

TRANSPORTATION STUDY: PROSTACK RACK VERSUS A METAL RACK WITH PVC COVERS

12/26/2006

OBJECTIVE OF LOGISTICAL STUDY:

- Simulate the transportation capability of the ProStack rack system with a commercial Metal rack with PVC covers
- Compare lab results with customer studies
- Compare results with previous lab studies
- Confirm insertion and removal of bottles from a ProStack Rack does not damage bottles
- Confirm nine years of customer experience with PSI Rack systems

TESTING HIGHLIGHTS

ASTM 4169 SCHEDULE E TRUCK VIBRATION, LEVEL II, 0.52 g rms

- Standard vibration test used: Truck II Random Vibration

PSI Developed and Introduced the Truck Bay Concept for Vibration Testing

- In previous lab tests:
 - Racks were restrained or attached the vibration table
 - Bottles were restrained or confined
- The Truck Bay concept:
 - Better simulates the real world transportation system
 - Permits free rack movement within bay
 - Permits free bottle movement between rack and 'door'

Equipment:

MTS hydraulic vibration table

Simulated truck bay

Fabricated by a truck bay manufacturer

Single bay dimensional specification:

Width 52" ID X Depth 42" with 3° floor pitch, 90° back wall

Metal safety bar on front of Bay at Distance of typical delivery truck door

Racks Tested

Commercial Racks

Metal with PVC sleeves

ProStack Rack with standard deck

Both racks tested were 4 wide X 5 high X 2 deep = 40 bottles

Commercial 5 Gallon Round Bottle

All from same production day / same mold

Weight range: 708 – 728 grams > Lightweight

Filled to uniform level

Commercial cap



Testing

Random Vibration Tests:

Metal Rack with PVC sleeves = 6 hours of tests

ProStack Rack = 30 hours of tests

Rack location noted on bottles

Bottles remained in same location during test

- **Most aggressive test**
- **'Action' in various rack locations varies**

Bottles that walked forward in metal racks were:

- **contained by the 'door'**
- **pushed back to start position every 15 minutes**

Bottles did not move forward in ProStack Rack

Bottles were monitored; failed bottles were identified and recorded

RESULTS

Metal Rack with PVC sleeves

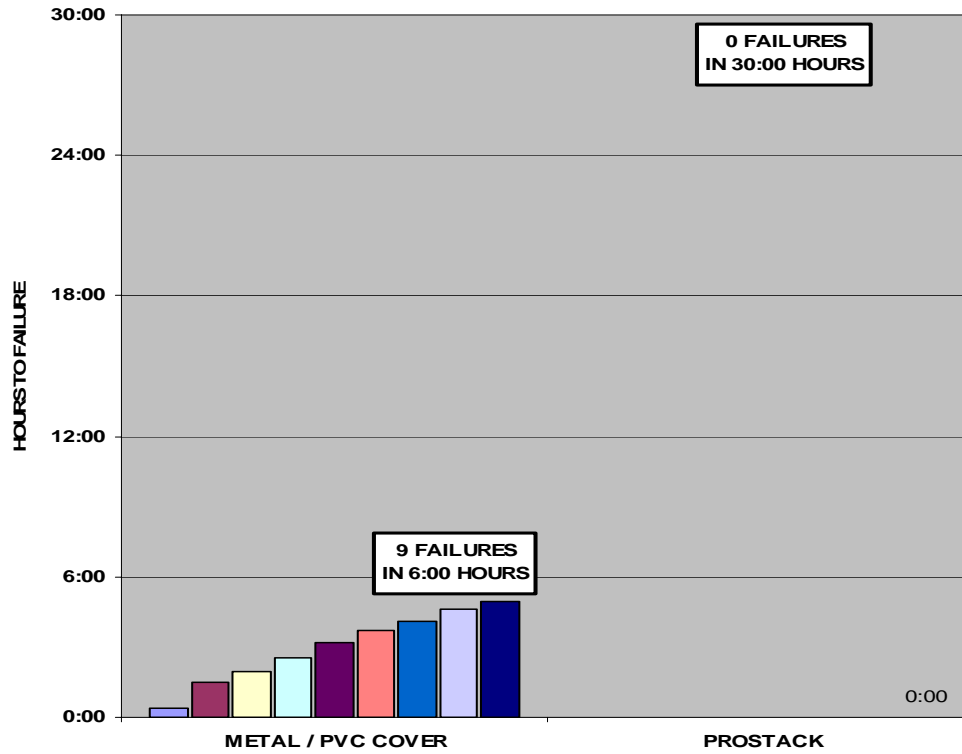
- **9 failures in 6 hours of testing**
- **Many front row bottles walked forward to the 'door'**

