FISH & RICHARDSON P.C.

1425 K STREET, N.W.
11TH FLOOR
WASHINGTON, DC 20005

Telephone
202 783-5070

Facsimile
202 783-2331

Web Site
www.fr.com

Frederick P. Fish
1855-1930

W.K. Richardson
1859-1951

FILED/ACCEPTED

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Office of the Secretary

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June 10, 2010

Marlene H. Dortch, Secretary
Federal Communications Commission
Office of the Secretary
445 12th Street S.W.
Room TW-A-325
Washington, D.C. 20002

FR

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WASHINGTON, DC

Re: In the Matter of Petition for Waiver of Sections 15.503(d) and 15.521(d) of the Commission's Rules

Dear Ms. Dortch:

Enclosed please find the original and four copies of a Petition for Waiver filed on behalf of Curtiss-Wright Controls, Inc. If there are any questions regarding this filing, please contact the undersigned.

Very truly yours,

Terry G. Mahn

Enclosures

cc (via email): Julius Knapp, Chief, OET
Bruce A. Romano, Associate Chief, OET
Mark Settle, Deputy Chief, OET
Alan Stillwell, Deputy Chief, OET
Karen Ansari, Chief, Technical Rules Branch, OET
Anthony Asongwed, Staff Engineer, OET

Before the

Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)
	)
Curtiss-Wright Controls Inc. Request for	)
Waiver of Part 15 of the Commission's Rules	)
Applicable to Ultra-Wideband Devices	)

REQUEST FOR WAIVER

Terry G. Mahn
Robert J. Ungar
Joseph Taylor
Fish & Richardson P.C.
1425 K Street N.W.
Suite 1100
Washington, D.C. 2005
(202) 783-5070

Counsel for Curtiss-Wright Controls Inc.

June 10, 2010

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REQUEST FOR WAIVER

Curtiss-Wright Controls Inc. ("CWCI") requests a limited waiver of the Commission's Part 15 rules and test procedures governing ultra-wideband ("UWB") ground penetrating radar ("GPR") devices. CWCI's Norwegian subsidiary, 3d-Radar AS, currently manufacturers and markets throughout Europe an advanced, stepped-frequency GPR system known as 3d-Radar.[1] Although the 3d-Radar system utilizes almost 3GHz of bandwidth to perform its GPR functions, it does not appear to meet the Commission's prevailing interpretation of a UWB transmission because the "instantaneous bandwidth" during any frequency step is less than 500 MHz.

In addition, the 3d-Radar system requires that average emission levels be measured with the stepped frequency function "active" to achieve its superior performance characteristics of deep signal penetration, high resolution imaging and fast "survey" speeds. Although Commission test procedures generally require stepped-frequency devices (including UWB) to be measured with the stepping function inactive, it has waived these procedures on several recent occasions upon a showing of good cause.

As explained in greater detail herein, the public interest will clearly be served by a limited waiver of the Commission's UWB rules and test procedures. The 3d-Radar

[1] The 3d-Radar is approved for EU operation under rules that are slightly different than the Commission's Part 15 UWB rules. *See* ETSI EN 302 065 v1.1.1 (2008-02) and ETSI EN 302 066-1 v1.1.1 (2008-02).

system represents a leap in GPR technology that will increase the efficiency of subsurface imaging, lower the costs of infrastructure repair and improve safety conditions both for infrastructure workers and the general public. Accordingly, this petition should be granted.

I. The 3d-Radar System Represents a Significant Advance in GPR Technology

Performance of GPR devices is typically measured in terms of three essential features: (i) the ability to penetrate deeply into subsurface structures; (ii) generate high resolution images; and (iii) operate at high "survey" speeds. To achieve deep signal penetration, a GPR device must operate at relatively low frequencies, generally below 1 GHz. For increased image resolution, the device must be able to operate over a very large bandwidth, generally 2 GHz or more. These objectives are often in conflict in a single device, requiring separate designs with multiple antennas and necessitating multiple surveys to obtain complete and accurate information on underground structures. However, multiple passes take time, consume valuable resources and often raise safety concerns when they must be performed on active transportation corridors.

Most GPR systems on the market today generate only two-dimensional images as the radar moves along the ground. A subsurface object generates an echo that is initially long but is reduced as the radar moves closer to the object and then increases again as the radar moves away. The resulting "echo path" is a hyperbola. With the signal wave speed known, the resulting images are "focused" in a process called migration whereby the echo readings are summed along the path of the hyperbola. The images represent vertical slices through the ground, but in only two dimensions.

One way of achieving three-dimensional imaging is to perform multiple scans, side-by-side, with a single GPR antenna. But this process is very time-consuming, inefficient and cannot be used for certain applications such as ordnance detection. An alternative is what 3d-Radar has developed – an array of closely spaced transmitting/receiving antennas that

transmit sequentially over a large band of spectrum and gather data from a wide swath of underground structures in a single pass.

Attachment 1 contains a schematic of the 3d-Radar system which features an electronically-scanned 31 antenna array that transmits over 1431 bands in 2 MHz steps between 140 MHz – 3GHz with a scan/cycle rate of approximately 2.86 milliseconds. The antenna array is towed (or pushed) approximately 30cm above the ground to enable survey vehicles to travel at normal highway speeds. The system's ability to travel at high speeds using a wide antenna array eliminates the need for multiple passes, resulting in less RF energy being transmitted at any one location. The 3d-Radar system is certified for use in the European Union and in other countries and has been on the international market for several years.[2]

II. Rule 15.503(d) Should be Waived to Permit a Fast, Stepped-Frequency Emitter Operating Over Nearly 3 GHz of Spectrum to Qualify as a UWB Device

The Commission will waive its rules if it determines that the public interest will be served and the waiver will not undermine the policy of the rule to be waived.[3] The public interest arguments for a waiver are set forth below and present a compelling narrative for why this advanced GPR technology should be authorized in the U.S., as it is currently in many countries throughout the world. In addition, because the 3d-Radar system is a very fast stepping device that operates over nearly 3 GHz of bandwidth, the Commission policy underlying its UWB definitional rules will not be undermined by such waiver.

Section 15.503(d) of the Commission's rules defines a UWB transmitter as "an intentional radiator that, <u>at any point in time</u>, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless

[2] The 3d-Radar system has been type approved in Europe as a UWB device pursuant to ETSI EN 302 065 v1.1.1 (2008-02).

[3] *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

of the fractional bandwidth."[4] According to the Commission staff, the 3d-Radar system fails to meet this definition of a UWB emitter because it does not exhibit an "instantaneous bandwidth" of at least 500 MHz. Although the staff appears to regard the phrase "at any point in time" to be synonymous with "instantaneous," the Commission's rules provide no guidance for what period of time constitutes an instantaneous measurement interval.[5] Because the 3d-Radar system transmits in discrete 2 MHz steps, the Commission staff has advised a single step would appear to be the instantaneous bandwidth for the device, and since each step is less than 500 MHz, a waiver of Section 15.503(d) is required.[6]

It is not altogether clear whether the staff here is applying a term that was designed only to have meaning within the context of pulsed UWB emitters. For example, a pulsed emitter with a frequency bandwidth of 500 MHz requires a pulse width on the order of 2 nsec. Thus, a workable definition of "instantaneous" for pulsed devices would be those with a pulse interval of less than or equal to 2 nsec. Anything shorter would generate a bandwidth of more than 500 MHz and anything longer would generate a bandwidth of less than 500 MHz.

For continuous wave ("CW") emitters, however, the term "instantaneous" is not so easy to apply. This question surfaced initially in March, 2006, when the FCC Lab was asked to measure an early version of the 3d-Radar system. In the draft test report prepared by

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[4] 47 C.F.R. § 15.503(d) (emphasis added).

