Memorandum

To: Kwok Chan

CC:

From: Steve Elliott

Date: 06/29/01

Re: Request to substitute routine RF exposure evaluation with information and analysis

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Summary

3Com corporation would like to request that the following analyses and supporting information be substituted for routine RF exposure evaluation for the Palm VII device (FCC id: DF63C80500). The fundamental reason for this request is that the Palm VII is designed with a very small transmitter battery making it impractical to support MPE measurements.

The characteristics of the device with respect to this analysis can be summarized as follows (items are numbered as in the response from Kwok Chan to our original memo):

1. The device uses a non replaceable, low capacity NiCd battery as a transmit energy source. This battery is re-charged by user replaceable AAA batteries. The re-charge algorithm in the device measures the NiCd battery voltage under load (while transmitting) and forces the user to stop transmitting and wait for a re-charge to complete before RF operation is again allowed. Figure 1 plots conducted device output power against time starting with a freshly charged NiCd until the point at which the device will not allow further RF activity (this happens when the loaded NiCd voltage drops below 4.06 volts). Plots have been provided for a typical transmit duty cycle of 7% (figure 1a) and a worst case duty cycle of 79% (figure 1b).
2. At best case (very early in life) this NiCd battery will supply approximately 100 cumulative seconds of transmit energy after a 70 minute charging time (initial charge). It quickly settles into a typical charge/discharge cycle of 60 minutes charging for every 60 seconds of cumulative transmission. Figure 2 (attached) shows a chart comparing available transmit energy verses charge times for the first 25 cycles assuming a discharge duty cycle of 79%.
3. The Palm VII measured EIRP is 4.94 W (3 W ERP).
4. The Palm VII device operates on the Mobitex packet data network. This is a contention based network in which many devices are expected to contend for and share a single physical channel. (or more correctly a channel “pair” since separate channels are used for transmit and receive). As such, the transmit duty cycles for each user device tend to be quite low. However, because of retries, transmit duty cycles can momentarily go much higher than the typical case. In a previous memo (attached) we examined 3 protocol scenarios of interest for SAR considerations. To summarize the findings, a Palm VII device would experience a transmit duty cycle of :
   - 8% over 6.7 seconds for a typical query/response transaction
   - 36% over 34 seconds for a maximum size e-mail up-load without retries

- an upper limit of 79% with worst case retry requests from the base station. This could persist for at most 132 seconds due to the capacity limitation of the NiCd.

5. The Palm VII device operates as an RF device only when the user holds the device in their hand and raises the antenna above 45 degrees at which point a position detecting switch allows the RF circuits to be energized. This, along with the re-charging behavior of our transmit energy source is called out numerous times in our user manual. The following references are provided:
   - Information on NiCd recharging – pages 10 and 231
   - Information on the antenna switch and proper use of the antenna - pages 16, 233

6. Based on Mr. Chan's response to our previous memo, we will add the following statement as an insert into our user manuals:

Note
The Palm VII™ organizer is for handheld use only, with the antenna positioned as specified in the handbook. By design, the transmitter becomes active only when the antenna is raised, approximately, beyond 45 degrees. To meet the FCC RF exposure requirement for mobile transmitting devices, we recommend that you be at least 10 inches away from all persons (except hands, wrists, feet, and ankles) when you use the organizer with the antenna raised.

The distance recommended above is based on the formula Kwok provided and 4.94 W EIRP as measured for the Palm VII.

