WHAT IS SENSORY ANALYSIS?

The use of ***people*** as ***instruments*** to ***measure*** sensory response to stimuli.

Flavor defined by Morton Meilgaard

"the term used to describe the complex interaction of taste, smell, and chemical irritation of foods in the mouth that add to its mouth-feel, such as carbonation, the burn of chili peppers, or the coolness of menthol"

Flavor is made up of:

Basic Tastes

Aromatics

- Olfactory stimulation
- Trigeminal nerve stim

Mouthfeels

- Chemical or physical sensations
- Astringent, dry/tannin, bite, burn, etc

What *can* we taste?

- Sweet
- Sour
- Salty
- Bitter
- *Umami*
  - response to salts of glutamic acids like MSG. Processed meats, cheeses, and soy sauce also contain glutamate

The “receptor map” is dead!

Hanig 1901, turned over by Collings, 1974

Can you smell sweet?

- Perception of flavor is a combination of sensory stimuli
  - Basic Tastes 5%
  - Smell is 90%
  - Touch 1% (trigem)
  - Balance is vision, hearing, etc

No, you can't!

But, Aroma can be an *Indicator* of flavor

Trigeminal & Tactile Sensation

- Carbonation
  - Related to level, partial pressure
  - Pain
  - Can increase perception of bitterness
- Fullness
  - Function of residual solids
  - Dextrins and Oligosaccharides (complex sugars)
- After feel
  - Astringency
  - Pain (chili peppers)

Aroma:

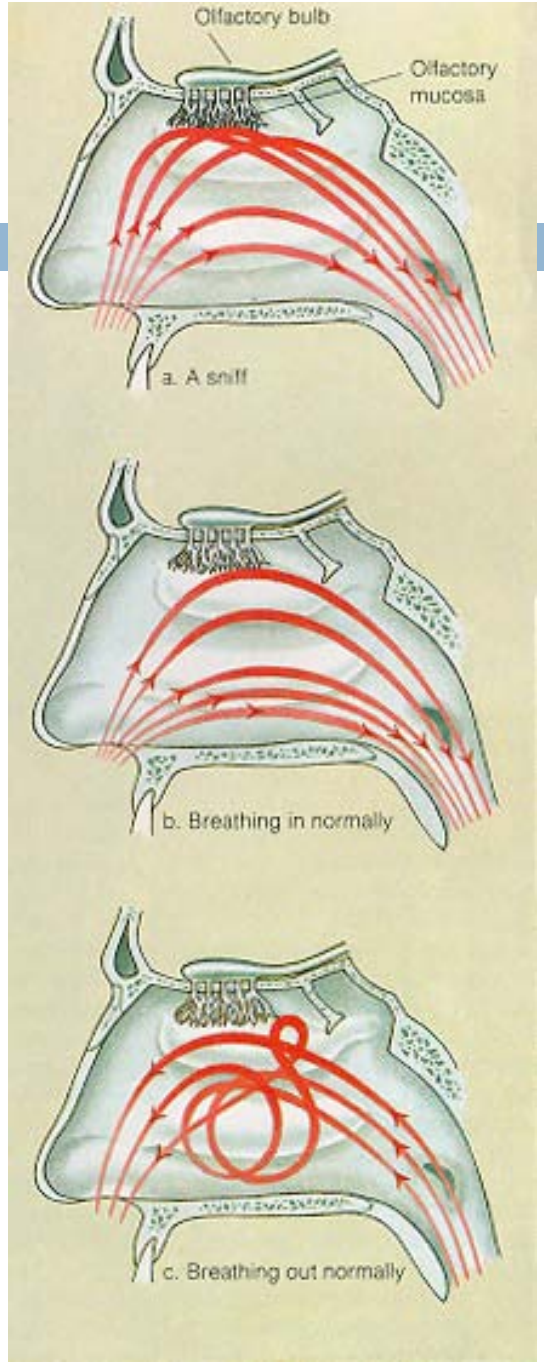
- The human nose is very sensitive

  More sensitive than a gas chromatograph!

- Perception changes based on situation

- Smell with sniffs in short burst for 1-2 seconds. After this receptors become saturated and can require 20 seconds +/- to reset

- Don’t forget to exhale



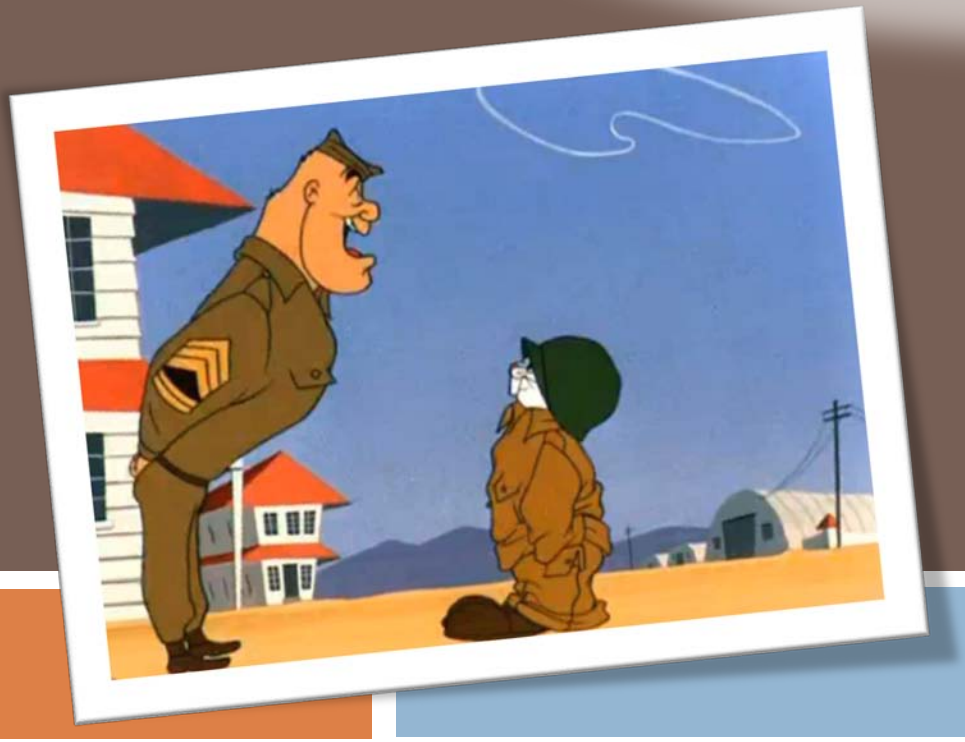
The Flavor Unit

- Concept introduced by Dr. Morton Meilgaard
  - Recognized 100's of compounds in beer
  - There are different thresholds for chemicals we can taste.
    - Example:
      - Ethanol — 50 grams / Liter (50,000+ ppm)
      - S-Methyl Mercaptan — 4 nanograms per Liter!! 10^{-9} grams per Liter (.0000001 ppm!)
  - Need a way to compare
    - One flavor unit = the starting threshold that a compound can be detected by the olfactory
    - Ethanol at 50 grams/Liter = 1 flavor unit
    - S-Methyl Mercaptan at 8 nanograms per Liter = 2 flavor units

Allows apples to apples comparison

BASIC TRAINING

What it comes down to is everyone who touches your beer should know how to talk about your beer!



WHO?

- Beer school for all new hires
- Brewer / Cellar / Lab
- Packaging
- Sales / Marketing
- Distributors
- Festivals / Tours / Promotions

HOW and WHEN?

- Schedule Panels as Meetings
  - Keep Consistent - same time and location
  - Goal is Regular Attendance

- Work it in so people look forward to it
  - End of Meetings
  - Shift Changes
  - Break in the Day

BEER SCHOOL

WHAT MAKES YOUR BEERS SPECIAL

- What is in it?
- Appearance / Aroma
- Taste / Flavor Characteristics / Aftertaste
- Style / Alcohol % / IBU
- Availability
- Food Pairings

YOUR BEER?

- Know the aroma and flavor characteristics of all your beers
  - MALTS
  - HOPS
  - YEASTS
  - SPICES

Whatever is in it have available for reference

Vocabulary & Recognition

- Use reference standards
  - i.e. spikes, aroma vials, malt, hops
- Repetition is the key to learning
- Don't Rush It!
  - Build vocabulary slowly to take pressure off
- Spikes
  - These are your Lego Blocks!

