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High-Efficiency Toilets in Commercial Applications

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Bill Gauley, P.Eng.
Veritec Consulting Inc. (a Miya Group Company)
Mississauga, ON, Canada

Background

- Even though they flushed a lot of water, the performance level of gravity-operated 3.5-G toilets was only fair
  - everyone had a plunger in the house
  - plugging and double-flushing occurred
- The flushing performance of commercial (flush valve-operated or flushometer) toilets was much better than gravity models

Background (con't)

- Move to 1.6-G models
  - Now the performance of gravity-operated toilets was EVEN WORSE!
  - Commercial toilets still offer superior flushing performance
- Drainline carry requirements based on fact that there didn't seem to be too many problems with 3.5-G units
  - If it worked for them (3.5-G), it will work for us (1.6-G)

How was Drainline test derived

- We didn't seem to be have problems with 5-gallon toilets
  - 5 major models averaged 58 feet of carry
- 5 most popular 3.5-G models avg. 47 feet
- Based on these results, the ANSI task force proposed a 40-foot carry requirement
  - i.e., requirement not based on what is required, but what was being achieved!

Drainline testing?

- Well – testing in a sense.
- We know that as flush volumes decrease the waste carry distance also decreases
- In fact, while flush rate has some effect on carry distance, by FAR the biggest factor is flush volume
- So – how far should a toilet be expected to carry waste?

Residential vs. Commercial

- The current ASME standard involves flushing 100 polypropylene balls (1/4”) down a toilet, through a 4” plastic drain pipe (2% slope)
- Average carry distance must be at least 40 feet (some balls may still be in toilet, others will be completely discharged from the pipe.
- Realistic? Meaningful? Based on...

A little like -

Important

- Drainline carry is important because there are 2 primary concerns with how toilets work –
  - How well do they flush?
  - How far do they transport waste?
- How much do we really know about these questions?

Flushing Performance

- The MaP testing program addressed flushing performance for residential toilets
  - Realistic solids
  - 4 balls of toilet paper (6 sheets each ball)
  - Set minimum at 250g
- Fine for residential, but...

Res vs. Comm

- Currently, the flushing performance and drainline carry requirements (as per the Standard) are the same for both residential and commercial toilets.
- A bit strange given that the physical operation of these 2 types of toilets is completely different (pressures, flow rates, supply piping, etc.)
- And, the duty factor that they are exposed to is completely different.

Testing should fit the need

- If testing is to be meaningful (for any product) it needs to be realistic
  - commercial-grade products are typically a little more robust (wheelbarrows, shovels, drills, trucks, etc.) – but not toilets
- Should be separate tests for residential and commercial toilets
  - Both for performance & drainline carry

So, we did some product testing

Valves

- Sloan Uppercut (1.6-G)
- Sloan Uppercut (HET)
- TOTO TMT 1NNC (1.6-G)
- TOTO TEC 1 GNC (HET)
- Sloan Crown II (1.6-G)
- Kohler Sensor (HET)
- Sloan Gem (HET)

Bowls (floor)

- A.S. Madera (HET)
- Vortens Vienna Flux (1.6-G)
- Kohler Wellcomme (1.6-G)
- Crane Whirlton (1.6-G)
- Eljer Signature (1.6-G)
- Kohler Highline (HET)
- Kohler Highcliff (1.6-G)
- Kohler Wellworth (HET)
- Zurn (HET)

Gravity Toilets

- Toto Drake
- Eljer Titan
- Vitra Dual-flush
- Eaga
- Stonehouse
- A.S. Flowise D-F
- Kohler Cimarron

Head to Head Comparisons

- Raw MaP Media
- Cased MaP Media
- Floating MaP Media
- “Super” Log (not lumber)
- Mixed Media (Certification)
- Paper Hand Towels
- Slurry (guess what this simu
- Feet of Toilet Paper
- Ball of Toilet Paper at front