[5] UWB devices in the European Union are not defined in terms of a minimum, instantaneous bandwidth as they are in the U.S. Communications devices require a minimum operating bandwidth of only 50 MHz (at -23dB relative to the maximum spectral power density) (*see* ETSI EN 302 065 v1.1.1 (2008-02)), whereas GPR devices have no minimum bandwidth requirement (*see* ETSI EN 302 066-1 v1.1.1 (2008-02).

[6] In the absence of a UWB waiver, the 3d-Radar would be treated as a narrowband system and would have to comply with the general radiated emissions limits in Section 15.209 of the Commission's rules and the restricted band requirements in Section 15.205. Due to the very wideband nature of the 3d-Radar System, however, it would not comply with either rule and, in fact, would require a waiver of the fundamental prohibition requirement in all broadcast bands as well as 21 other restricted bands listed in Section 15.205.

the FCC Lab,[7] the test engineers first noted that the system was unlike most other impulse GPRs because it developed its emission spectra by pulsing a CW signal sequentially over a very wide frequency range. The test report then stated:

> This technique creates an output spectral bandwidth greater than 500 MHz (as required to be classified as UWB) but will not generate this bandwidth in either a single step or over a one millisecond integration time, thus preventing the device from qualifying under the UWB rules as defined in (sic) 47 CFR 15.509.[8]

Thus, the FCC Lab indicated that the UWB minimum bandwidth requirement for a CW emitter could be measured over a single step or over a one millisecond integration interval. But, if this is the measure of "instantaneous," the 3d-Radar system easily meets the test. As indicated in Attachment 1, the 3d-Radar system sequences a CW signal between 100 MHz and 3 GHz in approximately 2.86 milliseconds which, when measured over a one millisecond interval, produces an "instantaneous bandwidth" of more than 1 GHz – clearly enough to satisfy the definitional requirement in Section 15.503.[9]

On previous occasions, the Commission staff have explained that the primary impediment to classifying a stepped frequency emitter as UWB lies in the requirements set forth in Section 15.31(c).[10] However, once again, the express language in the rule cannot be squared with the staff's interpretation. Section 15.31(c), adopted long before

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[7] *RF Characterization of a Proposed Federal Highway Administration (FHWA) Ground Penetrating Radar (GPR),* Federal Communications Commission, Office of Engineering and Technology, Laboratory Division, March 31, 2006.

[8] *Id.* at 2 (emphasis added).

[9] In a follow-up discussion with the FCC Lab engineers, it was explained that the 1ms integration period was derived from the analyzer dwell time required to measure average emissions from a UWB device. However, the Lab never explained what measurement time period should be used for determining the instantaneous bandwidth of a CW emitter nor why the 1ms period would not be an appropriate interval to use for a non-pulsed emitter.

[10] *See Petition for Waiver of the Part 15 UWB Regulations Filed by the Multi-band OFDM Alliance Special Interest Group*, ET Docket No. 04-352, Order, 20 FCC Rcd 5528, 5529 at n.13 (2005) ("*MBOA-SIG Waiver*") and Letter to Mr. Ari Q. Fitzgerald from Edmond Thomas, Chief, Office of Engineering and Technology (June 25, 2003) at n.24 (no docket number provided) ("*Siemens Waiver*").

the UWB rules were developed, deals only with swept-frequency measurements.[11] Hopping, stepping and sequencing devices approved under other sections of Part 15 do not appear to be limited by this rule;[12] thus, it is difficult to understand why UWB devices should be either. It is likewise difficult to understand how the rule can be read as a limitation on bandwidth when it so clearly applies to the measurement of field strength emissions.

3d-Radar is not alone in its belief that the UWB definition is being inadvertently interpreted to restrict the development of stepped frequency CW emitters. In 2004, NTIA urged the Commission to adopt specific UWB test procedures to accommodate non-impulse emitters by permitting measurements to be made with any hopped, stepped or gating functions active.[13] For reasons unclear, the FCC did not implement NTIA's measurement recommendations, yet the Commission referenced these recommendations favorably when it granted a UWB waiver for stepped frequency OFDM devices in 2005.[14] To the extent that the 3d-Radar system may be found not to meet the 500 MHz "instantaneous bandwidth" requirement, a waiver is requested to allow the bandwidth of this device to be determined with frequency stepping active.[15]

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[11] Section 15.31(c) was adopted pursuant to the 1989 comprehensive revisions to Part 15 of the Commission's rules. Operation of Radio Frequency Devices without an Individual License, Final Rule, 54 Fed. Reg. 17710, 17718 (April 25, 1989).

[12] *See e.g.*, 47 C.F.R. § 15.247.

[13] NTIA comments of December 10, 2004 in ET Docket No. 98-153 at 3-4.

[14] *See MBOA-SIG Waiver* at para. 10.

[15] An alternative would be to apply the FCC Lab's 1ms integration test, but allow any bandwidth occupied in that period to be counted only once. This would ensure that only very fast wideband emitters qualify for UWB treatment. Because the 3d-Radar system is a very fast stepping device that operates over nearly 3 GHz of bandwidth, the Commission policy underlying its UWB definitional rules will not be undermined by such waiver.

III. The UWB Test Procedures Should Allow or Should be Waived to Allow Average Measurements Above 960 MHz to be Made With the Stepping Function Active

The test procedures for UWB devices are set forth in Section 15.521(d) of the Commission's rules. For emissions above 960 MHz, the rule requires measurements to be made with an RMS average detector over a 1 MHz resolution bandwidth. The rule also provides that "if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on."[16] Finally, the rule states that "alternate measurement procedures may be considered by the Commission."[17]

By its express terms, the "gated on" test requirement in this rule applies only to pulsed UWB devices. Nonetheless, the Commission staff has applied the rule prophylactically to other types of emitters including hopped, stepped and sequenced UWB emitters. This expansive interpretation appears to come from language in the *First Report and Order* ("*1st R&O*") adopting the UWB rules where the Commission said that "measurements on a stepped frequency or frequency hopping modulated system are performed with the stepping sequence or frequency hop stopped."[18] The basis for this comment was understood to be the Commission's concern, at the time, that it had not yet developed test procedures for UWB emitters other than pulse-type.[19] But the rule that the Commission ultimately adopted was limited only to pulsed emitters.

When the UWB rules were adopted in 2002, the Commission was determined to remain "technology neutral." This approach meant conservative testing conditions would be imposed on all types of devices on the grounds that the Commission had very little

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[16] 47 C.F.R. § 15.521(d).

[17] *Id.*

[18] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, First Report and Order, 17 FCC Rcd 7435, 7450 para. 32 (2002).

[19] *Id.*

experience with the technology or the appropriate procedures for measuring the interference potential of such devices. As stated in the *1st R&O*:

> Various modulation types should be permitted as long as the products comply with all of the technical standards that are being adopted in this proceeding . . . We recognize that this may preclude certain types of modulations, such as swept frequency (*e.g.*, FMCW [frequency modulated continuous wave]), stepped frequency or frequency hopping systems. The current measurement procedures require that measurements of swept frequency devices be made with the frequency sweep stopped. The sweep is stopped because no measurement procedures have been proposed or established for swept frequency devices nor has the interference aspects of swept frequency devices been evaluated based on the different measurement results that would be obtained from measurements taken with the sweep active. Similarly, measurements on a *stepped frequency* or frequency hopping modulated system are performed with the stepping sequence or frequency hop stopped. With the sweep, step function or hopping stopped, it is unlikely that swept frequency (linear FM or FMCW) or stepped frequency modulated emissions would comply with the fractional bandwidth or minimum bandwidth requirements.[20]

Thus, the guidelines in the *1st R&O* prescribe that stepped frequency UWB devices be measured with the stepping function disabled. This policy echoes Section 15.31(c) of the Commission's rules which applies to non-UWB devices and requires that for swept frequency devices, measurements be made with the sweep stopped.[21]

In the *1st R&O*, the Commission recognized that it would be necessary to revisit its admittedly conservative rules to adopt more flexible technical standards, stating that:

> The standards we are adopting *may be overprotective and could unnecessarily constrain the development of UWB technology*. Accordingly, within the next six to twelve months we intend to review the standards for UWB devices and issue a further rule making to explore more flexible technical standards and to address the operation of additional types of UWB operations and technology.[22]

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[20] *Id.* (emphasis added).

