County, Missouri, about 6.2 miles west-northwest of downtown Springfield, MO. The KSGF WSR-88D was commissioned in September 1995 and has been in continuous operation since 1995. It is one of 159 WSR-88Ds in the nationwide network.

The KSGF WSR-88D is an S-band Doppler, dual polarized weather radar, which NWS uses to collect meteorological data to support weather forecasts and severe weather warnings for southern and central Missouri and adjoining states. The KSGF WSR-88D antenna transmits a narrow focused main beam with a width of 1 degree. In normal operation, the WSR-88D antenna rotates horizontally to cover all directions (i.e., azimuths). The radar antenna also varies the scan angle at which it points with respect to the horizon. The scan angle is measured along the axis of the main beam and can be changed in 0.1 deg increments. Currently, the KSGF WSR-88D operates at a minimum of scan angle of +0.5 degrees (deg) above the horizon. NWS proposes to reduce the minimum scan angle of the KSGF WSR-88D from the current minimum of +0.5 deg to +0.2 deg (the proposed action). Lowering the minimum scan angle would provide enhanced coverage of the lower portions of the atmosphere. No construction activities or physical modification of the KSGF WSR-88D would be required to implement the proposed action; the only change would be to the radar's operating software.

In April 1993, NWS prepared a National Environmental Policy Act (NEPA) document titled, *Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar*. That document analyzed operating the WSR-88D at a minimum scan angle of +0.5 degree (deg). This Draft EA builds on that prior study by examining the possible effects of operating the KSGF WSR-88D at a minimum scan angle of +0.2 (i.e., 0.3 deg lower than the minimum scan angle examined in the April 1993 SEA). Operating this radar at a lower scan angle would increase the area of radar coverage, providing additional data on atmospheric conditions to NWS forecasters and other data users. The area covered at 2,000 ft above site level (ASL) would increase by 46.7%. This radar coverage improvement would be very beneficial to NWS forecasters and others parties (e.g., public safety agencies and emergency responders) using the radar information.

The lower minimum scan angle would not result in the KSGF WSR-88D main beam impinging on the ground within 10,500 ft (2 miles) of the WSR-88D. The proposed action would slightly increase radiofrequency (RF) exposure levels in the vicinity of the KSGF WSR-88D. As shown in Table S-1, during normal operation of the radar with rotating antenna, RF exposure would comply with the safety standards developed by the Institute of Electrical and Electronic Engineers (IEEE) and the adopted by the American National Standards Institute (ANSI) for the general public and workers. Federal Communications Commission (FCC) and Occupational safety and Health Administration (OSHA) safety levels would also be met at all locations.

Table S-1: RF Power Density within Main Beam of KSGF WSR-88D at Minimum Scan Angle of +0.2 deg Compared to ANSI/IEEE Safety Standards

Location / Distance from Radar	Time-Averaged Power Density (mW/cm^2)	ANSI/IEEE General Public RF Safety Standard		ANSI/IEEE Occupational RF Safety Standard	
		Safety Standard (mW/cm^2)	Factor Below Std	Safety Standard (mW/cm^2)	Factor Below Std
Surface of Radome	0.602	1.0	1.66	5.0	8.3
Closest Structure -- Airport Traffic Control Tower (3,300 ft)	0.00075	1.0	1,300	5.0	6,600
Closest Illuminated Ground (10,500 ft)	0.000074	1.0	13,500	5.0	67,500

During infrequent stationary antenna operation, RF exposure levels within the WSR-88D main beam would exceed ANSI/IEEE and FCC safety levels for exposure of the general public within 1,740 ft of the WSR-88D antenna. FCC and ANSI/IEEE occupational safety levels would be exceeded within 777 ft. The KSGF WSR-88D operating at +0.2 deg would not impinge on the ground surface or any occupied structures within those distance and risks to human health would not result.

Because the KSGF WSR-88D operates in a frequency band dedicated to government radiolocation services and the main beam would not impinge on the ground surface in the radar vicinity, the proposed action would not cause radio interference with television, radio, cellular telephone, personal communications devices (PCDs), electro-explosive devices, fuel handling, or active implantable medical devices.

WSR-88D RF emissions have the potential to cause electromagnetic interference (EMI) with sensitive equipment used at astronomical observatories. Eight astronomical observatories are located within 150 miles of the KSGF WSR-88D. A minimum scan angle of +0.2 deg would not result in the WSR-88D main beam impinging on any of those observatories.

Lowering the minimum scan angle of the KSGF WSR-88D would not require physical changes to the radar, vegetation removal, or ground disturbance. The proposed action would not result in significant effects in the following subject areas:

- Land Use and Coastal Zone Management
- Geology, Soils, and Seismic Hazards
- Drainage and Water Quality

- Transportation
- Air Quality
- Flood Hazards
- Wetlands
- Biological Resources / Protected Species
- Cultural and Historic Resources
- Environmental Justice Socioeconomic Impacts
- Farmlands
- Energy Consumption
- Visual Quality/ Light Emissions
- Solid and Hazardous Waste
- Wild and Scenic Rivers

NWS evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KSGF WSR-88D to each angle between +0.4 and +0.2 deg in 0.1 degree increments. Operating the KSGF WSR-88D at alternative minimum scan angles of +0.4 deg or +0.3 deg would result in similar environmental effects as the proposed action. Like the proposed action, significant environmental effects would not result. A minimum scan angle of +0.4 or +0.3 deg would increase the radar's coverage area, but by less than the proposed action (i.e., minimum scan angle of +0.2) deg. Minimum scan angles lower than +0.2 deg would not increase coverage area and would result in increased ground clutter returns. Thus, a minimum scan angle of +0.2 deg is the most beneficial among those considered by the NW .

The no action alternative would result in continued operation of the KSGF WSR-88D at the existing minimum scan angle of +0.5 deg. The improvements in radar coverage resulting from the proposed project would not be achieved. The no-action alternative would not change RF exposure levels from existing. Under both the proposed action and the no action alternative, RF exposure during normal WSR-88D operations would conform to safety standards established by ANSI/IEEE, OSHA, and FCC. Similar to the proposed action, the no-action alternative would not cause significant effects to the natural or man-made environment.

The NWS will distribute the Draft EA to interested members of the public and government agencies for review and comment. Comments on the Draft EA will be accepted by NWS during a minimum 30-day comment period which will end on March 9, 2022. The NWS will provide official responses to all pertinent comments received during the Draft EA comment period in a Final EA report. The NWS will make a decision whether to implement the proposed lowering of the KSGF WSR-88D minimum scan angle after the Final EA report is completed.

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CONTENTS

FIGURES

TABLES

ABBREVIATIONS

ATCT	Airport Traffic Control Tower
AGL	above ground level
AAMI	Association for Advancement of Medical Instrumentation
ANSI	American National Standards Institute
ASL	above site level
deg	degree(s)
DoA	Department of Agriculture
EA	Environmental Assessment
E.O.	Executive Order
EED	electro-explosive device
EMI	electromagnetic interference
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FONSI	Finding of No Significant Impact
ft	foot, feet
HERO	Hazards of Electromagnetic Radiation to Ordnance
IEEE	Institute of Electrical and Electronics Engineers
JSPO	Joint System Program Office
KSGF	WSR-88D serving the Springfield, MO, area
m	meter(s)
MBTA	Migratory Bird Treaty Act (of 1918)
MHz	megahertz
mi	mile(s)
MPE	maximum permissible exposure
MO	Missouri
MSL	mean sea level
mW/cm^2	milliwatts per square centimeter
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar (also known as WSR-88D)
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NTIA	National Telecommunications and Information Agency
NWS	National Weather Service
PEIS	Programmatic Environmental Impact Statement
RF	radiofrequency

SEA	Supplemental Environmental Assessment
SHPO	State Historic Preservation Office
sq mi	square mile(s)
std	standard
U.S.	United States
USAF	U.S. Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WNW	west-northwest
WSR-88D	Weather Surveillance Radar – 1988, Doppler

1 BACKGROUND AND SCOPE OF REPORT

1.1 BACKGROUND

The National Weather Service (NWS) operates a nationwide network of weather radars that provide critical real-time information on atmospheric conditions to weather forecasters. Additional similar weather radars located in Alaska, Hawaii and Puerto Rico are operated by the Department of Transportation Federal Aviation Administration (FAA). The Department of Defense Air Weather Service also operates weather radars located at United States (U.S.) military installations in the U.S. and abroad. The weather radars operated by these three agencies are part of 159 WSR-88Ds in the nationwide network.

The network radars operated by NWS are named Weather Surveillance Radar-Model 1988 Doppler (WSR-88D) after the year they were first put into service and their capabilities to use Doppler shift measurements to determine wind velocities. They are also known as Next Generation Weather Radars (NEXRADs) or Weather Service Radars. Like all active radars, the WSR-88D transmits a radio signal, which reflects off targets and returns to the radar. The radar measures the strength of the return signal, its direction of return, and the time between transmission and return, which allows determination of the target characteristics. Because the WSR-88D has the potential to cause electromagnetic effects on the environment, NWS carefully considered these effects and strives to prevent effects, or when effects cannot be avoided, mitigate the significance of those effects. To that end, the NEXRAD Joint System Program Office (JSPO) prepared environmental reports evaluating potential electromagnetic effects of the WSR-88D during planning and implementation of the WSR-88D network. In 1984, the JSPO issued the first environmental document which considered electromagnetic effects (among other effects). That report is titled: *Next Generation Weather Radar Programmatic Environmental Impact Statement (PEIS), Report R400-PE201* [NWS, 1984]. In 1993, JSPO issued a supplemental report updating the analysis contained in the 1984 PEIS to account for changes since 1984 in electromagnetic standards and guidelines and developments in radar design and operational modes. The supplemental report is titled *Final Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD JSPO, 1993]. The 1993 SEA analyzed the potential electromagnetic effects of operating the WSR-88D at a minimum scan angle of +0.5 degree (deg) above horizontal, measured at the center of the WSR-88D main beam. The minimum scan angle of +0.5 deg represented the lowest scan angle used operation of the WSR-88Ds at that time.

The National Weather Service (NWS) owns and operates the WSR-88D serving the Springfield, MO, area. The radar identifier is KSGF and the radar is located at Springfield Branson National Airport, Greene County, MO, about 6.2 miles west-northwest (WNW) of downtown Springfield. The KSGF WSR-88D is part of the nationwide WSR-88D network. The NWS proposes to operate the KSGF WSR-88D at a minimum scan angle of +0.2 deg, which is lower than the current minimum scan angle of +0.5 deg above the horizon. Operating the KSGF WSR-88D at this lower scan angle was not analyzed in the 1993 SEA.

The National Oceanic and Atmospheric Administration (NOAA), the parent agency of NWS, require analysis of the potential environmental consequences of proposed actions to comply with the National Environmental Policy Act (NEPA). Procedures to be followed are set forth in NOAA Administrative Order (NAO) 216-6A (NOAA, 2016). Because NWS's proposed action of operating the KSGF WSR-88D at a minimum scan angle below +0.5 deg has the potential to cause environmental effects, there is a need to analyze potential environmental consequences, determine their significance, and develop measures to mitigate adverse impacts if necessary.

1.2 SCOPE OF REPORT

This Draft EA report analyzes the potential effects on persons and activities in the vicinity that could result from implementing the proposed action (i.e., lowering the KSGF WSR-88D minimum scan angle to +0.2 deg). Potential environmental effects of alternative minimum scan angles between +0.4 deg and +0.2 deg and the no-action alternative (i.e., continued operation of the KSGF WSR-88D at the current minimum scan angle of +0.5 deg) are also considered for comparison purposes. As part of that analysis, the findings of the 1993 SEA have been updated to account for changes in safety standards and guidelines that have been occurred since 1993 and site -specific conditions at the KSGF WSR-88D site and vicinity. The scope of this EA is limited to analyzing potential effects from lowering the minimum scan angle of the KSGF WSR-88D. Because the types of electromagnetic effects that may result and their significance depends on local conditions, including uses and topography of the local area, the analysis and findings in this EA are specific to the KSGF WSR-88D, and do not apply to other WSR-88Ds or the WSR-88D network as a whole.

2 PURPOSE AND NEED

The NWS is the nation's premiere meteorological forecasting organization. The agency's official mission is as follows:

> "The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure which can be used by other governmental agencies, the private sector, the public, and the global community [NWS, 2009]".

The nationwide network of 159 WSR-88Ds plays a crucial role in meeting the NWS mission. Data from the WSR-88Ds is used by the NWS to improve the accuracy of forecasts, watches, and warnings. As an example, the WSR-88D generates precipitation estimates allowing prediction of river flooding in hydrological basins of the area. The NWS then disseminates advance flood warnings to local and state public safety, emergency managers, and the public, allowing them to take appropriate actions to minimize hazards to life and property. Because the meteorological phenomena of greatest interest occur with a few thousand feet (ft) of the ground surface, radar coverage of lower portions of the atmosphere is of great value to forecasters.

However, the elevation above the ground at which the WSR-88D can collect atmospheric data rises with distance from the radar due to earth curvature and the upward tilt of the radar beam, which is currently +0.5 deg or greater. The proposed action of lowering the KSGF WSR-88D minimum scan angle to +0.2 deg would expand the geographic area with radar coverage below 10,000 ft AGL, a substantial benefit to forecasters and other users of WSR-88D data. This EA report describes the improvements in radar coverage that would result if the NWS operates the KSGF WSR-88D serving the Springfield, MO, area at a minimum scan angle of +0.2 deg and the environmental effects that may result.

The National Oceanic and Atmospheric Administration (NOAA) is the parent agency of the NWS. NOAA requirements for complying with the National Environmental Policy Act (NEPA) are contained in NOAA Administrative Order (NAO) 216-6A, *Compliance with the National Environmental Policy Act, Executive Orders 12114, Environmental Effects Abroad of Major Federal Actions; 11988 and 13690, Floodplain Management; and 11990 Protection of Wetlands* (NOAA, 2016)], and the Companion Manual for NOAA Administrative Order 216-6A; Policies and Procedures for Compliance with the National Environmental Policy Act and Related Authorities (NOAA, 2017). NWS is subject to those requirements. Appendix E of the NOAA Companion Manual specifies the proper level of NEPA review for actions proposed by NOAA components and lists types of actions that are categorically excluded from the need to prepare a NEPA analysis document (e.g., an EA or environmental impact statement [EIS]). Categorical Exclusion G6, which addresses NEXRAD Radar Coverage, states that "Actions that change the NEXRAD radar coverage patterns that do not lower the lowest scan angle and do not result in direct scanning of previously non-scanned terrain by the NEXRAD main beam" are categorically excluded from NEPA (NOAA, 2017). The proposed action would not meet these specifications and does not qualify for categorical exclusion treatment. Therefore, NEPA analysis is required for the proposed lowering of the KSGF WSR-88D minimum scan angle to +0.2 deg; this EA report satisfies that requirement.

3 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

3.1 PROPOSED ACTION

3.1.1 DESCRIPTION OF KSGF WSR-88D

The NWS of the Department of Commerce, Air Force of the Department of Defense, and FAA of the Department of Transportation operate a nationwide network of Doppler meteorological radars, known as NEXRAD or WSR-88D. The WSR-88D collects data on weather conditions and provides critical inputs to forecasters. The network is composed of 159 radars, most of which were installed in the late 1980s and 1990s. Each radar includes a roughly 28-ft diameter dish antenna mounted on a steel lattice tower of varying height (depending on local conditions), and shelters housing electronic equipment, a standby power generator and fuel tank, and a transitional power maintenance system. The dish antenna rotates 360 deg and is covered by a fiberglass radome to protect it from the elements.

Figure 1 is a photograph of the KSGF WSR-88D, which was commissioned on September 14, 1995 and has been in continuous operations since being commissioned. The KSGF WSR-88D serves the Springfield, MO, area and is operated and maintained by the NWS. The Springfield, MO, Weather Forecast Office (WFO) is the primary recipient of data from the KSGF WSR-88D and serves southern and central Missouri, northwestern Arkansas, northeastern Oklahoma, and southeastern Kansas. The KSGF WSR-88D is located is located at Springfield Branson National Airport, Greene County, MO, and is about 6.2 miles WNW of downtown Springfield. (see Figure 2). The radar antenna, radome, and steel-lattice tower are standard. Table 1 provides information on the KSGF WSR-88D.

