

EPA Small Can Test Matrix

Universal Technical Institute Avondale, Az.

- Orifice Tube and TXV Systems
 - Charge Condition
 - Vapor phase (can upright)
 - Liquid phase (can upside-down)
 - Mixed phase [Rotate-vertical-to-90]
- Condition High Blower – OSA
 - Engine at Idle
 - Engine at 1500 rpm



General Overview

- **Difficult to charge in vapor form (can Upright)**
 - Depending upon conditions can require up to 90 minutes to transfer all refrigerant from 12 ounce can into the A/C system
- **Charging in liquid form, can contents can be transferred in 5 to 10 minutes**
- **System condition has effect on refrigerant transfer**
 - Has partial refrigerant --- at atmosphere --- in vacuum
- **Engine speed has effect on refrigerant transfer**
- **System type - orifice tube or TXV has an effect on transfer**

General Overview Test

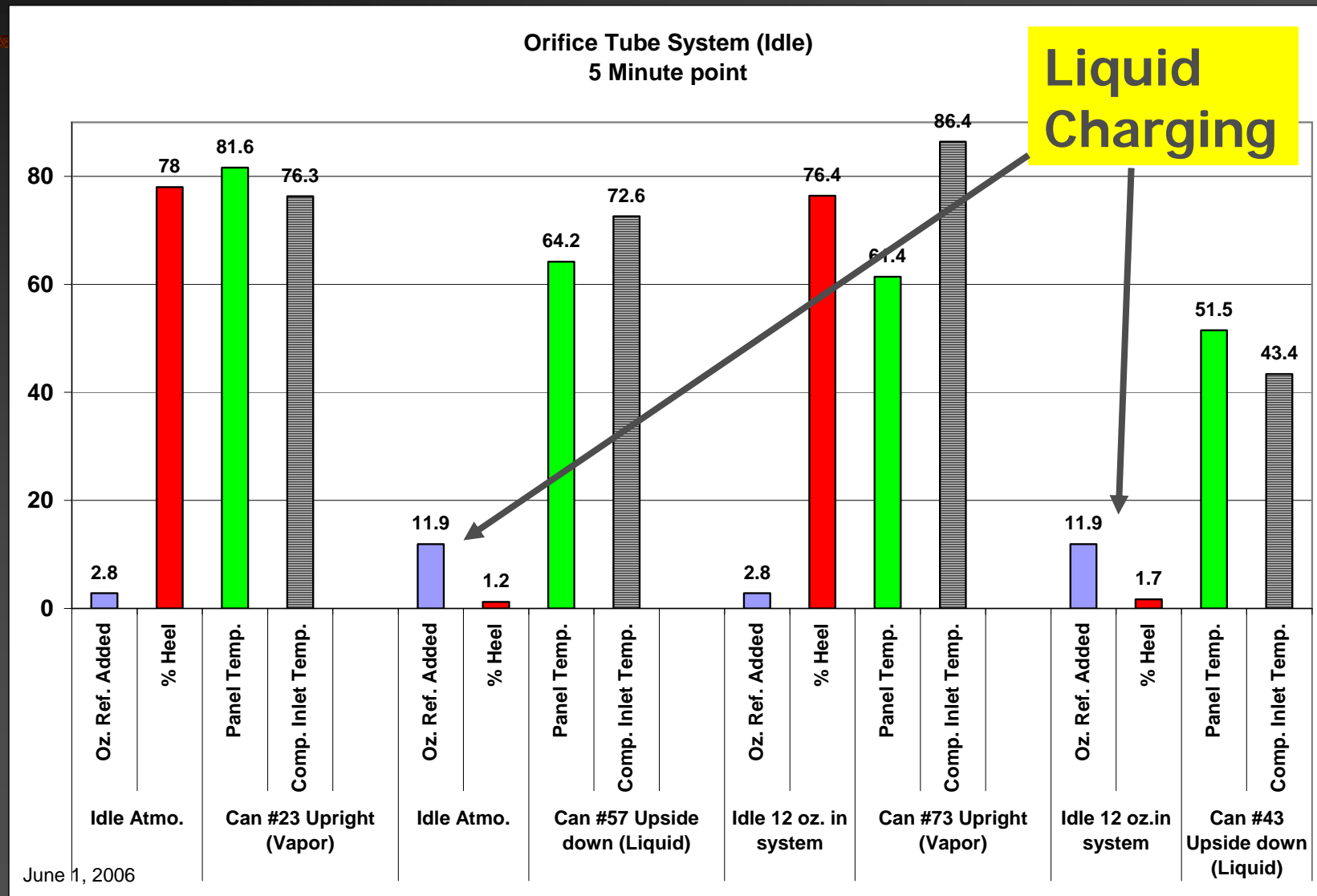
Evaluation of 72 - 12 oz. Cans

- Can residual (heel) ranged from:
 - Vapor form 33.6% (129 grams) to 47.9% (170 grams)
 - Liquid form 1.2% (4.2 grams) to 1.7% (5.9 grams)
 - Can rotation [0/90] 0.6% (2.2 grams) to 1.7% (5.9 grams)
- System high and low side pressure readings vary upon test conditions

