

INVESTIGATION OF RANGE- APPLICABLE LIGHTNING DETECTION SYSTEMS

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Objective

To investigate current operating systems that detect lightning and are used to guard the safety of personnel, to protect property, and to help safeguard sensitive equipment



Background / Motivation



- Oct 1, 2002
- Dec 2002: NTS Lightning Focus Group formed.
- Mar 2003: Defense Nuclear Facility Safety Review Board visit. “Electrical and Lightning Safety Review”
- 2004: SORD generated two reports about lightning and NTS.
- 2005: LFG developed Draft **SITE-WIDE LIGHTNING DETECTION AND PROTECTION** Order for NTS.
- May 2005: SORD given charge for White paper review.
- Jan 2006: Present findings to NSO Executive Council.
- Feb 2006: Draft Order approved by Cathy Carlson.
- Current: Order pending Change Review Group approval/implementation.



Methodology

- Reviewed technical literature and identified lightning detection and tracking systems and facilities
- Telephone interviews: Pantex, Kennedy Space Center, 45th Weather Squadron, Severe Storms Lab, NWS, Vaisala Systems Measurements Group
- Site visits: Pantex, LANL, New Mexico Tech – Langmuir Lab.
- Analyze data



Reviews

Systems/Networks

- Field Mills
- Magnetic Direction Finding (MDF)
- National Lightning Detection Network (NLDN)
- Lightning Detection and Ranging (LDAR)
- Lightning Mapping Array (LMA)

Major Facilities

- Cape Canaveral/KSC
- Pantex
- LANL/DX
- NTS
- SRL
- INEEL
- Richland
- YMPO
- White Sands Missile Range
- NOAA Severe Storms Lab
- New Mexico Tech



Lightning Detection Capabilities at Major Facilities

ORGANIZATION	Fields Mills ⁽¹⁾	Dedicated MDF	NLDN	LDAR/LMA
KSC	Y	Y	Y	Y
Pantex	Y	Y	Y	N
LANL/DX	Y	N	Y	N
NTS	Y	Y	Y	N
SRL	Y	N	Y	N
INEEL	N	N	N	N
Richland	N	N	Y	N
YMPO	N	Y ⁽²⁾	Y	N
White Sands	N	N	Y	Y ⁽³⁾
New Mexico Tech	NA	N	Y	Y
Severe Storms Lab	NA	Y	Y	Y

RED defines primary system used.

1. Detects electric field strength
2. Access to NTS MDF system
3. LMA being installed



Lightning Detection and Tracking Sensors for Major Facilities

ORGANIZATION	Fields Mills ⁽¹⁾	Dedicated MDF	NLDN	LDAR/LMA
KSC	31	5	105	7
Pantex	3	4	105	0
LANL/DX	6	0	105	0
NTS	6	6	105	0
SRL	1	0	105	0
INEEL	0	0	0	0
Richland	0	0	105	0
YMPO	0	6	105	0
White Sands	0	0	105	1
New Mexico Tech	NA	0	105	1
Severe Storms Lab	NA	1	105	1



RED defines primary system used

Technical Characteristics of the Four Primary Lightning Detection Systems Used by Major Federal Programs. NTS Systems are in Blue Shading

	Fields Mills ⁽¹⁾	Dedicated MDF	NLDN	LDAR/LMA
Sensor Spacing	8-16 km	40-75 KM	200-400 km	6-10 km
Effective Range	10-20 km	200-300 km	National	100 km
Lightning Detected	All (Field Strength)	Cloud-to-Ground	Cloud-to-Ground	All
Flash Detection Efficiency	≥ 90%	95%	80-90%	≈100%
Location Accuracy	2-20 km	0.5 km	0.5-1.0 km	0.1 km
Peak Location Rate	80-85 min ⁻¹	80-90 min ⁻¹	800 min ⁻¹	10,000 min ⁻¹
Source	Commercial	Commercial	Commercial	Research
Operational	Yes	Yes	Yes	No
Customers	Few	Many	National	Limited
Approximate Cost Installed	\$5,000-10,000 (each)	\$350,000 (3-5 DFs)	NA	\$400,000- 600,000



The Nevada Test Site (NTS) Lightning Detection, Alert, and Warning System has been Designed to:

- Help Guard The Safety Of Personnel Working On And Around the NTS
- Streamline The Flow Of Lightning Information To Customers
- Provide Site-specific Cloud-to-Ground Lightning Data To Customers
- Provide The Duty Forecaster With Time-Relevant Lightning Data
- Unify Meteorological Data Bases
- Compile A Climatological Data Base For Future Safety Analyses and Research

PROGNOSTICATION

DETECTION & ALERT

COMMUNICATION

PERSONNEL SAFETY



Other Assets Available to SORD Meteorologists to Predict Thunderstorm Activity and to Detect and Track Lightning:

- **NOAA NEXRAD Radar**
- **NOAA Weather Satellite Imagery – GOES West**
- **SORD NTS Weather Net**
- **SORD Upper-Air Sounding Systems – GPS and NOAA microARTS**
- **DRA Surface Observations**
- **Atmospheric Stability / Thunderstorm Prediction Parameters (Local and National)**