[21] The Commission has interpreted Section 15.31(c) of its rules to apply as well to stepped or frequency hopping modulation techniques. *See MBOA-SIG Waiver* at n.13.

[22] *1st R&O* at para. 1 (emphasis added).

In the same vein, the Commission stated, "[W]e believe that we should be cautious *until we have gained further experience with this technology*. Once additional experience has been gained with UWB operation, we may consider whether more flexible standards are appropriate."[23]

Just one year later, in its *Memorandum Opinion and Order* on reconsideration of the UWB rules, the Commission stated that:

> [W]e believe that the next 12 to 18 months should allow the introduction of UWB devices under our recently adopted rules. We also hope that additional tests using commercially available UWB devices will have been completed within that time frame . . . As these steps occur, we intend to continue our review of the UWB standards to determine where additional changes warrant consideration.[24]

With the passage of time, the underlying rationale for requiring very conservative measurement procedures has begun to fade. As we show below, in the eight years since the adoption of the UWB regulations, the Commission has had the opportunity to weigh its general policy against the operational necessities of UWB and other broadband devices whose performance depended on permitting emissions to be measured under normal operating conditions. Each time the Commission has granted a waiver of its rules and there are yet to be any reports of interference from devices operating pursuant to a waiver.

If 3d-Radar is required to measure its GPR system above 960 MHz with the frequency stepping function disabled, peak emissions will be reduced by approximately 12 dB. This will force the system to be operated at reduced performance levels and negate many of its advanced imaging features. For this reason, 3d-Radar seeks permission to use an "alternate measurement procedure" as contemplated by Section 15.521(d) of the rules, to

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[23] *Id.* at para. 21 (emphasis added).

[24] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems*, ET Docket No. 98-153, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 3857, 3858 para. 1 (2003).

allow it to measure emissions from its system under normal operating conditions – *i.e.* with the frequency stepping function active. In the alternative, 3d-Radar seeks a waiver of this rule to permit such measurement procedure for its system.

IV. This Waiver Request is Consistent with Recent Commission Waivers Granted for UWB and Other Similar Broadband Devices

The public interest arguments for a waiver of the UWB rules for the 3d-Radar system establish compelling reasons for why this GPR technology should be authorized for use in the U.S.

A. There is Precedent for Waiving the UWB Technical Restrictions When the Commission Finds that a Device Presents Little Threat of Harmful Interference

Since the adoption of the UWB rules in 2002, the Commission has shown a willingness to waive its technical restrictions when it believes the device presents little threat of harmful interference and the requested waiver would further important public interest goals. The 2005 *MBOA-SIG Waiver* relaxed the UWB measurement procedures for stepped frequency devices after the Commission determined that these devices would cause less interference than pulsed emitters operating over the same spectrum. The 2007 waiver to Curtiss-Wright Controls for its QUPID perimeter intrusion detection system was based on the decision that the location of the system and coordination with NTIA greatly reduced any chance of interference that might otherwise be caused by an increase in the average and peak emission limits of Section 15.511.[25] Finally, the 2008 waiver to UltraVision Security Systems to permit operation of a UWB surveillance system below 960 MHz was based on a determination that there would be little chance of interference from a device intended to be buried in the ground.[26] In each of these waiver decisions, the Commission considered the public benefits of these novel UWB technologies and

[25] *Curtiss-Wright Controls Inc. Embedded Computing Petition for Waiver of the Part 15 Ultra-Wideband (UWB) Regulations*, DA 07-198, Order, 22 FCC Rcd 815 (2007) ("*Curtiss-Wright Waiver*").

[26] *UltraVision Security Systems, Inc. Request for Interpretation and Waiver of Section 15.511(a) & (b) of the Commission's Rules for Ultra-Wideband Devices*, ET Docket No. 06-195, Order, 23 FCC Rcd 17632 (2008) ("*UltraVision Waiver*").

imposed reasonable conditions on use to assure there would be little likelihood of interference while it obtained additional data from their operations.

B. Prior Commission Waivers Demonstrate that UWB and Other Broadband Devices may be Properly Tested With the Frequency Stepping Function Active Without Threatening Harmful Interference

1. *Siemens Waiver* Permitting Measurement of its Vehicle Avoidance System With its Frequency Hopping Active

In 2003, Siemens requested, *inter alia*, a waiver of the UWB guidelines requiring emission measurements to be made with frequency hopping active.[27] Because the Siemens system did not qualify as a UWB device and did not operate across the restricted bands enumerated in Section 15.205 of the Commission's rules, a waiver was granted permitting the Siemens transmitter to operate at a high peak signal level and a waiver of Section 15.31(c) was granted permitting the system to be measured with its frequency hopping active.[28] Subsequently, in its *Second Report and Order and Second Memorandum Opinion and Order* in 2004, the Commission affirmed the *Siemens Waiver* and amended its rules to permit all Vehicle Collision Avoidance systems operating in the 5925-7250 MHz and 23.12-29 GHz bands to be measured under normal operating conditions.[29]

2. *MBOA-SIG Waiver* Permits UWB Measurements to be Taken With Frequency Stepping Active

In 2005, the Multi-band OFDM Alliance Special Interest Group ("MBOA-SIG") requested a waiver of Section 15.521(d) of the rules to permit UWB transmitters operating above 960 MHz that employ stepped frequency modulation to be measured using an average detector with the transmitter operating in its normal mode, *i.e.* *with the*

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[27] *Siemens Waiver.*

[28] *Id.*

[29] *Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission* Systems, ET Docket No. 98-153, Second Report and Order and Second Memorandum Opinion and Order, 19 FCC Rcd 24558 (2004).

stepping function active.[30] In granting the waiver request, the Commission justified it as being consistent with the 2004 decision to allow non-UWB stepped frequency collision avoidance devices operating in certain bands to be measured in their normal operating modes.[31] The Commission acknowledged that its initial UWB rules were very conservative due to uncertainty of the emission levels and test methodology required to protect incumbent spectrum users.[32] It further acknowledged NTIA's early recommendations that "measurements of [UWB] systems with frequency hopping, sweeping, stepping, or gating function turned on provides a more meaningful representation of the emissions generated by a device."[33]

Moreover, the Commission found that the MBOA-SIG demonstrated that the interference potential from a stepped frequency system, as measured in its normal operating mode, "is less than that of a UWB transmitter employing impulse modulation. Thus, any requirement to stop the . . . band sequencing . . . only serves to add another *unnecessary* level of conservatism."[34]

In addition, the Commission recognized that its waiver of the rules should be technology-neutral and, accordingly, waived the restriction in 15.521(d) to allow pulsed UWB systems to be measured with the gating function active (subject to the conditions of the *MBOA-SIG Waiver*).[35] As the Commission noted, "[W]e see no technical justifications to

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[30] *MBOA-SIG Waiver*. The devices operate in the 3.1- 5.03 and 5.65 – 10.6 GHz bands.