Table 1: Information on KSGF WSR-88D serving the Springfield, MO, area

Elevation, ground surface at tower base (mean sea level, MSL)	1,262 ft
Elevation, center of antenna (MSL)	1,360 ft
Tower Height (m)	25 m (82 ft)
Latitude (WGS84)	37°14’07” N
Longitude (WGS84)	93˚24’02” W
Operating Frequency	2,865 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No

Figure 1: Photograph of KSGF WSR-88D serving Springfield, MO, area

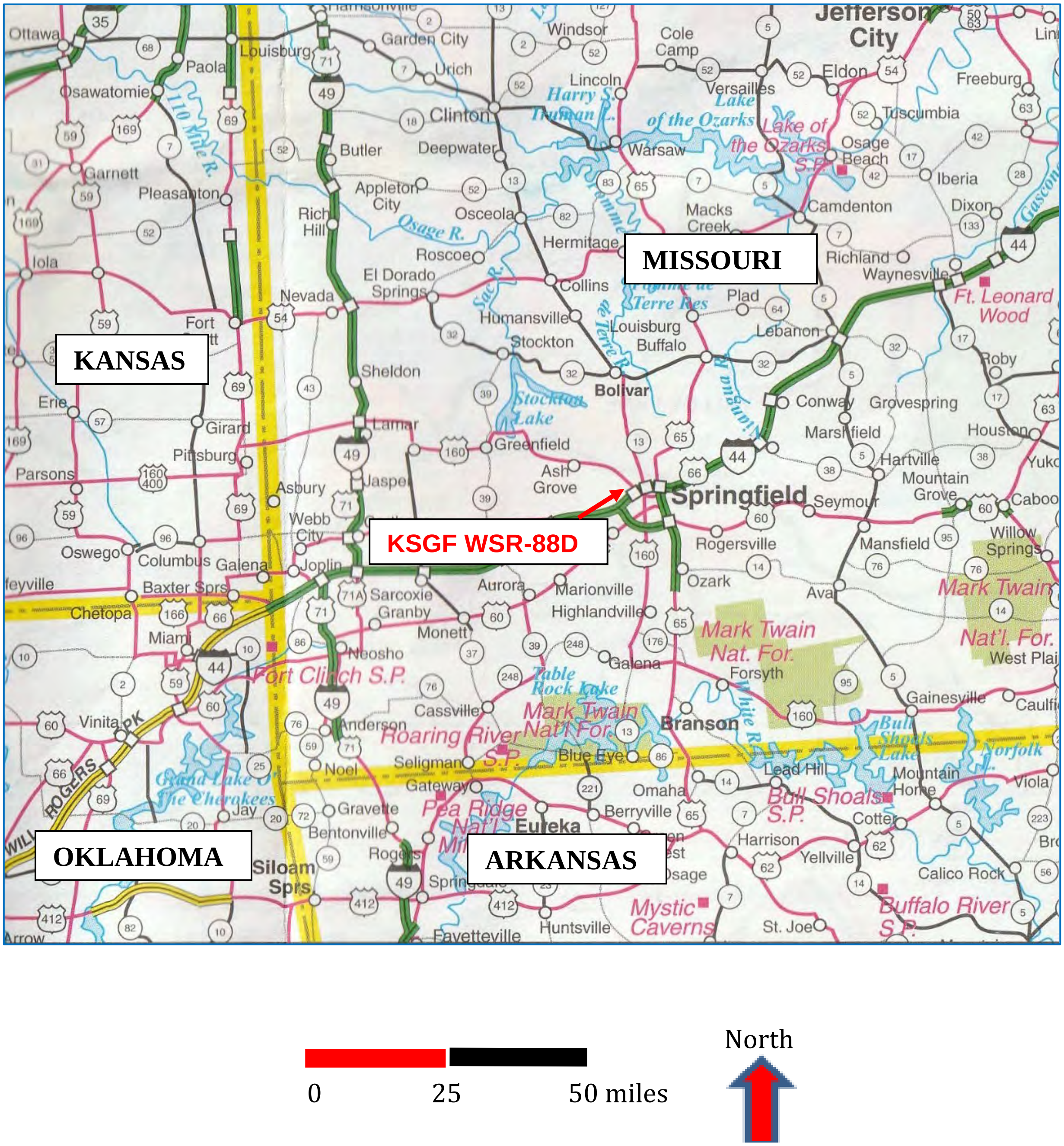

Figure 2: Location of KSGF WSR-88D

3.1.2 Proposed Change in Minimum Scan Angle

The WSR-88D is designed to detect and track weather phenomena within a roughly 230 mi distance of the radar. It accomplishes this task by emitting a narrow main beam from a rotating dish antenna. The antenna rotates continuously around a vertical axis to cover the surrounding area. The main beam scan angle is the number of degrees above or below horizontal at the center of the main beam. The upward tilt of the antenna (and therefore the scan angle of the main beam) can be changed, allowing the radar to scan the sky at angles up to+ 60.0 deg and down to -1.0 deg; however, in current operation, the maximum scan angle is +19.5 deg and the minimum scan angle is +0.5 deg.

The WSR-88D main beam has a total width of 1 deg in the horizontal and vertical directions (i.e., beam edge is ½ deg from the center of the beam), as shown in Figure 3. The power density of the WSR-88D is greatest at the center of the beam and decreases towards the edge of the beam. At the edge of the main beam, the power density is one half of the center of beam power density. In current operation, the minimum scan angle of the main beam is +0.5 deg (i.e., 0.5 deg above horizontal at the center of the main beam) and the lower edge of the main beam (i.e., lower half-power point) is at 0.0 deg or horizontal. NWS proposes to reduce the minimum center of beam scan angle to +0.2 deg, which is 0.3 deg lower than the current minimum scan angle.

Figure 4 is a schematic drawing showing the change in coverage that would result from lowering the KSGF WSR-88D minimum scan angle. The floor of coverage would decrease slightly, but at a scan angle of +0.2 deg would not impinge on the ground surface in the vicinity of the radar. Because the lowered radar main beam would not be significantly obstructed by nearby terrain, buildings, or trees, the radar would cover portions of the atmosphere which are currently not covered. Table 2 shows the improvement in radar coverage that would be achieved, which ranges from 46.7% increase in coverage area at 2,000 ft above site level (ASL) to 19.9% increase at 10,000 ft ASL. Figures 5, 6, and 7 show the improvement in radar coverage that would be achieved at 2,000 ft, 5,000 ft, and 10,000 ft ASL, respectively. The improvement in WSR-88D coverage would be beneficial to NWS forecasters and other users of radar data (e.g., emergency response mangers, water managers, farmers, transportation officials).

Table 2: Existing and Proposed Radar Coverage Areas for KSGF WSR-88D

Minimum Center of Beam Scan Angle (deg)	Coverage Floor (deg)	Area Covered (sq. mi.)		
		2,000 ft ASL	5,000 ft ASL	10,000 ft ASL
+0.5 (existing)	0.0	10,665	27,369	55,223
+0.2 (proposed)	-0.3	15,642 (+46.7%)	34,963 (27.7%)	66,231 (+19.9%)

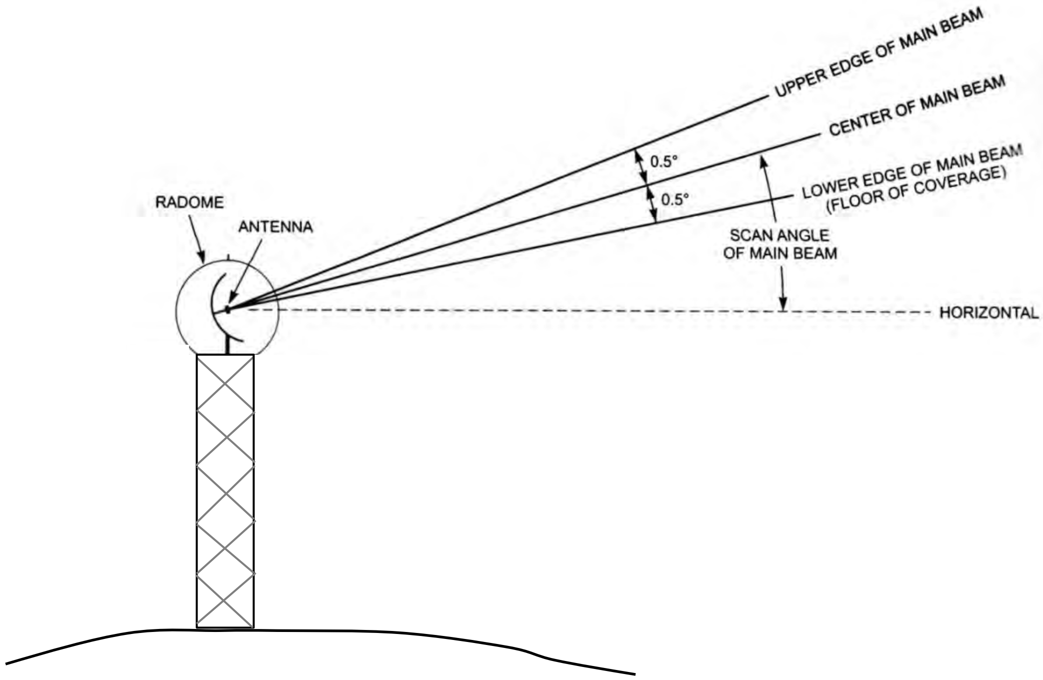

Figure 3: Schematic of WSR-88D Main beam

(Not to scale, width of main beam exaggerated)