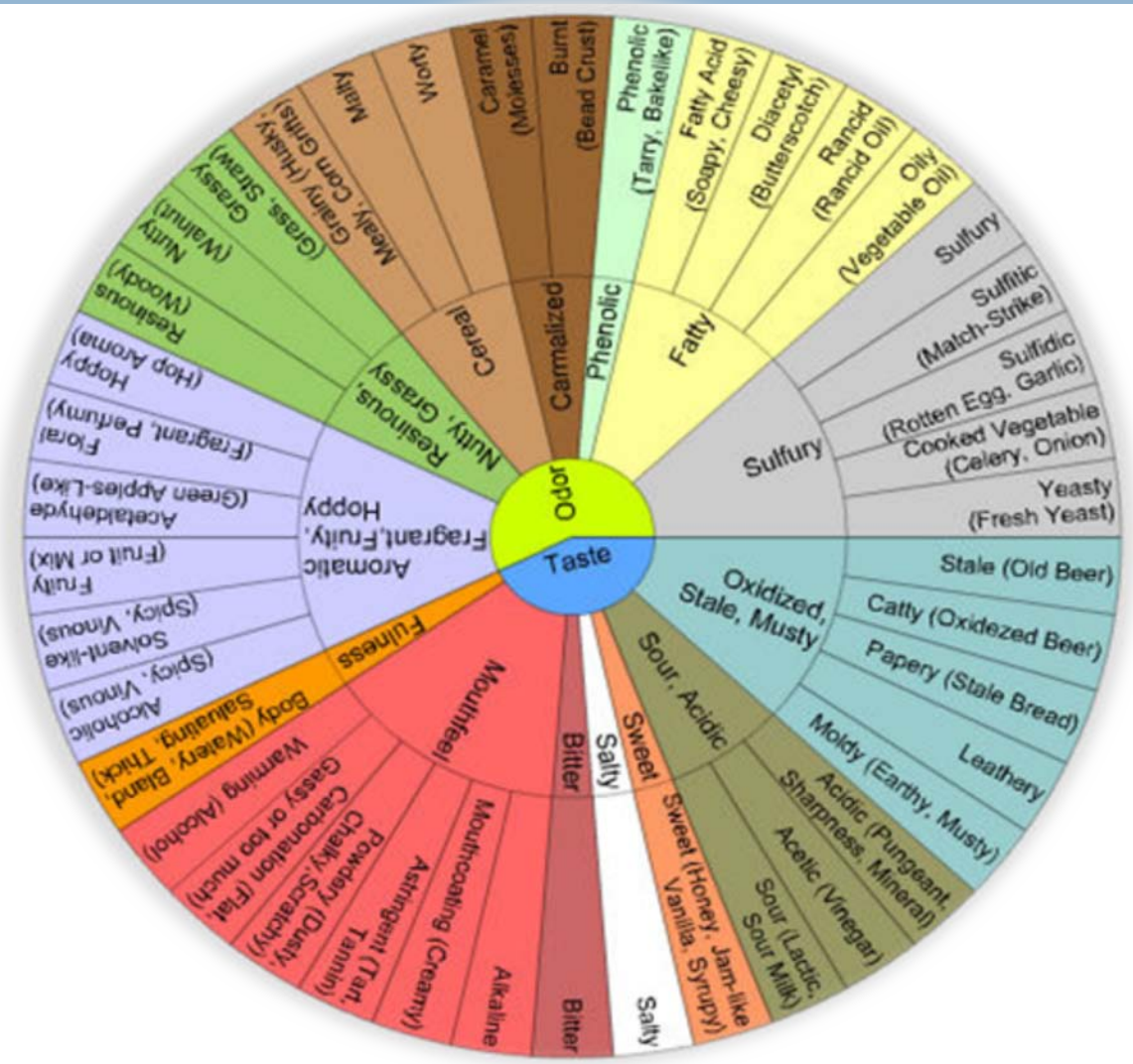
Teaching What and Why

- Common off aroma / flavor checks
  - Diacetyl Rests
- Aroma and tastings through-out the brewing processes
  - From Wort to Package
- Technical Feedback
  - True to Brand / Consistency

BUILDING BLOCKS

- No Pressure Panels
- Build up your own Attribute Library
  - Everyone Participates / Good Motivator
- Lower threshold levels
- Different Styles
- Oxidation Stages
- Brand Recognition

Flavor Wheel



SETTING UP FOR SUCCESS

Teach the Basics and Share as Much as Possible

APPEARANCE (Clarity and Chill Haze)

AROMA

SERVE AT AN APPROPRIATE DRINKING TEMPERATURE

TASTE (Don't DRINK!)

Scoring System

AFTERTASTE

We don't spit beer!

BLIND TASTING (Fair and Good Practice)

LIMIT THE NUMBER OF BEERS TO AVOID TASTEBUD BURNOUT

PALATE CLEANSERS (Plain Crackers and Water)

LEARN / TEACH TO NOT FINISH THE WHOLE SAMPLE

MOTIVATION

- **Change things up / variety**
  - Different types of Panels
    - Aroma Vials, Spikes, Triangle Tests, Preference
  - Everyone learns differently
- **Positive Rewards**
- **Feedback and Guidance**
- **SERIOUS BUSINESS BUT FUN!**

TRAINING, VALIDATION AND FEEDBACK OF A PRODUCTION/MARKET RELEASE PANEL

Cathy Haddock

Sensory Specialist Quality Assurance Dept. Sierra Nevada Brewing Co.

CBC Annual Meeting, 2011

Why is it important to have a trained and validated panel?

- **A trained sensory panel is a valuable instrument; each taster being a unique tool in the toolbox.**
  - Can not rely on just 1 opinion. Everyone has their own sensitivities.

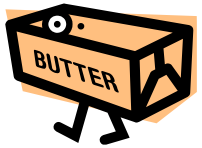
- **Example: Brew master who is blind to diacetyl is the sole taster for release of product to market. Not good!**

What is a Production Release Panel?

- Production Release Panel-a trained panel that evaluates product to be release to market.
- Panel can use various quality control tests such as a go-no go, in/out yes/no, pass/fail, quality ratings, etc. format.

Training Process- Production Release Panel

- If you are on the Production Release Panel you must be trained and validated on off flavor recognition and brand attribute!!



What to train with??

Train using spiking compounds.

- Flavor Activ…quick, easy, good shelf life, but costly, cost varies per compound.
- Seibel Training Kit….quick, easy, shorter shelf life (2 months-refrigerated), 25 vials for $180.
- Sigma Aldrich Flavor and Fragrances Kit-some dilution prep work. 22 vials for $473. No DMS or Acetaldehyde. Good shelf life.

Next Steps

- Identify what key flavors and off flavors are important and train on those compounds.
- Recommend spiking and training with a flagship brand, as well as any other brands if time and expense is available.

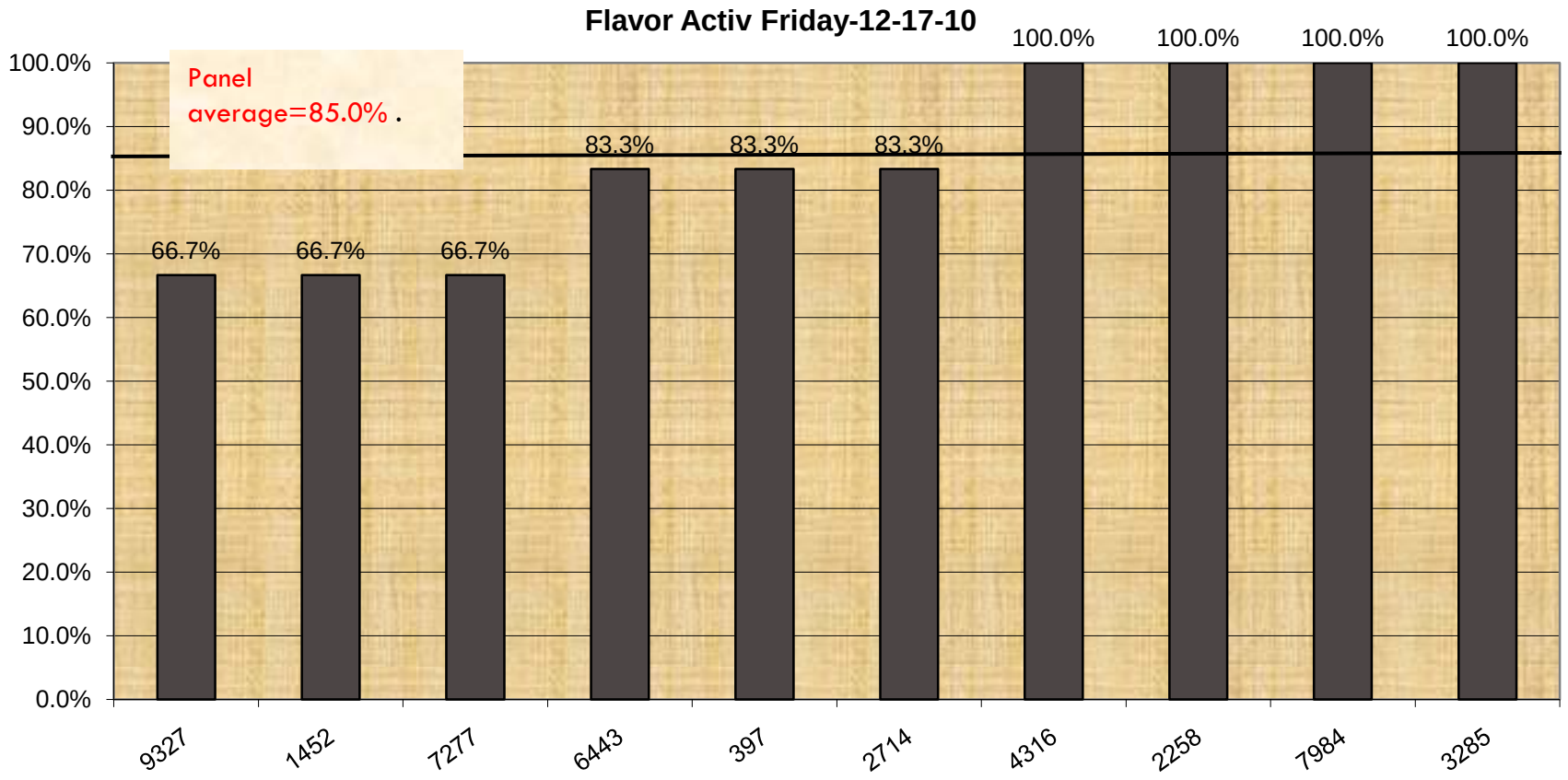
A spiking in one brand, can come across different in another brand.

Types of Training and Test Methods

Types of Training/Validation Methods:

- **Off Flavor Recognition Testing**-present panelist with spiked beer samples for evaluation and identification. *Recommend 6 samples in a session.*
- **Brand Attribute**-training with pantry reference standards, one-on-one and group exercises.
- **Sensitivity Threshold Testing-**provides training on how compounds are perceived at various concentrations as well as gain insight on panelist sensitivities.