[31] *See Id.* at n.13 and n.33.

[32] *Id.* at paras. 2, 9, 10 and 13.

[33] *Id.* at para. 10 (emphasis added).

[34] *Id.* at para. 14 (emphasis added).

[35] *Id.* at para. 18. The waiver conditions were as follows: (i) applies only to indoor or handheld UWB devices that operate in the 3.1-5.03 GHz and/or 5.65-10.6 GHz bands; (ii) fundamental emissions can not be located within the 5030-5650 MHz band; (iii) measurement of average and peak emission levels for hopped, stepped, sequenced or gated systems are to be performed with equipment operating in normal mode and repeated over multiple sweeps with the analyzer set for maximum hold until amplitude stabilized; (iv) if provisions are made to operate using a different number of hopped, stepped or sequenced channels, the system shall be designed to ensure that it complies; (v) the waiver does not apply to the determination of the UWB bandwidth or the classification of a device as an ultra-wideband transmitter; and

restrict these waivers only to gated DS ["direct sequence"]-UWB devices or to MB-OFDM systems. Frequency hopped, frequency stepped, band sequenced and gated emissions all appear similar to a receiver and should be treated equally under the conditions of this waiver."[36]

3. SafeView Imaging Device Waiver Permits Measurements to be Taken With Frequency Sweep Function Active

In 2006, the Commission granted a similar measurement waiver for a swept frequency device.[37] Although technically not a UWB device, the SafeView "SafeScout" imaging device is a broadband whole-body scanner designed to detect explosives and other contraband. The Commission waived Section 15.31(c) of its rules to permit average radiated emissions to be tested with the frequency sweep active rather than disabled as the rule requires and found that, when operated indoors (*e.g.* in airports), the SafeScout posed very little, if any, potential for harmful interference.[38] As an added measure of insurance, the Commission imposed conditions on the operation of the SafeScout including a limitation on the number of systems installed during the first twelve months, a restriction to indoor use only, various record keeping requirements and restrictions on re-sale.[39] Significantly, the *SafeView Waiver* was based primarily on consideration of factors such as attenuation and free space loss instead of actual interference testing.[40]

Like the broadband device waivers that came before it, the *SafeView Waiver* decision confirms, once again, the reasonableness of a regulatory policy that considers how a

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(vi) the waiver is effective until such time as the Commission finalizes a rulemaking proceeding dealing with the issues.

[36] *Id.* at para. 17 (emphasis added).

[37] *SafeView, Inc., Request for Waiver of Sections 15.31 and 15.35 of the Commission's Rules to Permit the Deployment of Security Screening Portal Devices that Operate in the 24.25 - 30 GHz Range*, ET Docket No. 04-373, Order, 21 FCC Rcd 8814 (2006) ("*SafeView Waiver*").

[38] *Id.* at para. 24.

[39] *Id.* at para. 29.

[40] *See SafeView, Inc., Request for Waiver of Sections 15.31 and 15.35 of the Commission's Rules to Permit the Deployment of Security Screening Portal Devices that Operate in the 24.25-30 GHz Range,* ET Docket No. 04-373, Memorandum Opinion and Order (2010).

device will actually operate in the field. A waiver allowing the 3d-Radar system to be measured as it actually operates – with the stepped frequency function active – will be fully consistent with this policy and other established precedent.[41]

C. In Evaluating Interference Potential, the Commission has Shown a Willingness to Waive its Emissions Limits Based on Conditions of Operation

As noted above, the *SafeView Waiver* was granted in part because the device would always be used within a building. In that decision, the Commission was satisfied that, given its normal operations, the chance of harmful interference would be greatly reduced.

In 2007, the Commission granted a waiver of the field strength rules to permit the operation of a UWB perimeter surveillance system.[42] The Commission found that a waiver would be in the public interest because it would promote homeland security efforts by enhancing the protection of installations that are important to the public well-being. One condition of the waiver was for a "separation zone" from any area accessible to the public to help prevent interference to other spectrum users.[43] Because these UWB devices were intended to be installed in secured installations, this separation zone was feasible and the condition reflected how the device would actually be operated.

In 2008, the Commission granted a waiver of the frequency restriction of Section 15.211 of its rules to permit operation of the UltraSensor UWB surveillance system between 80-600 MHz.[44] The system utilizes buried ground-penetrating radar transmitters pointing upward for intruder detection. The Commission held that the public interest would be served by a waiver because it would provide protection to a variety of secured facilities, including transportation, law enforcement and commercial establishments and that a

[41] It should be noted that the 3d-Radar device is sold throughout Europe and there have been no reports of interference.

[42] *Curtiss-Wright Waiver.*

[43] *Id.* at para. 22.

[44] *UltraVision Waiver.*

waiver would encourage the development of similar security systems.[45] To ensure that these systems would not increase the potential for harmful interference, the Commission imposed certain operational and technical conditions including a minimum separation distance from the boundary of the customer's facility, residential zones, and cable TV head-ends.[46] Thus, here again, the Commission considered the location and operating conditions of the UWB device in determining whether to grant the requested waiver.

In 2009, the Commission waived its Part 90 radiolocation rules to permit the operation of a through-wall motion sensing system on multiple channels, known as L-3 Cyterra.[47] This device steps through 200 frequencies, spaced 2 MHz apart. Although the Part 90 radiolocation rules permit only single channel operation, the Commission agreed that the number and spacing of frequency steps greatly improves the reliability and precision of the device. The Commission found that a waiver of the rules would benefit police and firefighters in actual emergencies involving threats to safety of life and limited the waiver to 5,000 units sold in the first year and 10,000 in the second year.[48] Significantly, the waiver prohibits outdoor use above ground level – an operating condition the Commission found would be unlikely to pose any threat of harmful interference.[49]

The 3d-Radar system is also a device whose interference potential must be evaluated based on its use and location. In this respect, it bears repeating that the 3d-Radar is a GPR device with its transmitting antennas pointed downward no more than 30 cm above the ground. Its use will be restricted to roadways, bridge abutments, railway tracks and similar types of infrastructure locations. Moreover, its design permits high speed operation and its 31-antenna array guarantees fewer surveys as compared to conventional

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[45] *Id.* at para. 12.

[46] *Id.* at para. 16.

[47] *L-3 CYTERRA, Request for Waiver to Allow Certification and Use of Electromagnetic Motion Detection and Ranging Devices Operating at 3100-3500 MHz*, WP Docket No. 09-2, Order, 24 FCC Rcd 14147 (2009).

[48] *Id.* at para. 9.

[49] *Id.*

GPR to acquire necessary infrastructure data – so its use will be both short- term and itinerant. Thus, the risk of interference from the system will be slight.

D. Waivers Have Been Granted to UWB and Broadband Devices to Protect Installations, Detect Intruders and Otherwise Promote Homeland Security and Public Safety Goals

Of the six waivers discussed herein, five have been for devices whose purpose is to further national goals such as protecting national security installations, detecting weapons and protecting public safety. 3d-Radar fits this pattern as the device will further the national goal to preserve, rebuild and revitalize the aging U.S. transportation infrastructure. The deployment of 3d-Radar systems will identify where repairs are needed before tragedy strikes. These systems will also promote the maintenance of highways and bridges to better enable transportation of goods and services while also contributing to environmental protection.