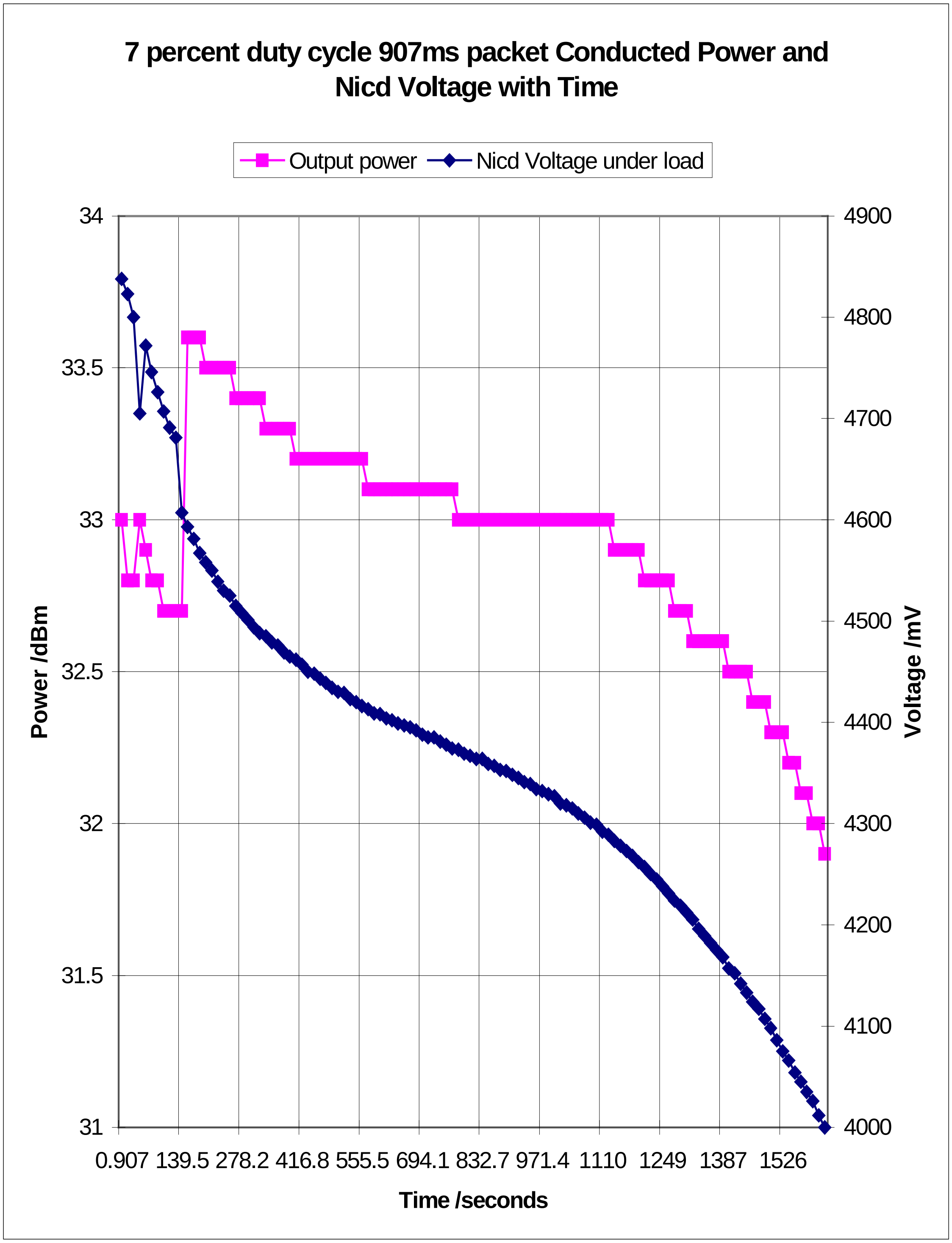

Figure 1 (a) Conducted power verses time (7% duty cycle).