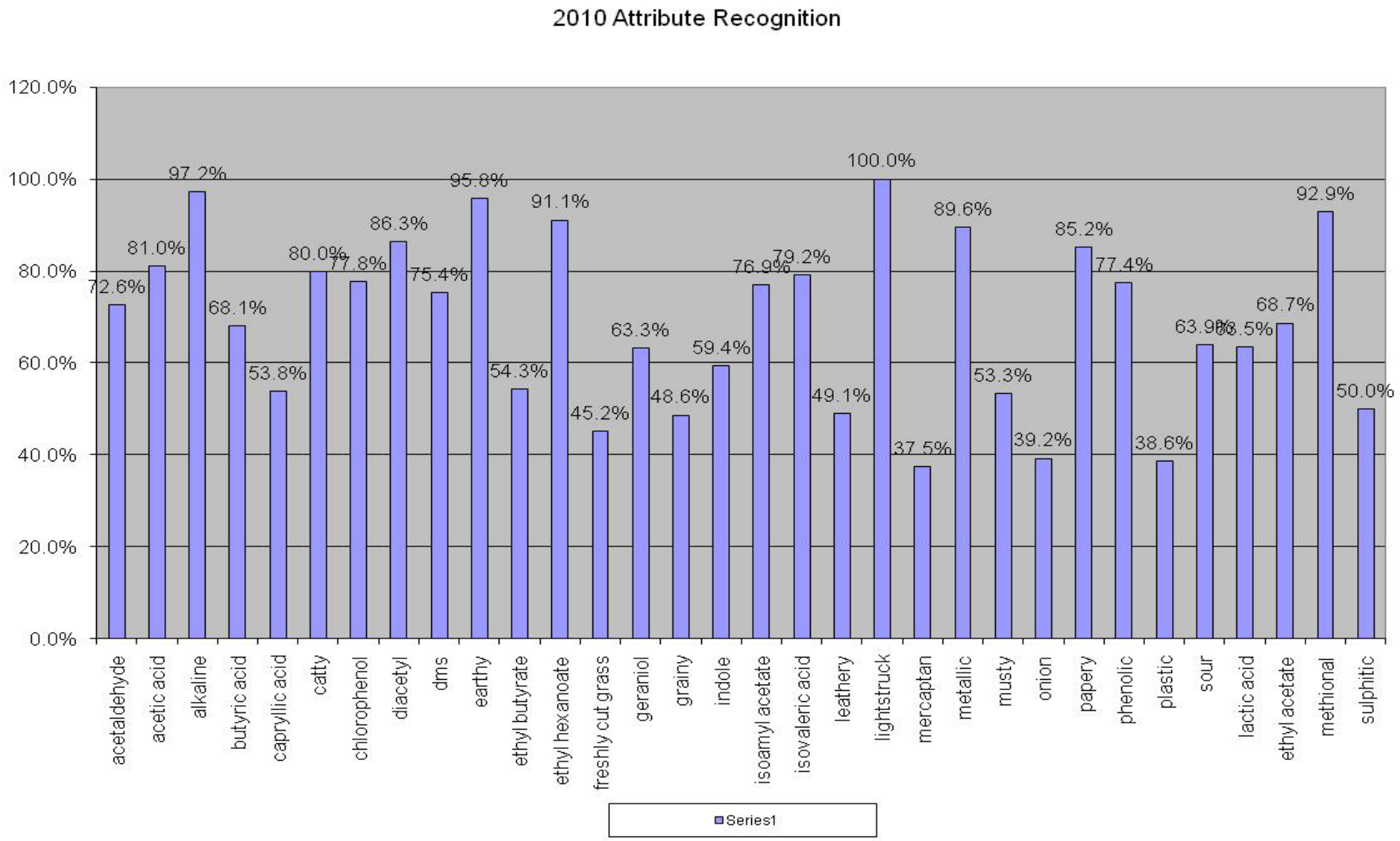
Tasters report from test session-taste panelists are known by a 4 digit code



Off Flavor Recognition- Spreadsheet

8/13/2010	8/27/2010	10/15/2010	10/22/2010	11/5/2010	11/19/2010	12/3/2010	12/17/2010	2010 avg		2009 avg	2009/ 2010avg
				62.6%				72.6%	acetaldehyde	39.5%	55.8%
				75.0%				81.0%	acetic acid	91.8%	84.0%
			100.00%					97.2%	alkaline	76.9%	69.2%
				75.0%				68.1%	butyric acid	59.7%	63.7%
								53.8%	capryllic acid	80.4%	#DIV/0!
	87.50%					90.9%		80.0%	catty	91.7%	76.5%
	87.50%				88.9%		90.0%	77.8%	chlorophenol	82.5%	80.9%
	87.50%				100.0%			86.3%	diacetyl	97.2%	97.5%
		62.50%						75.4%	dms	78.1%	59.2%
87.50%					100.0%			95.8%	earthy	81.7%	80.4%
		62.50%						54.3%	ethyl butyrate	72.6%	68.0%
		87.50%					90.0%	91.1%	ethyl hexanoate	86.7%	83.4%
								45.2%	freshly cut grass	62.5%	8.2%
			85.70%					63.3%	geraniol	72.3%	74.5%
75.00%					44.4%			48.6%	grainy	57.0%	42.2%
		50.00%				45.5%		59.4%	indole	58.6%	30.9%
87.50%					77.8%			76.9%	isoamyl acetate	82.7%	81.3%
	62.50%					81.8%		79.2%	isovaleric acid	68.8%	74.3%
37.50%					44.4%		70.0%	49.1%	leathery	59.7%	50.9%
			100.00%				100.0%	100.0%	lightstruck	94.4%	97.2%
	37.50%					18.2%		37.5%	mercaptan	43.0%	32.3%
		75.00%				90.9%		89.6%	metallic	82.2%	88.1%
		37.50%					80.0%	53.3%	musty	69.5%	62.9%
25.00%				37.5%				39.2%	onion	36.1%	35.9%
62.50%				87.5%			80.0%	85.2%	papery	86.9%	87.4%
				62.6%				77.4%	phenolic	61.4%	37.3%
			37.50%					38.6%	plastic	23.5%	33.5%
	50.00%					54.5%		63.9%	sour	64.2%	46.5%
			50.00%					63.5%	lactic acid	66.6%	66.6%
			50.00%					68.7%	ethyl acetate	65.0%	65.0%
								92.9%	methional	81.7%	81.7%
								50.0%	sulphitic	62.5%	58.4%
62.50%	68.75%	62.50%	70.53%	67.52%	75.92%	63.63%	85.00%	70.3%		64.2%	64.8%
										easy	75-100%
										mod	56-75 %
										hard	0-55%

Charts allow visualization of taste panel recognition abilities.



Brand Attribute Training

- Determine what are the key attributes in your brand and associated descriptors.
- Find Reference Standards to demonstrate those attributes.

  Example: Fruit note in Sierra Nevada Pale Ale is our yeast; make yeast cake and serve side by side with the beer.

- As a Panel, discuss changes in those attributes in different ages of beer.

Threshold Testing-
ASBC Method of Ascending Limits

- 6 triangle tests
- Go from lowest to highest concentration with threshold in the middle.
- Test samples increase in concentration, usually 2-fold.
- Get Best Estimate Threshold of group; geometric mean of the highest concentration missed and next higher (adjacent) concentration.
- Get an individual and panel BET average.
- Take into account amount of compound in beer matrix.

THRESHOLD OF ISOAMYL ACETATE

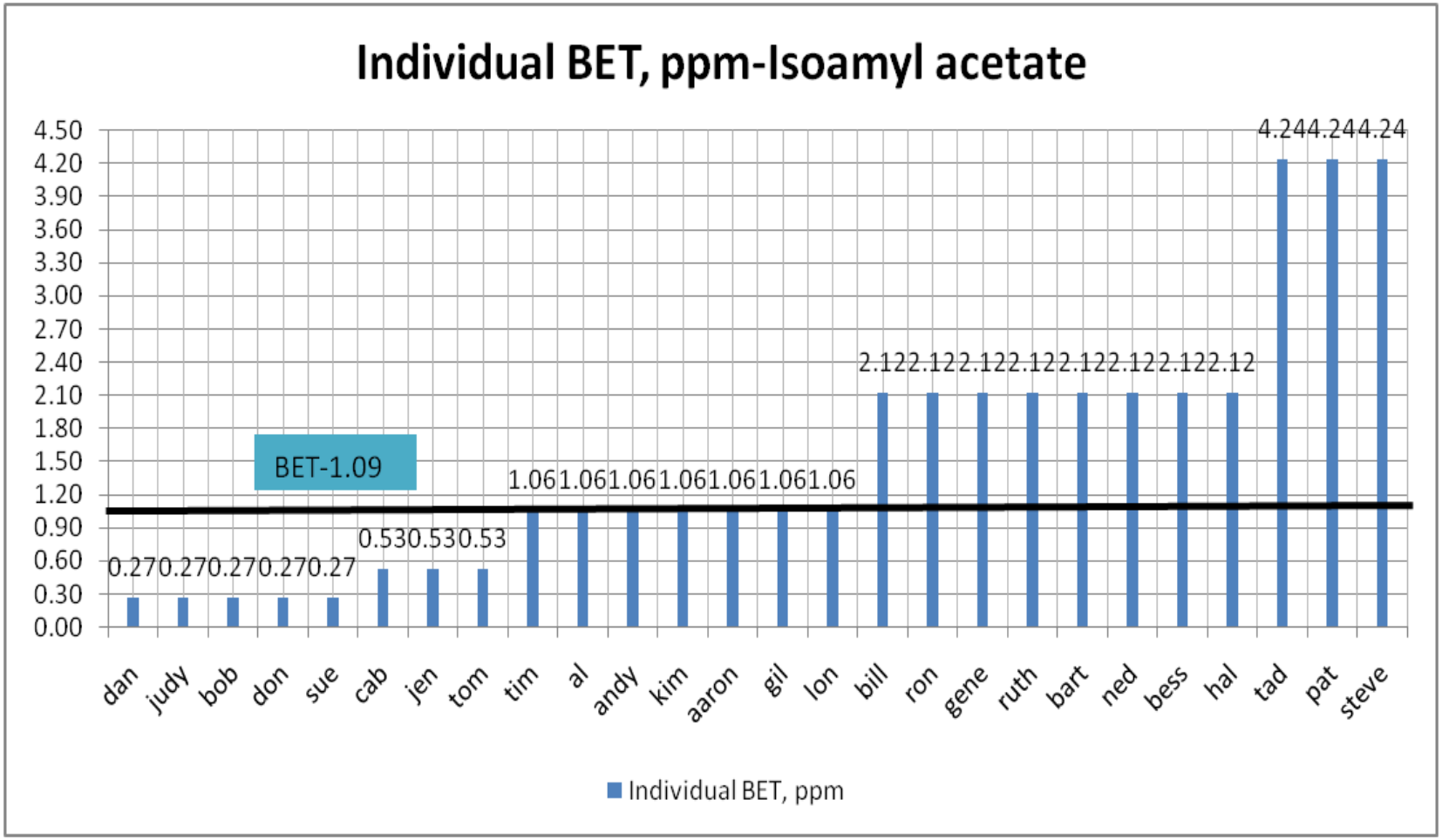
Procedure:	ASBC Sensory Analysis - 9 (Ascending Method of Limits)							**Number of Assessors:**	26	
Medium:	Miller High Life							**Dilution Factor:**	2	
Scale Steps:	6	**Sample:**	Isoamyl Acetate Aldrich Cat. # 112674 98%					**Form of Test:**	Simple / Aroma Only	
rving der	**Name**	**Concentration, ppm**						**Individual BET, ppm**	**Threshold Log 10**	**Description**
		0.375	**0.75**	**1.5**	**3**	**6**	**12**			
1	taster 1	N	N	Y	Y	Y	Y	1.06	0.026	
2	taster 2	Y	Y	Y	Y	Y	Y	0.27	-0.576	
3	taster 3	Y	Y	Y	Y	Y	Y	0.27	-0.576	
4	taster 4	N	Y	N	Y	Y	Y	2.12	0.327	
5	taster 5	N	N	N	N	Y	Y	4.24	0.628	fruity, banana
6	taster 6	N	N	Y	Y	Y	Y	1.06	0.026	banana
7	taster 7	Y	N	Y	Y	Y	Y	1.06	0.026	
8	taster 8	N	N	N	Y	Y	Y	2.12	0.327	
9	taster 9	N	N	N	Y	Y	Y	2.12	0.327	
10	taster 10	Y	N	N	Y	Y	Y	2.12	0.327	
11	taster 11	N	N	Y	Y	Y	Y	1.06	0.026	
12	taster 12	N	N	N	Y	Y	Y	2.12	0.327	
13	taster 13	Y	Y	Y	Y	Y	Y	0.27	-0.576	
14	taster 14	Y	Y	Y	Y	Y	Y	0.27	-0.576	
15	taster 15	N	Y	Y	Y	Y	Y	0.53	-0.275	
16	taster 16	N	N	Y	Y	Y	Y	1.06	0.026	
17	taster 17	N	Y	N	Y	Y	Y	2.12	0.327	
18	taster 18	N	N	Y	Y	Y	Y	1.06	0.026	Isoamyl acetate
19	taster 19	N	Y	N	N	Y	Y	4.24	0.628	fruity, banana
20	taster 20	N	N	N	Y	Y	Y	2.12	0.327	fruity, pear drop
21	taster 21	N	N	N	Y	Y	Y	2.12	0.327	
22	taster 22	N	Y	Y	Y	Y	Y	0.53	-0.275	
23	taster 23	N	N	N	N	Y	Y	4.24	0.628	
24	taster 24	N	Y	Y	Y	Y	Y	0.53	-0.275	
25	taster 25	N	N	Y	Y	Y	Y	1.06	0.026	
26	taster 26	Y	Y	Y	Y					