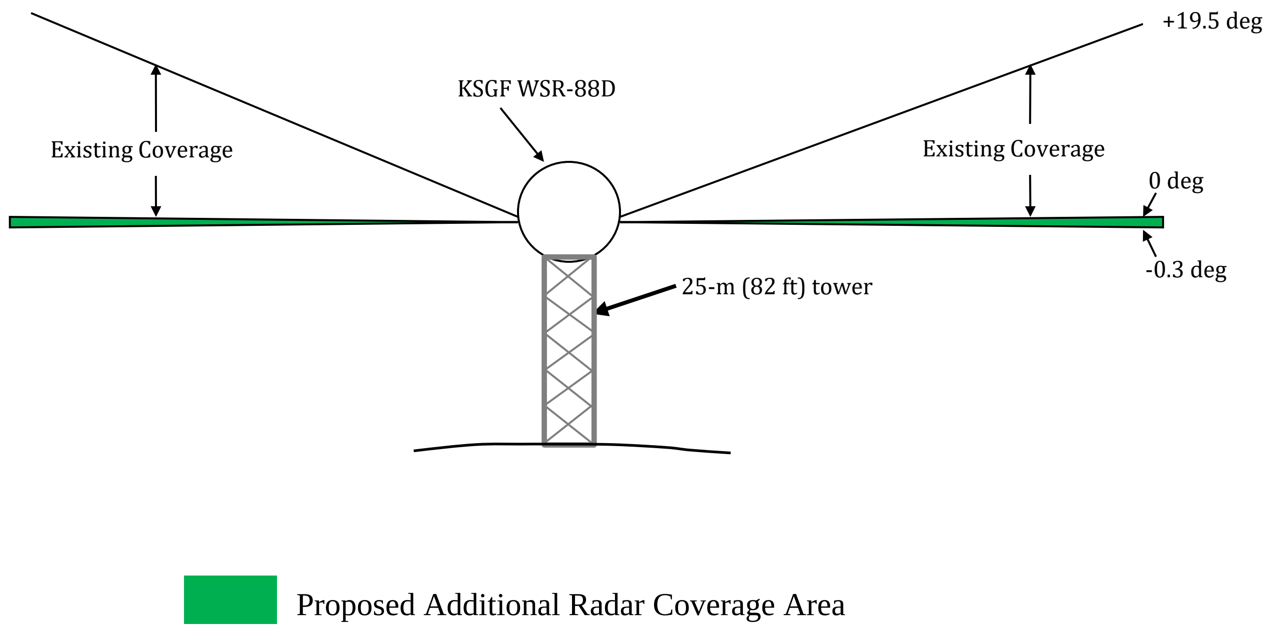

Figure 4: Drawing of Proposed Additional Radar Coverage

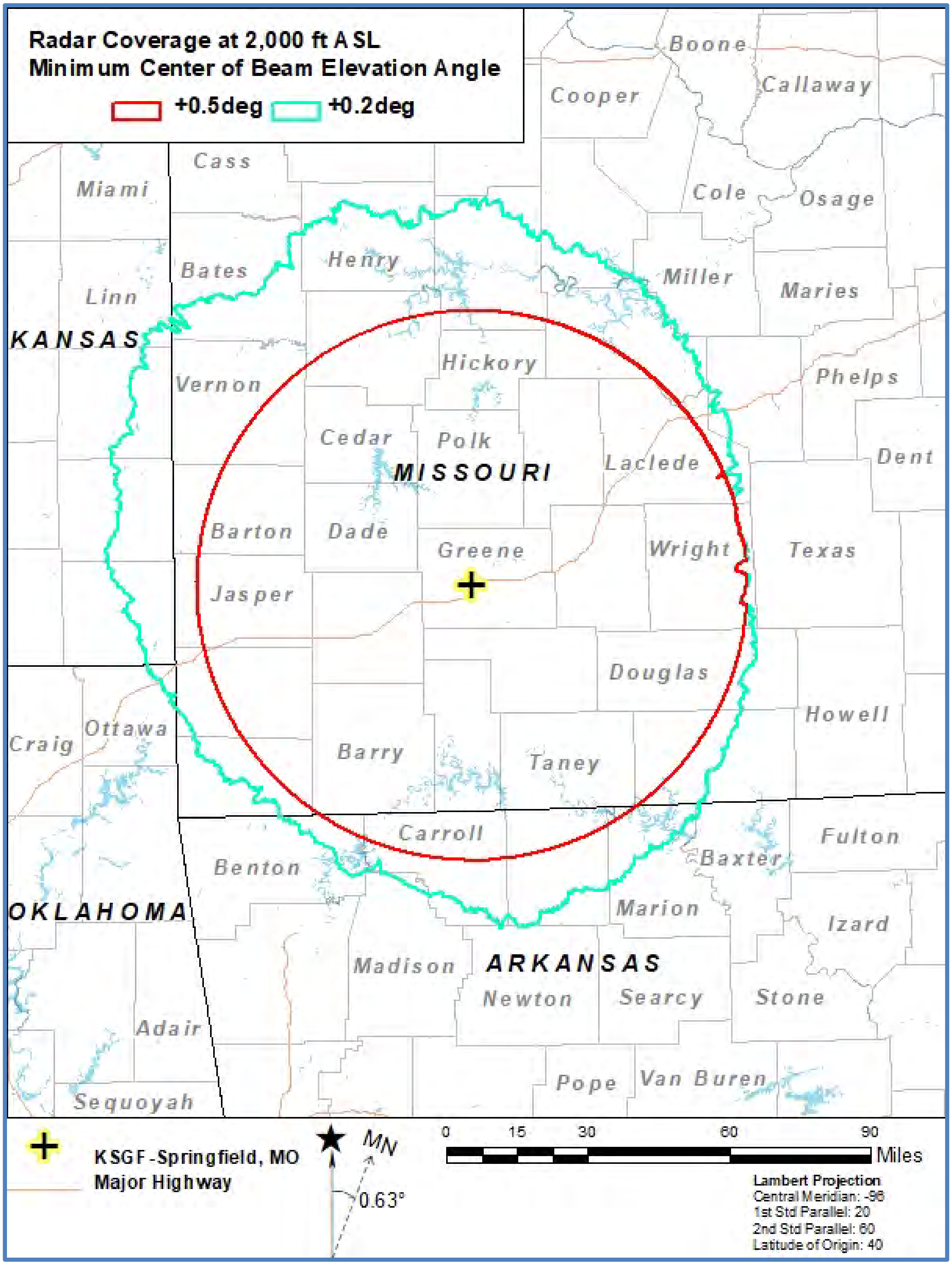

Figure 5: Existing and Proposed KSGF WSR-88D Coverage at 2,000 ft ASL

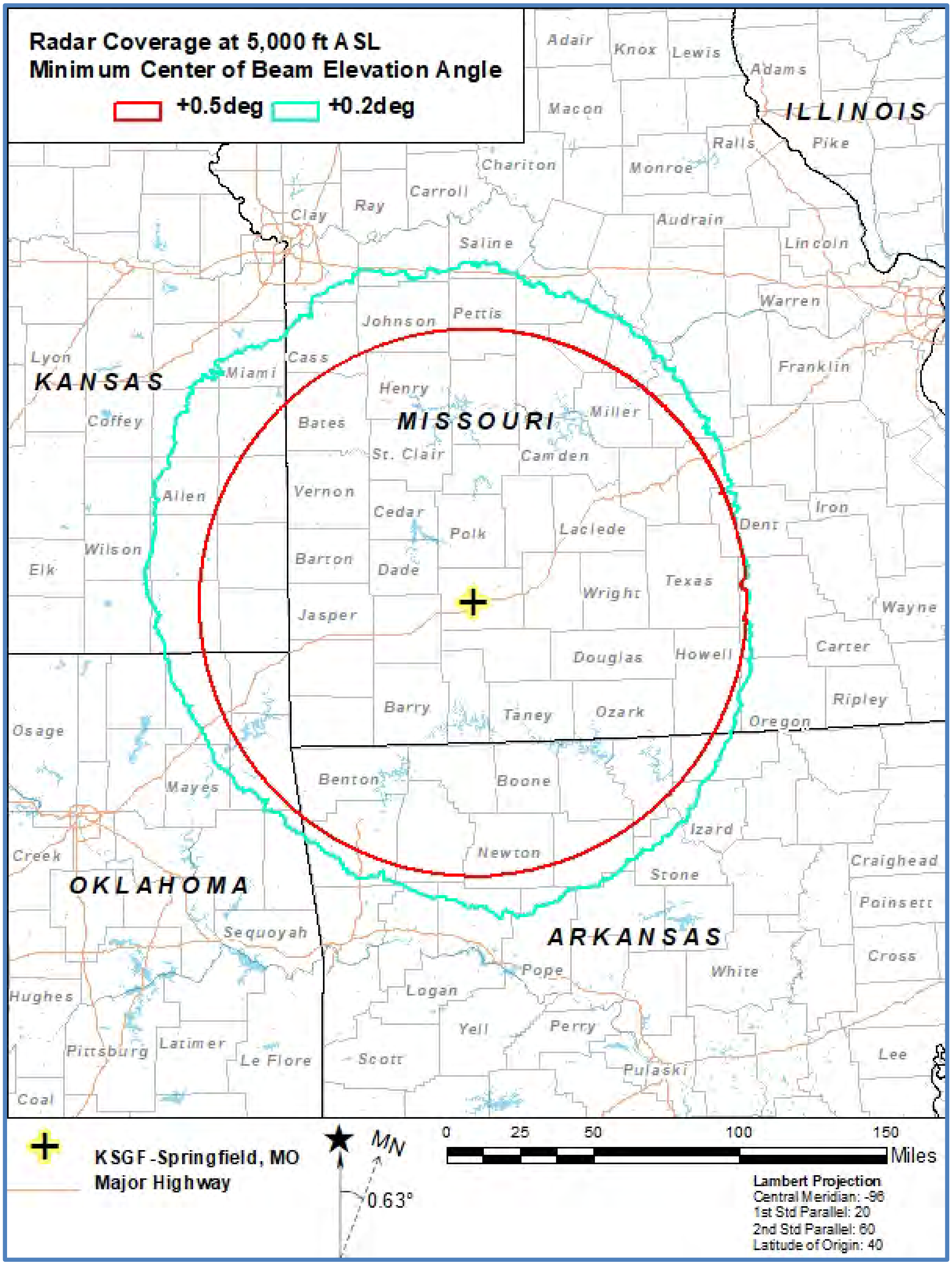

Figure 6: Existing and Proposed KSGF WSR-88D Coverage at 5,000 ft ASL

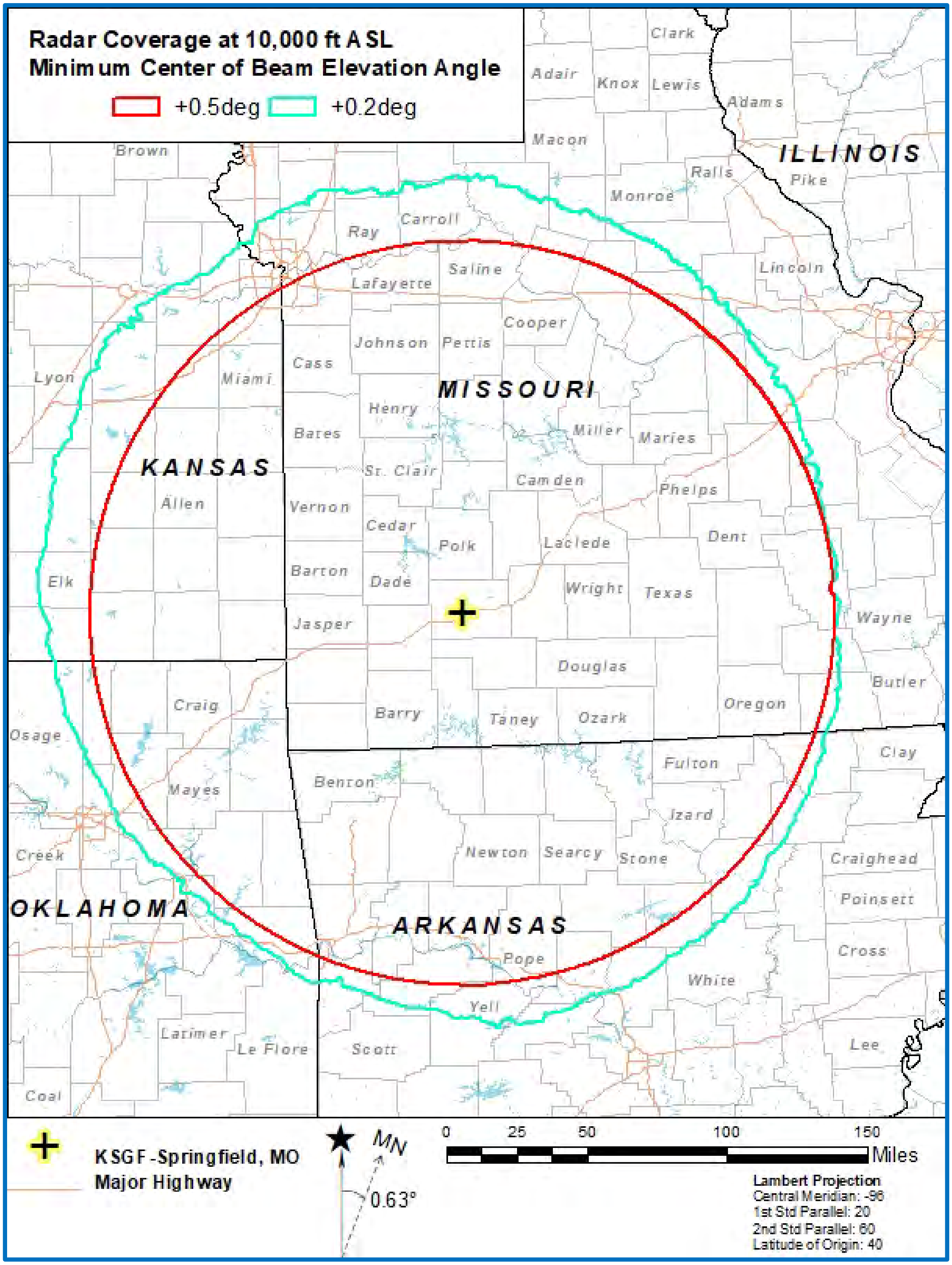

Figure 7: Existing and Proposed KSGF WSR-88D Coverage at 10,000 ft ASL

The existing WSR-88D transmitter and antenna are physically equipped to operate at the proposed minimum scan angle. The only change required to implement the proposed change would be modifications to the software that controls radar operations and processes data collected by the radar. No construction activities or ground disturbance would be required to implement the proposed action. The transmit power of the radar would also be unchanged.

3.2 ALTERNATIVES

NAO 216-6A requires analysis of the no-action alternative in EAs. For purposes of this EA report, the no-action alternative is defined as continuing to operate the KSGF WSR-88D serving the Springfield, MO, area with the current minimum center of main beam scan angle of +0.5 deg. This is the same minimum scan angle used by most other WSR-88Ds in the nationwide network. The no-action alternative and alternative minimum scan angles between +0.4 and -0.2 deg are analyzed in Section 5 of this EA.

4 ENVIRONMENTAL SETTING, CONSEQUENCES, AND MITIGATION

4.1 EXPOSURE OF PERSONS TO RADIOFREQUENCY RADIATION

4.1.1 SAFETY STANDARDS

The electromagnetic environment at a specific location and time is composed of the all the electromagnetic fields from various sources (natural and manmade) that arrive there. The electromagnetic spectrum in an area is a continuously usable resource whose dimensions are amplitude, time, frequency, and space. In areas large enough to permit adequate spatial separation of users, the electromagnetic spectrum can simultaneously accommodate many users if they are sufficiently separated in frequency. The electromagnetic environment at any point can change nearly instantaneously and will vary spatially, even at locations in close proximity; therefore, it is convenient to measure and characterize electromagnetic phenomena using averages over time and space.

Manmade contributions to the electromagnetic environment are both intentional and unintentional. Radio and television broadcasts, cellular telephone transmissions, and radar signals are examples of intentional contributions. Electromagnetic noise generated by power lines, fluorescent lights, and motors of all sorts are examples of unintentional human contributions. The KSGF WSR-88D transmits a radio signal at a frequency of 2,865 MHz, which is within the radiofrequency (RF) or microwave portion of the electromagnetic spectrum. Although microwaves can add heat to objects, they do not contain enough energy to remove electrons from biological tissue, and are a form of non-ionizing radiation. In this regard, microwaves are fundamentally different from ionizing radiations (e.g., X-rays, ultraviolet rays) which occur at higher frequency portions of the electromagnetic spectrum. Ionizing radiation occurs only at frequencies greater than 10^9 MHz. RF or microwave fields are non-ionizing radiation. Due to the fundamental differences between ionizing and non-ionizing radiation, safety standards and guidelines vary greatly for the two types of electromagnetic radiation. In this section only standards for non-ionizing radiation are addressed because KSGF WSR-88D RF emissions are non-ionizing.

The Institute of Electrical and Electronics Engineers (IEEE) developed safety guidelines for human exposure to RFR, and those standards have been adopted by the American National Standards Institute (ANSI) [ANSI/IEEE, 2019 and 2020]. The ANSI/IEEE safety standard is designed to protect all persons (including infants, elderly persons, and pregnant women) from adverse health effects from exposure to radiofrequency (RF), even if exposure should last over an entire lifetime. These guidelines set safety levels for maximum permissible exposure (MPE) to RF signals, which include a 10- to 50-fold safety margin and are intended to protect all members of the population.

MPEs are specified in power density of the radio signal in milliwatts per square centimeter (mW/cm^2) and vary with operating frequency. Separate MPEs have been established for exposure of the general public and workers and for time-averaged exposure and peak exposure.

Occupational safety standards are higher than those for the general public because workers are trained in RF safety practices and have greater ability to use that knowledge to protect themselves from potentially harmful RF exposure. The KSGF WSR-88D operating frequency is 2,865 MHz. The IEEE/ANSI safety standards for those frequencies are 1.0 mW/cm^2 for the general public (averaged over 30 minutes) and 5.0 mW/cm^2 for workers (averaged over 6 minutes). Federal Communications Commission (FCC) RF exposure standards for RF exposure of the general public and occupational exposure are the same as the ANSI/IEEE safety standards. The Occupational Health and Safety Administration (OSHA) regulates occupational exposure to RF emissions; the OSHA safety standard is 10.0 mW/cm^2 (averaged over 6 minutes) (OSHA, 2021).

4.1.2 RF Exposure Levels

The KSGF WSR-88D is mounted on a 25 m tall steel-lattice tower. Ground elevation is 1,262 ft MSL. The center of the antenna is at 1,360 ft MSL and the lower edge of the antenna is 84 ft above ground level (AGL). When operating at the current minimum scan angle of +0.5 deg, the lower edge of the beam is at 0.0 deg (i.e., horizontal) and the radar's main beam does not impinge on the ground surface or any occupied structures in proximity to the radar (see Appendix C). Operating at the proposed minimum scan angle of +0.2 deg would not change that situation; the main beam would not impinge on the ground surface or structures within 10,500 feet of the WSR-88D. The Airport Traffic Control Tower would be slightly below and outside the main beam; as a worst-case analysis main beam power density levels at the ATCT distance are shown in Table 3.

Compared to the existing minimum scan angle of +0.5 deg, lowering the minimum scan angle to +0.2 deg would result in a slight increase in RF exposure levels at air space in the vicinity of the radar. Appendix A includes calculations of the existing time-averaged RF exposure levels in the vicinity of the KSGF WSR-88D, and the RF exposure that would result if NWS lowers the minimum scan angle to +0.2 deg. Table 3 summarizes the results from Appendix A.

Table 3: RF Power Densities of KSGF WSR-88D Main Beam Compared to Safety Levels

Location / Distance from KSGF WSR-88D	Time-Averaged Power Density (mW/cm^2)	ANSI/IEEE General Public RF Safety Standard		ANSI/IEEE and FCC Occupational RF Safety Standard	
		Safety Standard (mW/cm^2)	Factor Below Std	Safety Standard (mW/cm^2)	Factor Below Std
Surface of Radome	0.602	1.0	1.66	5.0	8.3
Closest Structure: ATCT 3,300 feet northeast	0.00075	1.0	1,300	5.0	6,600
Closest Terrain: 10,500 ft east-southeast	0.000074	1.0	13,500	5.0	67,500

During normal operation of the WSR-88D with a rotating antenna, RF exposure levels at all locations would comply with safety standards for exposure of both workers (i.e., occupational exposure) and the general public.

During infrequent stationary antenna operation, RF exposure levels within the WSR-88D main beam would exceed ANSI/IEEE and FCC safety levels for exposure of the general public within 1,740 ft of the WSR-88D antenna. FCC occupational safety levels would be exceeded within 777 ft. No structures or terrain are within those distances and no RF safety hazards would result.

4.1.3 RF ELECTRO-STIMULATION

The ANSI/IEEE safety guidelines also cover possible induction of currents within the bodies of persons and the potential for electro-stimulation of persons who make contact with conductive objects in the RFR field. The result is potentially harmful sensation of shock and/or burn. These effects only occur for RF fields at frequencies below 110 MHz (ANSI/IEEE, 2006). The KSGF WSR-88D would continue to operate at 2,865 MHz, outside the frequency range where induced currents or electro-simulation occur, and would not cause these effects.

4.1.4 CUMULATIVE RF EXPOSURE

As shown in Table 3, the power density of RF transmissions decreases exponentially with distance from the antenna. At all locations in the vicinity, RF emitted by the WSR-88D during normal operation would be at substantially below the safety standard for RF exposure of the general public. It is improbable that radio emissions from an external source would add to the WSR-88D RF emissions during normal operation to cause cumulative RF exposure levels exceeding safety standards.

4.2 RF EXPOSURE OF EQUIPMENT AND ACTIVITIES

4.2.1 TELEVISION, RADIO, CELLULAR TELEPHONE, AND PERSONAL COMMUNICATIONS DEVICES (PCDS)

High-power radar, such as the WSR-88D, can interfere with operation of radio, television, cellular telephone, and PCDs in close vicinity to the radar antenna. However, these devices operate at different frequencies from the WSR-88D, reducing the potential for radio interference. NTIA regulations reserve the 2,700 to 3,000 MHz band for government radiolocation users (e.g., meteorological and aircraft surveillance radars) [NTIA, 2009]. The WSR-88D operates outside the frequencies used by television and radio broadcasts, cellular telephones, and personal communication devices. Lowering the minimum scan angle to +0.2 deg would not result in the main beam impinging on the ground surface within 2 miles of the radar and the potential for radio interference would be low. No mitigation is necessary.

4.2.2 ELECTRO-EXPLOSIVE DEVICES (EEDS)

Electro-explosive devices are used to detonate explosives, separate missiles from aircraft, and propel ejection seats from aircraft. Under extreme circumstances, electromagnetic radiation can cause unintended firing of EEDs. Calculations based on a U.S. Air Force (USAF) standard indicate that using electric blasting caps at distances beyond approximately 900 ft from the WSR-88D is a safe practice, even in the main beam of the radar, where the power density of the WSR-88D radio signal is greatest [USAF, 1982]. The U.S. Navy Hazards of Electromagnetic Radiation to Ordnance (HERO) regulations classify ordnance as safe, susceptible, or unsafe and unreliable, based on compliance with MIL-STD 664 (series). HERO safe ordnance is considered safe in all RFR environments. HERO susceptible ordnance may be detonated by RF energy under certain circumstances. HERO unsafe or unreliable ordnance has not been evaluated for compliance with MILSTD 664 or is being assembled, dissembled, or subject to unauthorized conditions, which can increase its sensitivity to RF emissions. Safe separation distances vary for susceptible and unsafe or unreliable ordnance [Naval Sea Systems Command, 2008]. For HERO susceptible ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (781)\ (f)^{-1}(\text{average power x antenna gain})^{½}$$

Where f is operating frequency in MHz and average power = maximum transmitted power × duty cycle. Inserting these values gives:

$$D = (781)\ (2{,}865)^{-1}\ (475{,}000\ W \times 0.0021 \times 35{,}500)^{½}\ ft$$
$$D = 1{,}622\ ft$$

For HERO unsafe or unreliable ordnance, the safe separation distance (D) in ft is calculated as follows:

$$D = (2{,}873)\ (f)^{-1}(\text{average power x antenna gain})^{½}$$
$$D = (2{,}873)\ (2{,}865)^{-1}\ (475{,}000\ W \times 0.0021 \times 35{,}500)^{½}\ ft$$
$$D = 5{,}967\ ft$$

HERO concerns are only applicable in locations illuminated by the main beam of the radar. When operating at a minimum scan angle of +0.2 deg, the KSGF WSR-88D main beam would not illuminate the ground within 10,500 ft of the radar, which outside the safe setback distance for HERO safe and unsafe ordnance. The Springfield Branson National Airport ATCT is outside the setback distance for HERO safe ordnance, but within the setback distance for HERO unsafe or unreliable ordnance. It is very unlikely that HERO unsafe or unreliable ordnance would be in use at the ATCT.

4.2.4 Fuel Handling

Electromagnetic fields can induce currents in conductive materials and those currents can generate sparks when contacts between conductive materials are made or broken. Sparks can ignite liquid fuels, such as gasoline. This phenomenon is rare, but can result in hazards to human health and property. This potential hazard arises during the transfer of fuel from container to another (e.g., fueling an automobile, boat, or airplane). The U.S. Navy developed a Technical Manual identifying the circumstances where this hazard may occur and providing direction on how to prevent it. The Technical Manual identifies a safe standoff distance based on radar operating characteristics [Naval Sea Systems Command, 2003]. Using formula contained in the

Technical Manual, the distance from the WSR-88D at which RFR hazards to fuel may occur is 537 ft. This hazard only exists in areas directly illuminated by the main beam. The WSR-88D main beam operating at a minimum center of antenna scan angle of +0.2 deg would not illuminate the ground or any occupied structures within 537 ft of the radar. The existing fuel tank for the standby generator at the base of the WSR-88D tower would not be illuminated by the WSR-88D main beam and hazards to fuel handling activities would not result. No mitigation is required.

4.2.5 ACTIVE IMPLANTABLE MEDICAL DEVICES

ANSI and the Association for Advancement of Medical Instrumentation (AAMI) developed the PC69:2007 standard to prevent external electromagnetic sources from causing electromagnetic interference with active implantable medical devices, including cardiac pacemakers and implantable cardiac defibrillators [ANSI/AAMI, 2007]. This standard specifies that cardiac pacemakers and ICDs must be tested by exposing them to a specified magnetic field and that the device must operate without malfunction or harm to the device. The specified field strength varies with frequency. For the WSR-88D operating frequency of 2,865 MHz, the field strength is 3 A/m. This is converted to power density (S) in units of W/m^2 by assuming free air impedance of 377 ohms:

$$S = 377\ |3|^2 \quad W/m^2$$
$$S = 3{,}393\ W/m^2$$

To convert to mW/cm^2, we multiply the numerator by 1,000 mW/W and the divisor by 10,000 $cm^2/\ m^2$ which gives a value of 339.3 mW/cm^2. The peak pulse power of the WSR-88D is given by the following formula (see Appendix A):

$$U_1 = 1.44 \times 10^9/R^2\ mW/cm^2$$

Inserting R = 2,060 ft gives a value of 339.3 mW/cm^2, which equals the threshold established by PC69:2007 standard. At distances of 2,060 ft or greater, the main beam of the WSR-88D would not adversely affect implantable medical devices. There would also be no hazards to implantable medical devices at locations outside the main beam. Operating at the minimum potential center of beam scan angle of +0.2 deg, the main beam of the KSGF WSR-88D would not illuminate the ground or structures within 2,060 ft of the radar.

Theoretically, persons in aircraft flying within 2,060 ft of the radar could be exposed to RF levels above the device susceptibility threshold set by ANSI/AAMI, but the likelihood of significant harm is extremely low. For persons in aircraft, the airframe would attenuate the RF level and the duration of exposure would be far less than the averaging time (6 to 30 minutes) specified in the RF safety standards, reducing the amount of RF exposure. Additionally, device susceptibility threshold in the PC69:2007 standard is based on coupling of the RFR directly into the device leads (which is the test protocol); the WSR-88D signal would be incident upon the surface of the body and would decrease considerably in strength at the location of the device leads within the body. Third, even in the unlikely event that the WSR-88D RFR couples into the device at levels above the susceptibility threshold, the device would revert to safe mode of operation that would prevent significant harm to the wearer or damage to the device [ANSI/AAMI, 2007].

FCC regulations at 47 CFR Part 95.1221 require that MedRadio medical implant devices and medical body-worn transmitters be able to withstand exposure to RF at the MPEs specified in FCC regulations at 47 CFR 1.1310 (FCC, 2017). As described in Section 4.1 above, RF exposure levels in the vicinity of the KSGF WSR-88D would comply with the FCC safety standards. Exposure of persons wearing implantable medical devices to the KSGF WSR-88D radio emissions would not result in adverse effects.

4.2.6 Astronomical Observatories

The WSR-88D can cause harmful electromagnetic interference (EMI) with charge-couple devices (CCDs) which electronically record data collected by astronomical telescopes (NEXRAD JSPO 1993). The potential for harmful EMI would arise if the WSR-88D's main beam would directly impinge on an astronomical observatory during low angle scanning. Table 4 lists eight astronomical observatories located within 150 miles of the KSGF WSR-88D. The elevation of the KSGF WSR-88D main beam at each observatory was calculated based on a minimum center of beam scan angle of +0.2 deg (i.e., lower half-power point of -0.3 deg) and factors in earth curvature, beam spreading, and terrain blockage. Lowering the minimum scan angle of the WSR-88D to +0.2 deg would not result in the main beam impinging on any of the eight observatories. No adverse effects on astronomical observatories would result.