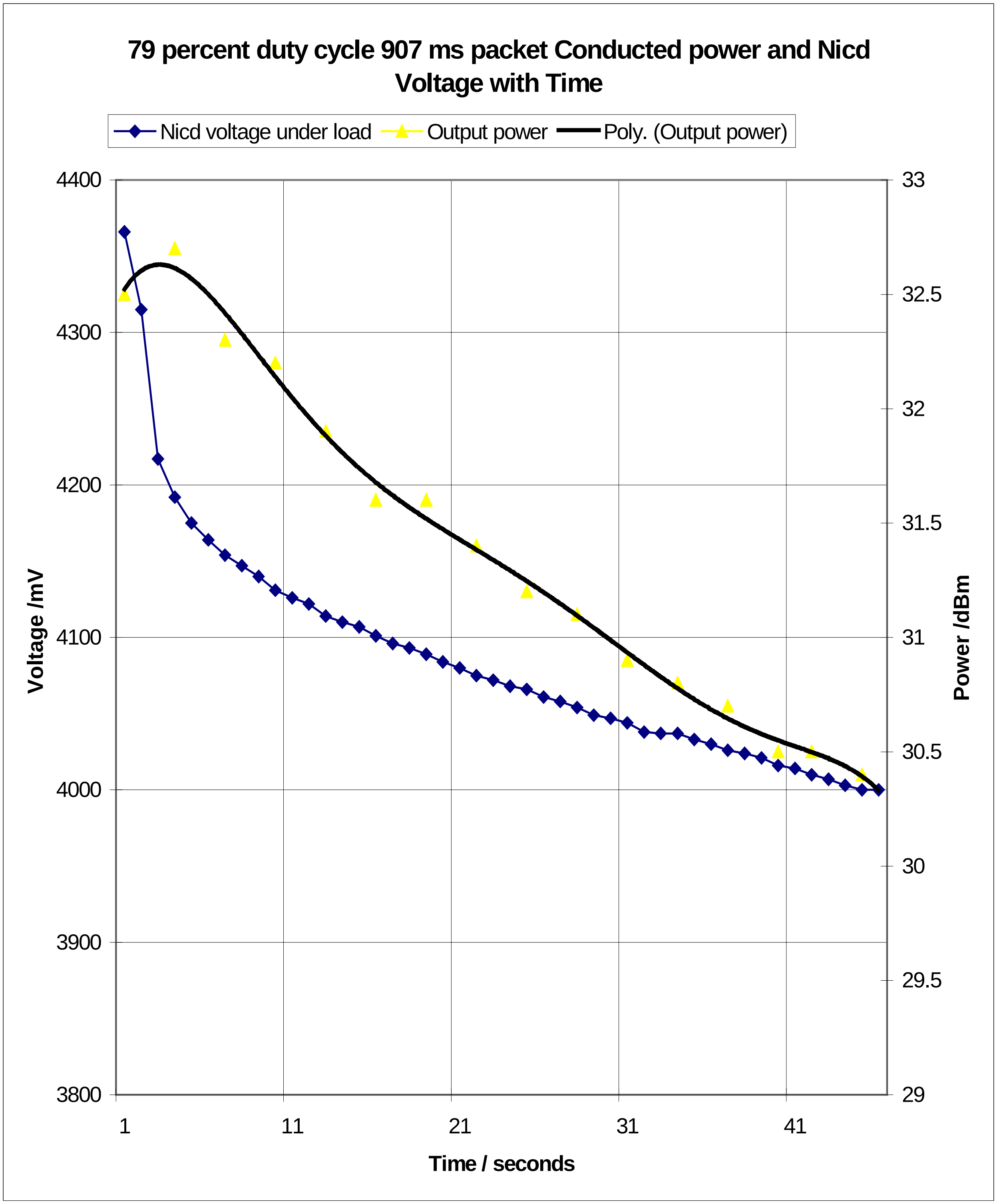

Figure 1 (b) Conducted power verses time (79% duty cycle).