Data collected at 2005 ASBC workshop by Everett Boiling

Statistical Summary:

Group Best Estimate Threshold (BET), ppm =	**1.09**
Sum Log 10 =	1.114
Average Log 10 =	0.056

Graph of Individual Tasters BET



More than Performance Feedback, …say Thank You!!

It takes a time and commitment to be on panel. A lot of training is involved.

Say "Thank you" with a ……

- Post-sensory treat/snack
- Rewards Program-gift certificates, prizes, etc. (Frequent Tasters Reward Program)
- End of the year parties
- Positive Feedback-be a cheer leader
- Free Beer!!

SENSORY STATISTICS:

TRANSFORM YOUR SUBJECTIVE TASTE PANEL INTO AN OBJECTIVE MEASUREMENT.

Beer's job is to deliver 10 minutes of pleasure…
So, we need to:

- Understand your brand's flavor profile: TTB (trueness to brand). Know the difference between normal process variation, process trends and/or anomalies. Consistency! Identify and classify flavors and determine their desired levels for a given brand. Then, pinpoint their origins from grain to glass/processing.
- Provide specific- technical- actionable flavor interpretations to help production correct flaws, identify trends and better control the outcome of each brew.
- Keep it simple, thorough repeatable, reproducible test method and data analysis.

What do I do with my production release data results?

- How bad is 'too bad'? Sellable vs. non-sellable finished product.
- What is normal/natural process variation?
- What is out of specification? What warrants investigation?
- How can you avoid flavor shift over time?
- Is the product defect enough to cause the consumer to notice? Complain? Recall?!?

Need to Move away from grading. 1 out of 10 panelist (no go) ≠ 90% A. What about 3 of 20? 85% B- 3 diacetyl comments?!?!

Move away from tests that generate limiting, unactionable, un'mine'able data – scaling, ttt. Final score = 16- 76%

(P)robability control charts-

sleep well through the power of simple statistics!

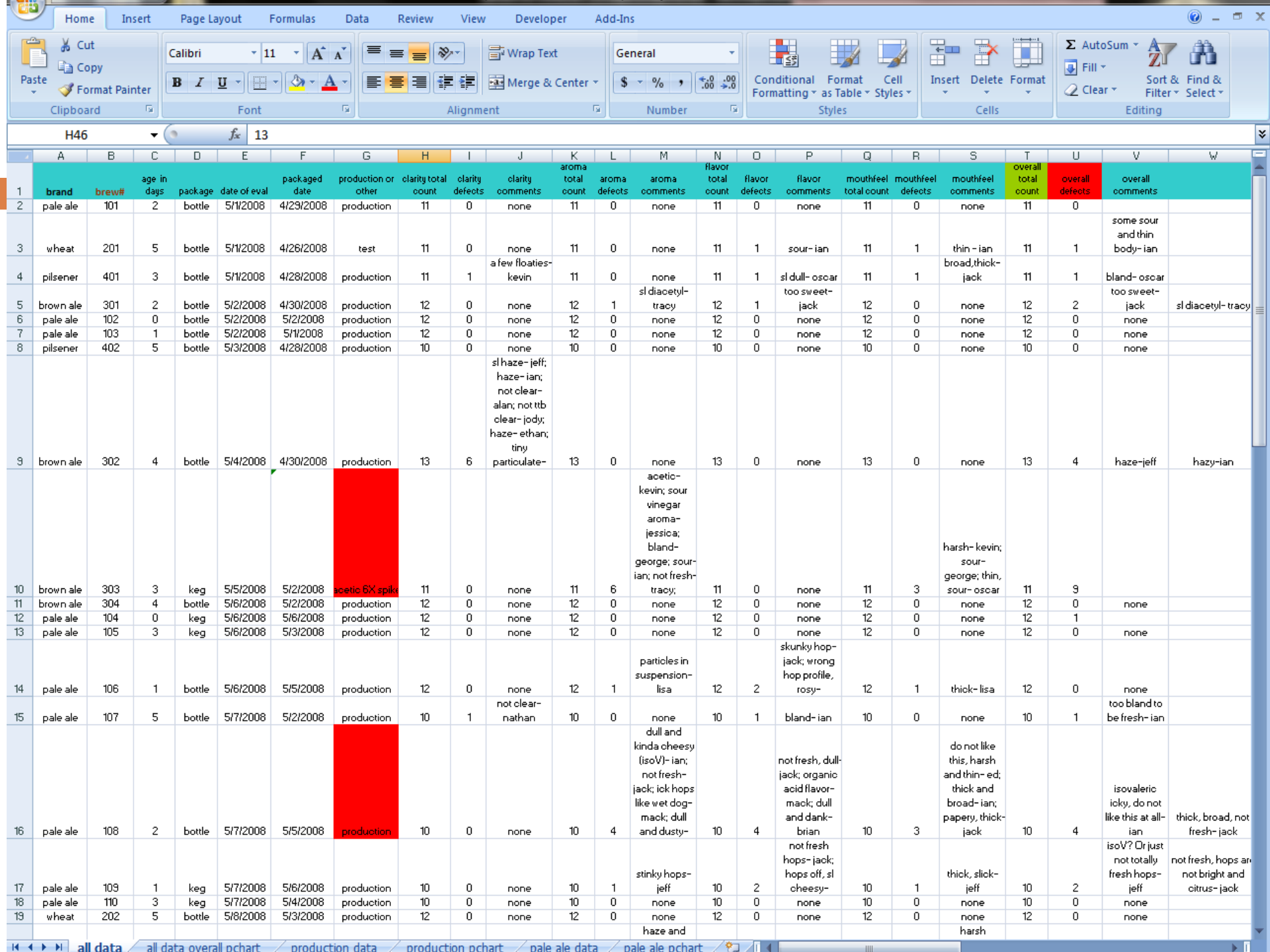
The perfect tool for Sensory Finished Product Release Panel Analysis:

- A p-chart (probability chart) is an attributes (ttb or not ttb) control chart that consists of points collected and plotted with the control/natural process limits from data in subgroups of varying sizes (different number of and panelists every panel).
- Think of the limits as the 'voice' of your process. P-charts monitors normal variations: whether your process is stable and predictable and determines whether a particular sample falls within the normal variation or falls outside and needs to be examined further. Can also monitor the effects of process improvement theories (test brew validation) or spikes (panel validation).
- P-charts can easily be created using simple excel add-ins that are pretty cheap and easy!

Production Release Ballot and Data Entry

Sample	1	2	3	4	5	6	7	8
V isual								
A aroma								
F lavor								
M outhfeel								
O verall								
COMMENTS								

- Check it out- probability charts in action…. Looks like your normal data entry spreadsheet.