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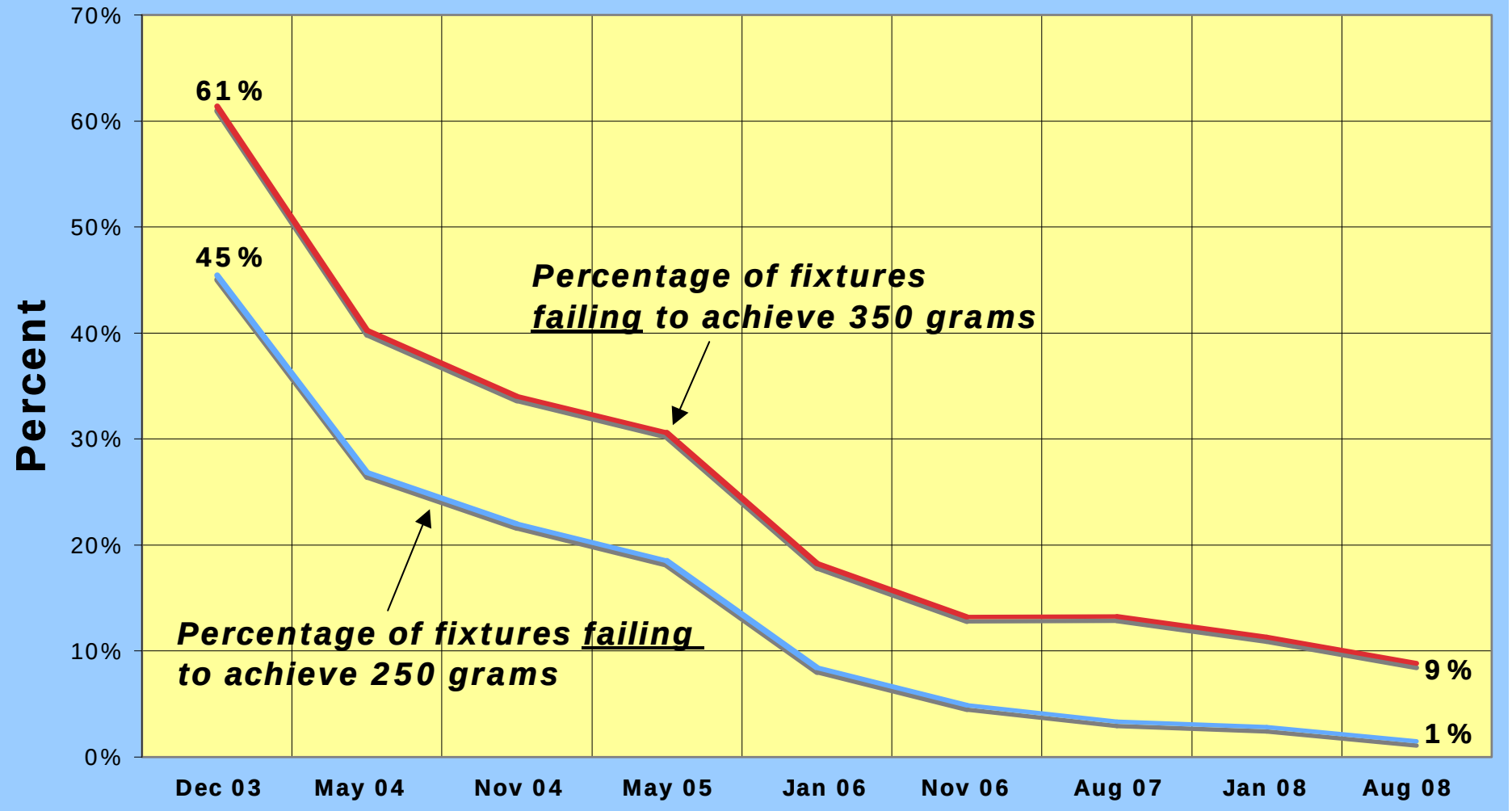
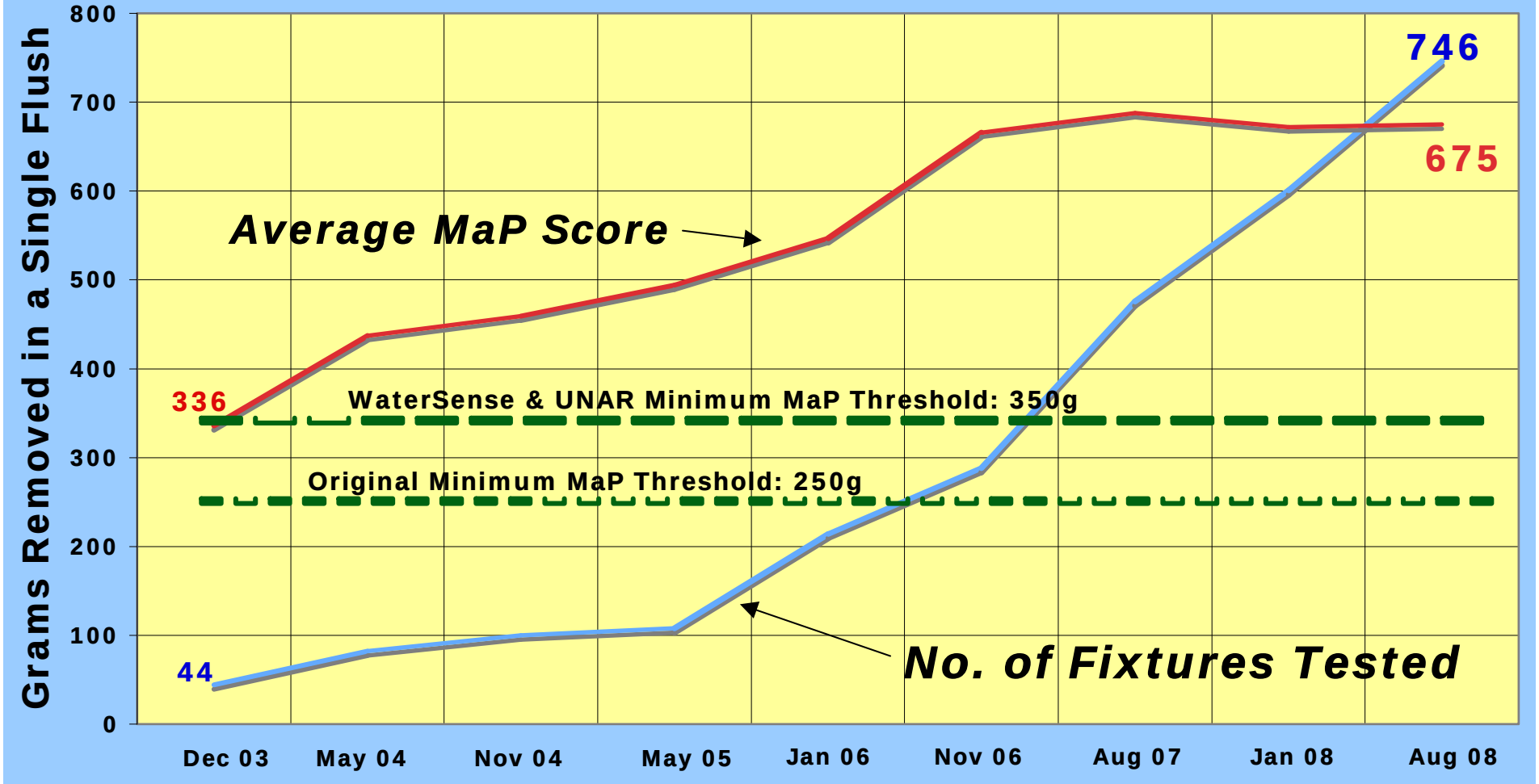
Results