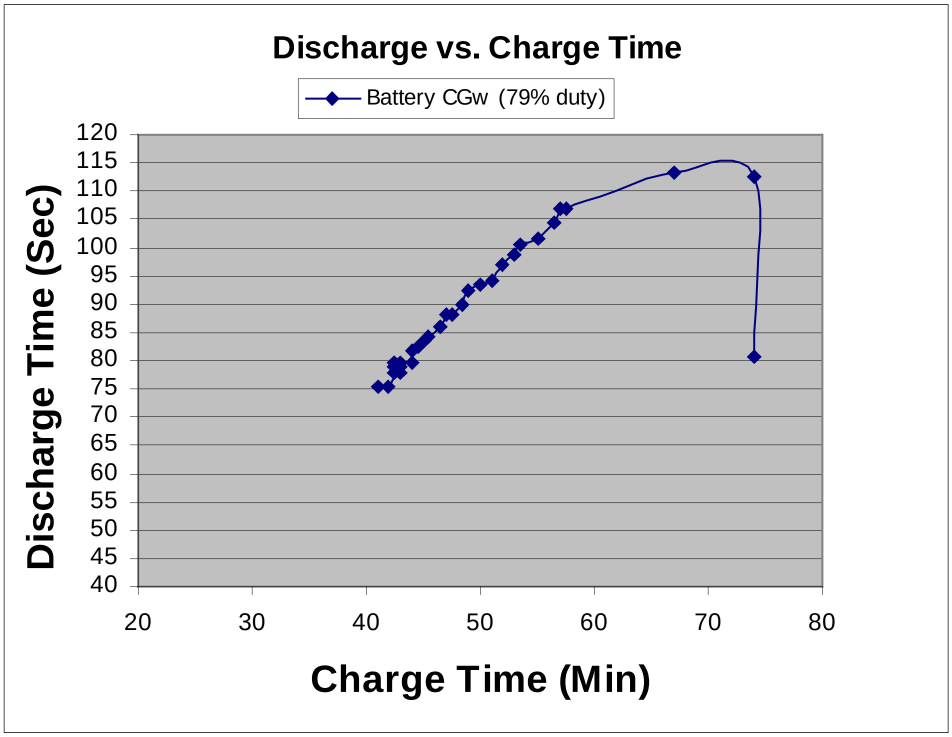

Figure 2 – Transmit (discharge) time verses recharge time.

Appendix 1 – prior memo

Memorandum

To: Kwok Chan

CC:

From: Steve Elliott, Ed Vertatschitsch

Date: 06/29/01

Re: Description of the operating characteristics of the Palm VII wireless PDA

Summary

Using a 30-minute period for General Population/ Uncontrolled Exposure, the maximum radiation is 104 seconds at 2W – a maximum duty factor of 6% (104/1800). The typical duty cycle is 2-8% based on our data (total transmission time of 245 to 515 mSec over a duration of 6.77 to 15.05 seconds). A detailed analysis of how these results were obtained follows.

Background

The Palm VII is a handheld wireless personal digital assistant. It is approximately 3.25 inches wide, 5.25 inches tall and 0.7 inches thick. It includes an integrated half-duplex packet radio and a flip-up antenna. The device operates on the BellSouth Wireless Data packet radio system in accordance with the Mobitex protocol for mobile terminals. The device transmits in the band 896-901 MHz and receives in the band 935-940 MHz. Modulation is an 8-kbps GMSK waveform of BT=0.3. Peak deviation is +/- 2 kHz and channel spacing is 12.5 kHz. The Palm VII operates in a similar manner and at the same power levels as other devices on the North American Mobitex network such as the RamFirst pager by RIM FCC ID L6AR900M-2-PQ.

Individually calibrated at the factory, the device can transmit up to 2W measured at the input to the antenna. The antenna is a 4" blade. The field strength of the Palm VII was measured at a 3 meter distance using a tuned dipole antenna for both vertical and horizontal polarization. These measurements were made by Spectrum Technologies for FCC part 90 certification.The highest level measured was found with vertical antenna polarization. The maximum peak field strength level is:

dBuV/m	132.17
Field Strength @ 3meters	4059756 uV/m

Energy for the RF power amplifier comes from four 1/3-AAA NiCd batteries. The user does not have access to the NiCd stack and it is not user replaceable. The NiCd can only be recharged from the two-AAA alkaline batteries under software control. The hardware therefore limits the total amount of energy provided to the power amplifier and rest of the radio.

Under the worst-case scenario, a brand new NiCd battery (first or second charge), on our most efficient device could transmit up to 104 seconds before requiring a 60-minute recharge. A typical device provides approximately 68 seconds of RF power at 2W between recharges, when transmitting large messages. It should be noted that these times do not represent continuous transmission times, but rather the total capacity of the transmitter energy source. As will be seen in the following analysis the maximum duty cycle of the transmitter for our device approaches a limit of 79% under a worst case communication protocol scenario.