Benefits and Shortcomings of the Four Primary Lightning Detection/Potential Systems

System	Benefits	Shortcomings
MDF and LDAR	<ul style="list-style-type: none"> - Indicates when the atmosphere is becoming electrically active - Displays electrical activity on maps as occurring - Indicates the movement of electrical activity - Indicates the amount of electrical activity - Indicates the trend of electrical activity - Indicates when the electrical activity is diminishing - Detection capability covers a large area, allowing time to assess local safety issues and provide warnings 	<ul style="list-style-type: none"> - High Cost - Need at least 2 DFs; 3 preferred - Limited range (< 300 km) - Requires professional interpretation
Field Mills	<ul style="list-style-type: none"> - Low Cost - Easy to Use - Detect all electrical discharges 	<ul style="list-style-type: none"> - Limited Range (not much better than eyes and ears) - Limited display capabilities - Threshold must be identified - False-positive alerts
NLDN	<ul style="list-style-type: none"> - Low cost & low maintenance - Easy to Use - Indicates when the atmosphere is becoming electrically active - Displays electrical activity on maps as occurring - Indicates the movement of electrical activity - Indicates the amount of electrical activity - Indicates the trend of electrical activity - Indicates when the electrical activity is diminishing - Detection capability covers a large area, allowing time to assess local safety issues and provide warnings 	<ul style="list-style-type: none"> - Not site specific - Limited accuracy



Benefits Of The NTS Lightning Detection System vs. The National Lightning Detection System

- Better detectability
- Better accuracy
- Archived data permits site-specific lightning threat analyses
- Site-specific and operation-specific displays for customers
- Streamlined and rapid data flow to customers
- Weather data integration for storm tracking and weather advisories
- Research



Summary

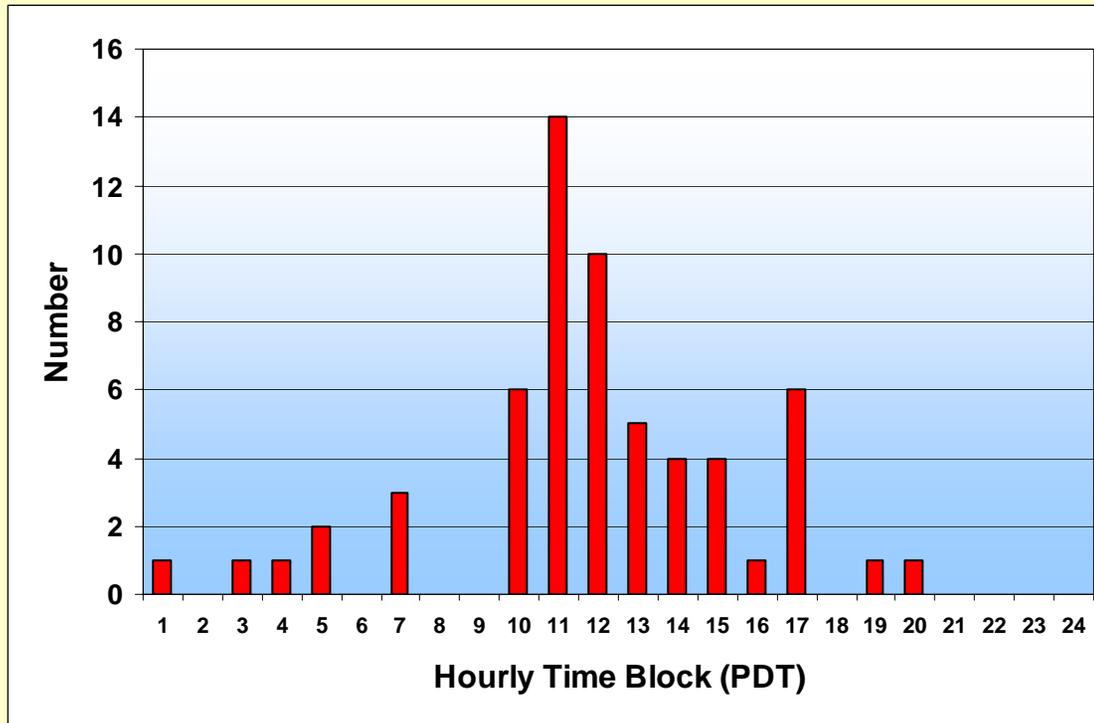
1. Assessed lightning detection and tracking systems at 10 major federal facilities
2. Four different systems/networks were identified
3. Compared the NTS system with those at other facilities
4. Field mills serve as the primary lightning detection system at only one site, LANL
5. Number of field mills at NTS is adequate to meet operational needs
6. The MDF system is the primary system at 4 sites and the NLDN is primary at 3 facilities
7. The LDAR/LMA is primarily a research grade system that is being evaluated and is not in commercial production
8. Addition of LDAR/LMA might increase lightning detection safety envelop by 5 to 10 min
9. Recommend reanalysis when LDAR/LMA system becomes operational and available



Questions



Extras



Distribution of the time of detection of the first CG flash within the 20-mile Lightning Alert Area on days when thunderstorms were forecast for the NTS in the 0800 PDT forecast package.