Table 4: Astronomical Observatories within 150 miles of KSGF WSR-88D

Astronomical Observatories within 150 miles of KSGF WSR-88D				
Observatory	**Location**	**Distance and Direction**	**Elevation (ft MSL)**	**Would WSR-88D main beam impinge at lower scan angle of +0.2 deg?**
Baker (Missouri State University)	Marshfield, MO	23 mi NE	1,390	No, ridge near Bassville, MO, blocks main beam at angle of +0.45 deg
Laws (University of Missouri)	Columbia MO	130 mi NNE	770	No, earth curvature places beam 6,000+ ft above observatory
Morrison (Central Methodist University)	Fayette, MO	134 mi NNE	760	No, earth curvature places beam 7,100+ ft above observatory
Warkoczewski (University of Missouri)	Kansas City, MO	139 mi NNW	930	No, earth curvature places beam 6,200+ ft above observatory

Astronomical Observatories within 150 miles of KSGF WSR-88D				
Wildhaven	Hallsville, MO	138 mi NNE	800	No, earth curvature places beam 7,500+ ft above observatory
Whispering Pines (Arkansas technical University)	Harrison, AR	70 mi S	1,120	No, earth curvature places beam 1,400+ ft above observatory
Powell (Astronomical Society of Kansas City)	Louisburg, KS	118 mi NW	1,070	No, earth curvature places beam 1,400+ ft above observatory
PSU-Greenbush (Pittsburg State University)	Girard, KS	85 mi WNW	990	No, earth curvature places beam 1,600+ ft above observatory

4.2.7 Summary of RF Exposure Effects

Table 5 summarizes impacts to potentially RF-sensitive equipment and activities. The potential for the proposed action to cause radio interference with other radio users would be very low.

Table 5: Potential Effects of KSGF WSR-88D on Equipment and Activities

Equipment / Activity	Applicable Standard	Setback Distance	Would Main Beam Impinge Within Setback Distance?	Potential for Significant Effects
TV, Radio, Cellular Telephone, and Personal Communications Devices (PCDs)	NTIA Frequency Allocations	n/a	n/a	Very Low
EEDs	U.S. Navy HERO Safe/Unsafe	1,622 ft / 5,967 ft	Yes	Very Low
Fuel Handling	U.S. Navy Hazards to Personnel, Fuel, and Other Flammable Material	537 ft	No	Very Low
Active Implantable Medical Devices	AAMI PC69:2007, FCC 47 CFR Part 95.1221	2,060 ft	No	Very Low
Astronomical Observatories	Exposure to WSR-88D Main Beam	n/a	n/a	Very Low

4.3 LAND USE AND COASTAL ZONE MANAGEMENT

Missouri is not a coastal state and does not have a Coastal Zone Management Program (NOAA, 2022). The proposed action would not adversely affect the coastal management zone.

The KSGF WSR-88D is located at Springfield Branson National Airport and nearby land uses are aviation and commercial. The proposed action would not change land uses at the KSGF WSR-88D site or vicinity and would not adversely affect nearby land uses.

4.4 GEOLOGY, SOILS, AND SEISMIC HAZARDS

Springfield is within the Springfield Plateau geophysical province. Bedrock consists of shale, siltstone, sandstone, and limestone marine sedimentary units of Mississippian age (roughly 320 to 360 million years ago) (American Association of Petroleum Geologists, 1986) . Soil is Creldon silt loam on 0 to 3% slope. This soil forms from weathered limestone and is moderately well drained. The depth to the water table is 18 to 36 inches and this soil is not hydric. It is considered prime farmland. The frequency or flooding or ponding is “none” (Natural Resources Conservation Service, 2021).

U.S. Geological Survey (USGS) considers the Springfield area to have a moderate risk of seismic hazards (USGS, 2021). The proposed action would not affect the WSR-88D tower structure or change its seismic risk level.

Lowering the minimum scan angle of the KSGF WSR-88D would not require physical changes to the radar or result in ground disturbance. The proposed action would have no effect on geology, soils, or seismicity. No mitigation measures are required.

4.5 DRAINAGE AND WATER QUALITY

The KSGF WSR-88D site drains northward via roadside drainage swales to Rainer Brook, which is a tributary of Clear Creek and the Sac River. The Sac River flows through Stockton Lake and empties into the Osage River upstream of Harry S. Truman Reservoir. The Osage River is a tributary of the Missouri River (USGS, 1959, 1982, and 2021a through e). Lowering the minimum scan angle of the KSGF WSR-88D would not result in ground disturbance. The proposed action would not affect the amount of impervious surface area at the radar site, the rate of storm runoff flowing from the site during or after precipitation events, or generate water pollutants. The proposed action would have no effect on drainage or water quality. No mitigation measures are required.

4.6 TRANSPORTATION

The KSGF WSR-88D is collocated with the Springfield WFO and is accessed via West Highway EE a two-lane paved public road. The proposed action requires modification of the WSR-88D software to be able to scan at angles below +0.5 deg. To implement the change in scan angle, NWS technicians and engineers would travel to the KSGF WSR-88D site to perform initial testing and ensure that the modified software is operating properly. Travel to the site would be minimal and would not result in significant congestion on local roads. Transportation effects would not be significant. No mitigation measures are required.

4.7 AIR QUALITY

The KSGF WSR-88D is equipped with a standby generator that is used if primary power is interrupted and also periodically for testing. The proposed action would not change the power consumption of the WSR-88D or affect the hours of operation of the standby generator, and no change in air emissions would result. A Clean Air Act Federal Conformity Determination is not required. No mitigation measures are required.

4.8 FLOOD HAZARDS

Executive Order (E.O.) 11988, *Floodplain Management*, requires the Federal Government to avoid adverse impacts to the 100-year or base floodplain (that is, the area subject to a 1 percent annual chance of flooding), unless there is no practicable alternative [President, 1977a]. The KSGF WSR-88D site is not within a special flood hazard or other flood hazard area (FEMA, 2022). The proposed action of lowering the minimum would not affect floodplains or flood hazards. No mitigation measures are required.

4.9 WETLANDS

E.O. 11990, *Protection of Wetlands*, requires the Federal Government avoid funding or implementing projects which would adversely impact wetlands unless there is no practicable alternative [President, 1977b]. Based on National Wetland Inventory maps prepared by the U.S. Fish and Wildlife Service (USFWS), the WSR-88D site does not contain federal jurisdictional wetlands. The nearest wetlands area is a 0.08-acre palustrine emergent persistent temporarily flooded wetland (PEM1A) located about 200 ft north across West Highway EE from the WFO and WSR-88D parcel. Larger palustrine emergent persistent seasonally flooded wetlands (PEM1C) wetlands are located about 600 ft southeast and 900 ft west of the KSGF WSR-88D site. Those wetlands are about 0.5 and 4.5 acres in size, respectively (USFWS, 2021). The proposed action would not result in ground disturbance or changes to drainage and would not affect federal jurisdictional wetlands; no mitigation is required.

4.10 BIOLOGICAL RESOURCES / PROTECTED SPECIES

The USFWS administers the Endangered Species Act (ESA) and Migratory Bird Treaty Act. The KSGF WSR-88D is located within the area served by the USFWS Missouri Fish and Wildlife Office in Columbia, MO. The EA preparers obtained a protected species list from that office (see Appendix B). Four species listed as threatened or endangered and one candidate species for listing potentially occur in the area. The potential for the proposed action to affect each of those species are discussed below:

Three bat species could potentially occur in the area -- gray bat (*Myotis grisecens*), Indiana bat (*Myotis sodalist*), and Northern long-eared bat (*Myotis septentrionalis*). Grey bat and Indiana bat are listed as endangered and the Northern long-eared bat is listed as threatened.

The gray bat is long-eared with light brown to brown fu that is listed as endangered. Historically the gray bat occurred from West Virginia to Florida and west to Oklahoma and Kansas, but the current range is reduced. Gray bats are believed to occur in Greene County. Critical habitat has not been designated for this species. Gray bats hibernate in limestone caves during the winter and migrate up to 300 miles to maternity caves during the March and April. They forage over water along reservoirs and river and summer caves are almost always within one mile of water (USFWS, 2021b). The KSGF WSR-88D site does not contain caves or suitable foraging habitat for gray bats.

Indiana bat is medium-sized grayish chestnut colored migratory bat that ranges widely throughout the eastern, north-central, and south-central U.S. and is listed as endangered. It is believed to occur in Greene County, but the county does not contain critical habitat for the Indiana bat. Indiana bats hibernate in caves and mines, and migrates to wooded areas to raise young. Summer roosts are typically behind exfoliating bark of large, often dead, trees (USFWS, 2021c). The KSGF WSR-88D site does not contain suitable habitat for the Indiana bat.

Northern long-eared bat is medium-sized bat that occurs widely throughout the eastern and north-central U.S. but has declined in population due to white-nose syndrome. It is listed as threatened and is believed to occur in Greene county. Critical habitat has not been designated for this species. Northern long-eared bats hibernate in caves, mines, and culverts and migrate to wooded areas to raise young (USFWS, 2021d). The KSGF WSR-88D site does not contain suitable habitat for the northern long-eared bat.

One freshwater fish species – Ozark Cavefish (*amblyopsis rosae*) is listed as threatened and is believed to occur in Greene County. Critical habitat has not been designated for this species. Ozark cavefish is a small, blind, pinkish-white fish that inhabits water bodies within caves. They are carnivorous and primarily feed on crayfish, salamander eggs, insects, and crustaceans. (USFWS, 2022). The KSGF WSR-88D site does not contain aquatic or cave habitat which could be inhabited by Ozark cavefish.

One species which is a candidate for listing – monarch butterfly (*Danaus plexippus*) – could occur in Greene County. The KSGF WSR-88D site is not within critical habitat for the monarch butterfly. Monarch butterflies are brightly colored and lay eggs on milkweed host plants, and larvae emerge in two to five days and feed on milkweed. Adults live two to five weeks, except when overwintering when they enter suspended reproduction and may live up to nine months. In temperate climates, monarchs seasonally migrate up to 1,800 miles (USFWS, 2021e). The KSGF WSR-88D site does not contain suitable habitat for monarch butterflies.

The proposed action would not include construction activities and would not result in ground disturbance or vegetation removal. The proposed action would not directly affect listed or candidate species or disturb suitable habitat for those species.

Lowering the minimum scan angle to +0.2 deg from the current +0.5 deg would result in a thin sliver of the atmosphere, which is currently below the main beam overage area, being exposed to the main beam of the WSR-88D (see Figure 4). The portion of this atmosphere above the newly exposed sliver of atmosphere is currently within the main beam and RF exposure levels would not change. The sliver of the atmosphere where new main beam coverage would result in increased RF exposure levels would be very small in close proximity to the WSR-88D - 5 ft thick at a distance of 900 ft from the WSR-88D and increasing in thickness with distance from the radar. At 1 mile it would be 28 ft thick and at five miles it would be 138 ft thick. Birds, bats, or insects flying within the newly covered sliver of the atmosphere would be exposed to RF emissions from the WSR-88D. The RF levels in the sliver of airspace would be no greater than in RF levels in the existing covered airspace, which occurs just above the newly exposed air space. At distances of several miles or greater where the volume of newly covered airspace would be substantial, RF levels would be very low. At a distance of 900 ft, RF exposure levels would be 100 times less than safety standards for human exposure. Based on the extremely low RF levels at distance from the WSR-88D, RF exposure of birds, bats, or insects flying within the newly covered airspace would not be harmful.

Increased RF exposure could result if birds, bat, or insects fly in a path that keeps it within the WSR-88D main beam for extended periods of time. However, during normal operation the WSR-88D main beam is continuously moving. At a distance of 1,000 ft the WSR-88D main beam is moving at an effective speed of about 89 miles per hour and it is very unlikely that a bird, bat, or insect could fly within the WSR-88D main beam for any length of time.

The proposed action would not result in significant impacts to protected species, critical habitat, or migratory birds. No mitigation measures are required.

4.11 CULTURAL AND HISTORIC RESOURCES

Section 106 of the National Historic Preservation Act of 1966 (as amended) requires that federal agencies consider the effects of their actions on historic places and, if effects may result, provide the State Historic Preservation Officer (SHPO) with an opportunity to comment on their actions. Section 106 regulations are set forth in 36 CFR Part 800, *Protection of Historic Properties* (Advisory Council on Historic Preservation, 2010).

Because the proposed action would not involve ground disturbance, no impacts to archaeological or paleontological resources would result. The proposed action's area of potential effect (APE) is defined as area within 1,740 ft of the KSGF WSR-88Ds where RF exposure of persons within the WSR-88D main beam could potentially exceed safety levels (see Appendix A). The Missouri Historic Districts and Sites Map Viewer was searched for historic places in the vicinity of the KSGF WSR-88D. No historic places occur within the APE (Missouri Department of Natural

Resources, 2022). Under Section 106 Regulations 36 CFR Section 800.2 (a)(1), *Protection of Historic Properties*, if the proposed action doesn't have the potential to affect historic properties, NWS "has no further obligations under section 106" and consultation with the Missouri SHPO regarding possible impacts on historic properties is not required [Advisory Council on Historic Preservation, 2010].

4.12 ENVIRONMENTAL JUSTICE AND SOCIOECONOMIC IMPACTS

E.O. 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires federal agencies to identify and address, as appropriate, disproportionately high and adverse environmental or human health effects on minority populations and low income populations (President, 1994).

The KSGF WSR-88D is located at Springfield Branson National Airport in Greene County, MO. Nearby lands are used for aviation, commercial, agricultural, and government purposes. The nearest residences are located about 0.5 mile west and south of the radar. The proposed action would not generate air or water pollutants or hazardous waste. The project would modify the operation of the KSGF WSR-88D by reducing the minimum scan angle from +0.5 deg to +0.2 deg. The lowered WSR-88D main beam would not impinge on the ground in proximity to the radar and would comply with safety standards for human exposure to RF energy and setbacks for activities (e.g., fuel handling and EED use) that are potentially sensitive to RF exposure. No disproportionately high and adverse effects would result to any persons, including minority or low income populations. No mitigation is required.

4.13 FARMLANDS

The Farmland Protection Policy Act sets forth federal policies to prevent the unnecessary conversion of agricultural land to non-agricultural use. NRCS regulations at 7 CFR Part 658, *Farmland Protection Policy Act*, are designed to implement those policies. Completion of Form AD-1006 and submission to the U.S. Department of Agriculture (DoA) is required if a federal agency proposes to convert land designated as prime farmland, farmland of statewide importance, or unique farmland to non-agricultural use. Soil at the KSGF WSR-88D site is classified as prime farmland (NRCS, 2021). However, the WSR-88D site and adjoining properties are committed to non-agricultural uses. The proposed action would not convert farmland to non-farm use. No mitigation is necessary.

4.14 ENERGY CONSUMPTION

The proposed action would not change electric use by the WSR-88D and would have no effect on energy consumption. No mitigation is necessary.

4.15 VISUAL QUALITY/ LIGHT EMISSIONS

The proposed action would not change the appearance of the KSGF WSR-88D or result in new emissions of visible light. The proposed action would have no effect on visual quality. No mitigation is necessary.

4.16 SOLID AND HAZARDOUS WASTE

The proposed action would result in no changes to solid or hazardous waste generation. No mitigation is necessary.

4.17 WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act of 1968 protects free-flowing rivers of the U.S. These rivers are protected under the Act by prohibiting water resource projects from adversely impacting values of the river: protecting outstanding scenic, geologic, fish and wildlife, historic, cultural, or recreational values; maintaining water quality; and implementing river management plans for these specific rivers. The wild and scenic rivers closest to the KSGF WSR-88D are the Eleven Point River, about 100 mile east-southeast in Mark Twain National Forest; North Sylamore Creek, about 100 miles southeast in Ozark National Forest; and Big Piney River, about 50 miles to the south in Ozark National Forest (National Park Service, 2021). The proposed action would not affect any of these wild and scenic rivers. No mitigation is necessary.

5 ALTERNATIVES TO THE PROPOSED ACTION

5.1 MINIMUM SCAN ANGLES BETWEEN +0.4 AND +0.2 DEG

NWS evaluated the benefits and potential impacts of lowering the minimum center of beam scan angle of the KSGF WSR-88D to each angle between +0.4 and +0.2 deg in 0.1 degree increments (see Appendix C). That analysis found that the proposed action of lowering the minimum scan angle to +0.2 deg would result in the significant improvement in radar coverage.

A minimum scan angle of +0.4 or +0.3 deg would increase the radar's coverage area, but by less than the proposed action (i.e., minimum scan angle of +0.2) deg. A minimum scan angle lower than +0.2 deg would not increase coverage area and would have the drawback of increasing ground clutter returns.

Because a minimum scan angle of +0.2 deg would result in significant improvement in radar coverage area while avoiding significant environmental impacts, NWS selected +0.2 deg as the proposed minimum scan angle for the KSGF WSR-88D.

5.2 NO ACTION

The no action alternative consists of continued operation of the KSGF WSR-88D at the existing minimum scan angle of +0.5 deg. The improvements in radar coverage summarized in Section 3 would not be achieved and the project objectives would not be met.

The proposed action would result in increased RF exposure compared to existing WSR-88D operations as described in section 4.1; the no-action alternative would not change RF exposure levels from existing. Under both the proposed action and the no action alternative, RF exposure during normal WSR-88D operations would conform to safety standards established by ANSI/IEEE, OSHA, and FCC.

Similar to the proposed action, the no-action alternative would not result in adverse effects in the following topic areas:

- Land Use and Coastal Zone Management
- Geology, Soils, and Seismic Hazards
- Drainage and Water Quality
- Transportation
- Air Quality
- Flood Hazards
- Wetlands
- Biological Resources / Protected Species
- Cultural and Historic Resources
- Environmental Justice and Socioeconomic Impacts
- Farmlands

- Energy Consumption
- Visual Quality/ Light Emissions
- Solid and Hazardous Waste
- Wild and Scenic Rivers

6 FINDING

The proposed action of lowering the scan angle of the KSGF WSR-88D from the current minimum of +0.5 deg to +0.2 deg would not result in significant changes in the quality of the human environment. Lowering the minimum scan angle would also not add to the environmental effects of past, present, and reasonably foreseeable future actions to cause cumulatively significant effects

The proposed action would improve the quality of meteorological radar data available to NWS forecasters and others users of the data. This may indirectly benefit the residents and businesses of the Springfield, MO, WFO service area (southern and central Missouri, northwestern Arkansas, northeastern Oklahoma, and southeastern Kansas) by improving the accuracy of forecast and severe weather alerts, which could result in environmental benefits if weather dependent economic activities (e.g., agriculture, construction, outdoor recreation, transportation, water management) become more efficient or safer as a result of improved weather services. The resulting environmental benefits are difficult to quantify, but are unlikely to be significant.

