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THE 1988 LIGHTNING VERIFICATION PROJECT ON THE NEVADA TEST SITE

A. Introduction

The mission of the Weather Service Nuclear Support Office (WSNSO) in Las Vegas, Nevada is to provide all meteorological services in support of the Department of Energy (DOE), Nevada Operations Office (NV), programs at the Nevada Test Site (NTS) and elsewhere. These services are performed under the authority of both the National Weather Service (NWS) and DOE/NV.

The WSNSO is responsible for conducting a broad meteorological program to help assure the safe conduct of both nuclear and non-nuclear projects sponsored by DOE/NV. Emphasis is placed on meteorological services in direct support of underground nuclear weapons testing. To furnish the required services, WSNSO maintains a staff of meteorologists and technicians having special training in atmospheric transport, dispersion, and deposition/fallout processes; in the decay of airborne radioactive materials; and in the operation and maintenance of special computer/communications systems and meteorological field equipment support.

B. Lightning Detection on the Nevada Test Site

WSNSO meteorologists and meteorological technicians provide a 24-hour weather watch for the NTS and its surrounding areas including the Tonopah Test Range. Given the critical nature of operations on the NTS facility, WSNSO maintains a high level of awareness of cloud-to-ground (CG) lightning.

Recent development of equipment that can accurately locate and detect certain properties of lightning on a real-time basis has made this task easier. NWS Western Region meteorologists are especially familiar with the Automatic Lightning Detection System (ALDS) operated by the Bureau of Land Management (BLM) (Krider, et al, 1980). However, real-time lightning products are only available via AFOS at 30-minutes intervals, which is unsatisfactory to provide timely support of operations at the NTS. To ensure the maximum protection of personnel and equipment, the WSNSO activated its own lightning detection system at the NTS in July 1986.

The NTS network currently consists of four Direction Finders (DFs) manufactured by Lightning Location and Protection, Inc. (Krider, et al, 1980). Figure 1 shows that currently one DF is located in each of the corners of the NTS. The rectangular shape of the NTS leads to east-west baselines of approximately 40 km, and north-south baselines of almost 75 km. As seen in Figure 2, lightning information from the DFs is multiplexed from the NTS to the Position Analyzer (PA) at DOE/NV in Las Vegas. From the PA, the processed lightning data are routed to various display devices in the DOE family of operations. Additionally, flash information such as flash polarity, number of return strokes, and all raw DF information, is transmitted to an archive device. The archival capability allows WSNSO meteorologists access to detailed flash data for system analysis and research applications.

C. The LIVES-88 Project

The 1988 summer thunderstorm season is providing an unparalleled opportunity for a rigorous field validation study and operational meteorological research project. Diverse NTS resources are being unified to permit an increasingly thorough characterization of NTS thunderstorm activity for the 1988 Lightning Identification Verification Evaluation Studies (LIVES-88). Though the 1987 season did not provide the wealth of data the 1986 thunderstorm project did, data provided from the two seasons together allowed a limited NTS lightning climatology to be specified (Scott, 1988). It is hoped that information gained during the 1988 lightning season will not only aid meteorologists in understanding the lightning phenomena, but will heighten NTS efforts in the area of lightning safety.

The National Severe Storm Laboratory (NSSL) has performed the most thorough lightning detection field validation study to date (McGorman and Rust, 1988). During the 1987 thunderstorm season, the NSSL utilized two fixed cameras and one mobile camera to evaluate two major lightning detection systems across central Oklahoma. The wealth of resources available on the NTS should allow WSNSO to achieve an even more detailed study in the western United States.

Reynold's Electric Company (REECo) is responsible for closed circuit television (CCTV) on the NTS. Currently, REECo has one fixed CCTV location in the center of the NTS that can easily be adapted to lightning surveillance. Several other temporary CCTV locations are set up for surveillance around the NTS. Each fixed CCTV site has been precisely surveyed for latitude/ longitude coordinates and elevation. Utilizing these cameras, along with a portable videocamera made available through Lawrence Livermore National Laboratory, WSNSO should be able to collect high quality lightning location data this summer on the NTS. The LIVES-88 project commenced in early July and will terminate in late September.

LIVES-88 will verify the accuracy and the detection efficiency of the lightning detection system for both negative and positive CG flashes. In addition, the project will allow WSNSO to observe the effect, if any, of terrain on system performance. Armed with this information, the WSNSO meteorologist will better be able to assess the lightning hazard on the NTS.

D. New Technology

In addition to last year's equipment list, several exciting new pieces of technology are available to enhance our research and operational capabilities.

1) Corona Current/Electric Field System. Identifying strong electric fields, and thus the potential for CG lightning, is extremely critical for individuals involved with weapons or explosives. Under fair weather conditions, the electric field at the surface of the earth is about + 110 volts/meter. As a thunderstorm begins to build, the electric field in the vicinity of the cloud starts to increase in response to electrification processes in the cloud. Thus, changes in the static electric field can signal strength and intensity of an approaching storm.