- In EVERY test the performance of gravity toilets equaled or exceeded that of commercial models
- Surprising?
- Would have been surprising 10 years ago.
- Gravity models have improved so much in the last few years that they can routinely outperform commercial models
  - and they don’t need a larger supply line or minimum pressure

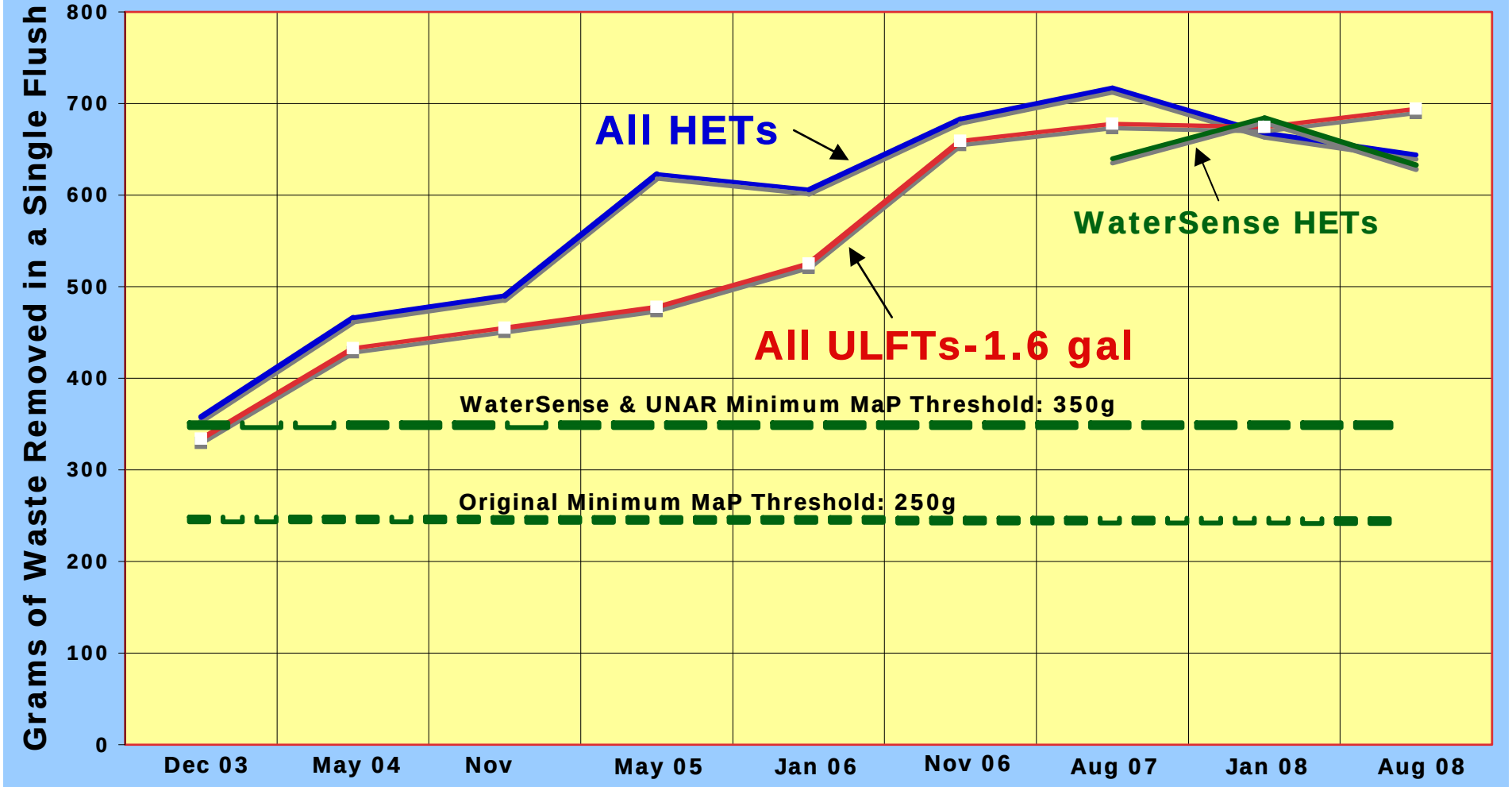
Percentage of MaP-tested fixtures failing to meet minimum performance



Toilet Fixtures Tested - Average MaP Score



Average MaP Scores - 2003 to 2008



HET vs. 1.6-G Commercial

- The performance of commercial HET toilets was slightly less than the performance of the 1.6-G models
- BUT – HET performance levels will certainly meet (or most likely exceed) expectations of the end user.
- Performance is not the issue!

Is there an issue?

- Remember – 2 issues
  - Performance (res & comm)
  - Drainline carry (res & comm)
- Previous drainline carry studies (using realistic test media) indicated that, if the drain piping is installed properly, HETs will transport waste further than needed in residential applications
  - We may be able to further lower flush volume

Drainline in Commercial Applications

- Residential – 3” pipe, 2% slope, supplemental flows (all good)
- Commercial – 4” pipe, 1% slope, little supplemental flows (not so good)
- Residential – we can estimate approximately how far waste should travel in “normal” home
- Commercial - ???????

How Far?

- In an effort to develop a drainline carry requirement for commercial toilets, a number of “experts” were asked for their opinion of how far a toilet SHOULD be expected to transport waste in a commercial building.
- Answer: Too many variables!
  - Distances, slopes, bends and dips, other flows, etc.

Tipping Point

- We know that flush volume is a primary factor in drainline carry
- We are not experiencing too many drainline problems at this time
- We know (if we continue to lower the flush volume) there will be problems at some point.
- Where is that point - the tipping point?

How was Drainline carry requirements developed?

- Ironically, of all the performance tests contained in ANSI A112.19.2, the drainline carry test has the most field validity. Its requirement correlates to the [proven] performance of 5-1/2 gpf WCs – which everyone knows worked. The test was developed by determining the actual carry capability of 5-1/2 gpf toilets in a laboratory environment where [using the current ANSI standard test protocol] it was determined that those old “gas-guzzler’s” maximum carry capability was 58 feet. Based on this knowledge, the WG dropped that down to 40 feet recognizing that other drain tributaries also fed fluid to help flow and the belief that 5-1/2 gpf toilets probably used more water than needed. (Bruce Martin)

Err on the side of caution

- Not too scientific (3/4-inch balls?)
- Provides no indication where the cut-off (tipping point) is.
- We experienced problems with the introduction of the 1st 1.6-gpf toilets in North America.
- Is guessing a valid solution?

