SECTION 5
SUMMARY AND CONCLUSIONS

5.1 SUMMARY

The measurements given in this report were conducted on the Unisys wind profiler located in Platteville, Colorado, operating on the frequency 404.37 MHz.

In assessing the effect of potentially interfering signals on wind profiler performance, we examined various characteristics such as the type of interfering signal modulation, percentage of time within each minute that the interfering signal is exposed to the profiler, duty cycle, pulse width and PRF (if applicable) of the interfering signal. In addition, although the performance of profilers may vary as a function of design type, the Unisys design that was tested is considered to be representative of current 400 MHz wind profiler radar technology.

It is important to note that a profiler system, as a coherent processor, experiences the highest susceptibility to interfering signals when such signals are on frequency and coherent with the profiler. If the interfering signals are either off-tune or are not coherent, then the profiler's susceptibility is substantially reduced. If a signal is present only a small percentage of time within each minute, then the susceptibility is also substantially reduced. For example, in cases where an interfering radar signal was simulated continuously versus a simulation with intermittent signals (in which the interference occurred for 1 s out of every 10 s), an increased interference threshold was observed.

Potentially interfering signals also affect the profiler less if their spectral density is spread over a larger portion of spectrum, resulting in lower total interfering power in the profiler's passband. This is expected theoretically, and was confirmed by the measurements. This means, again, that an on-tune FM signal will affect the profiler less than an on-tune CW signal with the same power. And, as noted, the coherence or lack thereof of an interfering signal has a large effect on profiler susceptibility.

Off-tuning any signal has the effect of substantially reducing the profiler susceptibility to interference and as a result we were not able to observe interference to the profiler with non-chirped signals tuned 1 MHz off the profiler's center frequency.

Other factors are important in reducing profiler susceptibility to interference. The presence of a limiter and range-Doppler processing in the profiler receiver system would significantly lower the susceptibility to low duty cycle interference (e.g., < 1.0%). Also, siting considerations have an impact on a profiler operation. Having locations in remote areas with a minimum of urban development will present fewer possibilities for the occurrence of interfering signals. Terrain that acts in a shielding fashion could also reduce interference from (or to) ground-based systems.

The results of tests made by injecting signals into the profiler receiver can be summarized as follows. Coherent interference can be a potential problem for a wind profiler, but it is not expected that any signal will be coherent with a profiler. Pulsed signals can produce noticeable interference levels if the pulsed input simulates a continuously boresighted radar. However, interference susceptibility levels are substantially higher when realistic radar operations in the 440-450 MHz band are simulated (i.e., when the interfering radar signal is injected into the profiler for 1 s out of every 10). Interference from radars increases in severity as pulse widths lengthen or if pulse repetition frequencies are increased. The wider the chirp range of a radar, the less severe the interference potential, given other factors remaining equal.

It is noted that factors such as wind profiler characteristics, performance requirements, and interference susceptibility may vary depending on the function or mission of the profiler.

5.2 CONCLUSIONS

1. Emission spectrum measurements conducted on a Unisys wind profiler (both high and low mode) are shown in Figures 4-2 and 4-3, respectively. These spectra are asymmetrical about the carrier and show good spectrum conservation, due to factors such as MSK coding and solid-state transmitters.

2. Wind profiler measurements showed that subharmonic (202 MHz) and second (808 MHz) and third harmonic (1212 MHz) emissions (Table 4-1) were in the range of 37 to 60 dB down from the fundamental. Fourth harmonic (1616 MHz) levels were at least 70 dB down from the fundamental.

3. Profiler antenna selectivity characteristics (Figures 4-5 and 4-6) will not improve profiler resistance to interference from systems tuned to within ±10 MHz of the profiler frequency, but would probably improve compatibility (by providing about 30 dB of rejection) for systems tuned more than 100 MHz from the profiler center frequency.

4. The average gain (computed in decibels) of the wind profiler antenna at ground level near the profiler horizon (Figure 4-11) was measured to be -25 dBi (±8 dB standard deviation). The low profiler sidelobe levels will enhance profiler compatibility with other systems.

5. Table 5-1 gives the range of interference threshold levels that resulted in a 3-dB degradation in profiler S/N for four types of signals that represent typical operations in the 440-450 MHz band. The 3-dB criterion was selected due to the limitation of the measurement setup and may not be an acceptable level of interference for profiler performance.

6. In tests conducted with an ICOM RG-7000 (intended to represent a typical land mobile/amateur receiver), emissions from the wind profiler were not discernible above the receiver's internally generated noise at distances exceeding 1.6 km along a single radial when the receiver was tuned to the profiler center frequency. The receiving system utilized a vertically polarized omnidirectional discone antenna at a height of 2.1 m above ground level. Terrain, vegetation, and structural blocking were minimal. These results, coupled with the remote siting envisioned for (200-500 MHz) profiler systems, indicate that profiler operations should be compatible with most land mobile/amateur operations.

TABLE 5-1
INTERFERENCE THRESHOLDS RESULTING IN
3-dB INCREASE IN PROFILER'S SYSTEM NOISE LEVEL

Type of signal[a]	On-Tune (dBm at R_x input)	1 MHz Off-Tune (dBm at R_x input)
CW	-135	b
16 kHz FM[c]	-130 to -135	-80 to -85
Pulse[d]	-80 continuous signal injection intermittent signal injection[b]	continuous and intermittent signal injection[b]
Chirp[d]	-60 continuous intermittent[e]	f

[a] For pulse and chirp signals, the receiver inputs levels are peak values.
[b] The measurements stopped at -70 dBm and the exact value could not be determined.
[c] Tone modulated.
[d] Based on selected input signals, see Section 4.6.
[e] The measurements stopped at -60 dBm and the exact value could not be determined.
[f] Assumed same as cochannel chirp results.

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14. SUPPLEMENTARY NOTES

15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report provides the results of measurements that were conducted on a 404.37 MHz wind profiler located in Platteville, Colorado. These measurements included: radiated spectra (both high and low mode), radiated harmonic and subharmonic power measurements, characterization of the antenna frequency response, determination of the radiated antenna gain values near ground level, susceptibility of profiler performance to interference from selected emission waveforms, and the effects on a typical land mobile/amateur operation from wind profiler emissions. In addition, the report presents a detailed wind profiler system description including operations/functions, system hardware, digital signal processing, as well as an analytical estimation of the interference effects on profiler performance. The information contained within this report can serve as an aid in conducting Electromagnetic Compatibility (EMC) analysis to determine compatibility between wind profilers and other systems.

16. Key Words *(Alphabetical order, separated by semicolons)*

Wind Profiler Characteristics
Wind Profiler Interference Susceptibility
Wind Profiler Radars
Wind Profiler Radiated Measurements
Wind Profiler System Description

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