V. The Public Interest Will be Served by Granting 3d-Radar's Waiver Request

A. The 3d-Radar Device Represents an Advance in GPR Technology

The 3d-Radar GPR system is designed to measure the underlying supportive strata of highways and airport runways, as well as the integrity of foundations of buildings and bridges. It can detect shifting ground conditions, the presence of underground water, voids and cracks in materials. It can also detect buried cables, pipes and tunnels, and can even detect anti-personnel weapons. Regular and repeated use of such systems will help to discover degraded and dangerous conditions long before they become apparent to the naked eye, thereby facilitating the maintenance of the nation's highway and bridge infrastructure, saving lives and reducing costs.

The 3d-Radar system represents a significant advance over existing GPR technologies. As noted above, its stepped frequency, multiple antenna array system is capable of producing greater image resolution at varying depths, thus resulting in more accurate

readings of sub-surface structures. Its unique antenna array can generate up to 31 simultaneous data profiles for each survey pass, as compared to conventional GPR which can generate only one profile per pass. In addition, the air-coupled antenna array is designed to operate at elevations up to 30 cm off the ground allowing for high speed mobile applications that are critical to many state and federal infrastructure projects.

Moreover, the 3d-Radar system is considerably more cost effective to operate than a conventional GPR device. For example, to cover the same geographic area in three dimensions, a single channel GPR would have to make 30 additional passes for every one survey made by the 31-channel array 3d-Radar. In addition, a conventional GPR would have to change-out its antenna system four times (at 200, 400, 800, and 1600 MHz center frequency) to obtain the same level of penetration and image resolution per pass as the 3d-Radar. This means the 3d-Radar is approximately 120 times more "field efficient" than a conventional GPR. Thus, a road or bridge deck that requires one hour of road/lane closure for the 3d-Radar system will require almost a full week of closure for a traditional single channel GPR.[50]

The 3d-Radar is also more "spectrum efficient" than a conventional GPR. If a single channel GPR is required to make 30 additional passes per antenna system to collect the same data that the 3d-Radar obtains in one pass, it means the conventional GPR is on the air 30 times longer. Any possible interference concern that a spectrum licensee might have with the 3d-Radar system pales in comparison to the concerns it should have for GPRs now on the market.

An additional improvement over conventional GPR is the programmability of the 3d-Radar system to optimize the frequency range for the specific ground conditions being investigated. Raw data can be stored both as time and frequency domain to improve ground structure analyses and allow for the post-processing of image information. With

[50] The need for road closure depends on the level of detail for a study. For example, a survey to locate very small cracks and defects in a bridge deck requires a high resolution survey where the 3d-Radar would be operated at walking speeds. In such cases, road closure would advisable. On the other hand, large network-based surveys intended to generate a coarse overview of pavement can be done at traffic speeds, where no road closure is necessary.

the 3d-Radar system, ground structures can be more accurately characterized in terms of their thickness and quality, base layers, voids and the presence of cables, pipes and similar structures. Conventional impulse GPR devices do not offer these features.

In sum, the 3d-Radar device delivers what no other product on the market today can offer – a safe, cost-effective GPR solution to address many of the national infrastructure initiatives that are of critical importance to the federal and state governments. Without the requested waiver and testing allowance, however, the 3d-Radar device will not be commercially feasible and the U.S. will continue to lag behind the European Union and other countries in terms of GPR technology now being employed for infrastructure repair and renewal.

B. Advanced GPR Techniques are Urgently Needed for National Infrastructure Repair and Revitalization

The public interest argument for the requested waiver is straightforward and compelling. It has been estimated by the American Society of Civil Engineers that automobile repairs due to deteriorating highways cost the public $54 billion every year[51] and, as of 2005, 156,335 of the nation's 595,363 bridges, or 26.3 percent, were structurally deficient or functionally obsolete.[52]

Throughout the U.S., highways and bridges are in a state of decay.[53] More than a decade ago, recognizing the necessity of new methods of improving highway safety, the Transportation Equity Act of 1998[54] set aside $28 billion for much needed maintenance of the interstate highway system and earmarked $250 million for research into innovative

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[51] American Society of Civil Engineers, *Report Card for America's Infrastructure* (2005) at 38, http://apps.asce.org/files/pdf/reportcard/2005_Report_Card-Full_Report.pdf.

[52] American Society of Civil Engineers, *Policy Statement 208 - Bridge Safety* (adopted January 25, 2009), http://www.asce.org/Content.aspx?id=8578.

[53] *See e.g.*, Additional Issues, http://www.whitehouse.gov/issues/additional-issues (visited May 24, 2010).

[54] Transportation Equity Act of 1998 ("TEA") Pub. L. 105-178 (1998).

technologies.[55] Ten years later, the National Institutes of Standards and Technology ("NIST") identified the nation's crumbling infrastructure as a critical national need, proposing to fund research into new technologies to identify decaying roads, bridges and water systems.[56] According to NIST, there is a need for new sensing technologies:

> The need for advanced sensing technologies is *national* because every municipality and state in the nation faces infrastructure management challenges. The need is *critical* because portions of infrastructure are reaching the end of their life-spans and there are few cost-effective means to monitor infrastructure integrity and to prioritize the renovation and replacement of infrastructure elements.[57]

In its proposal, NIST specifically mentions the virtue of ground penetrating radar and suggests it might be too expensive to use routinely.[58] A GPR system like 3d-Radar, however, by maximizing the number of readings in a given area in a given amount of time, reduces that cost considerably.

It is only in the last several years that these staggering infrastructure problems have been addressed. President Obama, in his presidential campaign, promised new infrastructure investment which would also promote hiring. The ARRA stimulus bill designated $27.5 billion for infrastructure repair.[59] The last time any significant funds were dedicated to roads and bridges was with the 1956 Federal Highway Act, popularly known as the National Interstate and Defense Highways Act – a different emphasis for different times, but no less valid today. Rebuilding the infrastructure will provide jobs, strengthen defense, speed disaster relief, enable the rapid movement of goods and services and, as the President has promised, bolster the long term growth of a competitive economy.

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[55] Funding for the TEA was never provided and the Act – to be in effect for six years – was allowed to lapse.

[56] Technology Innovation Program, National Institute of Standards and Technology, *Advanced Sensing Technologies for the Infrastructure: Roads, Highways, Bridges and Water* (June, 2008), http://www.nist.gov/tip/upload/cnn_white_paperfinal.pdf.

[57] *Id.* at 1.

[58] *Id.* at 4.

[59] American Recovery and Reinvestment Act of 2009, Pub. L.111-5, Title XII.

GPR has become an important tool for diagnosing road and bridge decay since it first became commercially available in the early 1970's. As technology has improved, GPR systems have become more accurate and versatile so that today, they are mainstays of state and federal highway maintenance. The 3d-Radar system represents the next generation of GPR technology. It is faster, cheaper to use, more accurate and can diagnose various sub strata layers all at once in three-dimensional imaging. Indeed, it is reasonable to assume that these systems will become the paradigm for GPR devices of the future. At a time when the nation is so committed to finally revitalizing its roadways and bridges, the requested waiver sought in this petition compels Commission approval.

C. The Federal Government is in the Process of Approving the 3d-Radar for Use on Federal Highways

The Federal Highway Administration ("FHWA") has been working with 3d-Radar for the past several years to obtain NTIA authorization to deploy this GPR technology on federal roadways. Under NTIA rules, a federal agency may operate a GPR device without licensing provided the device is properly certified under Commission rules or is the subject of a Commission waiver.[60] Because the 3d-Radar device does not appear to meet the Commission's definition of a UWB device, it cannot be certified without a waiver and thus, would have to operate under an NTIA license.

The approval process for NTIA licensing is complex.[61] Every federal agency with allocated spectrum between 300 MHz and 3 GHz may provide input during this process and can seek to impose its own terms and conditions on any license authorization. Typically, an agency concerned about possible interference to its radio operations would request that its allocations be "notched" out of a device's emissions profile. But if

[60] NTIA, *NTIA Manual of Regulations and Procedures for Federal Frequency Management [Redbook]*, rev. September 2009, Section 7.8.