A microswitch detects the antenna position. When the antenna is below 45 degrees the software prevents the unit from powering any RF circuits and therefore prevents wireless activity. The Palm VII is designed as a "query/response" device. This means that the user initiates all wireless activity. Paging-like services are **not** supported. When the device is stored in a pocket or purse, the RF circuits are not on. Unlike cellular/PCS telephones, the Palm VII is not held against the head or body while in use.

Two primary applications are provided on the device; wireless e-mail, and web-like information access. To make a query, the user would fill out information in a pre-loaded form on the device or enter a new e-mail and then tap a "submit" or "send" button on the screen. The device transmits this query after requesting access. The BellSouth network routes the request to one of our servers which fetches the information and returns a response to the device. A typical request from the device is 50 to 200 bytes of information. The entire query response sequence would be as follows:

Step	Time	Transmitter Keyed?
Wait for access	250 mSec (avg)	
Switch from Rx to Tx + slot delay	200 mSec (avg)	
Tx ACTIVE	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Ack	37 mSec	
Wait for access	250 mSec (avg)	
Switch from Rx to Tx + slot delay	200 mSec	
Tx access request	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Grant	37 mSec	
Switch from Rx to Tx	20mSec	
Transmit request	97-367mSec (3-12 blocks)	Yes
Server delay	4-12 sec	
Receive Response	1 sec	
Switch from Rx to Tx	20 mSec	
Transmit ACK	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Wait for Access	250 mSec	
Switch from Rx to Tx + slot delay	200 mSec (avg)	
Transmit INACTIVE	37 mSec	Yes

As can be seen this results in a total transmission time of 245 to 515 mSec over a duration of 6.77 to 15.05 seconds. The transmit duty cycle during this time is between 2% and 8%. This is very typical for a shared access, contention based, half-duplex packet data network. The device must switch between transmit mode and receive mode and must follow the rules for channel access, both of which significantly limit the ability to transmit inbound data.

While the typical case indicates a very small transmit duty cycle, for SAR considerations we need to examine a couple of other scenarios. Although most query responses are small, it is possible for the device to deliver an inbound e-mail of a maximum allowed size of 5k bytes. The largest allowed packet is 512 bytes. Thus, a 5 kbyte message would be divided into 10 full size packets which would be sent back to back without intervening server delays. The following sequence would occur:

Step	Time	Transmitter Keyed?
Wait for access	250 mSec (avg)	
Switch from Rx to Tx + slot delay	200 mSec (avg)	
Tx ACTIVE	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Ack	37 mSec	
Wait for access (start of repeat)	250 mSec (1st access, 750 mSec 2nd through 10th)	
Switch from Rx to Tx + slot delay	200 mSec	
Tx access request	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Grant	37 mSec	
Switch from Rx to Tx	20mSec	
Transmit 1 packet	907 mSec (32 blocks)	Yes
Switch Tx to Rx	20 mSec	
Receive Ack	37 mSec	
Repeat the above 9 additional times	(2.028 seconds each with transmitter on 1.004 sec)	
Wait for server response	5-13 seconds	
Transmit ACK	37 mSec	Yes
Wait for Access	250 mSec	
Transmit INACTIVE	37 mSec	Yes

In this case 5k bytes of data would be delivered inbound over a period of 25.7 to 33.7 seconds with the transmitter keyed for 9.2 seconds yielding a duty cycle of 27 to 36 percent.

The BellSouth network has two types of retries. With the first type the base station requests a re-send of a given packet which the device sends back immediately. This happens when the packet is partially decoded. The second type of retry occurs when the packets are not heard at all by the base station. The device re-sends these messages after a time-out period. Each of these types of retries has its own max retry counter. For the first type (re-send) the max counter is 5 (initial try + 5 re-sends). For the second type (time-out retry) the max counter is 4 (initial try + 4 time-out retries).