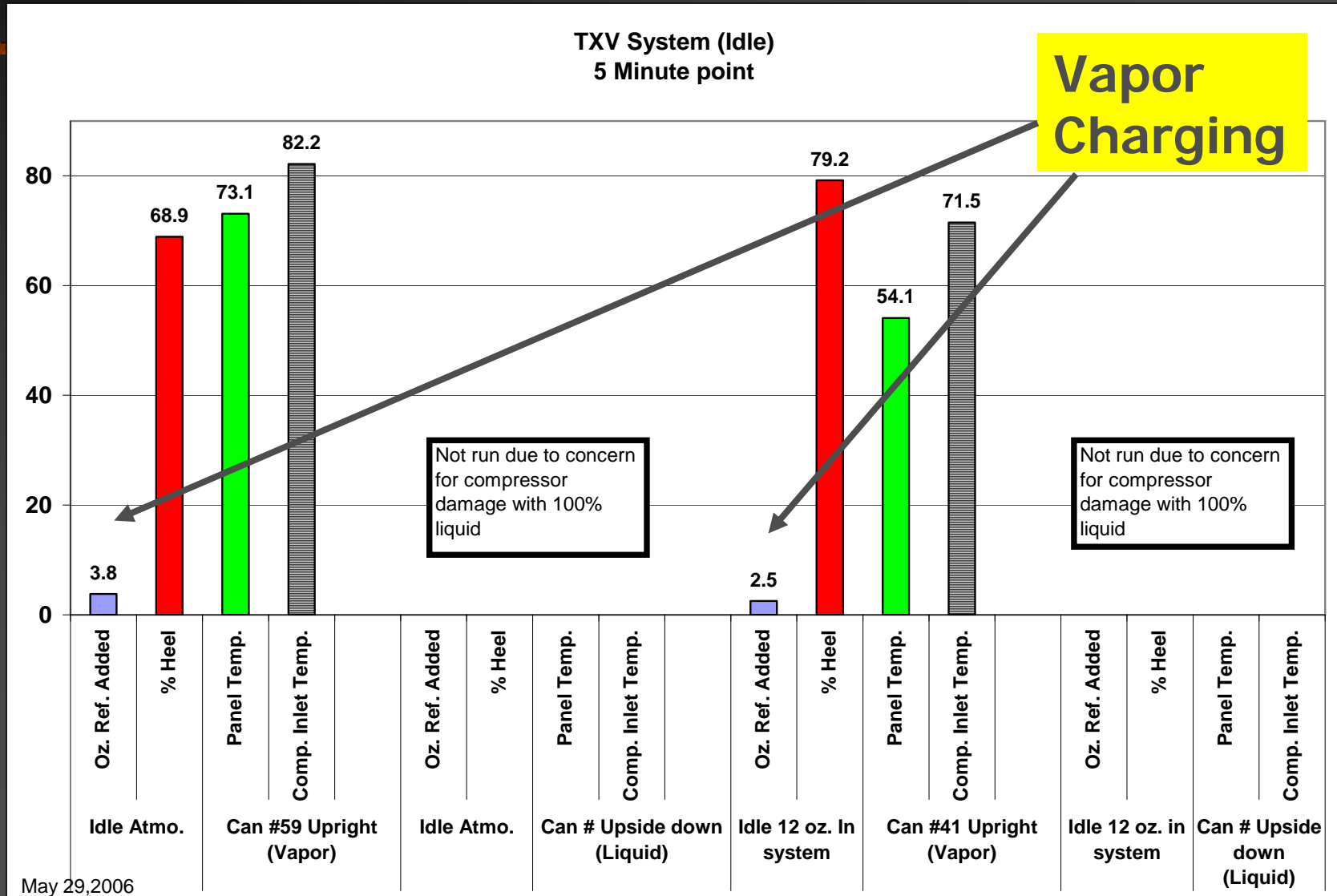
General Small Can Overview

- Panel outlet temperatures vary depending upon amount of refrigerant in system
 - Temperature spread between (4) panel outlets ranged from:
 - Improper charge amount 28 degrees F
 - Near production charge amount 7 degrees F.
- With reduced system charge compressor inlet temperatures were warmer
 - 44 degrees F. on OT system
 - 27 degrees F. on TXV system