[61] *Id.* at Section 8. Where equipment is not authorized by the FCC, it is up to the federal agency wishing to use a device that operates in a specific part of the spectrum to file a request with NTIA's Spectrum Planning Subcommittee ("SPS"). The SPS makes its recommendation to the Office of Spectrum Management ("OSM") and, can issue a certification that the spectrum can be used as proposed. The request, supporting data and comments from OSM are then sent to the Frequency Assignment Subcommittee ("FAS"). The FAS then coordinates the approved system with the FCC.

notching is required by multiple federal agencies concerned only with their own spectrum, the broadband features of a device may be defeated and benefits to the public will never be fully realized. This is precisely what is happening with the 3d-Radar device.

Attachment 2 shows the federal bands requested to be notched as a condition for obtaining individual agency consent required for NTIA licensing of the 3d-Radar system. In almost every instance, however, the grounds for notching are based on overly-conservative assumptions about potential interference that have little basis in reality. Because the agencies are not required to justify their notching requests, there is no record of an interference analysis for 3d-Radar or anyone else to review or challenge. In short, FHWA (and 3d-Radar) must contend with a "take-it-or-leave-it" approach that arbitrarily protects federal spectrum without any consideration of the lost opportunity "costs" to the public.

The actual degradation in GPR image resolution from notching is shown in the spectrum plots in Attachment 3. With notching active in the various bands requested by the federal agencies, the subsurface images become blurred due to higher sidelobes and increased "ringing." The high sidelobes are a direct result of spectrum notching and tend to mask important features, making it difficult to interpret the data and accurately measure pavement thickness. In addition, with extensive notching, weak features in sub surfaces may go undetected which can be problematic for both repair and safety concerns. While an important feature of the 3d-Radar system is the ability to notch out sensitive spectrum with software, this feature, taken to the extreme, can result in degrading the most important attributes the system has to offer – high speed surveys with increased image resolution performed efficiently and safely for the benefit of the public.

A waiver of the UWB rules would supplant the agency-by-agency planning process which, thus far, has resulted in the mass notching of usable spectrum and a threatened diminution in some of the 3d-Radar's most important features. A Commission waiver would also allow state and local governments to deploy this GPR technology

for their infrastructure projects, many of which are interrelated with federal efforts. The national highway system is a prime example. With federal and state highways forming one large interconnected grid, it makes sense to use a common GPR technology authorized under a common regulatory scheme. But wideband device licensing is not an option under Commission rules; therefore, it is important to its market success that the 3d-Radar technology not be subject to different, and possibly conflicting, regulations. The Commission can prevent this from happening by adopting one set of "waiver conditions" to govern both the authorization and deployment of the 3d-Radar system regardless of whether it is used on federal or non-federal infrastructure projects. In addition, a waiver will eliminate possible confusion or uncertainty in the market and will serve the public interest by allowing this advanced GPR technology to be deployed throughout the country for national infrastructure repair and revitalization projects.

VI. Conclusion

Based on the foregoing, CWCI respectfully requests that the Commission grant this waiver petition in the public interest.

Respectfully submitted,

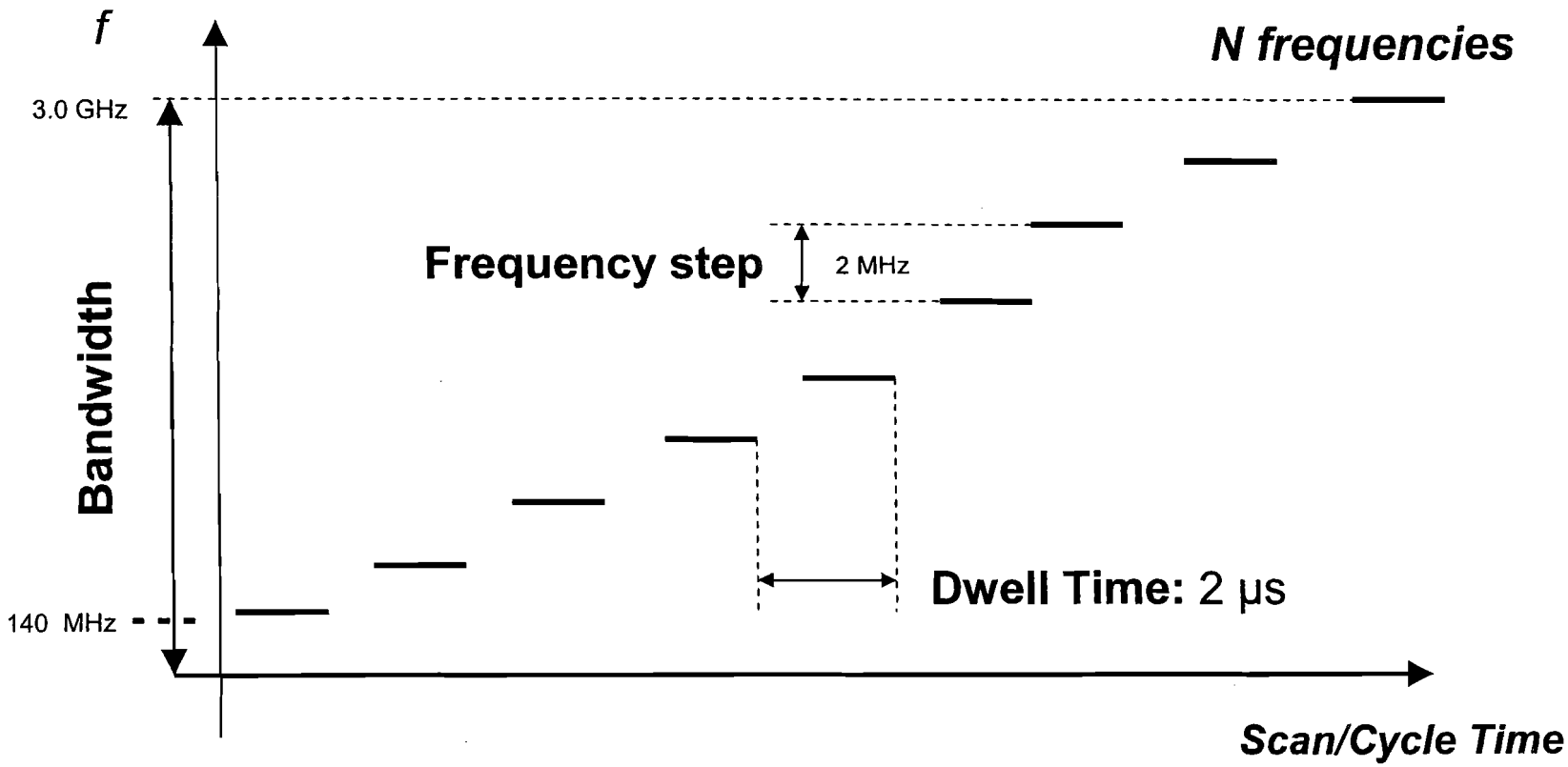
By: _____

Terry G. Mahn
Robert J. Ungar
Joseph Taylor
Fish & Richardson P.C.
1425 K Street N.W.
Suite 1100
Washington, D.C. 2005
(202) 783-5070

Counsel for Curtiss-Wright Controls Inc.