Do Commercial HETs Work?

- Commercial HETs have been proven to meet flushing performance expectations (fortunately, we can test this in the lab)
- The jury is out regarding how low of a flush volume we can have in commercial toilets and avoid problems in the field.
- Maybe it's 1 gallon?
- But then again, maybe the lowest acceptable limit is 1.6 gallons!!

Hard to go back...

- A blindfolded man is standing on the top of a large cliff
- He asks another man nearby how many steps he can take without falling off the cliff
- The man says, “Keep walking until you fall off the cliff and then take one step less.”

Raw MaP Media Comparison, g

6L (1.6-G) Valves	6L-Bowls	600g
HET Valves	6L-Bowls	350g
6L (1.6-G) Valves	HET Bowls	472g
HET Valves	HET Bowls	300g
Gravity		800 – 1,000g

Cased MaP Media Comparison, g

6L (1.6-G) Valves	6L-Bowls	975g
HET Valves	6L-Bowls	810g
6L (1.6-G) Valves	HET Bowls	900g
HET Valves	HET Bowls	694g
Gravity		1,000g

Floating MaP Media Comparison, g

6L (1.6-G) Valves	6L-Bowls	473g
HET Valves	6L-Bowls	290g
6L (1.6-G) Valves	HET Bowls	545g
HET Valves	HET Bowls	276g
Gravity		500 - 800g

Super Log Media Comparison, g

6L (1.6-G) Valves	6L-Bowls	244g
HET Valves	6L-Bowls	202g
6L (1.6-G) Valves	HET Bowls	250g
HET Valves	HET Bowls	238g
Gravity		250g

Certification Sponges Comparison, passes out of 7 trials

6L (1.6-G) Valves	6L-Bowls	7.0
HET Valves	6L-Bowls	6.5
6L (1.6-G) Valves	HET Bowls	5.7
HET Valves	HET Bowls	4.6
Gravity		6 to 7

Hand Towel Comparison, number of paper towels

6L (1.6-G) Valves	6L-Bowls	7.5
HET Valves	6L-Bowls	5.5
6L (1.6-G) Valves	HET Bowls	6.5
HET Valves	HET Bowls	4.5
Gravity		6 to 10

Seat Cover Comparison

6L (1.6-G) Valves	6L-Bowls	2.5
HET Valves	6L-Bowls	1.6
6L (1.6-G) Valves	HET Bowls	2.4
HET Valves	HET Bowls	1.7
Gravity		3 to 5

Metres of Toilet Paper Comparison, m

6L (1.6-G) Valves	6L-Bowls	9.7
HET Valves	6L-Bowls	8.6
6L (1.6-G) Valves	HET Bowls	9.5
HET Valves	HET Bowls	8.7
Gravity		10 (max)

Ball of Toilet Paper above Bowl Water Level – Front of Bowl

6L (1.6-G) Valves	6L-Bowls	1.9
HET Valves	6L-Bowls	1.6
6L (1.6-G) Valves	HET Bowls	1.9
HET Valves	HET Bowls	1.6
Gravity		3.0

- **Slurry Test Comparison**
  - All models (1.6-G and HET and Gravity) were able to pass 250g of soybean paste mixed into 1.0 litres of water and slowly poured into bowl.
  - Not surprising. Almost all toilets can flush water.

Conclusions / Recommendations

- While there was a definite ‘performance edge’ associated with flushometer toilets in the past, this is no longer the case
- There should be different certification criteria for commercial vs. residential toilets
  - Commercial fixtures are subjected to a harsher environment and should have to pass a more rigorous set of tests
  - Gravity models that meet these requirements should be able to label themselves as “commercial grade”

Con't

- There is no innate reason that flush volumes should be the same for commercial and residential toilets
- While we are comfortable with the drainline carry abilities of residential HETs we have no idea how close we are to crossing the line where we will begin to experience drain problems with commercial toilets.
- Maybe commercial toilets should continue to flush with 1.6 gallons?

con’t

- Manufacturers still need to do a little work to improve commercial HETs (based on the improvements made to gravity models I have little doubt that they will succeed)
- Flushing performance is not the main issue
- Drainline carry MAY be the issue (need guinea pigs for the next couple of years)
  - If no problems in the field, then let’s endorse use of commercial HETs.

Thank you

Questions?

Bill Gauley, P.Eng.
bill@veritec.ca