Can Charging After 5 Minutes (Idle) Orifice Tube System

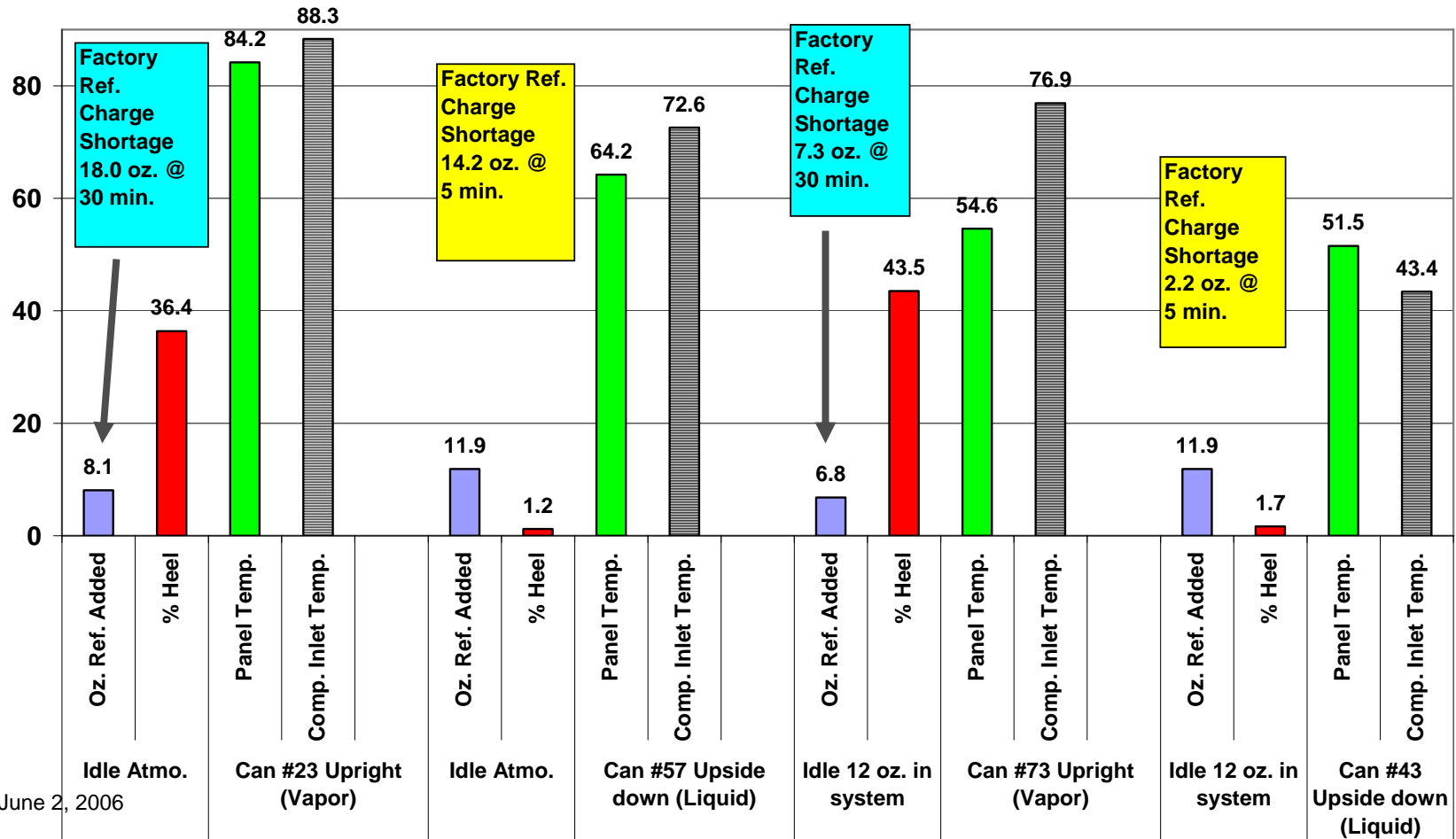


Can Charging After 5 Minutes (Idle) TXV System



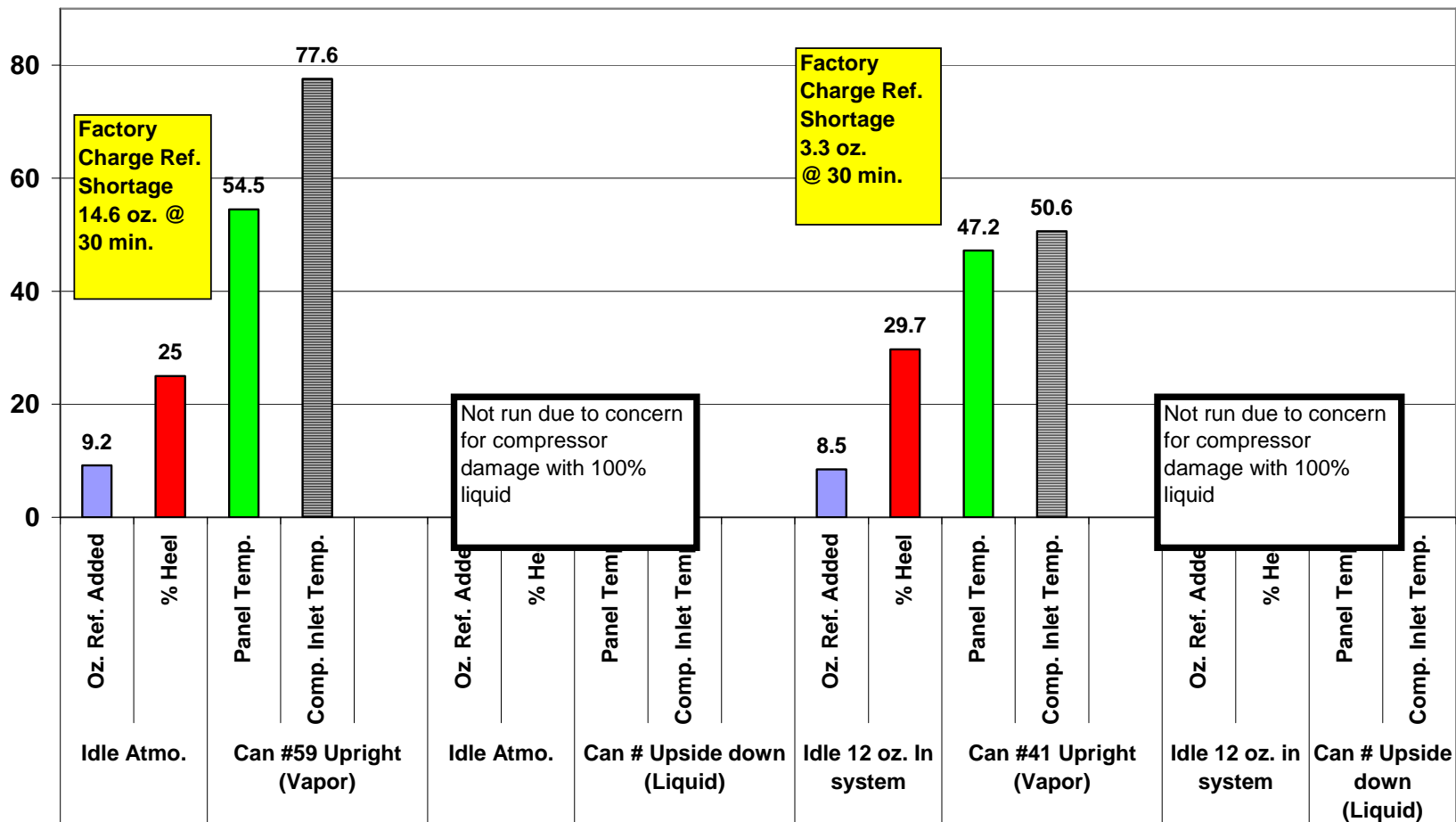
Charging Can Upright - Upside-down Orifice Tube System