While it is extremely unlikely that both types of retries would repeat to their maximum counts, it is possible in theory, and results in an absolute worst case transmit duty cycle. The pattern would be <1st attempt>, <re-send #1 on 1st attempt>, <re-send #2 on 1st attempt>, <re-send #3 on 1st attempt>, <re-send #4 on 1st attempt>, <re-send #5 on 1st attempt>, (timeout) <2nd attempt>, <re-send #1 on 2nd attempt>, <re-send #3 on 2nd attempt>… <re-send #5 on 5th attempt> resulting in 30 transmit bursts for each packet.. The resulting sequence for a 5 kbyte inbound message is:

Step	Time	Transmitter Keyed?
Wait for access	250 mSec (avg)	
Switch from Rx to Tx + slot delay	200 mSec (avg)	

Tx ACTIVE	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Ack	37 mSec	
Wait for access (start of the two repeat Sections – time-out retries and new Packets)	250 mSec (1st access, 750 mSec each time-out retry, 750 mSec each new packet	
Switch from Rx to Tx + slot delay	200 mSec	
Tx access request	37 mSec	Yes
Switch from Tx to Rx	20 mSec	
Receive Grant	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit 1 packet	907 mSec (30 blocks)	Yes
Switch from Tx to Rx	20 mSec	
Receive Re-send Request	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit re-send #1	907 mSec (30 blocks)	Yes
Switch Tx to Rx	20 mSec	
Receive Re-send Request	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit re-send #2	907 mSec (30 blocks)	Yes
Switch Tx to Rx	20 mSec	
Receive Re-send Request	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit re-send #3	907 mSec (30 blocks)	Yes
Switch Tx to Rx	20 mSec	
Receive Re-send Request	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit re-send #4	907 mSec (30 blocks)	Yes
Switch Tx to Rx	20 mSec	
Receive Re-send Request	37 mSec	
Switch from Rx to Tx	20 mSec	
Transmit re-send #5	907 mSec (30 blocks)	Yes
Switch Tx to Rx	20 mSec	
Timeout on 1st 4 tries	0 (captured in 750mSec above)	
Repeat above 4 more times with the longer access time The following Ack causes success on the last try.	Each is 6.911 seconds with Tx key time = 5.479	
Receive Ack 5th try only	37 mSec	
Repeat the above 9 additional times With the longer access time	(34.555 seconds each with transmitter on 27.395 sec)	
Wait for server response	5-13 seconds	
Transmit ACK	37 mSec	Yes
Wait for Access	250 mSec	
Transmit INACTIVE	37 mSec	Yes

In this case the 5k byte message would be delivered inbound over a total time of 350 to 358 seconds. The transmitter would be keyed for 274 seconds yielding a transmit duty cycle of 76 to 78%. If we remove the initial access delays and the server delay it becomes evident that the transmit duty cycle of the BellSouth network approaches the absolute limit 79% (27.395/34.555).

As mentioned above, this sequence is extremely unlikely. It requires that each packet have a block error rate such that it is decoded by the base station well enough for the base station to ask for all possible re-sends, the last re-send is not heard at all which results in a time-out and finally on the fifth attempt of these groups of 6 send/re-sends the message is correctly received. In addition, the device must have good enough coverage to correctly receive each acknowledgement and network access grant. This process must be repeated for all 10 unique packets. Failure to receive any one of the unique packets within the described retry constraints results in termination of the entire transaction. User interaction is required continue.

Once a transaction is terminated (either because it is successful or timed out) the user must manually initiate another transaction since the device will not queue up more that 5 kBytes of messages and automatically send them.

The preceding analysis describes a theoretical worst case transmission profile for the Palm VII device from a radio protocol perspective. However, recalling from page 1 of this memo that the maximum capacity of the transmit energy source in the device is 104 seconds best case, it becomes evident that the device would never complete such a transmission attempt. Instead, it would get about 1/3 of the way through and halt the transmission because a re-charge would be required. Use of the device would be blocked for the 60 minute (approx.) recharge time.

The limiting factor then for the Palm VII is the capacity of the NiCd transmit energy source. Considering the worst case 30-minute period for General Population/ Uncontrolled Exposure, the maximum radiation is 104 seconds at 2W – a maximum duty factor of 6% (104/1800).

Please feel free to contact either Ed or myself if further details or clarification of this analysis is required.