A problem inherent to all surface based electric field measurement devices such as this is the space charge layer. The space charge layer develops near the earth's surface when grounded objects such as people, trees, or antennas go into corona discharge. (Corona discharge occurs when the electric field around exposed conductors becomes so intense the surrounding air becomes ionized, and an electric current flows from that object to neutralize the field). This space charge layer can mask a much larger field strength aloft (Moore and Vonnegut, 1977). Thus, the electric field measured at the surface may appear to be small when it is really large above the space charge layer. This could be dangerously misleading to someone involved in handling explosives, or to anyone in an exposed environment.

Since the intensity of corona discharge is a function of electric field strength, the electric field can be measured by directly measuring the corona current. In the past, the corona detector has generally been ignored as an operational tool due to inherent limitations. These limitations (no response below a field strength of 1000 volts/meter, and wind dependence), however, have been overcome utilizing new instrumentation. WSNSO has deployed these new corona detectors to assess their viability in an operational environment at the NTS.

2) Optical Lightning Detector. To the operational meteorologist probably the most exciting system we are testing is the ultrasensitive photocell system which optically detects lightning during daylight, when it is difficult to detect visually, especially intra-cloud lightning. The device accomplishes this task by sensing small, but rapid changes in light associated with lightning, i.e., the total cloud illumination obvious at night, but invisible in the day. It also detects lightning at night, some of which may not be visible.

Initial results (two cases) indicate that the device could give as much as a 10-minute lead-time from the first intra-cloud flash to the first CG flash. Additionally, the device could help the observer quantify lightning frequency and distinguish a thunderstorm from a non-thunderstorm.

E. Conclusions

The LIVES-88 project and the evaluation of prototype lightning technology have implications for the NTS and beyond. It is hoped that data gathered this summer will improve WSNSO's ability to fulfill our mission on the NTS and the NWS warning mission, in general. In addition, it is hoped future investigators will be able to build on the groundwork currently being laid.

References

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Moore, C.B. and B. Vonnegut, 1977: The Thundercloud, Lightning. Volume 1: Physics of Lightning, R. H. Golde, ed, 78-79.

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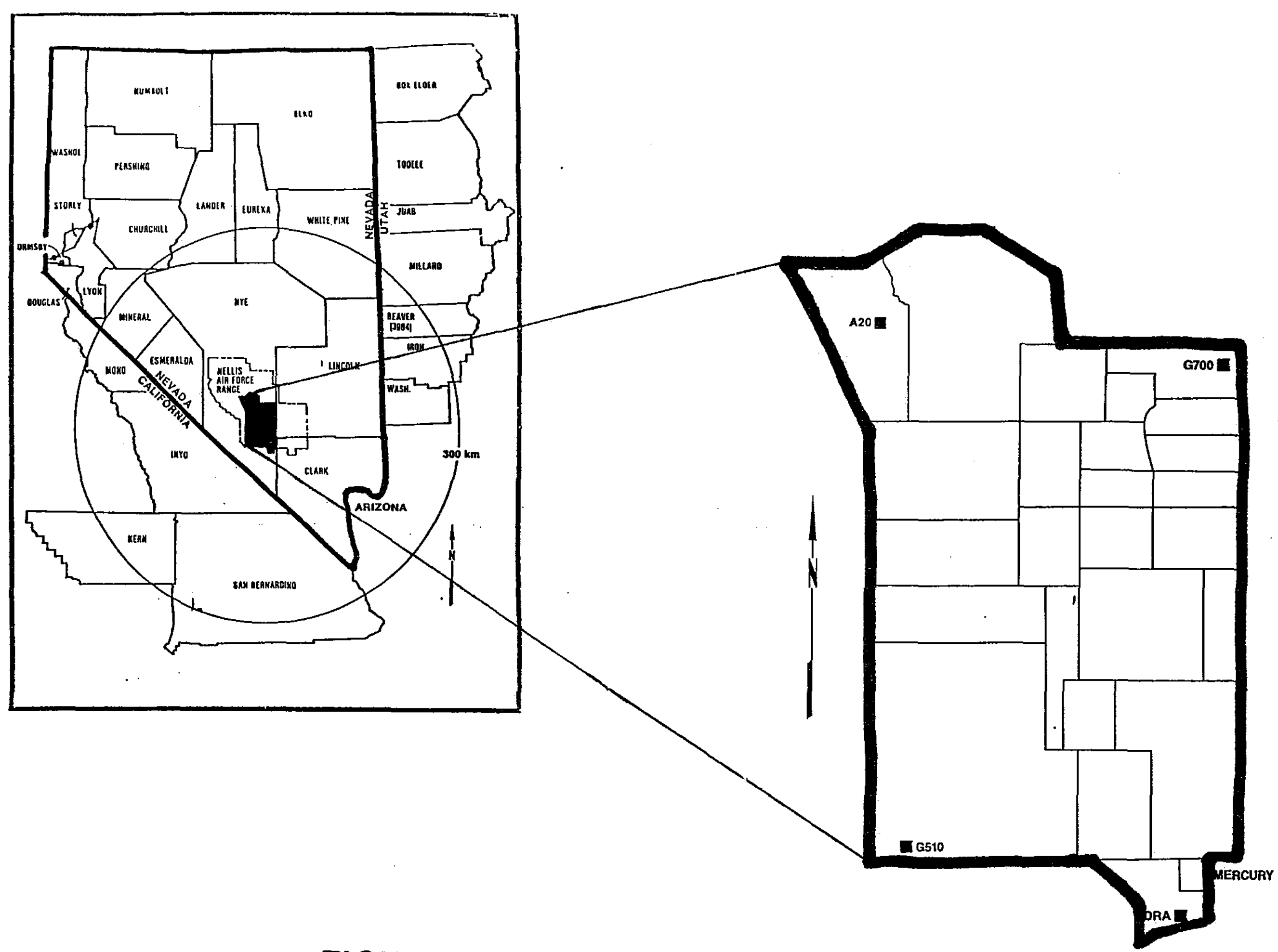