Implementation of the proposed action would not have the potential to cause significant changes in the environmental. A Finding of No Significant Impact is warranted for the proposed action.

7 DOCUMENT PREPARERS

This Draft EA was prepared by Sensor Environmental LLC under contract to Centuria Corporation. Centuria Corporation provides support to the NWS Radar Operations Center (ROC) in Norman, OK.

Mr. James Manitakos, CEO, served as Sensor's Project Manager. Alion Science and Technology Corporation prepared radar coverage maps and calculated coverage areas under subcontract to Sensor. Mr. Andre Tarpinian, Radio Frequency Engineer, served as Alion's Project Manager. Ms. Jessica Schultz, Deputy Director of the NWS Radar Operations Center, and Mr. William Deringer, Acting Program Manager, from the ROC assisted in preparation of this EA. Mr. Kelsey Angle, Meteorologist-in-Charge, and staff from the Springfield, MO, WFO, also assisted in preparation of this EA.

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Environmental Assessment Report

ENVIRONMENTAL ASSESSMENT (EA)

LOWERING THE MINIMUM SCAN ANGLE OF THE WEATHER SURVEILLANCE RADAR - MODEL 1988, DOPPLER (WSR-88D) SERVING THE SPRINGFIELD, MISSOURI, AREA

APPENDICES

APPENDIX A

RADIOFREQUENCY RADIATION POWER DENSITY CALCULATIONS

1. OBJECTIVE

This appendix quantifies the power densities of the radiofrequency radiation (RFR) emitted by the Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) during operations that include minimum scan angles of +0.5 to +0.2 degrees (deg). The calculated power densities will be used to analyze the potential for effects to result from exposure of humans, equipment, and activities to the WSR-88D radio signal, and the significance of any identified potential effects.

2. METHODOLOGY

This memorandum builds upon the analysis included in the 1993 *Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* [NEXRAD Joint System program Office, 1993]. The 1993 analysis analyzed the potential electromagnetic effects of the WSR-88D signal when the radar operates at a minimum center of beam scan angle of +0.5 deg. This memorandum builds on that analysis by considering operation at a lower minimum scan angle of +0.2 deg. The parameters of the WSR-88D are shown in Table A-1 and are not changed from the 1993 analysis:

TABLE A-1: Operating Characteristics of WSR-88D serving the Pendleton, OR area (KSGF)	
Parameter	**Value**
Operating Frequency	2,865 megahertz (MHz)
Wavelength at system center frequency (2,850 MHz)	0.331 ft, 10.1 cm
Maximum pulse power	475 kiloWatts (kW)
Maximum duty cycle	0.21%
Antenna diameter	28 ft, 853 cm
Antenna gain	35,500:1, 45.5 dB
Beam width to half-power points	1.0 deg
First sidelobe relative power density, maximum	0.00325, -25 dB
Other sidelobe maximum power density, relative to main beam	0.0004, -34 dB

The NWS proposes to modify the minimum center of beam scan angle used during operation of the KSGF WSR-88D below the +0.5 angle currently used. This would not require changes to the antenna, other hardware which composes the WSR-88D, or the radiated pulse power of the WSR-88D. However, incorporating scans at angles below +0.5 deg could affect the amount of RFR exposure experienced by persons, equipment, and activities at or near ground level in the vicinity of the radar. This memorandum quantifies that change.

3. MODIFIED VOLUME SCAN PATTERN 31

The WSR-88D uses a number of complex volume scan patterns to maximize the quality and usefulness of the meteorological data it collects. The 1993 report analyzed volume scan pattern 31, which results in the highest levels of ground-level RFR exposure. Volume Scan Pattern

(VCP) 31 consists of eight 360 deg rotations of the antenna at various scan angles. NWS proposed to add two additional antenna rotations at a scan angle of +0.2 deg to this scan pattern to increase the range at which the radar can detect and track meteorological phenomena, especially at low elevations within the atmosphere. This memorandum assumes that the two added scans would be at +0.2 deg (i.e., lower half power point of -0.3 deg. Adding two +0.2 degree scans would result in the greatest possible increase in ground level RFR exposure. The modified VCP 31 would be as follows:

- Two complete rotations at +0.2 deg
- Two complete rotations at +0.5 deg
- Two complete rotations at +1.5 deg
- Two complete rotations at +2.5 deg
- One complete rotation at +3.5 deg
- One complete rotation at +4.5 deg

The complete pattern would include 10 rotations of the antenna at a speed of 0.8 revolutions per minute (rpm), the pattern would take about 12 minutes and 22 seconds to complete [Turner, 2011].

4. CALCULATION OF RF POWER DENSITIES

Appendix A of the 1993 SEA includes detailed calculations of the RFR power density and exposure levels resulting from volume scan pattern 31. The proposed scan change would not affect the distance of the transition from the near field to the far field, calculated at 640 to 800 ft in section A.3 of the 1993 Appendix A.

4.1 Far Field

The values of U_1, U_2, and U_3 would be unchanged from the values derived in 1993 Appendix A. The maximum pulse power density within the main beam (U_1) is given by the formula:

$$U_1 = 1.44 \times 10^9/R^2 \text{ milliWatts per square centimeter (mW/cm}^2\text{)}$$

where R is the distance from the antenna in ft. The maximum pulse power density at locations greater than 6 deg off the main beam axis (i.e., outside the area illuminated by the main beam and first five sidelobes is U_2 (unchanged from 1993 Appendix A), given below:

$$U_2 = 5.76 \times 10^5/R^2 \text{ mW/cm}^2$$

The RF human exposure standards are based on time-averaged RF exposure for six minutes (occupational exposure) or 30 minutes (general public exposure) [American National Standards Institute/Institute of Electrical and Electronic Engineers, 2005]. We use six minutes as the averaging time as a worst-case analysis. The time-averaged power density for the main beam rotating continuously at +0.5 deg, considering the contributions from both the main beam and the first five sidelobes is given by U_3 (unchanged from 1993 Appendix A), below:

$$U_3 = 1.35 \times 10^4/R^2 \text{ mW/cm}^2$$

At this point the analysis must consider the proposed modifications to VCP 31. The modified VCP 31 would have two additional +0.2 deg scans. Within our six minute averaging time, these two added scans would replace the RFR contribution from one +1.5 deg and one +2.5 deg scan. As described in the 1993 appendix, U_4 sums the RFR contributions at center of antenna level from each of the scans performed during the six minute period of interest. The coefficients for the +0.2 deg scans are 2.4/6 reflecting the proportion of the 6 minutes and 1.0 because the center of beam will essentially be at antenna level (i.e., +0.2 deg which equates to 2.8 ft, or one-tenth of the beam width at the far field transition distance of 800 ft). The corresponding coefficients for the two +0.5 deg scans within the six minutes are 2.4/6 and 0.5, and for the one +1.5 deg scan within the six minutes are 1.2/6 and 0.012. The modified U_4 calculation is given below

$$U_4 = [(2.4/6)\ (1.0) + (2.4/6)\ (0.5) + (1.2/6)\ (0.012)]\ U_3$$

$$U_4 = (0.602)U_3$$

Inserting the U_3 value of $1.35 \times 10^4/R^2$ milliwatts/cm^2 (mw/ cm^2), yields:

$$U_4 = 8.13 \times 10^3/R^2 \quad mW/cm^2$$

U_4 is the 6-minute time-averaged power density at locations in the far field directly illuminated by the main beam and at the same elevation as the WSR-88D antenna, considering the RFR contributed from the main beam and the first five sidelobes. According to the WSR-88D specification, sidelobes of higher order than the first five will contain less than 5% of the eradiated energy. The 1993 SEA calculated the average power density of these higher order sidelobes at $4/R^2$ mW/cm^2. We add this to U_4 to obtain U_5, the total time-averaged power density at an elevation even with the center of antenna elevation and distances greater than 800 ft from the antenna:

$$U_5 = 8.13 \times 10^3/R^2 + 4/R^2 = 8.134 \times 10^3/R^2 \quad mW/cm^2$$

4.2 Near Field

Appendix A of the 1993 SEA calculates the height Y of the mathematical cylinder illuminated by all scans during the six-minute period using the formula Y = 28 + R Tan (2 deg) + 0.035R . Since the modified scan pattern of interest includes scans of +0.2. +0.5, and +1.5 degs, the angular range is 1.3 deg, and we recalculate Y as follows:

$$Y = 28 + R \times \text{Tan}\ (1.3\ \text{deg}) = 28 + 0.023R$$

The circumference of the illumination cylinder is 2πRY and the total area A is

$$A = 2\pi RY = 176R + 0.14R^2$$

The average power radiated is less than or equal to 1 kW, and the average power over the cylindrical surface cannot exceed this value divided by the area. At the mid-height of the cylinder, the local power density will exceed the average value by a factor of 2 (unchanged from the 1993 analysis). We introduce this factor, multiply by 10^6 to convert from kW to mW, and divide by 929 to convert from sq ft to square centimeters (sq cm):

$$U_6 = 2 * 10^6 / (929) (176R + 0.14R^2) = 15,378 / (R^2 + 1,257 R) \text{ mW/cm}^2$$

U_6 is the time-averaged RFR exposure within the area illuminated by the WSR-88D main beam up to distances of 640 ft where the beam begins to spread.

4.3 RF Exposure Levels near KSGF WSR-88D

Table A-2 shows the time-averaged RF power densities that would result at locations directly illuminated by the main beam of the KSGF WSR-88D when operating in modified VCP 31. The near field is within 640 ft of the radar and the U_6 formula is used to calculate these near field values. At greater distances, the far field formula for U_5 is used. For comparison purposes, corresponding values for the original VCP 31 are also shown. As can be seen from Table A-1, use of modified scan pattern 31 would lower the elevation at which the main beam occurs and would also slightly increase the time-averaged power densities in both the near and far fields.

Table A-2: Comparison of RF Power Densities within the WSR-88D Directly Illuminated Area Using VCP 31 and Modified VCP 31

Place	Distance (ft)	Original VCP 31 Lowest Elev (ft MSL)	Original VCP 31 Time-Avg Power Density (mW/cm2)	Modified VCP 31 Lowest Elev (ft MSL)	Modified VCP 31 Time-Avg Power Density (mW/cm^2)
Surface of Radome	20	1,346*	0.598	n/a	0.602
Airport Traffic Control Tower	3,300 ft NE	1,346	0.00053	1,329	0.00075
Closest Illuminated Ground	10,500 ft ESE	1,346	0.000053	1,289	0.000074
5 miles	26,400	1,346	0.000008	1,196	0.000012

*****Elevation of bottom edge of KSGF WSR-88D antenna

NWS may infrequently operate the KSGF WSR-88D with a stationary antenna, resulting in the main beam being continuously pointed at the same location for a period of time. The RF exposure level within the main beam can be calculated using equation U_1 multiplied by the radar duty cycle

$$U_7 = (1.44 \times 10^9/R^2)\ 0.0021 = 3.024 \times 10^6/R^2 \qquad (\text{mW/cm}^2)$$

When operating in stationary antenna mode, the KSGF WSR-88D would exceed the American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) and Federal Communications Commission (FCC safety levels within the following distances:

- ANSI/IEEE and FCC General Public Safety Level (1.0 mW/cm^2): 1,740 ft
- ANSI/IEEE and FCC Occupational Safety Level (5.0 mW/cm^2): 777 ft

5. REFERENCES

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APPENDIX B

PROTECTED SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Missouri Ecological Services Field Office
101 Park Deville Drive
Suite A
Columbia, MO 65203-0057
Phone: (573) 234-2132 Fax: (573) 234-2181

In Reply Refer To: November 17, 2021
Consultation Code: 03E14000-2022-SLI-0303
Event Code: 03E14000-2022-E-00901
Project Name: KSGF WSR-88D Lower Scan Angle

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

This response has been generated by the Information, Planning, and Conservation (IPaC) system to provide information on natural resources that could be affected by your project. The U.S. Fish and Wildlife Service (Service) provides this response under the authority of the Endangered Species Act of 1973 (16 U.S.C. 1531-1543), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d), the Migratory Bird Treaty Act (16 U.S.C. 703-712), and the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

Threatened and Endangered Species

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and may be affected by your proposed project. The species list fulfills the requirement for obtaining a Technical Assistance Letter from the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. N**ote that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days.** The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

Consultation Technical Assistance

Refer to the Midwest Region S7 Technical Assistance website for step-by-step instructions for making species determinations and for specific guidance on the following types of projects: projects in developed areas, HUD, pipelines, buried utilities, telecommunications, and requests for a Conditional Letter of Map Revision (CLOMR) from FEMA.

Federally Listed Bat Species

Indiana bats, gray bats, and northern long-eared bats occur throughout Missouri and the information below may help in determining if your project may affect these species.

Gray bats - Gray bats roost in caves or mines year-round and use water features and forested riparian corridors for foraging and travel. If your project will impact caves, mines, associated riparian areas, or will involve tree removal around these features – particularly within stream corridors, riparian areas, or associated upland woodlots –gray bats could be affected.

Indiana and northern long-eared bats - These species hibernate in caves or mines only during the winter. In Missouri the hibernation season is considered to be November 1 to March 31. During the active season in Missouri (April 1 to October 31) they roost in forest and woodland habitats. Suitable summer habitat for Indiana bats and northern long-eared bats consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts (i.e., live trees and/or snags ≥5 inches diameter at breast height (dbh) for Indiana bat, and ≥3 inches dbh for northern long-eared bat, that have exfoliating bark, cracks, crevices, and/or hollows), as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Tree species often include, but are not limited to, shellbark or shagbark hickory, white oak, cottonwood, and maple. Individual trees may be considered suitable habitat when they exhibit the characteristics of a potential roost tree and are located within 1,000 feet (305 meters) of other forested/wooded habitat. Northern long-eared bats have also been observed roosting in human-made structures, such as buildings, barns, bridges, and bat houses; therefore, these structures should also be considered potential summer habitat and evaluated for use by bats. If your project will impact caves or mines or will involve clearing forest or woodland habitat containing suitable roosting habitat, Indiana bats or northern long-eared bats could be affected.

Examples of unsuitable habitat include:

- Individual trees that are greater than 1,000 feet from forested or wooded areas;
- Trees found in highly-developed urban areas (e.g., street trees, downtown areas);
- A pure stand of less than 3-inch dbh trees that are not mixed with larger trees; and
- A stand of eastern red cedar shrubby vegetation with no potential roost trees.

Using the IPaC Official Species List to Make No Effect and May Affect Determinations for Listed Species

1. If IPaC returns a result of "There are no listed species found within the vicinity of the project," then project proponents can conclude the proposed activities will have **no effect** on any federally listed species under Service jurisdiction. Concurrence from the Service is not required for **No Effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records. An example "No Effect" document also can be found on the S7 Technical Assistance website.

2. If IPaC returns one or more federally listed, proposed, or candidate species as potentially present in the action area of the proposed project – other than bats (see #3 below) – then project proponents can conclude the proposed activities **may affect** those species. For assistance in determining if suitable habitat for listed, candidate, or proposed species occurs within your project area or if species may be affected by project activities, you can obtain Life History Information for Listed and Candidate Species through the S7 Technical Assistance website.

3. If IPac returns a result that one or more federally listed bat species (Indiana bat, northern long-eared bat, or gray bat) are potentially present in the action area of the proposed project, project proponents can conclude the proposed activities **may affect** these bat species **IF** one or more of the following activities are proposed:

a. Clearing or disturbing suitable roosting habitat, as defined above, at any time of year;
b. Any activity in or near the entrance to a cave or mine;
c. Mining, deep excavation, or underground work within 0.25 miles of a cave or mine;
d. Construction of one or more wind turbines; or
e. Demolition or reconstruction of human-made structures that are known to be used by bats based on observations of roosting bats, bats emerging at dusk, or guano deposits or stains.

If none of the above activities are proposed, project proponents can conclude the proposed activities will have **no effect** on listed bat species. Concurrence from the Service is not required for **No Effect** determinations. No further consultation or coordination is required. Attach this letter to the dated IPaC species list report for your records. An example "No Effect" document also can be found on the S7 Technical Assistance website.

If any of the above activities are proposed in areas where one or more bat species may be present, project proponents can conclude the proposed activities **may affect** one or more bat species. We recommend coordinating with the Service as early as possible during project planning. If your project will involve removal of over 5 acres of suitable forest or woodland habitat, we recommend you complete a Summer Habitat Assessment prior to contacting our office to expedite the consultation process. The Summer Habitat Assessment Form is available in Appendix A of the most recent version of the Range-wide Indiana Bat Summer Survey Guidelines.

Other Trust Resources and Activities

Bald and Golden Eagles - Although the bald eagle has been removed from the endangered species list, this species and the golden eagle are protected by the Bald and Golden Eagle Act and the Migratory Bird Treaty Act. Should bald or golden eagles occur within or near the project area please contact our office for further coordination. For communication and wind energy projects, please refer to additional guidelines below.

Migratory Birds - The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests, except when specifically authorized by the Service. The Service has the responsibility under the MBTA to proactively prevent the mortality of migratory birds whenever possible and we encourage implementation of recommendations that minimize potential impacts to migratory birds. Such measures include clearing forested habitat outside the nesting season (generally March 1 to August 31) or conducting nest surveys prior to clearing to avoid injury to eggs or nestlings.

Communication Towers - Construction of new communications towers (including radio, television, cellular, and microwave) creates a potentially significant impact on migratory birds, especially some 350 species of night-migrating birds. However, the Service has developed voluntary guidelines for minimizing impacts.

Transmission Lines - Migratory birds, especially large species with long wingspans, heavy bodies, and poor maneuverability can also collide with power lines. In addition, mortality can occur when birds, particularly hawks, eagles, kites, falcons, and owls, attempt to perch on uninsulated or unguarded power poles. To minimize these risks, please refer to guidelines developed by the Avian Power Line Interaction Committee and the Service. Implementation of these measures is especially important along sections of lines adjacent to wetlands or other areas that support large numbers of raptors and migratory birds.