Home Insert Page Layout Formulas Data Review View Developer Add-Ins

Cut Copy Format Painter Paste Clipboard

Calibri 11 Font

Wrap Text Merge & Center Alignment

General Number

Conditional Formatting Format as Table Cell Styles Styles

Insert Delete Format Cells

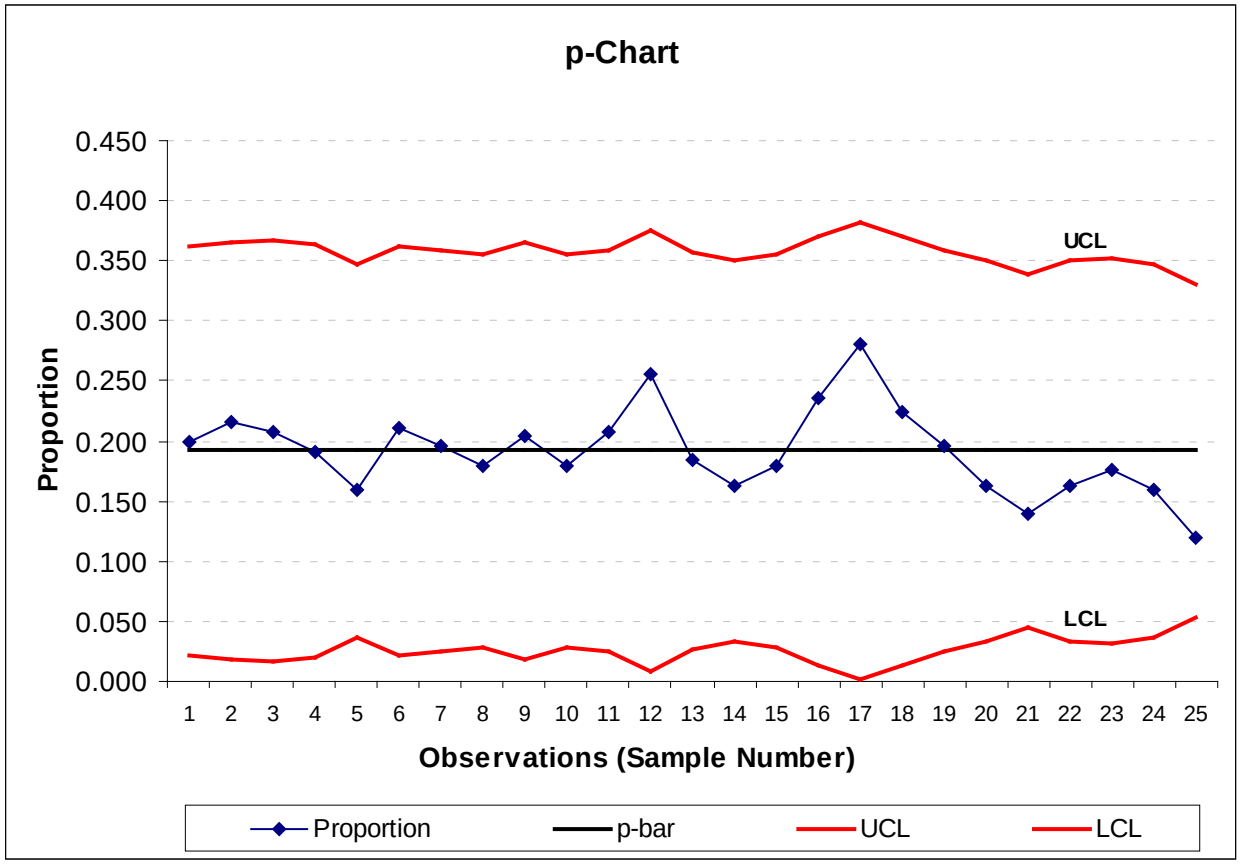
AutoSum Fill Clear Sort & Filter Find & Select Editing

H46 13

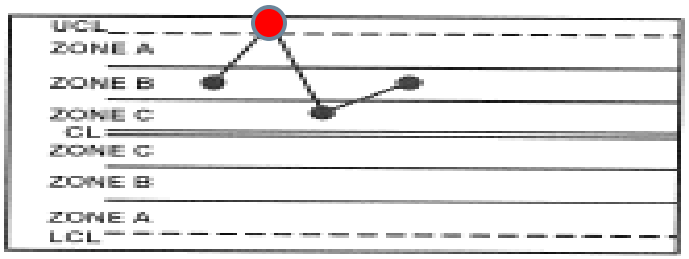
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	brand	brew#	age in days	package	date of eval	packaged date	production or other	clarity total count	clarity defects	clarity comments	aroma total count	aroma defects	aroma comments	flavor total count	flavor defects	flavor comments	mouthfeel total count	mouthfeel defects	mouthfeel comments	overall total count	overall defects	overall comments	
2	pale ale	101	2	bottle	5/1/2008	4/29/2008	production	11	0	none	11	0	none	11	0	none	11	0	none	11	0		
3	wheat	201	5	bottle	5/1/2008	4/26/2008	test	11	0	none	11	0	none	11	1	sour-ian	11	1	thin-ian	11	1	some sour and thin body-ian	
4	pilsener	401	3	bottle	5/1/2008	4/28/2008	production	11	1	a few floaties-kevin	11	0	none	11	1	sl dull-oscar	11	1	broad,thick-jack	11	1	bland-oscar	
5	brown ale	301	2	bottle	5/2/2008	4/30/2008	production	12	0	none	12	1	sl diacetyl-tracy	12	1	too sweet-jack	12	0	none	12	2	too sweet-jack	sl diacetyl-tracy
6	pale ale	102	0	bottle	5/2/2008	5/2/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	0	none	
7	pale ale	103	1	bottle	5/2/2008	5/1/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	0	none	
8	pilsener	402	5	bottle	5/3/2008	4/28/2008	production	10	0	none	10	0	none	10	0	none	10	0	none	10	0	none	
9	brown ale	302	4	bottle	5/4/2008	4/30/2008	production	13	6	sl haze-jeff; haze-ian; not clear-alan; not ttb clear-jody; haze-ethan; tiny particulate-	13	0	none	13	0	none	13	0	none	13	4	haze-jeff	hazy-ian
10	brown ale	303	3	keg	5/5/2008	5/2/2008	acetic 6X spike	11	0	none	11	6	acetic-kevin; sour vinegar aroma-jessica; bland-george; sour-ian; not fresh-tracy;	11	0	none	11	3	harsh-kevin; sour-george; thin, sour-oscar	11	9		
11	brown ale	304	4	bottle	5/6/2008	5/2/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	0	none	
12	pale ale	104	0	keg	5/6/2008	5/6/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	1		
13	pale ale	105	3	keg	5/6/2008	5/3/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	0	none	
14	pale ale	106	1	bottle	5/6/2008	5/5/2008	production	12	0	none	12	1	particles in suspension-lisa	12	2	skunky hop-jack; wrong hop profile, rosy-	12	1	thick-lisa	12	0	none	
15	pale ale	107	5	bottle	5/7/2008	5/2/2008	production	10	1	not clear-nathan	10	0	none	10	1	bland-ian	10	0	none	10	1	too bland to be fresh-ian	
16	pale ale	108	2	bottle	5/7/2008	5/5/2008	production	10	0	none	10	4	dull and kinda cheesy (isoV)-ian; not fresh-jack; ick hops like wet dog-mack; dull and dusty-	10	4	not fresh, dull-jack; organic acid flavor-mack; dull and dank-brian	10	3	do not like this, harsh and thin-ed; thick and broad-ian; papery, thick-jack	10	4	isovaleric icky, do not like this at all-ian	thick, broad, not fresh-jack
17	pale ale	109	1	keg	5/7/2008	5/6/2008	production	10	0	none	10	1	stinky hops-jeff	10	2	not fresh hops-jack; hops off, sl cheesy-	10	1	thick, slick-jeff	10	2	isoV? Or just not totally fresh hops-jeff	not fresh, hops ar not bright and citrus-jack
18	pale ale	110	3	keg	5/7/2008	5/4/2008	production	10	0	none	10	0	none	10	0	none	10	0	none	10	0	none	
19	wheat	202	5	bottle	5/8/2008	5/3/2008	production	12	0	none	12	0	none	12	0	none	12	0	none	12	0	none	
													haze and						harsh				

all data | all data overall pchart | production data | production pchart | pale ale data | pale ale pchart

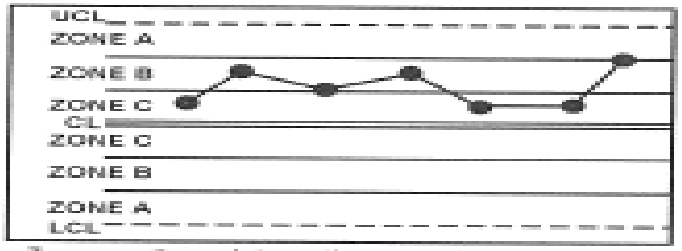
Normal process variation.



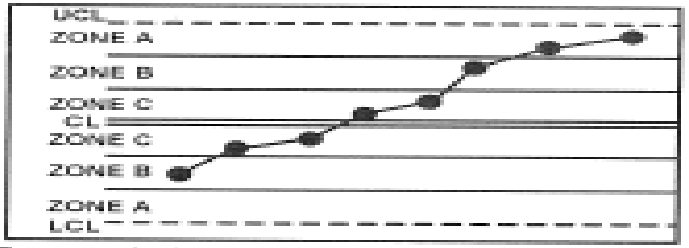
Out of Control data patterns- alert! Your process is changing behavior!!