Orifice Tube System End of Test 100% Vapor or Liquid at Idle Condition
Factory Refrigerant Charge 26.1 oz. (739.9 grams)



Charging Can Upright (Idle 30 min.) TXV System

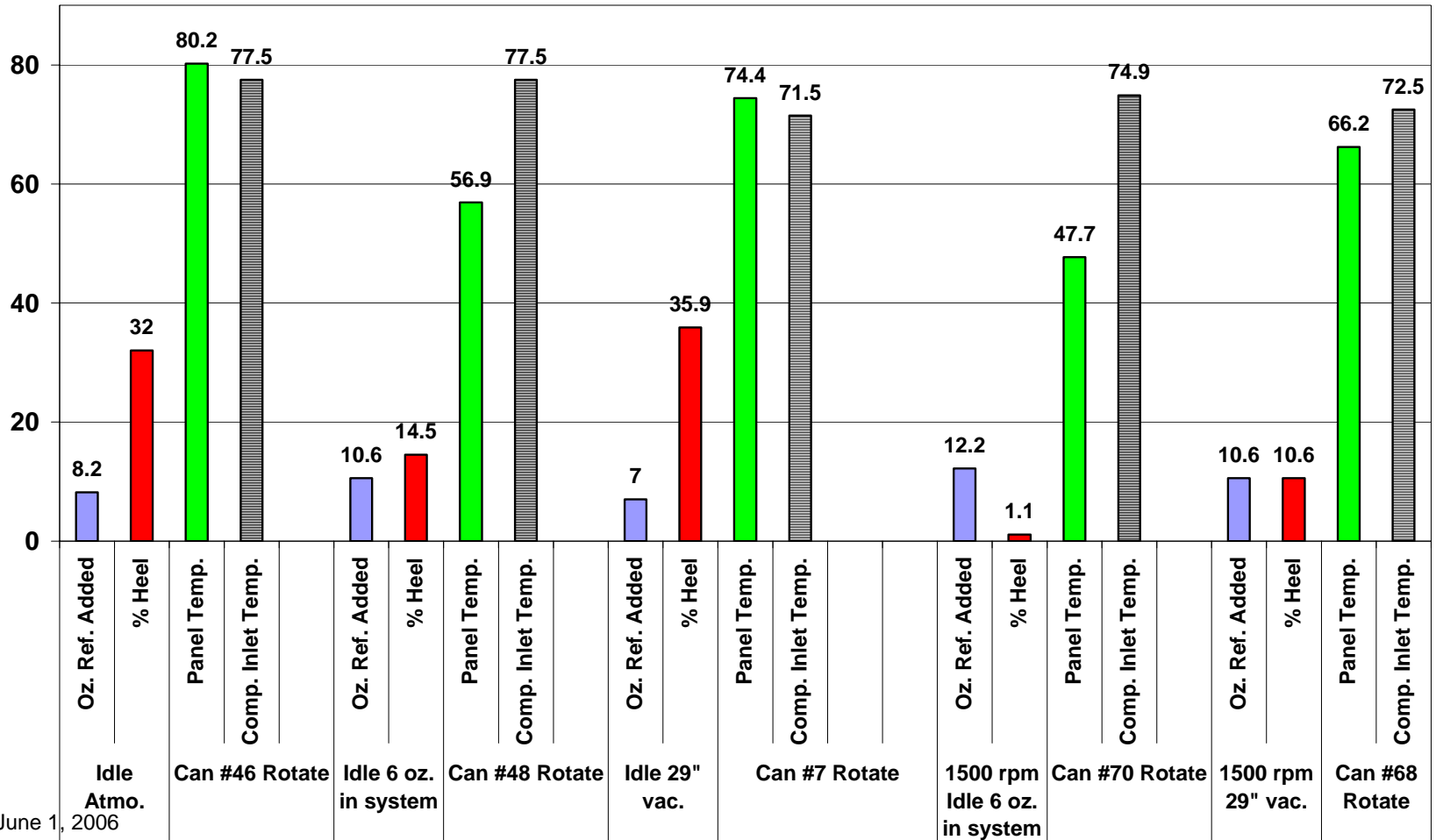
TXV System End of Test Idle
Factory Refrigerant Charge 23.9 oz. (680 grams)



Charging Vapor/Liquid Phase 5 min.

Orifice Tube System Rotating can vertical/90 degrees (Idle and 1500 rpm)