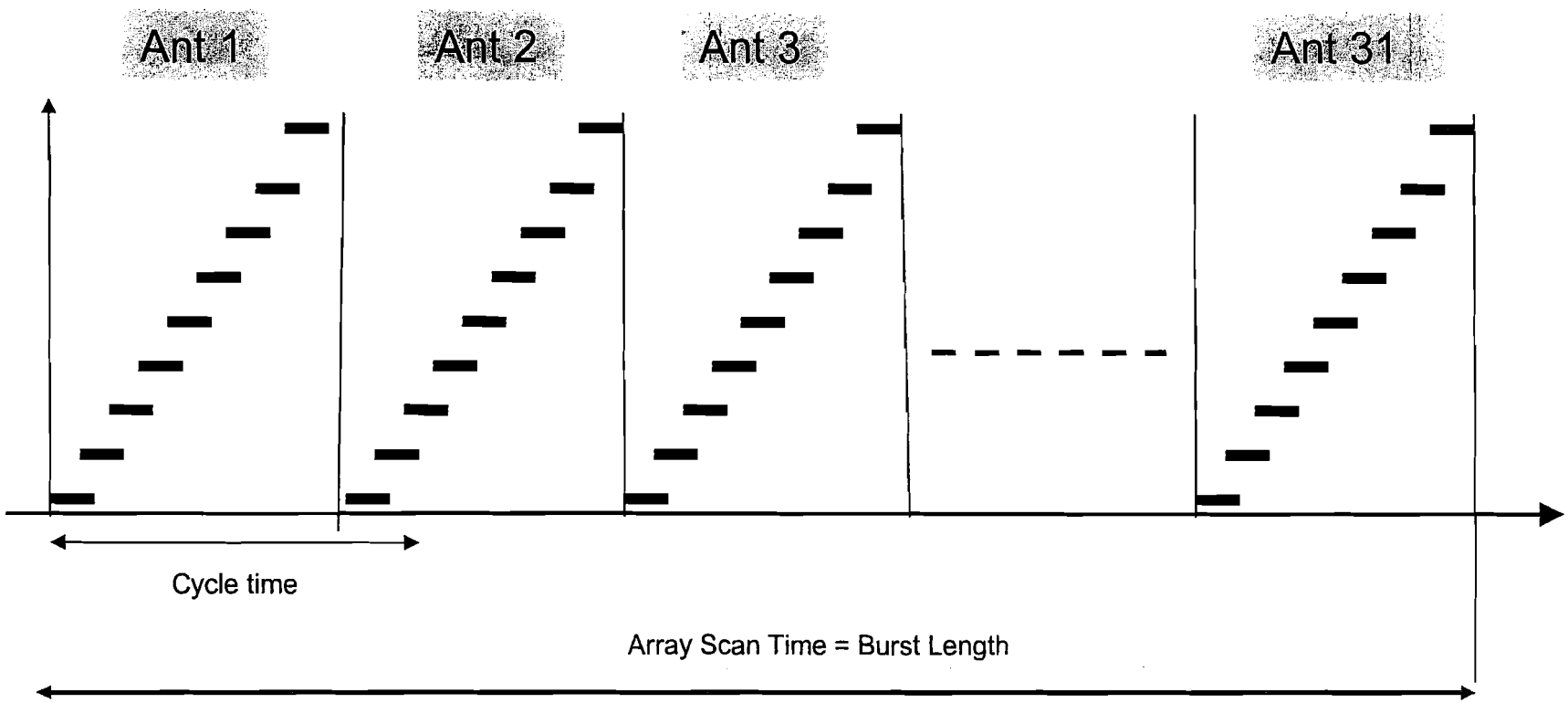
ATTACHMENT 1

Schematic representation of step frequency GPR



Number of steps: 1431
Scan/Cycle time: 2.86 ms

Antenna Array Scan



Scan/Cycle repetition rate: 300 Hz

ATTACHMENT 2

Notched Restricted Bands

Frequency Range	Purpose
161 - 174 MHz	Land Mobile Operations
328.6 – 335.4 MHz	Aeronautical radionavigation operations
406-406.1 MHZ	SARSAT
406.1 – 420 MHz	Land Mobile Operations
608 – 614 MHz	Radio astronomy
960 – 1215 MHz	Aeronautical radionavigation operations
1240-1370 MHz*	Aeronautical surveillance radars
1400 – 1427 MHz	Radio astronomy
1559 – 1610 MHz	Aeronautical radionavigation operations/GPSL1s
1660.5-1668.4 MHz	Radio astronomy
2025-2110 MHz	Meteorological satellite
2200-2290 MHz	Aeronautical telemetry/Space ground link sub/Satellite earth stations
2290-2300 MHz	Deep space network facility
2700-2900 MHZ*	Next gen weather/airport surveillance radar/ASR-11
2900-3000 MHz*	Maritime radar

*These notches are anticipated to be implemented based on proximity to relevant facilities via GPS.

Restricted Bands Not Notched

1645.5 – 1646.5	Mobile satellite
1718.8 – 1722.2	Fixed and Mobile
2310 – 2390	Radiolocation Broadcasting Satellite
2483.5 – 2500	Mobile satellite

Unrestricted Bands Notched

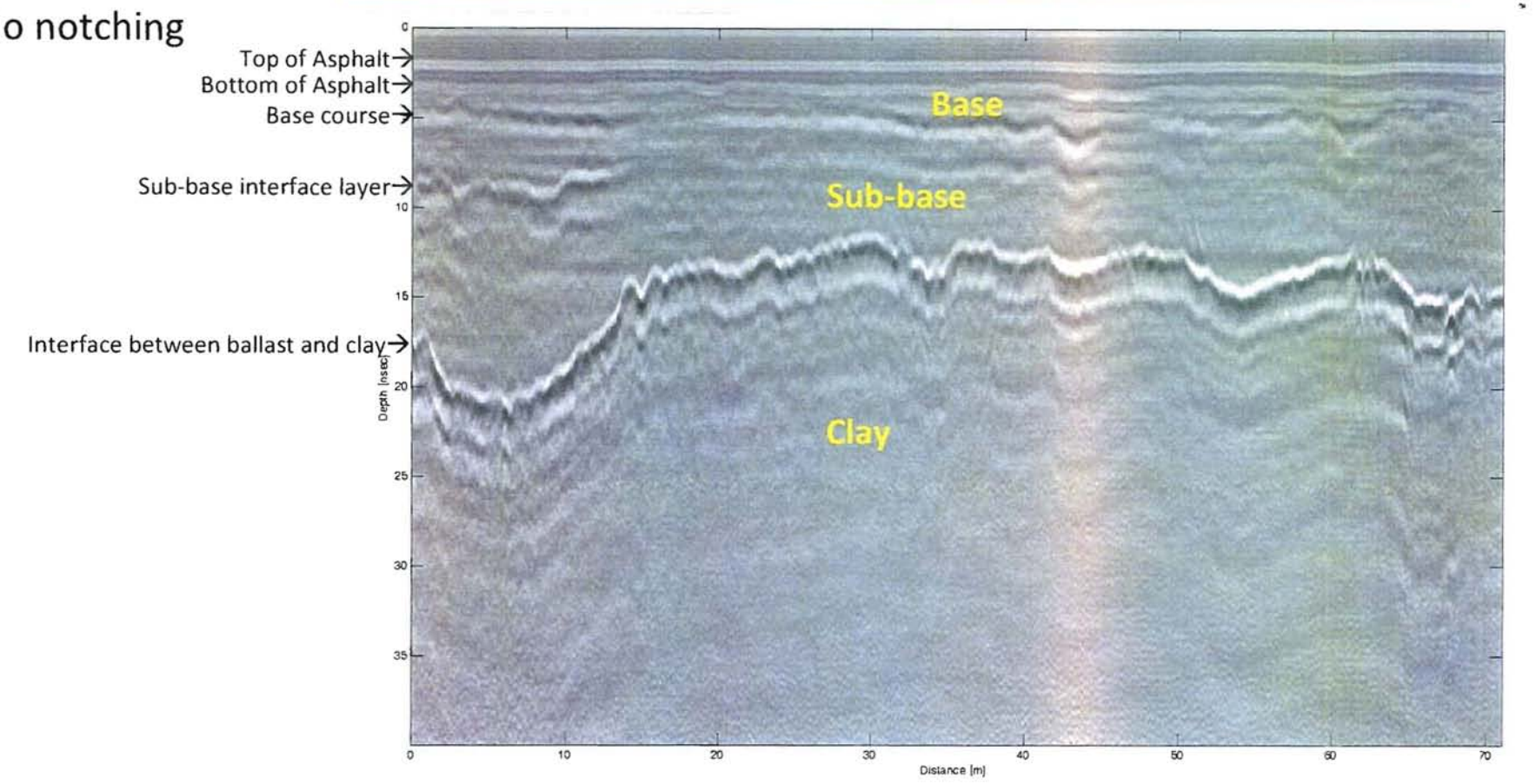
161-162.0125	Land mobile
173.2-174	Land mobile
410-420	Land mobile
1240-1300	Aeronautical surveillance
2025-2110	Meteorological satellite
2900-3210	Maritime radar