Wind Energy - To minimize impacts to migratory birds and bats, wind energy projects should follow the Service's Wind Energy Guidelines. In addition, please refer to the Service's Eagle Conservation Plan Guidance, which provides guidance for conserving bald and golden eagles in the course of siting, constructing, and operating wind energy facilities.

Next Steps

Should you determine that project activities **may affect** any federally listed species or trust resources described herein, please contact our office for further coordination. Letters with requests for consultation or correspondence about your project should include the Consultation Tracking Number in the header. Electronic submission is preferred.

If you have not already done so, please contact the Missouri Department of Conservation (Policy Coordination, P. O. Box 180, Jefferson City, MO 65102) for information concerning Missouri Natural Communities and Species of Conservation Concern.

We appreciate your concern for threatened and endangered species. Please feel free to contact our office with questions or for additional information.

Karen Herrington

Attachment(s):

- Official Species List

- USFWS National Wildlife Refuges and Fish Hatcheries
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

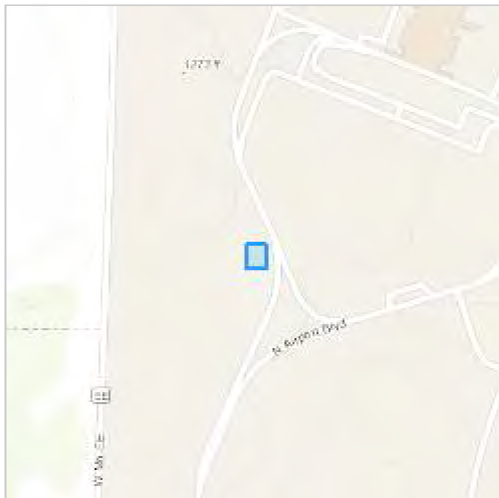
This species list is provided by:

Missouri Ecological Services Field Office
101 Park Deville Drive
Suite A
Columbia, MO 65203-0057
(573) 234-2132

Project Summary

Consultation Code: 03E14000-2022-SLI-0303
Event Code: Some(03E14000-2022-E-00901)
Project Name: KSGF WSR-88D Lower Scan Angle
Project Type: COMMUNICATIONS TOWER
Project Description: Lowering the minimum scan angle of the KSGF WSR-88D. No construction or ground disturbance would result.
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@37.235254,-93.40043211215846,14z



Counties: Greene County, Missouri

Endangered Species Act Species

There is a total of 5 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6329	Endangered
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5949 General project design guidelines: https://ecos.fws.gov/ipac/project/JKFJF6NHXJGTXD7VQ4CDLBE4UM/documents/generated/6868.pdf	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045 General project design guidelines: https://ecos.fws.gov/ipac/project/JKFJF6NHXJGTXD7VQ4CDLBE4UM/documents/generated/6868.pdf	Threatened

Fishes

NAME	STATUS
Ozark Cavefish *Amblyopsis rosae* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6490	Threatened

Insects

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

WETLAND INFORMATION WAS NOT AVAILABLE WHEN THIS SPECIES LIST WAS GENERATED. PLEASE VISIT HTTPS://WWW.FWS.GOV/WETLANDS/DATA/MAPPER.HTML OR CONTACT THE FIELD OFFICE FOR FURTHER INFORMATION.

APPENDIX C

TECHNICAL MEMORANDUM AND TRIP REPORT

SENSOR ENVIRONMENTAL LLC
www.sensorenvirollc.com

TECHNICAL MEMORANDUM

TO: Edward Ciardi, Program Manager, EVP Weather Systems, Centuria Corporation	**FROM:** James Manitakos, CEO, Sensor Environmental LLC
CC: Jessica Schultz, Deputy Director, National Weather Service Radar Operations center Andre Tarpinian, Senior RF Engineer, Alion Science and Technology Corp.	**SUBJECT:** Analysis of Lower Scan Angles for Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) Serving Springfield, MO, Area
DATE: December 23, 2021	

1. BACKGROUND AND NEED

The National Weather Service (NWS) proposes to reduce the minimum vertical scan angles used during normal operation of the WSR-88D serving Springfield, MO, area. Information on this radar is shown in Table 1. This WSR-88D was commissioned in September 1995 and has been in operation at its current location since 1995.

TABLE 1: Information on WSR-88D Serving the Springfield, MO, Area	
Location	Springfield-Branson National Airport, Springfield, Greene County, MO
Commissioning Date	September 14, 1995
International Civil Aviation Organization designator	KSGF
Elevation, ground surface at tower base (mean sea level, MSL)	1,262 feet (ft)
Elevation, center of antenna (MSL)	1,360 ft
Tower Height (m)	25 m (82 ft)
Latitude (WGS84)	37˚14’07” N
Longitude (WGS84)	93˚24’02” W
Weather Forecast Office (WFO)	Springfield-Branson National Airport 5805 West Highway EE Springfield, MO 65802-8430
Meteorologist-in-Charge (MIC)	Kelsey Angle Email: Kelsey.angle@noaa.gov Tel. (316)841-6371
Operating Frequency	2,865 megaHertz (MHz)
Spot Blanking or Sector Blanking used	No

NWS currently operates the KSGF WSR-88D at a minimum center-of-beam scan angle of + 0.5 degree (deg). The WSR-88D main beam has a width of 1 deg to the half power points. Half of the beam (i.e., 0.5 deg) is below the axis, resulting in an essentially horizontal floor for existing radar coverage. As a result, the WSR-88D cannot provide radar coverage of the atmosphere below the elevation of the WSR-88D antenna. At considerable distance from the radar, earth curvature increases the height above the ground surface of the uncovered area. To increase the amount of radar coverage provided by the KSGF WSR-88D, NWS proposes to operate the radar with a center-of-beam scan angle as low -0.2 deg, which would result in the lower half power point of the main beam at -0.7 deg.

2. INVESTIGATIONS PERFORMED

To analyze the benefits and potential impacts of lowering the minimum scan angle of the KSGF WSR-88D, Sensor Environmental LLC and our subcontractor Alion Science and Technology Corporation performed the following tasks:

1. We visited the KSGF WSR-88D with NWS staff from the Springfield, MO, Weather Forecast Office (WFO) to ascertain site conditions and activities in the vicinity (see Attachment A, Trip Report).
2. We obtained 360-degree calibrated panoramic photograph taken at 20-m level of the KSGF WSR-88D tower, which is about 30 ft lower than the center of antenna height.
3. We prepared maps showing the extent of WSR-88D coverage at 2,000 ft above site level for each (center of beam) scan angle from the current minimum of +0.5 degree to -0.2 degree.
4. We identified areas of terrain and activities that are potentially sensitive to radiofrequency (RF) radiation exposure in proximity to the WSR-88D that would be directly illuminated by the main beam at each lower scan angle under consideration.

3. WSR-88D COVERAGE

The Project team used Alion Integrated Target Acquisition System (ITAS) terrain-based computer model with GIS-based interface to project the terrain-dependent radar coverage for the KSGF WSR-88D at 2,000 ft above site level (ASL). The radar coverages shown in Attachment B are based on Digital Terrain Elevation Data (DTED) Level 2 topographic data and 4/3 earth radius to account for atmospheric refraction of the WSR-88D main beam. The lower half-power point of the unobstructed WSR-88D main beam is considered the minimum elevation of WSR-88D coverage. Table 2 shows KSGF WSR-88D coverage areas at 2,000 ft above site level (ASL) for the range of minimum scan angles under consideration by NWS.

TABLE 2: KSGF WSR-88D Radar Coverage Areas for Minimum Scan Angles				
Coverage Altitude (ft ASL)	**Minimum Center of Beam Scan Angle (deg)**	**Lower Half-power Point (deg)**	**Area in Lambert Projection (sq mi)**	**Change from Existing Minimum Scan Angle**
2,000	+0.5 (existing)	0.0	10,665	n/a
	+0.4	-0.1	13,552	+27.1%
	+0.3	-0.2	15,248	+43.0%
	+0.2	-0.3	15,642	+46.7%
	+0.1, 0.0, -0.1, -0.2	-0.4 or lower	15,462	+46.7%

KSGF WSR-88D is located on nearly level ground at Springfield-Branson National Airport in Springfield, Greene County, Missouri. When operating at the current minimum center of beam minimum scan angle of +0.5 deg, the KSGF WSR-88D is not subject to terrain blockage except for minor blockage due east (E). (see Attachment B). At a minimum scan angle of +0.4 deg, radar coverage would improve in all directions except due E. At a minimum scan angle of +0.3 deg, coverage would increase to the southeast (SE) through south (S) and southwest (SW) through northeast (NE) . At a minimum scan angle of +0.2, additional improvements in coverage would occur to the northwest (NW) through north (N). No additional improvement would result at minimum scan angles below +0.2 deg.

4. HUMAN EXPOSURE AND POTENTIALLY RF-SENSITIVE ACTIVITIES

Exposure to radiofrequency (RF) radiation can potentially be harmful to humans and RF-sensitive activities. Table 3 presents the safe setback distances from the WSR-88D for human exposure, implantable medical devices, fuel handling, and EEDs (Sensor Environmental LLC, 2011). Safety standards for implantable medical devices, fuel handling, and EEDs are based on instantaneous exposure. Safety standards for human exposure are based on time-averaged exposure; therefore, exposure during both rotating antenna and stationary antenna operations are considered.

<table>
<tr><th colspan="4">TABLE 3: Safe Setback Distances For Human Exposure And Potentially RF-Sensitive Activities Directly Illuminated By The WSR-88D Main Beam</th></tr>
<tr><th>Activity</th><th colspan="2">Safe Setback Distance (ft)</th><th>Source</th></tr>
<tr><td rowspan="2">Human Exposure</td><td>Rotating Antenna</td><td>20</td><td rowspan="2">American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)</td></tr>
<tr><td>Stationary Antenna</td><td>1,740</td></tr>
<tr><td>Implantable Medical devices</td><td colspan="2">2,060</td><td>ANSI/Association for the Advancement of Medical Instrumentation (AAMI)</td></tr>
<tr><td>EEDs (Safe/Unsafe)</td><td colspan="2">1,622 / 5,967</td><td>Naval Sea Systems Command</td></tr>
<tr><td>Fuel Handling</td><td colspan="2">537</td><td>Naval Sea Systems Command</td></tr>
</table>

5. DIRECTLY ILLUMINATED TERRAIN AND STRUCTURES

The safe setback distances from the WSR-88D for human exposure, implantable medical devices, fuel handling, and electro-explosive devices (EEDs), are given in section 4 of this memorandum. The greatest safe setback distance for human exposure or any of these activities for exposure of EEDs, which include blasting caps, some types of ordnance, and equipment used in aviation systems (e.g., ejection seats and separation systems for air-launched missiles). Hazard of Radiation to Ordnance (HERO) regulations characterize EEDs as either unsafe or safe with differing setback distances. HERO unsafe or unreliable EEDs have not been evaluated for compliance with MILSTD 664 or are being assembled, dissembled, or subject to unauthorized conditions, which can increase its sensitivity to RF emissions. HERO safe EEDs have been evaluated for compliance with MILSTD 664 and are not being assembled or dissembled (Naval Sea Systems command, 2008). Based on the U.S. Navy HERO regulations, the safety setback distances for HERO safe and unsafe EED, respectively are 1,622 ft and 5,967 ft, respectively. U.S. Air Force safety regulations consider a 900 ft setback distance from radars such as the WSR-88D safe for all types of blasting caps (U.S. Air Force, 1982).

Attachment C contains maps showing terrain directly illuminated by the KSGF WSR-88D main beam at minimum center of beam scan angles of +0.5 seg (current operation) through -0.2 deg. At the current minimum scan angle of +0.5 deg or lower minimum scan angles of +0.4 or +0.3 deg, the WSR-88D main beam does not impinge on the ground within 3 miles (the closest illuminated ground for +0.3 deg scan angle is 17,000 ft or 3.2 miles to the E. At a minimum scan angle of +0.2 deg, the nearest terrain that would be illuminated is about 10,500 ft or 2 miles to the east-southeast (ESE). More distant terrain to E, NE, and SE would also be directly illuminated. At minimum scan angles of +0.1 deg or less, additional terrain in all directions would be directly illuminated. The terrain directly illuminated terrain at a minimum scan angle of +0.2 deg would be outside the safe setback distance for human exposure, implantable medical devices, HERO unsafe and safe EEDs, and fuel handling.

Photographs 2A through 2D in Attachment A Trip Report are panoramic photographs taken from the 25-m level of the KSGF WSR-88D tower and show a 360 deg view of the horizon. As shown in Photograph 2a, the Springfield-Branson National Airport Traffic Control Tower (ATCT), 3,300 ft NE of the KSGF WSR-88D, is slightly below the 0.0 deg horizon. The ATCT would be illuminated by sidelobes of the WSR-88D main beam operating at +0.2 deg scan angle, but is farther from the radar than the safe setback distances for human exposure and all activities except HERO unsafe EEDs, which are extremely unlikely to be in use at the upper portions of the ATCT. As shown in Photograph 2B, the exhaust stacks of the John Twitty Energy Center are currently illuminated by the WSR-88D main beam and would continue to be illuminated at lower scan angles. The energy center is 5.9 miles south of the KSGF WSR-88D, which exceeds all safe setback distances for human exposure and potentially RF-sensitive activities. No hazards to humans or potentially RF-sensitive activities would result from lowering the KSGF WSR-88D minimum scan angle to +0.2 deg.

6. ASTRONOMICAL OBSERVATORIES

The WSR-88D can potentially cause adverse electromagnetic interference (EMI) with charge-couple devices (CCDs) which electronically record data collected by astronomical telescopes (NEXRAD JSPO), 1993). Due to the sensitivity of astronomical equipment which is designed to detect very faint signals from space, this equipment is vulnerable to EMI. The potential for harmful EMI would arise if the WSR-88D main beam would directly impinge on an astronomical observatory during low angle scanning. The area of potential impacts to observatories is within 150 miles of the WSR-88D. Portions of four states - Missouri, Arkansas, Oklahoma, and Kansas - are within 150 miles of the KSGF WSR-88D. No astronomical observatories in Oklahoma are within 150 miles, but five observatories in Missouri, one in Arkansas, and two in Kansas are within 150 miles. Table 4 lists observatories within150 miles of the WSR-88D, their locations, and elevations.

Due to the distances from the WSR-88D (70 to 139 miles) combined with earth curvature, the KSGF main beam at a minimum can angle of +0.2 deg would pass 1,400 ft or more over all of the observatories except the Baker Observatory. The Baker Observatory is located 23 miles NNE of the WSR-88D and is about 30 ft higher elevation than the WSR-88D antenna. However, a ridge located 14 miles ENE of the WSR-88D (in section 12, Township 30N, Range 21 E) southwest of Bassville, MO is on a direct line between the WSR-88D and the observatory. That ridge, elevation 1,360 ft MSL, would block the WSR-88D main beam at all angles lower than +0.45 deg (i.e., lower half-power point of -0.05 deg). As a result, the main beam at all minimum scan angles under consideration would pass about 120 ft over the Baker Observatory, Since the main beam would be higher above observatory ground level than the observatory telescopes, it would not directly impinge on the telescopes. In summary, WSR-88D main beam operating at a minimum scan angle of +0.2 deg would not directly impinge on any astronomical observatories.

TABLE 4: Astronomical Observatories within 150 miles of KSGF WSR-88D

Observatory	Location	Distance and Direction	Elevation (ft MSL)	Would WSR-88D main beam impinge at lower scan angle of +0.2 deg?
Baker (Missouri State University)	Marshfield, MO	23 mi NE	1,390	No, ridge near Bassville, MO, blocks main beam at angle of +0.45 deg
Laws (University of Missouri)	Columbia MO	130 mi NNE	770	No, earth curvature places beam 6,000+ ft above observatory
Morrison (Central Methodist University)	Fayette, MO	134 mi NNE	760	No, earth curvature places beam 7,100+ ft above observatory
Warkoczewski (University of Missouri)	Kansas City, MO	139 mi NNW	930	No, earth curvature places beam 6,200+ ft above observatory
Wildhaven	Hallsville, MO	138 mi NNE	800	No, earth curvature places beam 7,500+ ft above observatory
Whispering Pines (Arkansas technical University)	Harrison, AR	70 mi S	1,120	No, earth curvature places beam 1,400+ ft above observatory
Powell (Astronomical Society of Kansas City)	Louisburg, KS	118 mi NW	1,070	No, earth curvature places beam 1,400+ ft above observatory
PSU-Greenbush (Pittsburg State University)	Girard, KS	85 mi WNW	990	No, earth curvature places beam 1,600+ ft above observatory

7. RECOMMENDATION

Lowering the minimum scan angle of the KSGF WSR-88D serving the Springfield, MO, area to +0.2 deg would increase coverage area at 2,000 ft above site level by 46.7% and would not result in adverse effects to person or activities or astronomical observatories. A minimum scan angle lower than +0.2 deg would provide no additional increase in radar coverage and would increase ground clutter returns. Therefore, a minimum center of beam scan angle of +0.2 deg is recommended for the KSGF WSR-88D.

8. MEMORANDUM AUTHORS

This memorandum was prepared by Sensor Environmental LLC under contract to Centuria Corporation, which is a support contractor to the National Weather Radar Operations Center. Mr. James Manitakos, CEO, served as Sensor's Project Manager. Alion Science and Technology Corporation prepared radar coverage maps and calculated coverage areas under subcontract to Sensor. Mr. Andre Tarpinian, Radio Frequency Engineer, served as Alion's Project Manager.

9. REFERENCES

ANSI/IEEE. *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 3 kHz to 300 GHz*. IEEE Std C95.1-2019 (February 8, 2019).

ANSI/IEEE. *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 3 kHz to 300 GHz, Corrigenda 2*. IEEE Std C95.1-2019 (September 24, 2020).

ANSI/AAMI. *American National Standard, Active Implantable Medical Devices – Electromagnetic compatibility – EMC test protocols for cardiac pacemakers and implantable cardioverter defibrillators*, ANSI/AAMI PC69:2007 (2007).

Go Astronomy, www.go-astronomy.com/obvservatories.htm, accessed December 11, 2021.

Naval Sea Systems Command. *Technical Manual, Electromagnetic Radiation Hazards (U), (Hazards to Personnel, Fuel, and Other Flammable Material) (U),* NAVSEA OP 3565/NAVAIR 16-1-529, Volume 1, Sixth Revision (February 1, 2003).

Naval Sea Systems Command. *Technical Manual, Electromagnetic Radiation Hazards (U), (Hazards to* Ordnance*) (U)*, NAVSEA OP 3565/NAVAIR 16-1-529,Volume 2, Seventeenth Revision, (September 11, 2008).