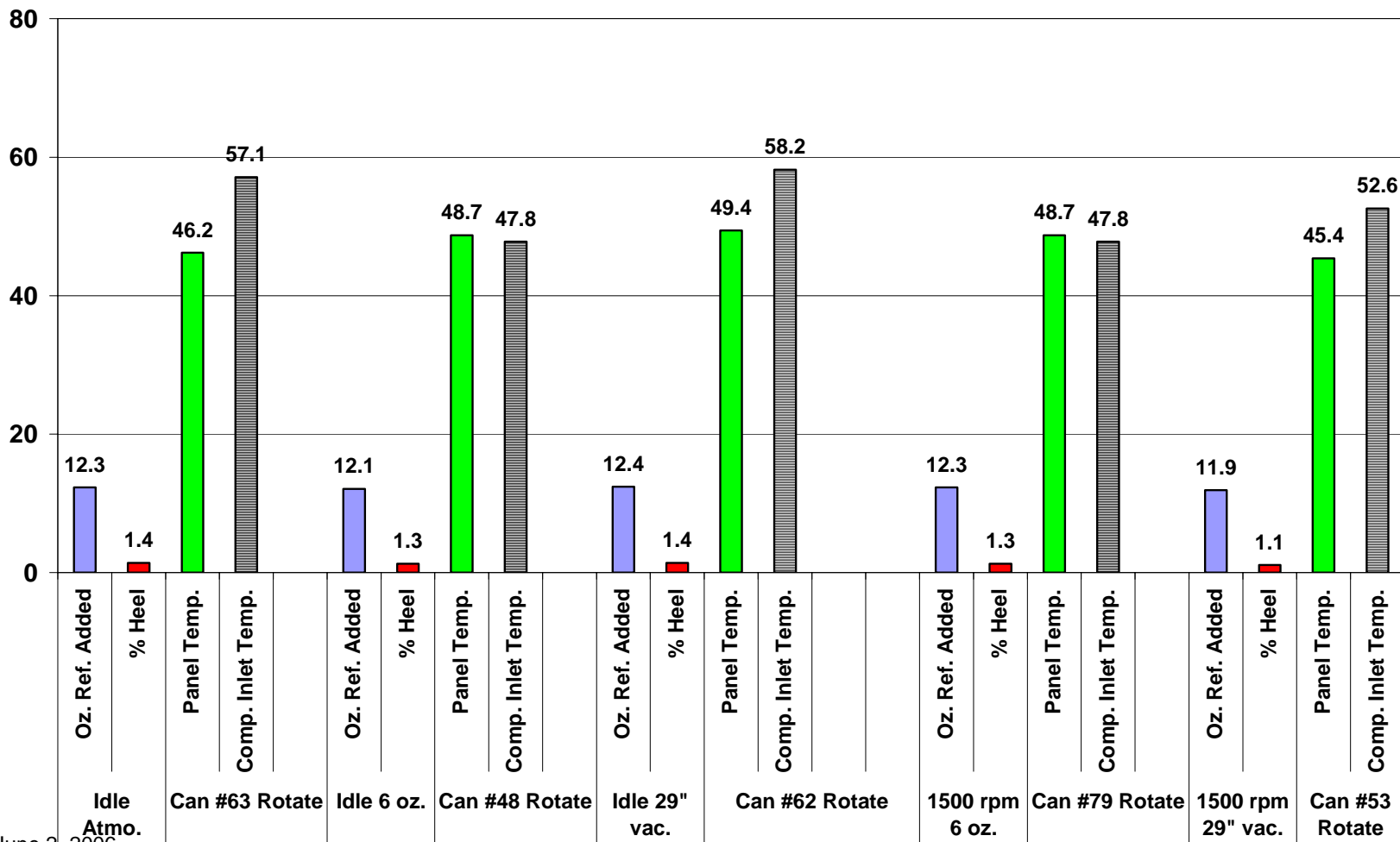
Orifice Tube System 5 Minute Point Can Rotated
Idle and 1500 rpm



Charging Vapor/Liquid Phase 5 min.

TXV System Rotating can vertical/90 degrees (Idle and 1500 rpm)

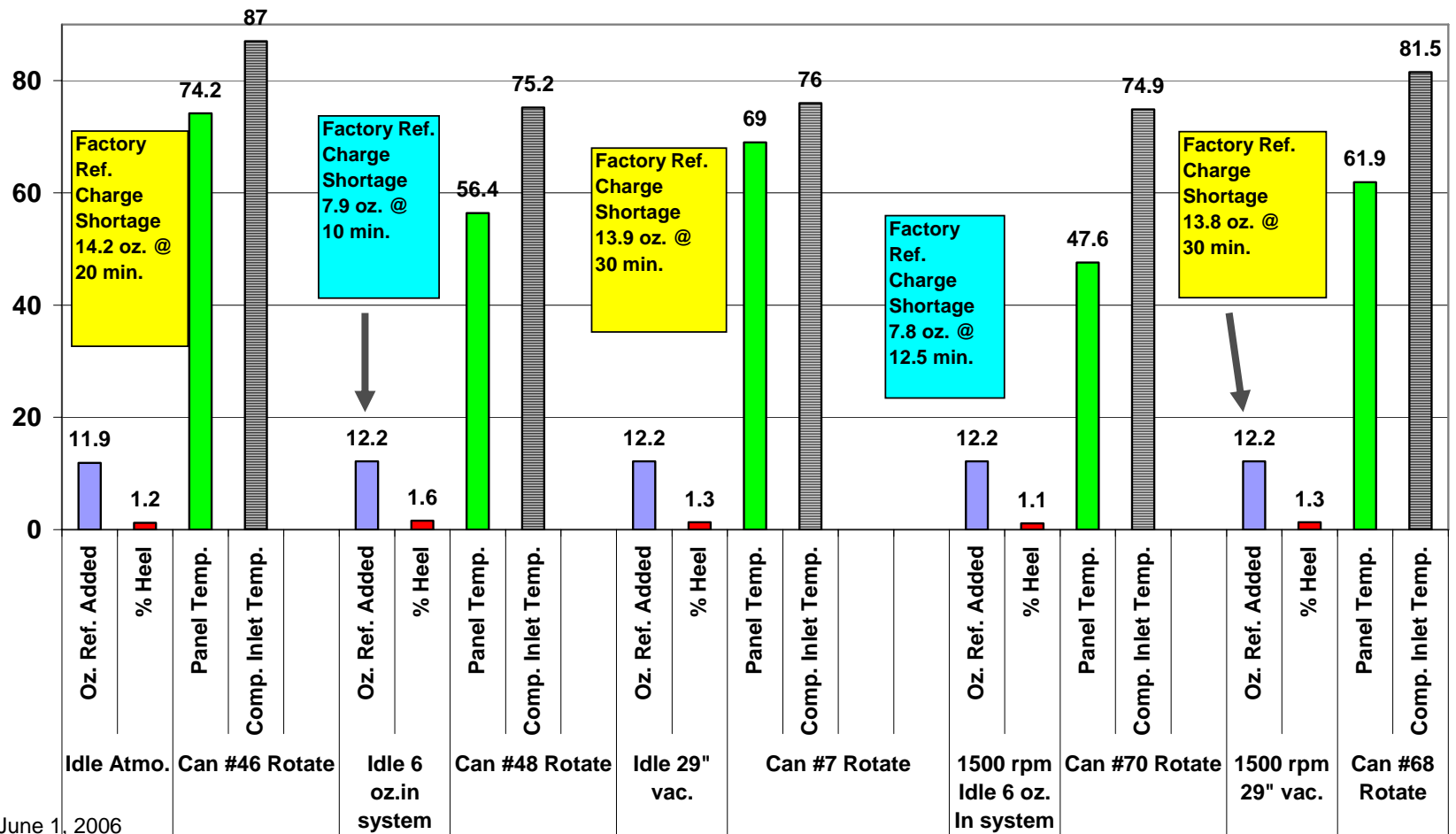
TXV System 5 Minute Point Can Rotated
Idle and 1500 rpm