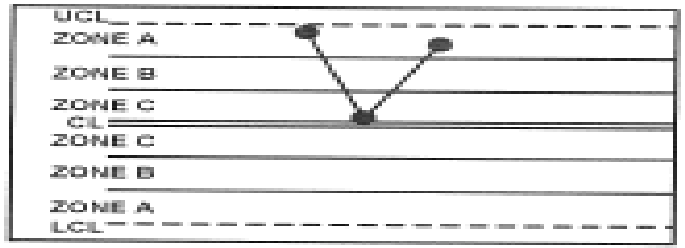
One or more points outside of the control limits



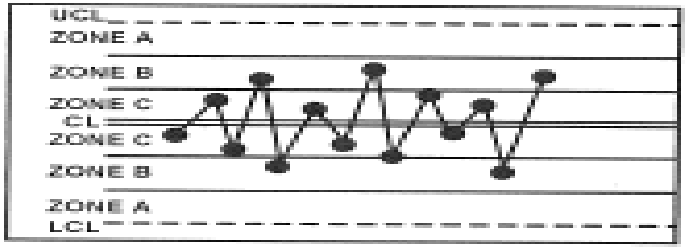
7 consecutive points on the same side of centerline



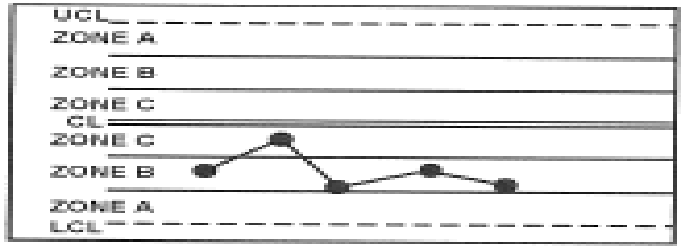
7 consecutive intervals entirely increasing or decreasing



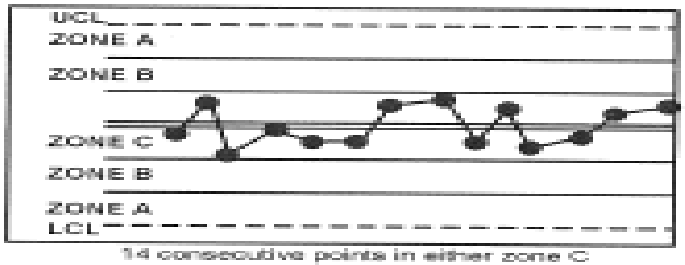
2 out of 3 consecutive points in the same zone A or beyond



14 consecutive points alternating up and down

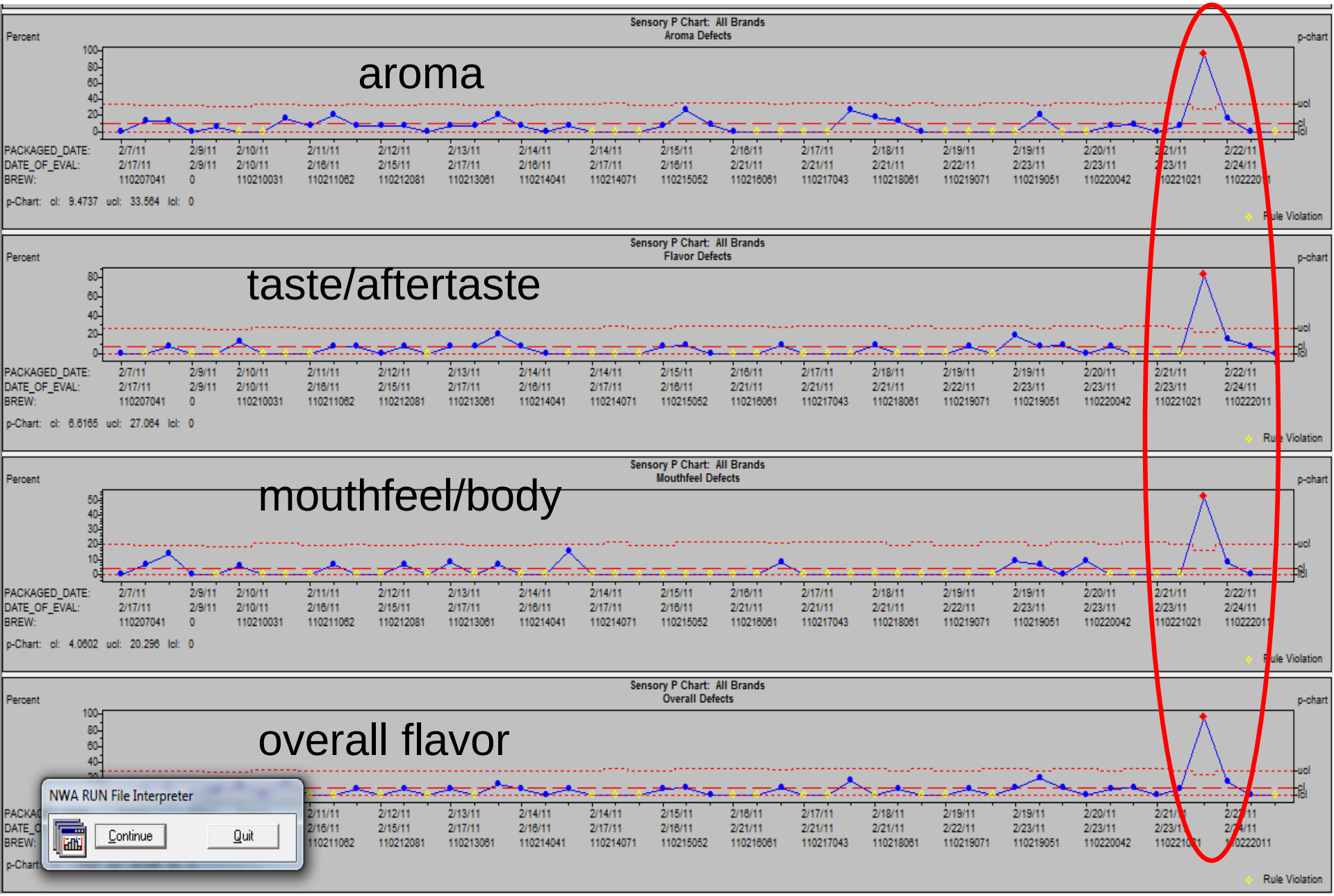


4 out of 5 consecutive points in the same zone B or beyond

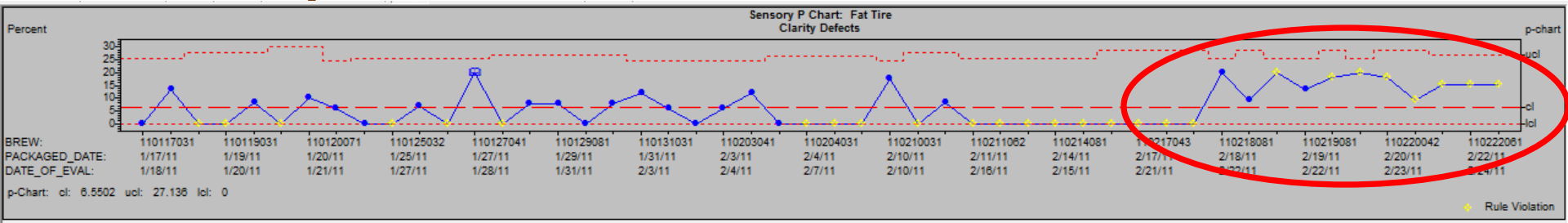


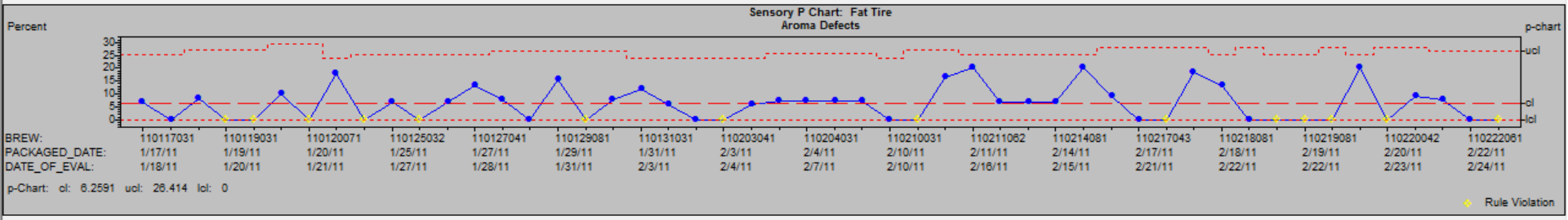
14 consecutive points in either zone C

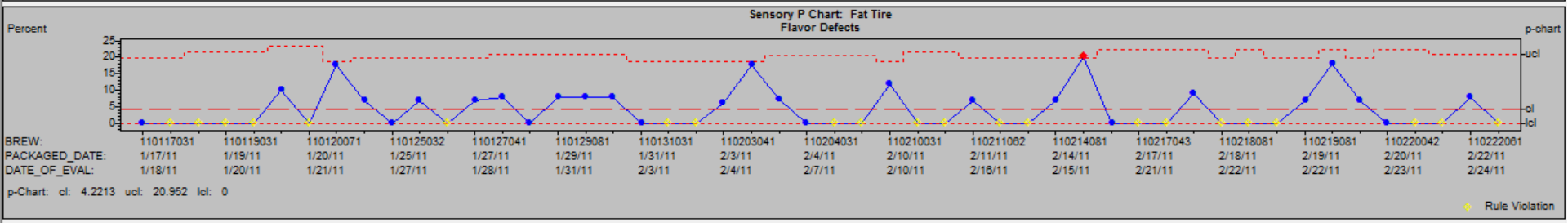
Is your panel ‘plugged in’? Validation via spiked sample.

