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**ELECTRONIC LEVEL INDICATOR
FOR THE REMOTE VERIFICATION
OF WIND INSTRUMENT POSITION**

R. J. SAND

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**E. I. du Pont de Nemours & Co.
Savannah River Laboratory
Aiken, S. C. 29801**

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by

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ABSTRACT

A battery-powered, electronic level indicator was built to aid in mounting wind direction instruments at several elevations on a 365-meter TV tower. Two gravity-sensing transducers in each wind instrument are positioned to indicate their orientation with respect to two horizontal axes, thereby determining the variation of the vertical drive shaft from the zenith angle. Electrical signals from the transducers are transmitted through cables to a monitoring station on the ground.

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ELECTRONIC LEVEL INDICATOR FOR THE REMOTE VERIFICATION OF WIND INSTRUMENT POSITION

INTRODUCTION

The Savannah River Laboratory (SRL) gathers data from wind instrumentation mounted on a local 365-meter television antenna tower. The degree of accuracy required for these data necessitates precise positioning of the wind direction instruments to obtain accurate azimuth and elevation measurements. Azimuthal corrections, if any, are noted by sighting on known landmarks and are mathematically incorporated in subsequent data analyses. Elevations are mechanically corrected to put data errors within tolerance. The wind instruments are mounted on booms fastened to the tower. Pitch and roll adjustments permit positioning of individual instruments to indicate true wind direction.

During installation of the wind instruments, tower climbers encountered difficulties in final boom adjustment. Clamp-on bubble levels attached to secondary reference points were used to position the instruments, but sighting from ground-based telescopes indicated gross positional errors. Therefore, an electronic level indicator was developed to ascertain precise wind instrument position. Gravity-sensing electrolytic transducers were mounted directly in the wind instruments, and their electronic nature allowed both tower climbers and ground personnel to observe and confirm the accuracy of installation.

INSTRUMENT DESCRIPTION

The wind direction instruments are Climet Bivane Wind Transmitters (Figure 1), manufactured by Climet Instruments Co., Sunnyvale, California.¹ To obtain reliable information about the instrument position, it was necessary to mount the gravity-sensing transducers^{2,3} inside the bivane electronics housing. Because the vertical drive shaft of the bivane is securely attached to the base plate of the electronics frame, a suitable reference is provided to determine instrument position. The transducers are mounted on custom machined platforms to facilitate assembly of the modified bivanes. These platforms were machined and installed such that one transducer was parallel to the boom pitch axis, while the other was parallel to the boom roll axis (Figures 2 and 3).

Figure 1. Bivane Wind Direction Indicator

Figure 2. Top View of Sensor Platform

Figure 3. Sensor Assembly

MAIN DRIVE UNIT

To reduce the weight of the instrument package to be taken up the tower by the tower climbers, a solid state unit was designed to drive and monitor the transducers (Figure 4). This instrument has circuitry to display position with respect to two axes simultaneously. Each detector has two five-position rotary switches (Figure 5) for coarse, medium, and fine sensitivity, and power supply voltage. The fifth position on each meter switch is marked "TRANS." This switch position electrically removes the meter from the circuit and shorts the terminals to minimize meter wear when not in use. Also included is a zero test button which replaces the transducer with a dummy load to simulate true level on the instrument.

TRANSDUCER SENSORS

The circuitry of the electronic level indicator can be divided into several blocks as shown in the block diagram (Figure 6).

Because of the electrolytic nature of the transducers, an AC power source is required to prevent chemically plating the electrolyte onto one electrode. A sinewave oscillator module⁴ was buffered with an amplifier,⁵ using a gain of one to drive the transducers (Figure 7). Each transducer operates as two potentiometers in series, with each half of the transducer changing resistance oppositely to the other half. That is, as one half increases resistance, the other half decreases resistance (Figure 8). The differential amplifiers are then placed across each half of the transducer. These amplifiers utilize a gain of two, because at true level, each amplifier sees half the driving voltage across the transducer (Figure 9). The output of each of these amplifiers is rectified (full-wave-positive) and is referenced to the battery ground.

The meter output is a measure of the voltage difference between the rectifier outputs to provide a proportional signal relative to the deviation from desired instrument position. Zero-center microammeters converted to voltmeters allow directional deviation to be displayed (Figure 10). Each three-range voltmeter contains a fine, medium, and coarse leveling scale depending upon the degree of accuracy required. On the fine scale with ± 25 divisions, each division is equivalent to an angle of 0.6 minute.

Figure 4. Solid-State Main Drive Unit
and Ground Monitor

Figure 5. Panel Face of Main Drive Unit

Figure 6. Block Diagram of Circuitry

Figure 7. Main Drive Circuit

Figure 8. Sensing and Zero-Test Circuits

Figure 9. Amplifier and Rectifier Circuits

Figure 10. Meter Response Circuits

POWER PACK

Included in the instrument are battery voltage test positions for the positive and negative power supply. Because of the portability requirements, battery power was necessary. Mercury batteries, because of their more desirable voltage discharge characteristics and onplant availability, were chosen to supply ± 12 volts to the circuits (Figure 11).

Figure 11. Power Supply

GROUND-LEVEL MONITORING UNIT

As an added convenience to personnel observing the setup procedures of the instruments, a ground-level monitoring unit (Figure 12) was provided to permit observation of level indication without requiring this information to be relayed by radio from the tower climbers. The monitoring box was designed to monitor the meter outputs of the electronic level indicators at various tower elevations and to drive similar meters on the ground. Existing cables down the tower from each level connected the ground-level monitor to the main drive unit. Unfortunately, due to capacitance in the cables, the ground level unit did not operate when level indicators were above 91 m.

SENSITIVITY

The level indicator has a sensitivity of 0.6 minute of angular displacement from the vertical, a factor of over 30 times better than the design criterium of ~ 20 minutes. The indicator was cali-

brated against a bubble level certified by the National Bureau of Standards. The response of the meters is shown in Table I and Figure 13.

Figure 12. Ground-Level Monitor Unit

Table I. Calibration of Electronic Level Indicator

Reference Deflection, divisions	Angular Change, min.	Meter Deflection, divisions		
		Fine	Medium	Coarse
-5	-8.620	-15.0	-3.25	-1.75
-4	-6.896	-11.0	-2.5	
-3	-5.172	-8.1	-2.0	
-2	-3.448	-5.5	-1.1	
-1	-1.724	-3.0	-0.75	
0	0.0	0.0	0.0	0.0
1	1.724	2.5		
2	3.448	5.0

Figure 13. Calibration of Electronic Level Indicator

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