Charging Vapor/Liquid Phase End of Test

Orifice Tube System Rotating can vertical/90 degrees (Idle and 1500 rpm)

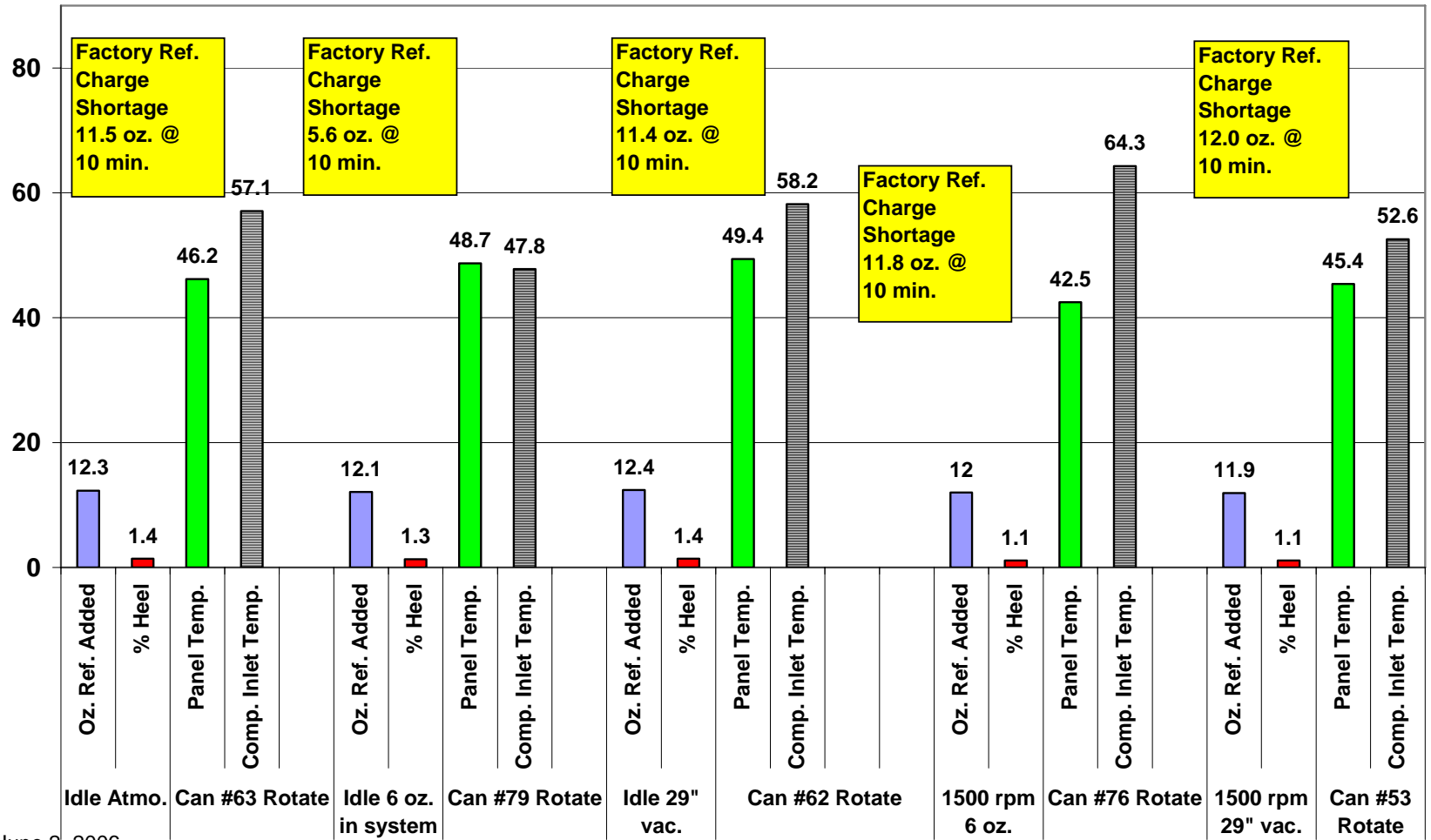
Orifice Tube System End of Test Can Rotated (Idle & 1500 rpm)
 Factory Refrigerant Charge 26.1 oz. (739.9 grams)