NEXRAD JSPO. *Final Supplemental Environmental Assessment (SEA) of the Effects of Electromagnetic Radiation from the WSR-88D Radar* (April 1993).

NTIA. *Manual of Regulations and Procedures for Federal Radio Frequency Management.* May 2014.

U.S. Air Force. *Explosive Safety Standards*. U.S. Air Force Regulation 127-100(c1). July 27, 1982.

ATTACHMENT A

TRIP REPORT, KSGF WSR-88D

TRIP REPORT

Traveler: James Manitakos, Sensor Environmental LLC

Destination: Weather Forecast Office (WFO) and KSGF Weather Surveillance Radar, Model 1988 Doppler (WSR-88D) serving the Springfield, MO, area

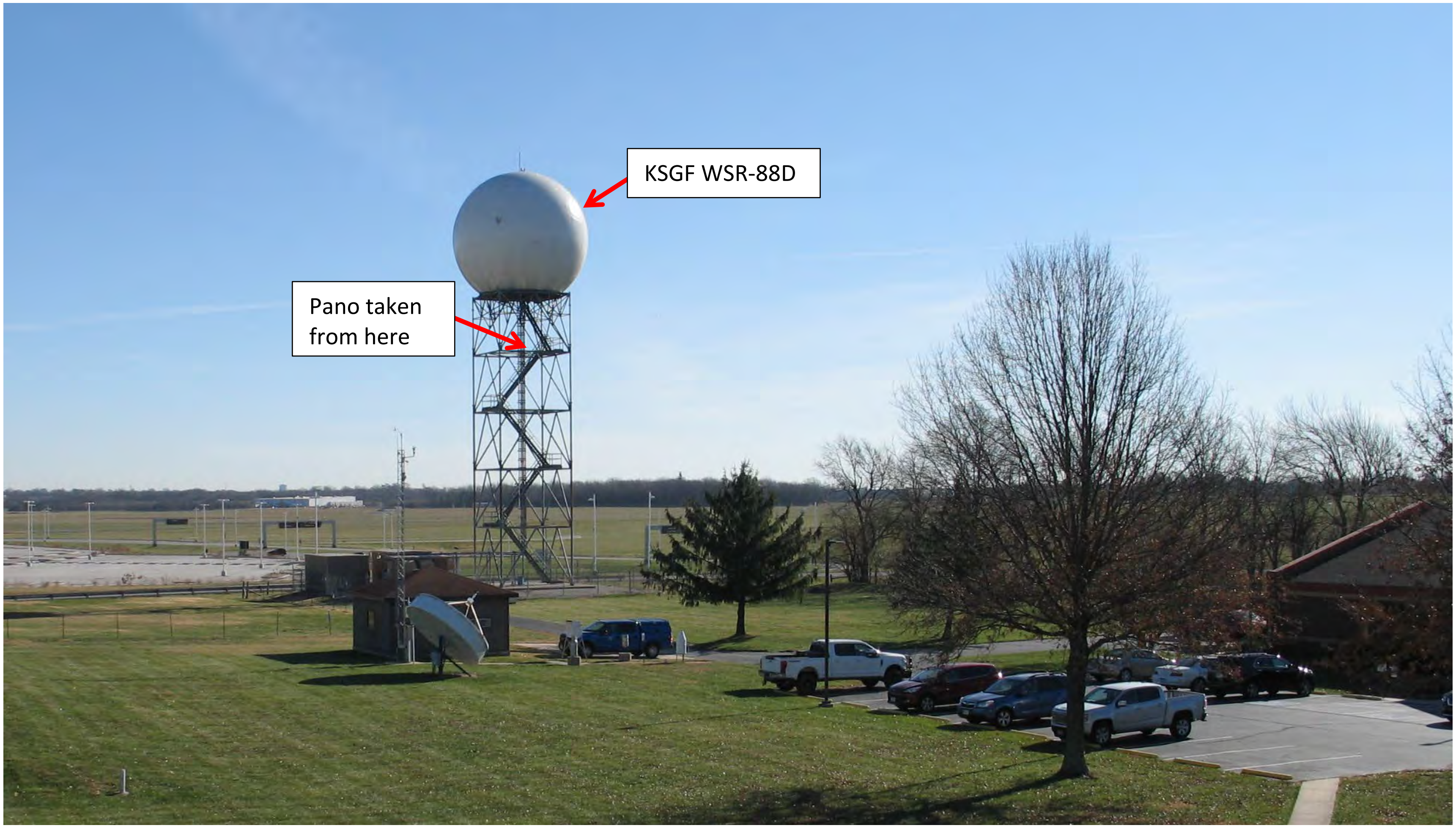
Dates: December 7 - 9, 2021

Purpose: Field Inspection of radar and vicinity and obtaining 360-degree panoramic photographs from of KSGF WSR-88D tower.

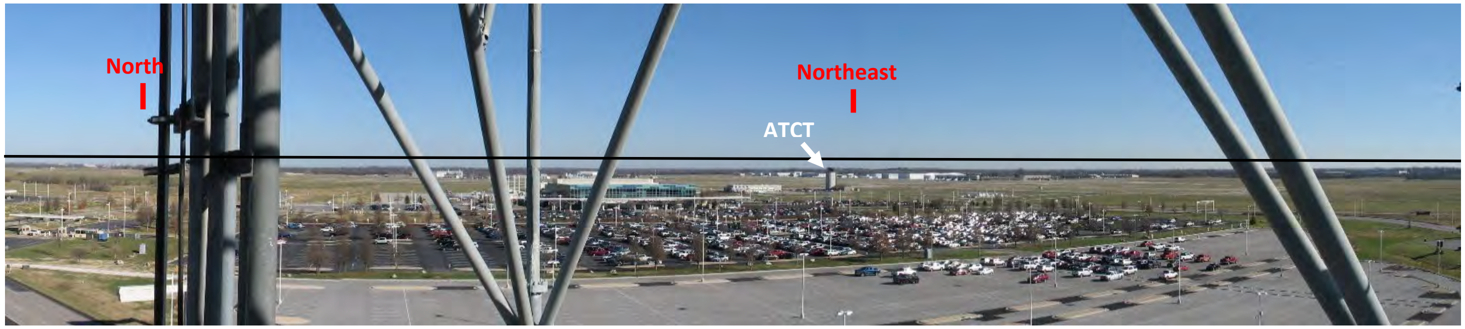
Summary: December 7: Mr. Manitakos drove from Paducah, KY, to Springfield, MO.

Dec. 8: Weather: 39° F, mostly sunny. Mr. Manitakos took pictures of the KSGF WSR-88D and investigated land uses in the vicinity of the radar. He met at the Springfield WFO with support staff. The WFO staff and Mr. Manitakos went over the radar coverage plots for KSGF WSR-88D. Mr. Manitakos took a photograph of the KSGF WSR-88D (Photograph 1) and panoramic photographs (Photograph 2) from the 20-m level of the KSGF WSR-88D, which is about 30 ft below the center of the WSR-88D antenna.

Dec. 9: Mr. Manitakos drove to St. Louis, MO, and flew back to San Francisco, CA.



Photograph 1: KSGF WSR-88D serving Springfield MO, area viewed from west-northwest.



Photograph 2A: Panoramic photograph from KSGF WSR-88D tower [— 0 deg]

Photograph 2B: Panoramic photograph from KSGF WSR-88D tower [— 0 deg]

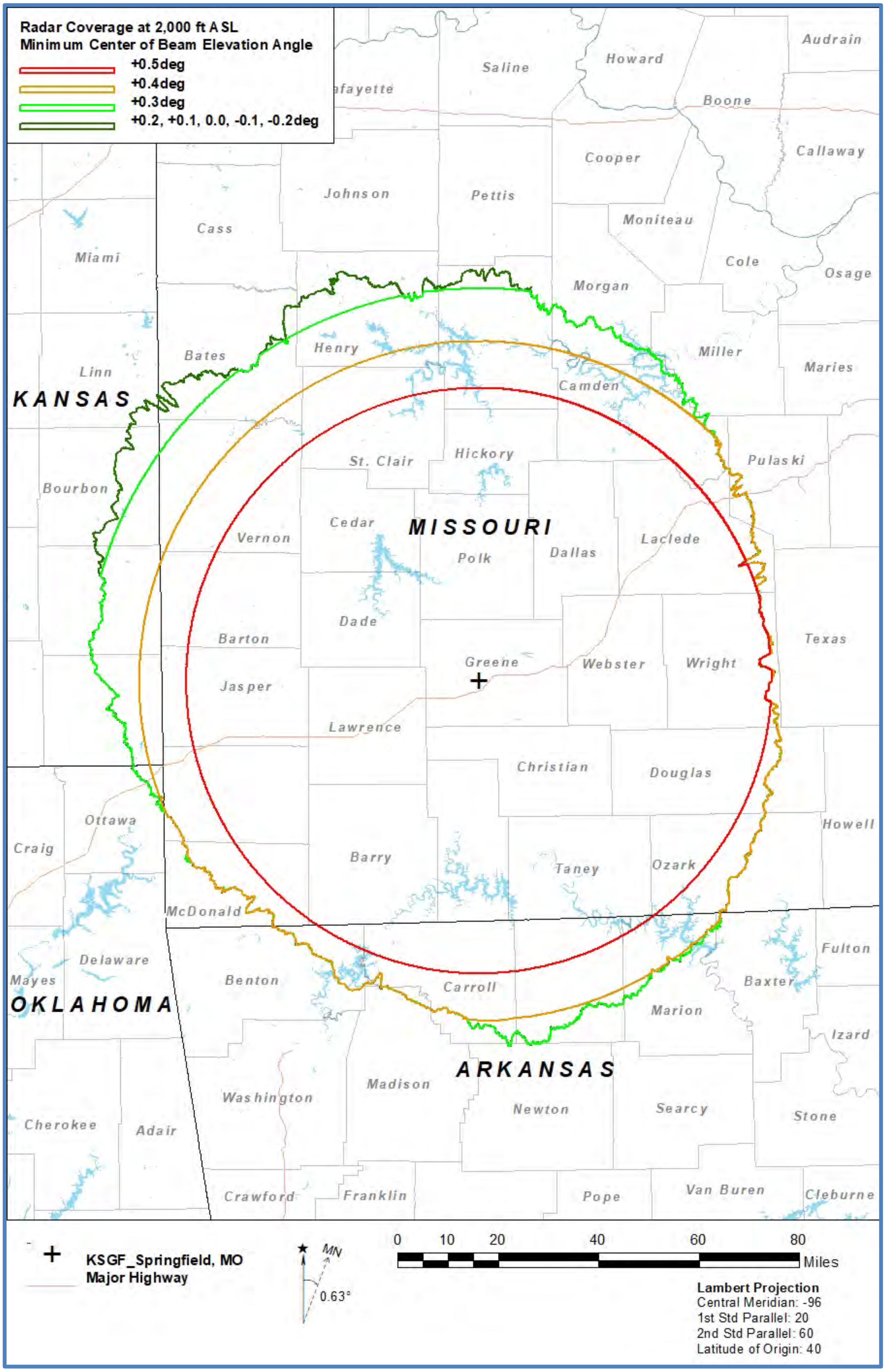
Photograph 2C: Panoramic photograph from KSGF WSR-88D tower [— 0 deg]

Photograph 2D: Panoramic photograph from KSGF WSR-88D tower [— 0 deg]

ATTACHMENT B

KSGF WSR-88D COVERAGE MAP

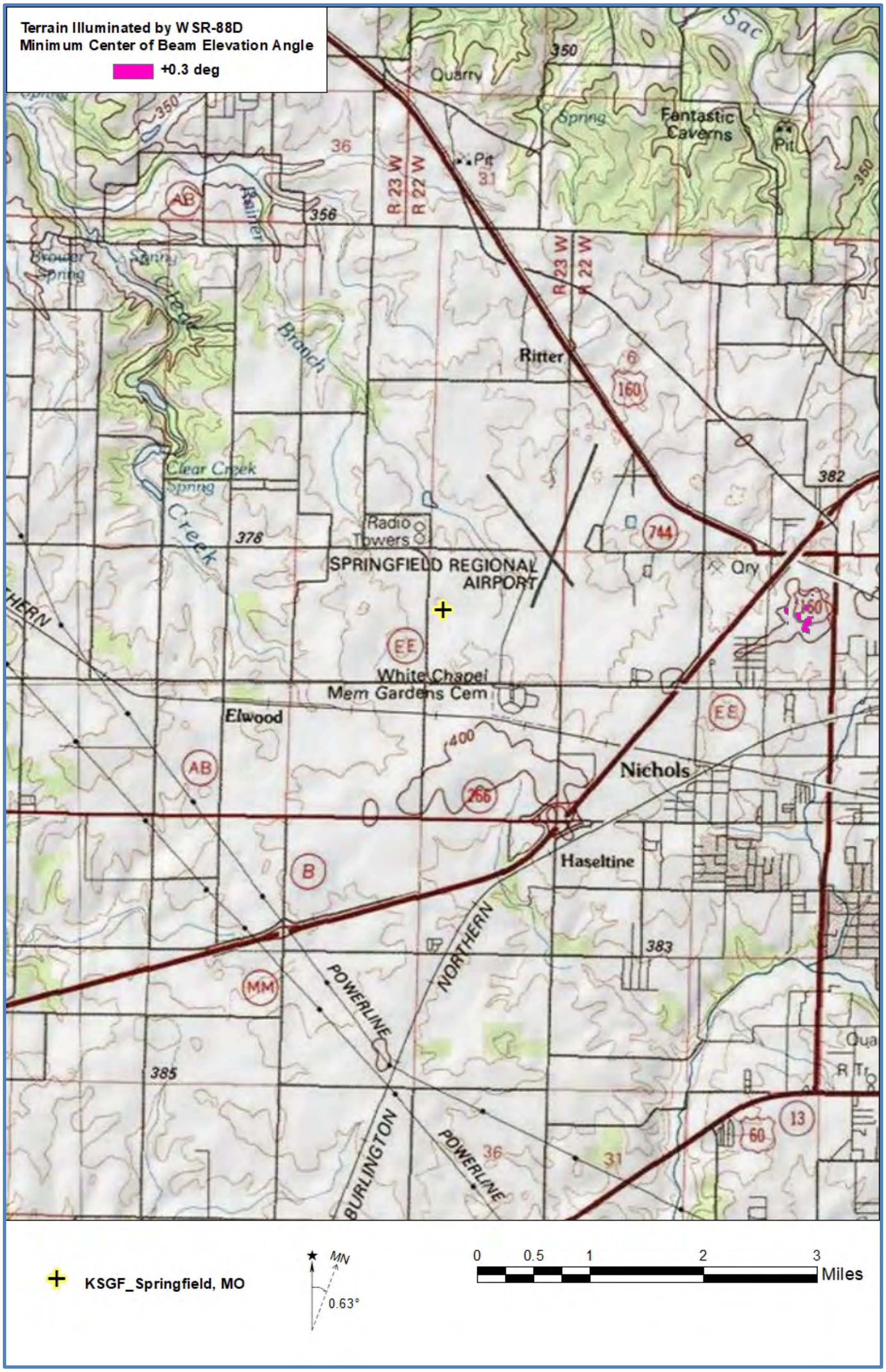
MINIMUM SCAN ANGLES +0.5 deg to -0.2 deg

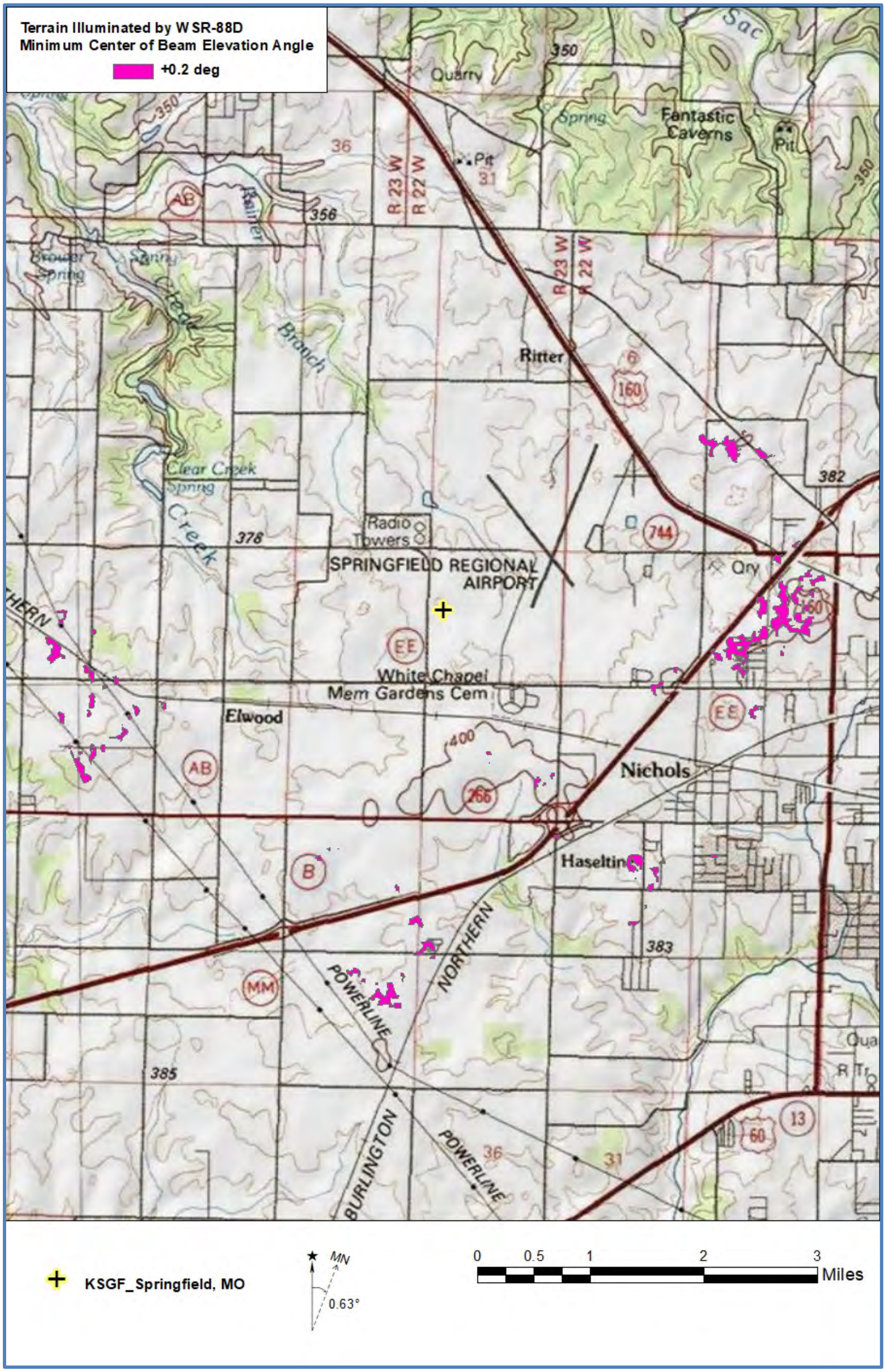

Radar Coverage at 2,000 ft ASL
Minimum Center of Beam Elevation Angle
+0.5deg
+0.4deg
+0.3deg
+0.2, +0.1, 0.0, -0.1, -0.2deg
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
KSGF_Springfield, MO
Major Highway
MN
0.63°
0 10 20 40 60 80
Miles
Lambert Projection
Central Meridian: -96
1st Std Parallel: 20
2nd Std Parallel: 60
Latitude of Origin: 40