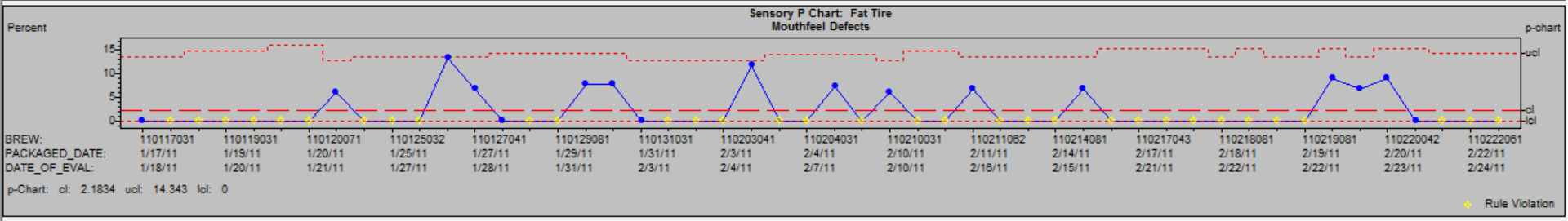


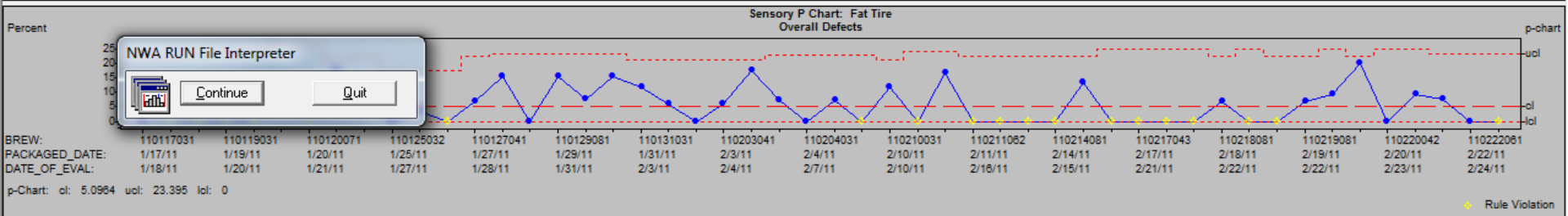
clarity trend



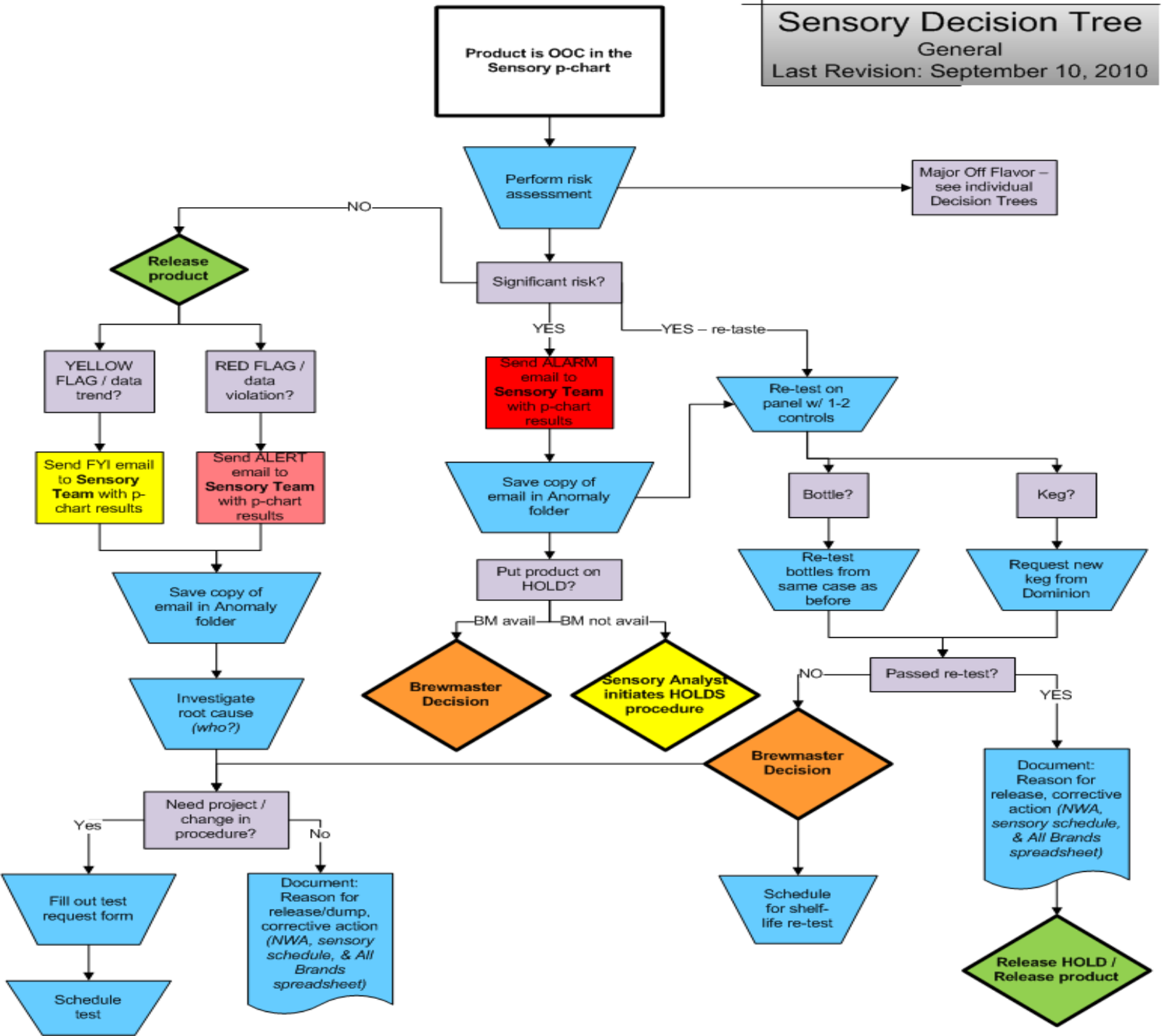








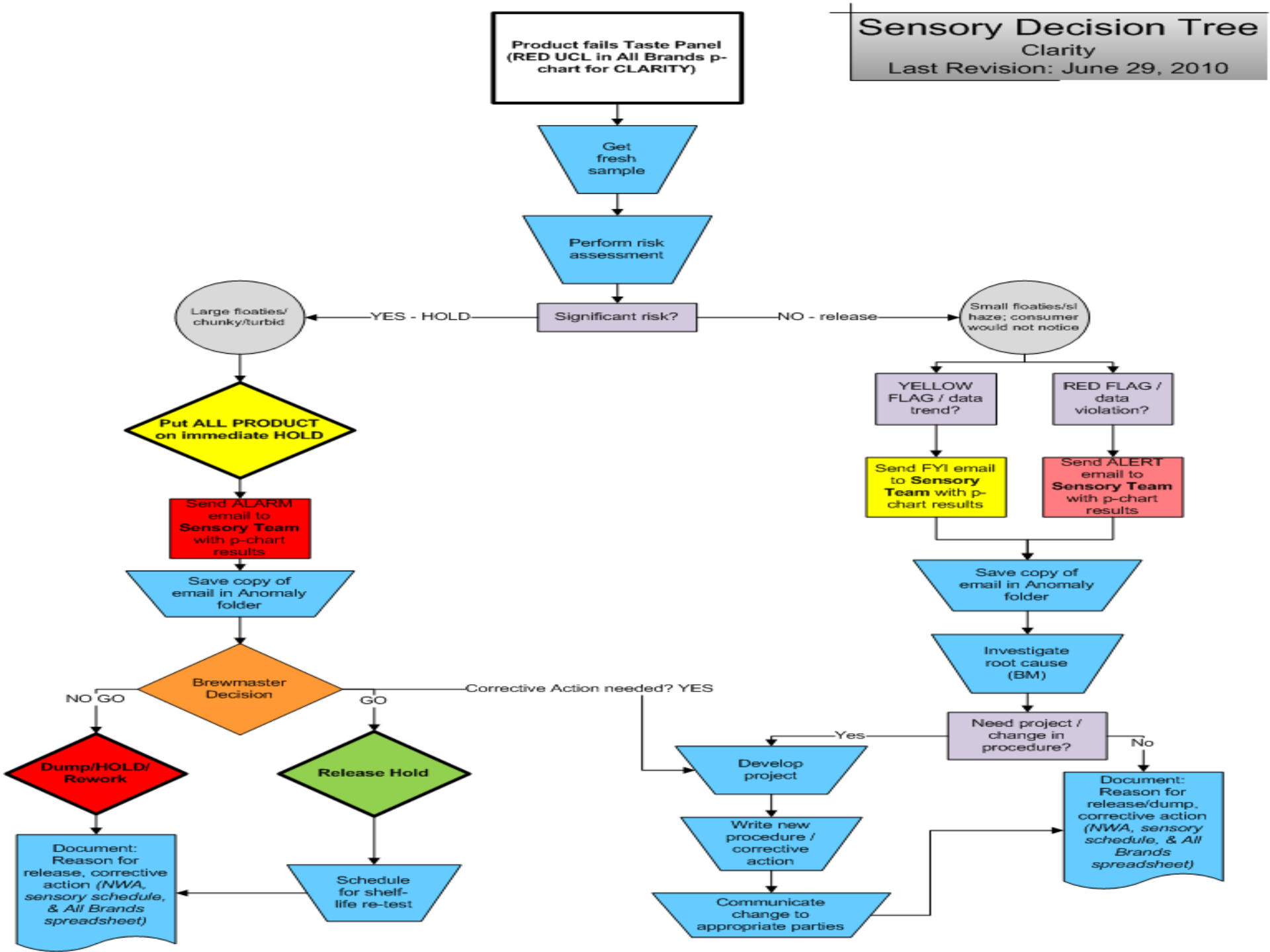
Decision tree- FYI/Alert- trend. Investigate, report, document, follow up.