Charging Vapor/Liquid Phase End of Test

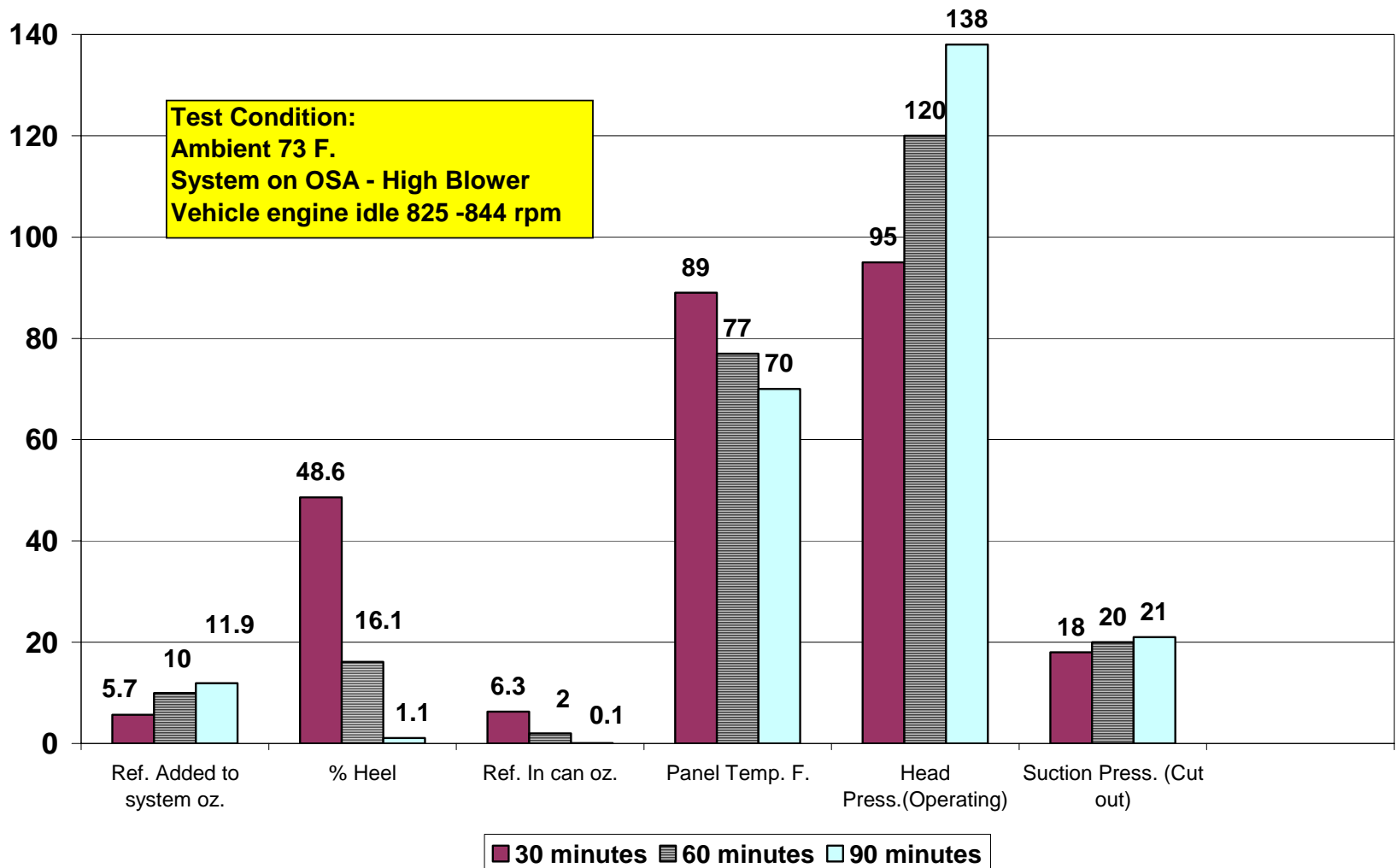
TXV System Rotating can vertical/90 degrees (Idle and 1500 rpm)

TXV System End of Test Can Rotated



Charging Vapor Phase (Idle)

Orifice Tube System - Extended Idle Time Small Can Charging (Vapor)



EPA 30# Cylinder Test Matrix

MACS Technical Center and Universal Technical Institute Avondale, Az.

- Establishing heel from 30# cylinders
 - Removed as empty from service equipment obtained from A/C service activity
 - MACS Technical Center
 - UTI Training facility
- Determine heel in 30# cylinders
 - When transferring 3.5 to 4 Lbs.



Heel in 30# Cylinders Removed as Empty From Service Equipment

- **Summary Of Cylinders Checked at MACS and UTI**
- **MACS Cylinders were from one service facility**
- **UTI Cylinders were from their school training shops**
- **Cylinders were recovered at room temperature two times**

Heel in 30# Cylinders Removed as Empty From Service Equipment

■ Summary Of Cylinders Checked at MACS

Cylinder #	Tank Pressure as Received PSIG	Total Refrigerant Recovered after 2nd Recovery oz.	% Cylinder Heel
1	0	2.000	0.417%
2	0	1.010	0.210%
3	0.5	1.230	0.256%
4	0	1.250	0.260%
5	0	1.500	0.313%
6	0	2.000	0.417%
7	69.5	37.250	7.760%
8	0	1.500	0.313%
9	0	1.250	0.260%

Average	5.443	1.134%
	Ounces	% Heel

Heel in 30# Cylinders Removed as Empty From Service Equipment

■ Summary Of Cylinders Checked at UTI

Cylinder #	Tank Pressure as Received PSIG	Total Refrigerant Recovered after 2nd Recovery oz.	% Cylinder Heel
1	53	9.430	1.965%
3	25	5.590	1.165%
4	yes	21.400	4.458%
5	yes	0.600	0.125%
6	0	1.450	0.302%
7	49	9.520	1.983%
Average		7.998	1.666%
		Ounces	% Heel

Transfer Refrigerant From 30# Cylinders

- Difficult to transfer in vapor form (cylinder Upright)
 - Transfer in vapor state (upright) lower portion of cylinder frosted
 - Final refrigerant removal required upside-down position and heat blanket