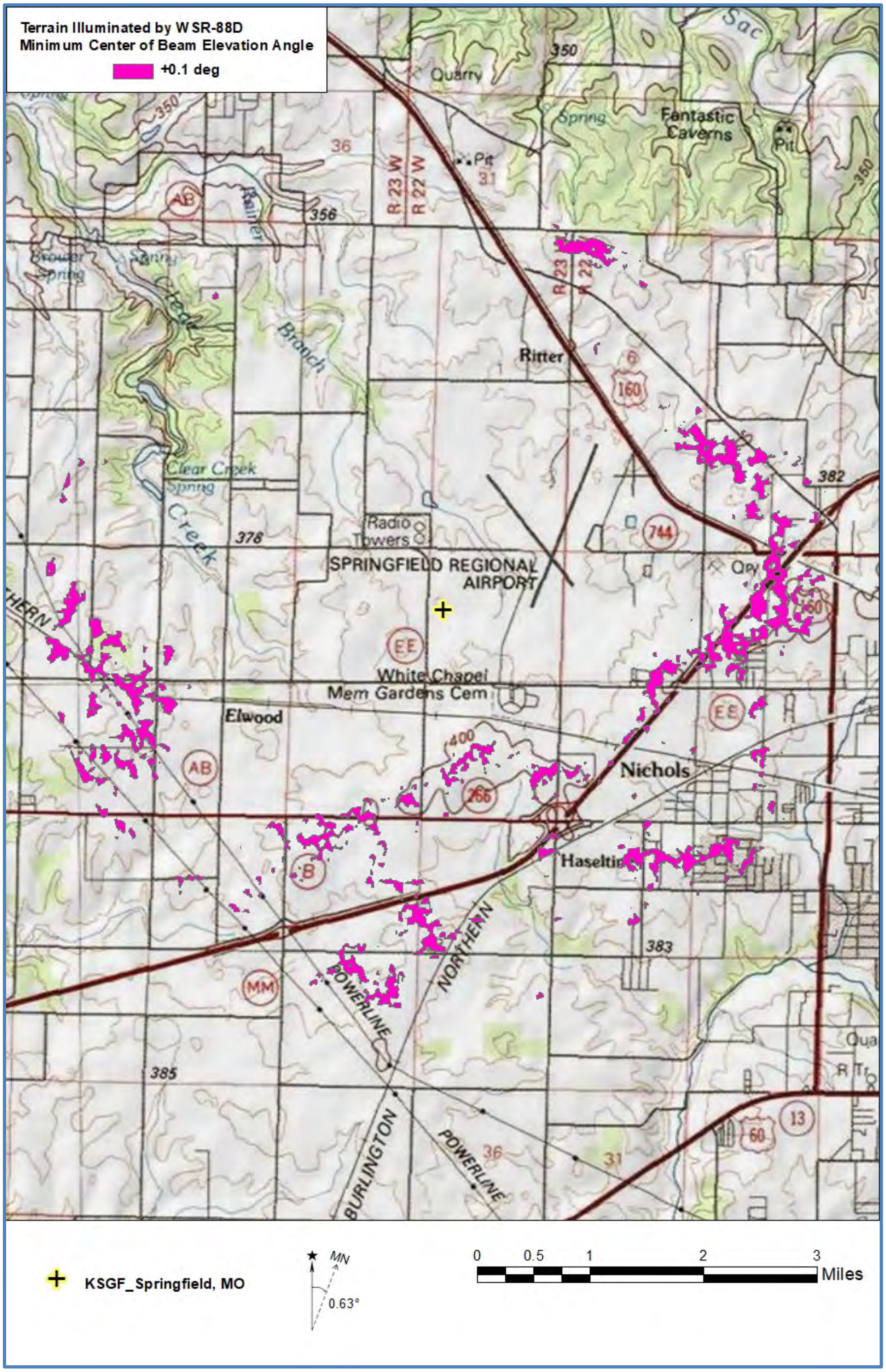
ATTACHMENT C

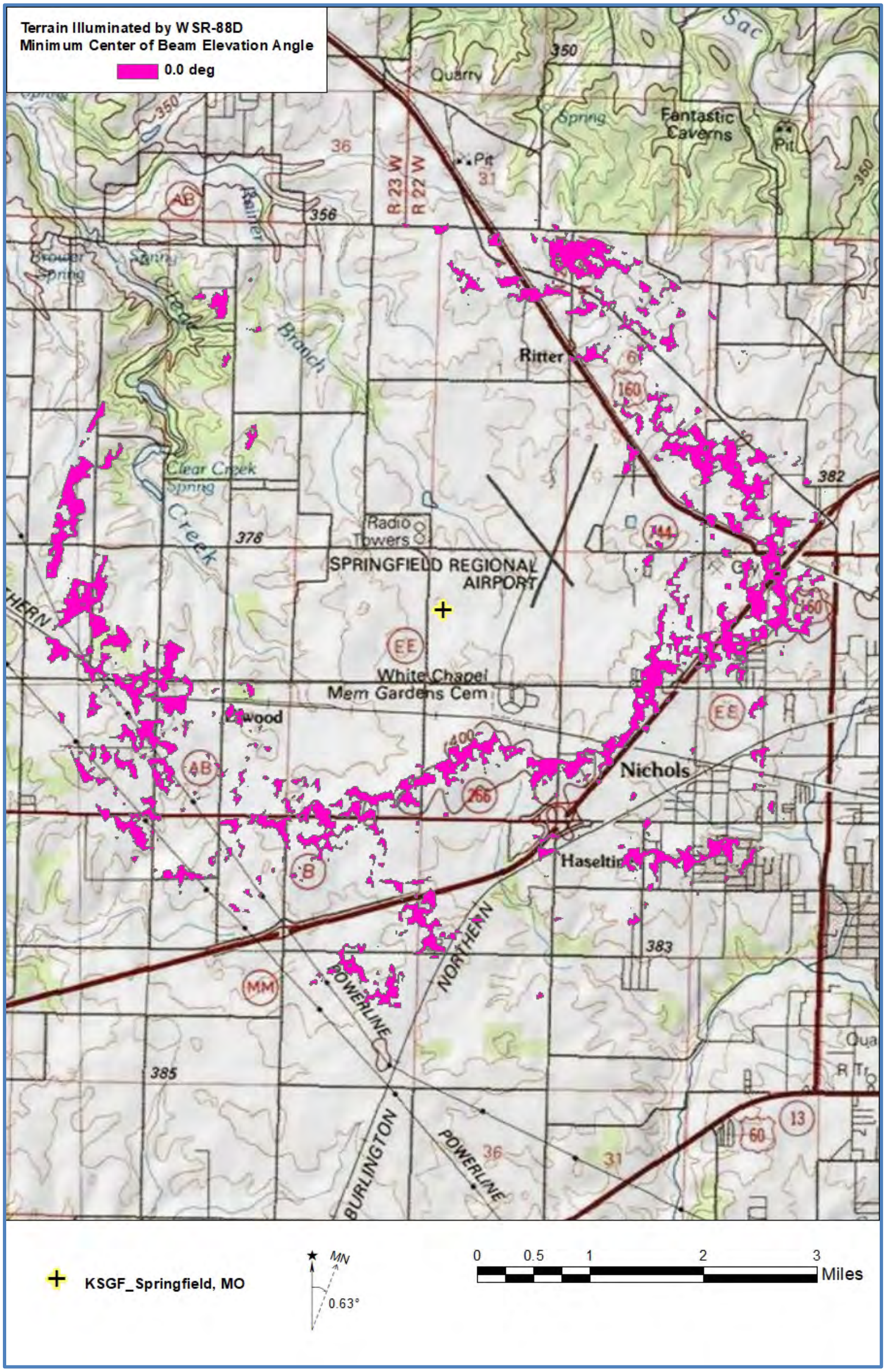
KSGF WSR-88D NEARBY DIRECTLY ILLUMINATED TERRAIN

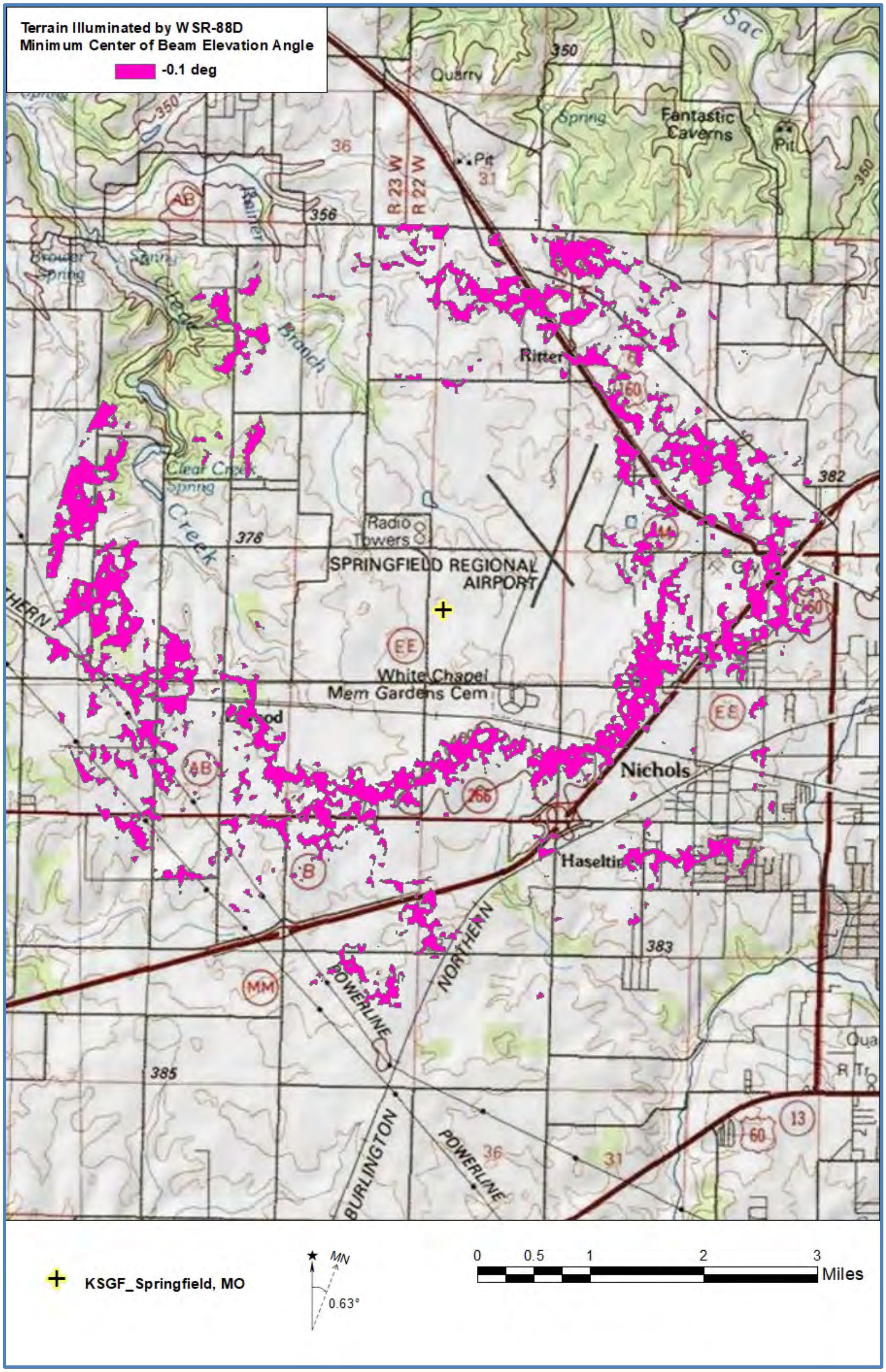
AT SCAN ANGLES OF +0.5 to -0.2 deg

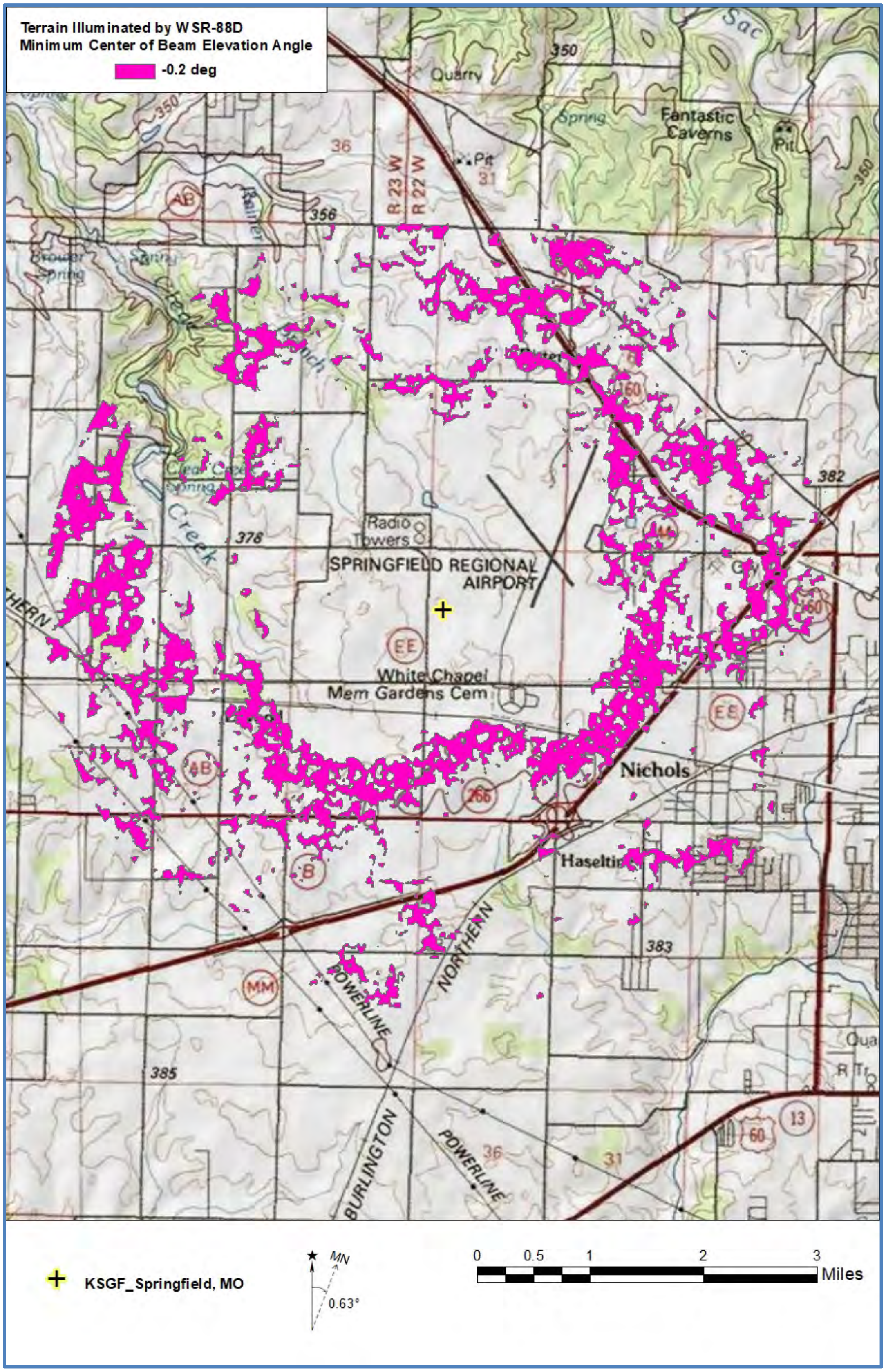

Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.3 deg
SPRINGFIELD REGIONAL AIRPORT
Radio Towers
Ritter
Elwood
Nichols
Haseltine
White Chapel Mem Gardens Cem
Fantastic Caverns
Quarry
Clear Creek
POWERLINE
BURLINGTON NORTHERN
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.2 deg
SPRINGFIELD REGIONAL AIRPORT
Radio Towers
Ritter
Elwood
Nichols
Haseltine
White Chapel Mem Gardens Cem
Fantastic Caverns
Quarry
Clear Creek Spring
POWERLINE
NORTHERN
BURLINGTON
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
+0.1 deg
Quarry
Fantastic Caverns
Spring
Pit
R 23 W
R 22 W
Ritter
160
Clear Creek Spring
Radio Towers
SPRINGFIELD REGIONAL AIRPORT
744
EE
White Chapel Mem Gardens Cem
Elwood
AB
Nichols
266
Haseltin
B
MM
POWERLINE
NORTHERN
BURLINGTON
383
385
378
382
356
350
60
13
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3
Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
0.0 deg
SPRINGFIELD REGIONAL AIRPORT
Ritter
Nichols
Haseltine
White Chapel Mem Gardens Cem
Radio Towers
Fantastic Caverns
Quarry
Clear Creek Spring
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3 Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
-0.1 deg
SPRINGFIELD REGIONAL AIRPORT
Nichols
Haseltine
Ritter
Fantastic Caverns
Radio Towers
White Chapel Mem Gardens Cem
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3 Miles


Terrain Illuminated by WSR-88D
Minimum Center of Beam Elevation Angle
-0.2 deg
SPRINGFIELD REGIONAL AIRPORT
Radio Towers
White Chapel Mem Gardens Cem
Nichols
Haseltine
Fantastic Caverns
Quarry
KSGF_Springfield, MO
MN
0.63°
0 0.5 1 2 3 Miles