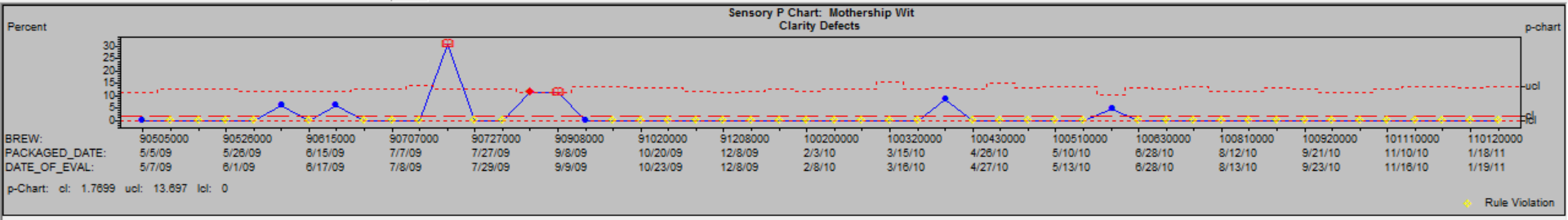
Sensory Decision Tree

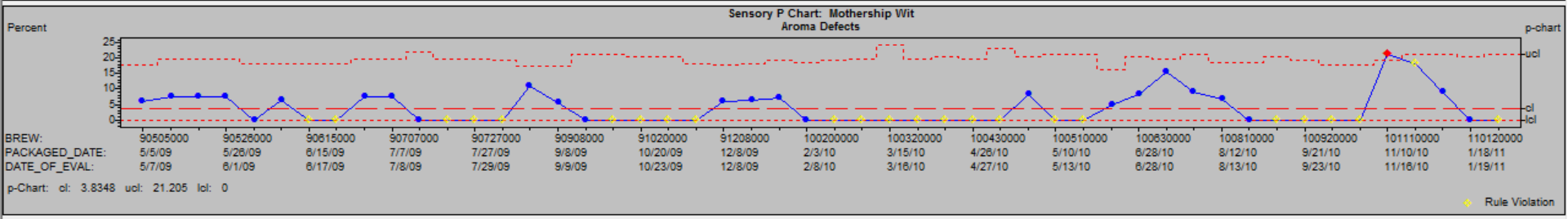
Clarity

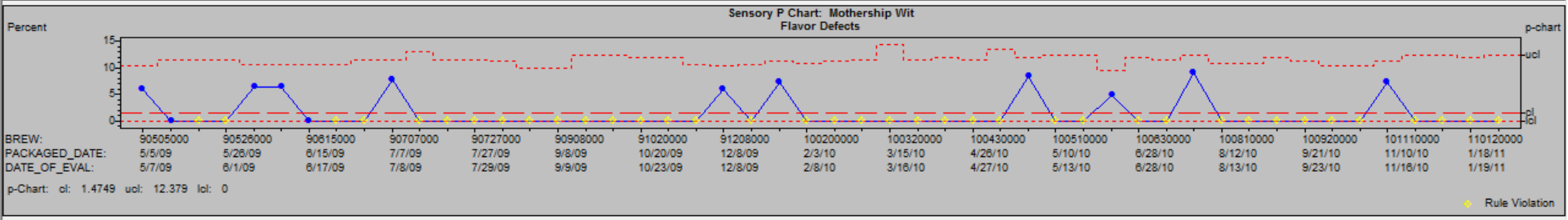
Last Revision: June 29, 2010

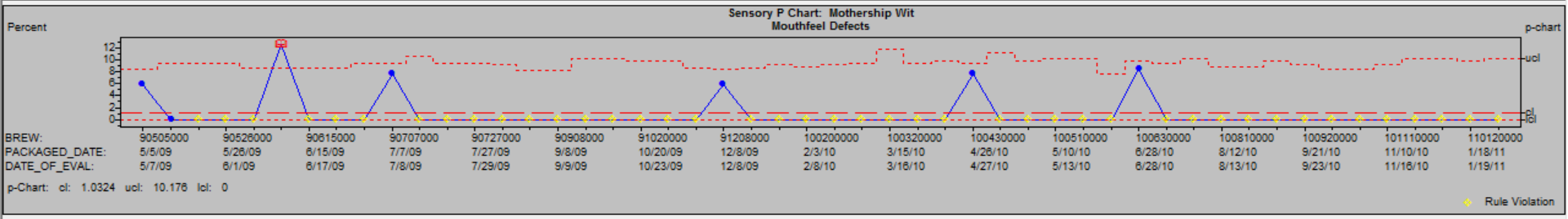


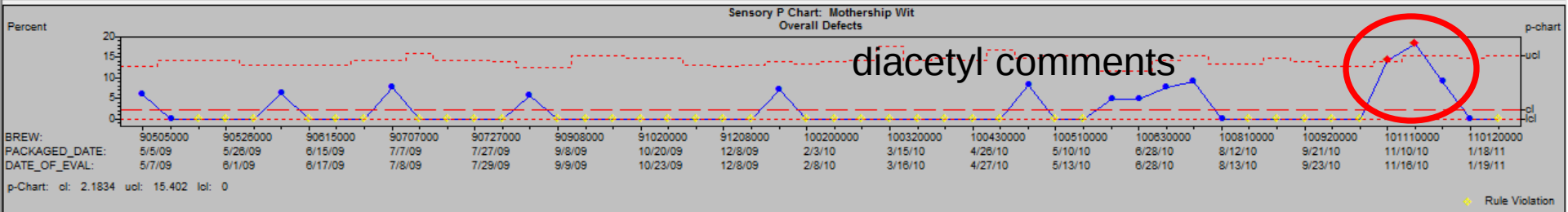
overall flavor out of control-not true to brand.









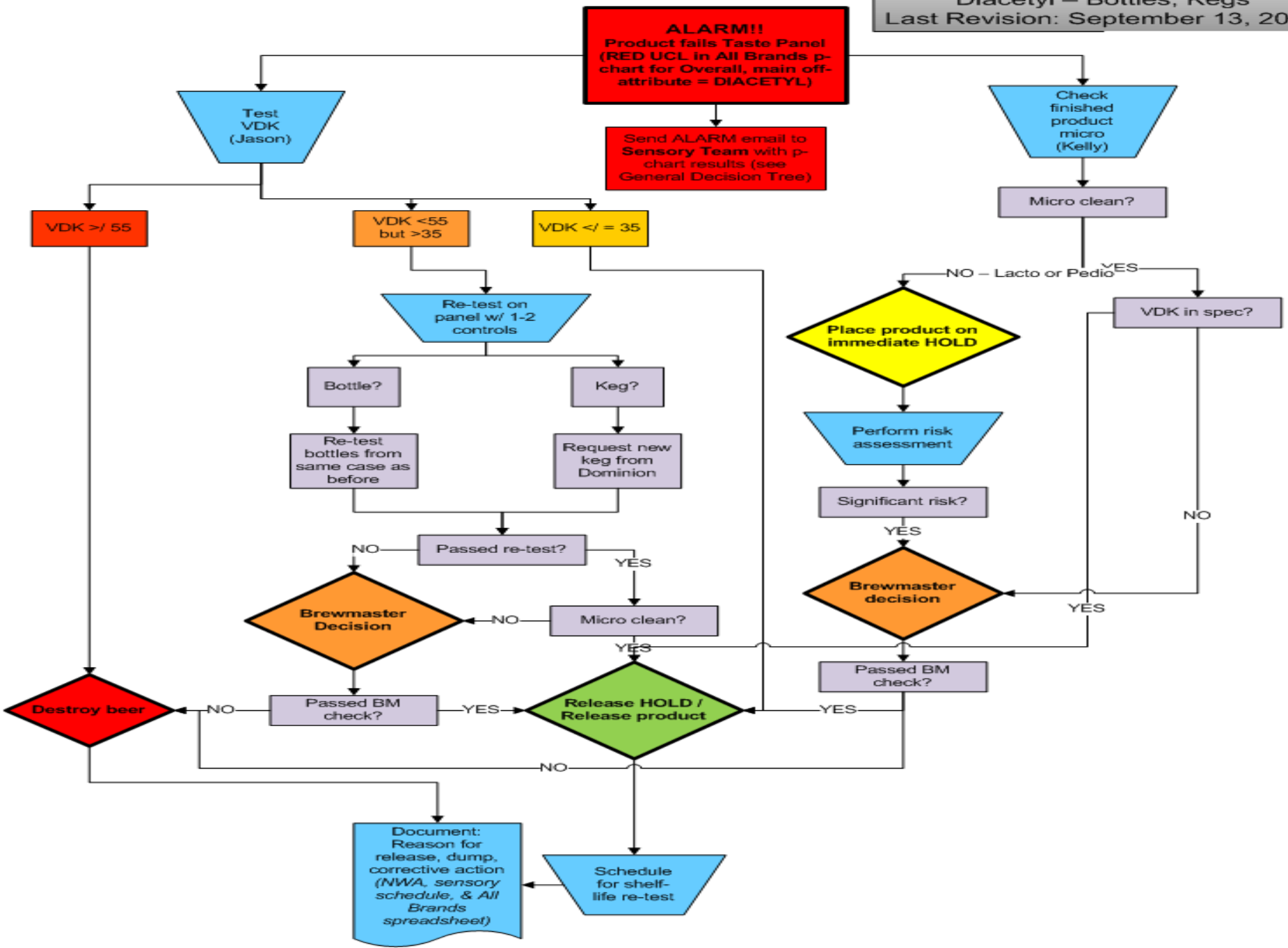


diacetyl comments

Sensory Decision Tree

Diacetyl – Bottles, Kegs

Last Revision: September 13, 2010



Each 'out of spec' scenario needs to flow like this

… Closed Loop Corrective Action Plan!

- Identify Problem/Attribute (diacetyl comments and red OOC in aroma and overall)
- Assignable Cause (slow fermentation, t-down too early)
- Corrective Action (flag tank, measure diacetyl before t-down)
- Hold the gains (change SOGs, train on new procedure)

Taste Panel vs. Sensory Program

1. ID process, method, measurement owners
2. Initial Measurement Validation (MSA)
3. Implement and maintain applicable SOG's
4. Training Protocol & Records
5. Establish appropriate charts (Pcharts)
6. On going Validation Method
7. Calibration
8. OOC/OOS Action Plan Development/Decision Trees
9. First Pass Analysis- using OOC/OOS Action Plan
10. Document First Pass Analysis in control chart
11. Cleaning the data set- Brewmaster Ready
12. Trends/Pareto Analysis and Recommendations
13. Present in Quality Meeting
14. Transition to Project/Investigation ideation

P CHART ADD-IN WEBSITES

- http://www.isixsigma.com/library/content/n070223a.asp
- http://www.qimacros.com/qiwizard/pchart.html
- http://www.pqsystems.com/products/SPC/SQCpack
- www.XLSTAT.com

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