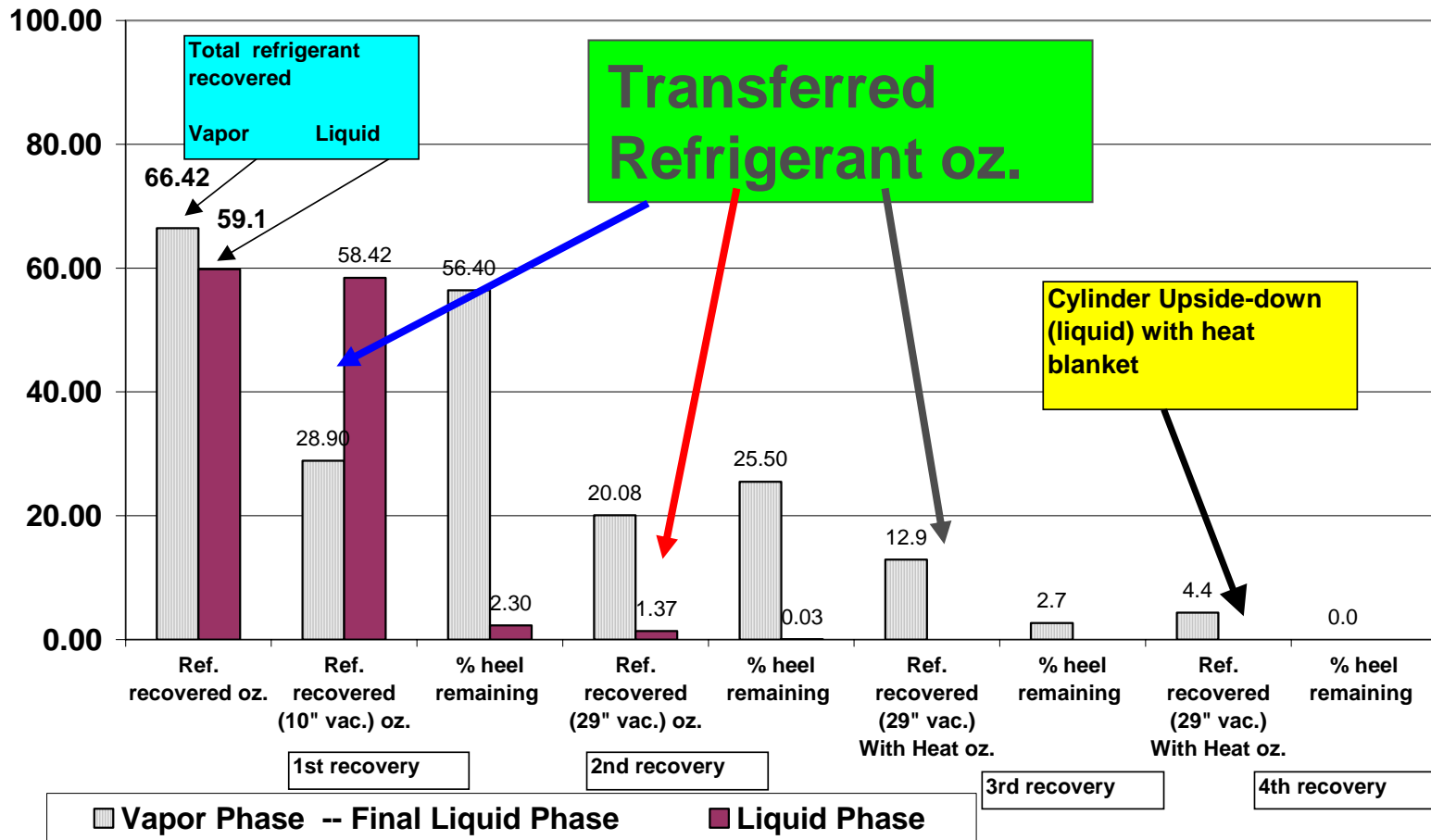
Frost Line



Refrigerant Transferring 3.5-4 lbs From 30# Cylinders

Vapor and Liquid state

30# Cylinder Refrigerant Transfer -- Vapor and Liquid State
(5 Cylinder Average)



Service Equipment Refrigerant Measurement Service Cylinders

- Indicated Refrigerant Transferring on Service Equipment did not always reflect actual amount



Test Condition	Cylinder #	Refrigerant Phase	Equipment Reading oz.	Recorded Weight oz.	% Equipt. Error
Service Cyl.	MACS #7 1st rec.	Vapor	23	24.51	-6.2%
Service Cyl.	MACS #7 2nd rec.	Vapor	2	12.74	-84.3%
Service Cyl.	UTI #1	Vapor	6	9.43	-36.4%
Service Cyl.	UTI #3	Vapor	11	4.74	132.1%
Service Cyl.	UTI #7	Vapor	2	6.7	-70.1%

Service Equipment Refrigerant Transferring 3.5-4 lbs Measurement (Vapor)

Test Condition	Cylinder #	Refrigerant Phase	Equipment Reading oz.	Recorded Weight oz.	% Equipt. Error
UTI Ref. Transfer	F1	Vapor	6	21.7	-72.4%
UTI Ref. Transfer	F3	Vapor	8	30.3	-73.6%
UTI Ref. Transfer	F5	Vapor	13.7	30.4	-54.9%
UTI Ref. Transfer	F8	Vapor	1# 15 oz		
			31	32.4	-4.3%
UTI Ref. Transfer	F9	Vapor	1# 7oz		
			23	29.8	-22.8%

Service Equipment Refrigerant Transferring 3.5-4 lbs Measurement (Liquid)

Test Condition	Cylinder #	Refrigerant Phase	Equipment Reading oz.	Recorded Weight oz.	% Equipt. Error
UTI Ref. Transfer	F2	Liquid	3# 10 oz		
			58	66.3	-12.5%
UTI Ref. Transfer	F4	Liquid	3# 3oz		
			51	62.9	-18.9%
UTI Ref. Transfer	F6	Liquid	3# 2oz		
			50	43.7	14.4%
UTI Ref. Transfer	F7	Liquid	2# 4oz		
			36	52.7	-31.7%
UTI Ref. Transfer	F10	Liquid	3# 12oz		
			60	69.3	-13.4%