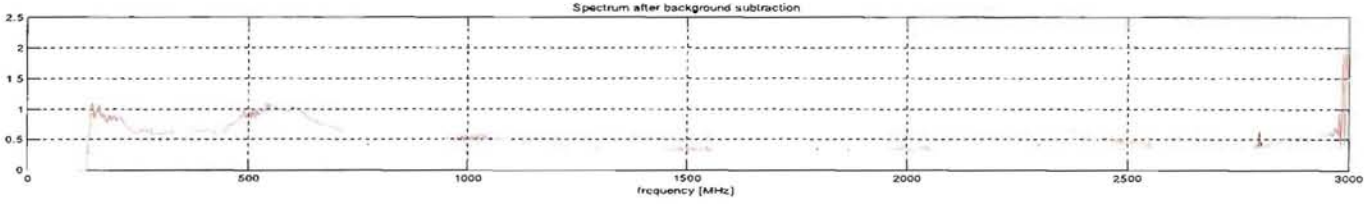
ATTACHMENT 3

Notching disabled

Radargram (vertical profile from road section)

No notching



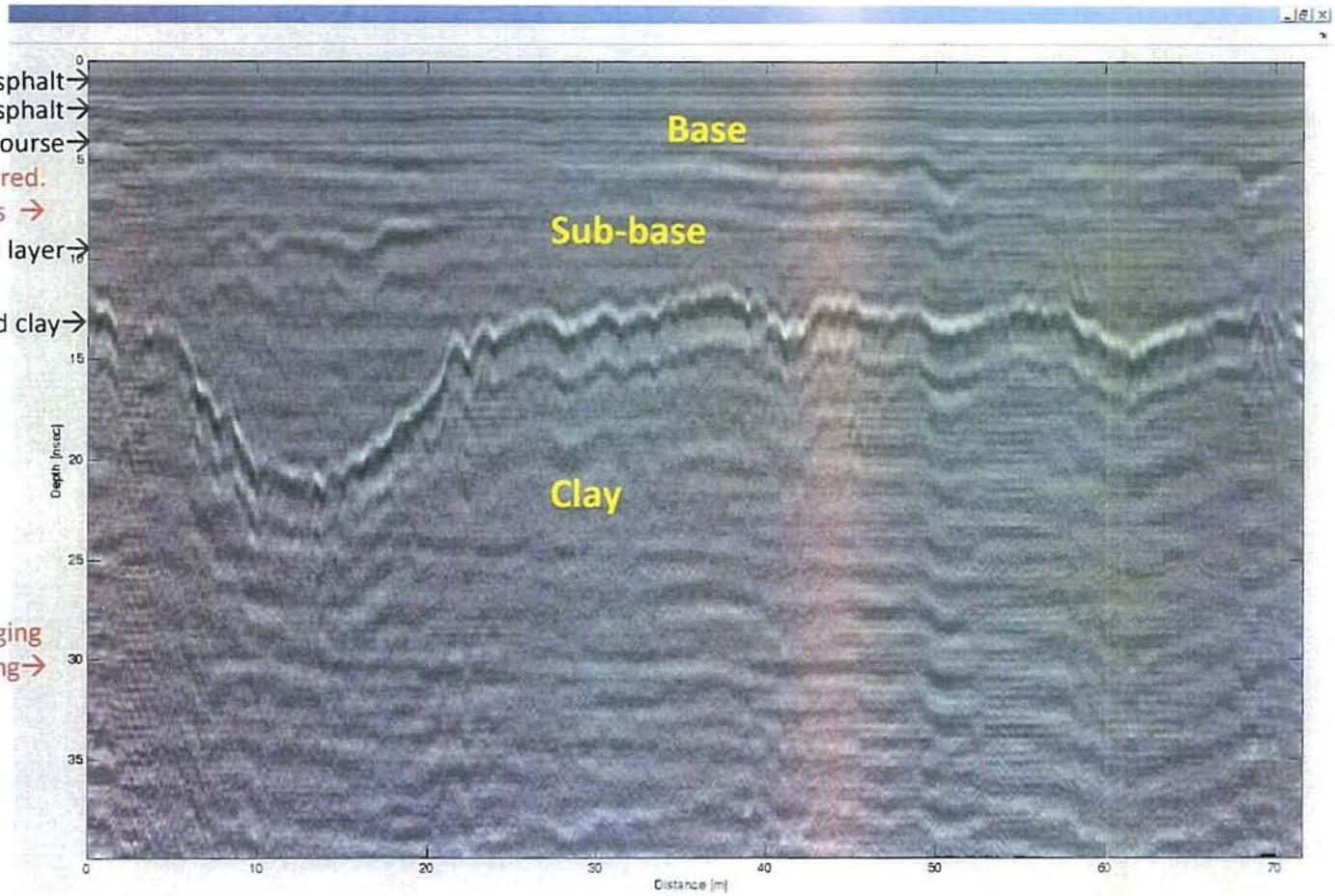


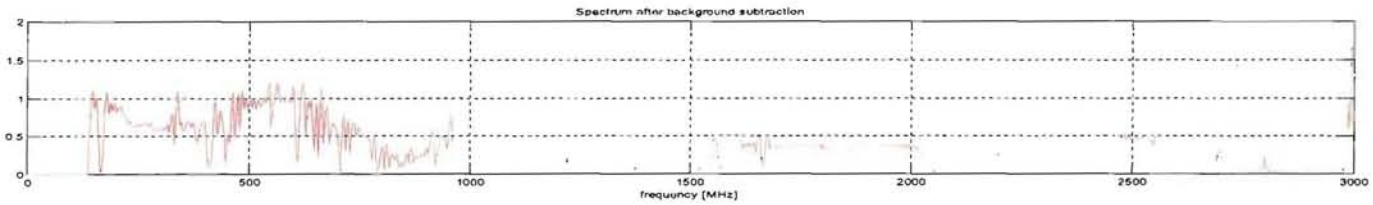
Received frequency spectrum with continuous data

Notching enabled

Radargram (vertical profile from road section)

Top of Asphalt→
Bottom of Asphalt→
Base course→
Image is much more blurred.
Difficult to measure asphalt thickness →
Sub-base interface layer→
Interface between ballast and clay→
Increased sidelobe level and ringing due to the effect of notching→





Received frequency spectrum with frequency notches causing "holes" in the spectrum.