FIGURE 1
NTS ALDS NETWORK

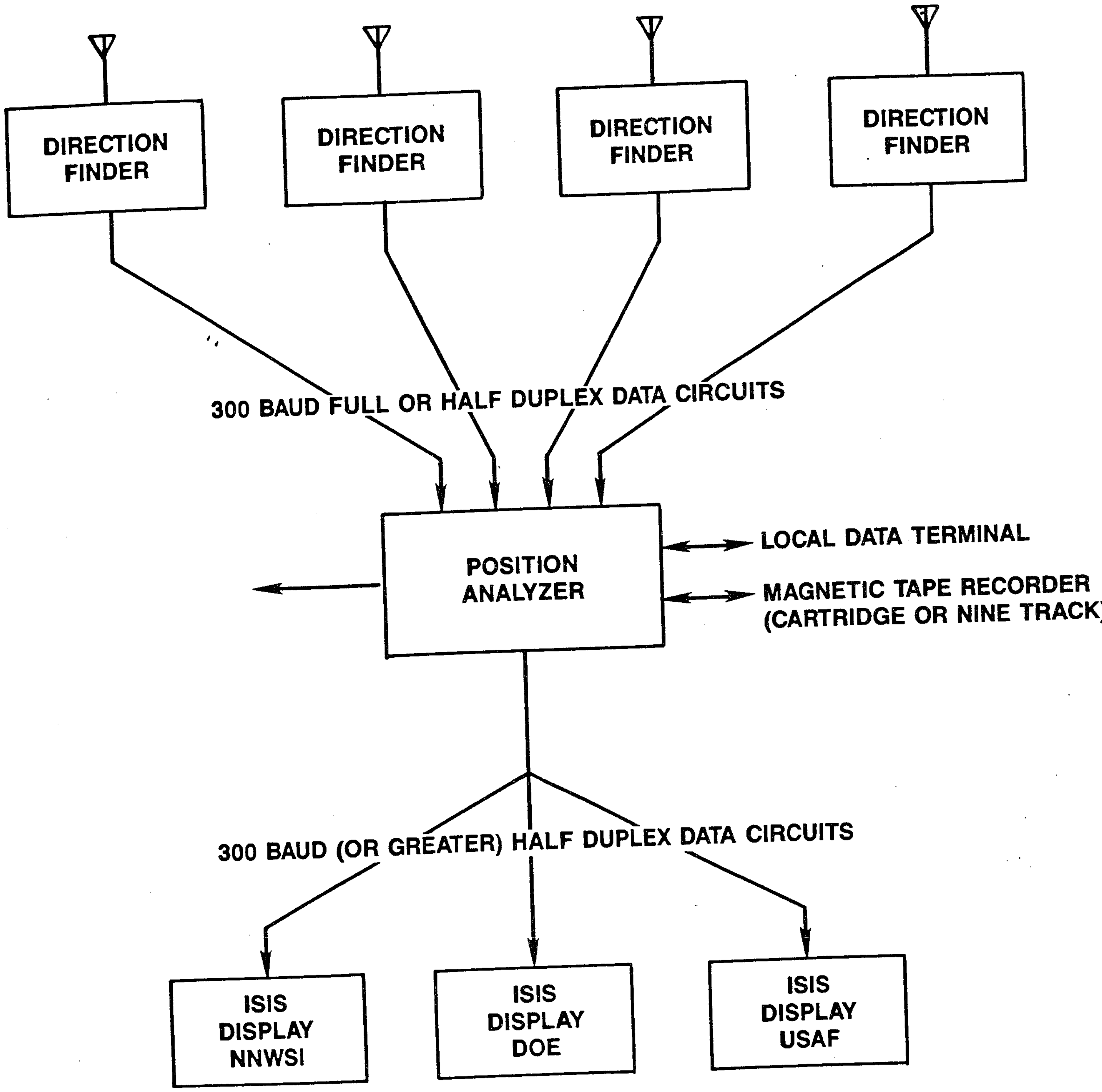

FIGURE 2
NETWORK CONFIGURATION FOR THE NTS LIGHTNING LOCATING SYSTEM