ProStack Rack

- **No failures in 30 hours of testing**
- **No bottles walked forward to the 'door'**

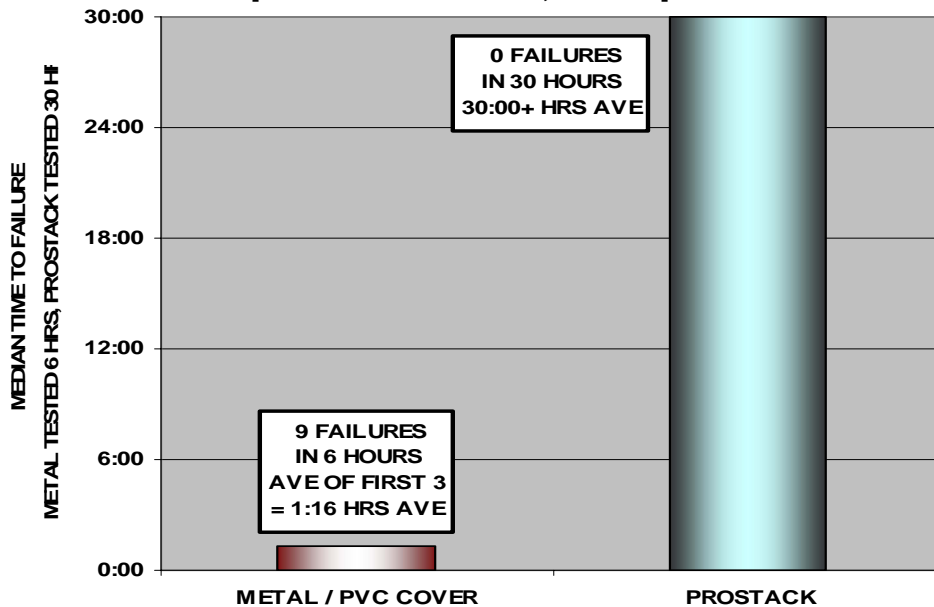
**PROSTACK
VERSUS
METAL RACK WITH PVC COVERS**

TIME OF FAILURES
[ASTM 4169 SCHEDULE E, TRUCK II]



**PROSTACK
VERSUS
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AVERAGE TIME TO FAILURE
[ASTM 4169 SCHEDULE E, TRUCK II]



** CALCULATED ON FIRST THREE FAILURES METAL RACK W/ PVC COVERS COMPARED WITH NO PROSTACK FAILURES IN 30 HRS

BOTTLE PULL TEST

PROCEDURE:

Bottle marked in 5 locations, L1 – L5, [90° with 22.5° increments], to concentrate and systematize the test abuse area

Filled 5-gallon bottle located on 5th rack level, front pocket

Skid and rack elevated 1 foot

Manually pulled filled bottle out from cylinder at a 30° downward angle, the most difficult interference condition

Bottle returned at 0° to simulate robot loading

Pull and return started at location L1

Rotated one location for each pull/return cycle to L5

Then reset to L1

500 pull/return cycles on the bottle, 100 cycles at each location; 5 to 10 times more pulls than anticipated in commercial bottle life.

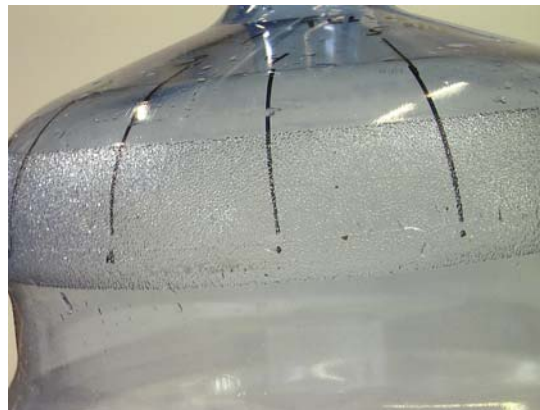
RESULTS OBSERVED WITH PROSTACK RACKS

- **No leaks**
- **No bottle damage**
- **No bottle scuffing**
- **No rack wear**

The Bottle Pull Test was not performed on the Metal rack:

Many different metal rack shapes and sleeve materials are used

No defects occurred on the ProStack Rack Pull Test; therefore, the metal rack could not have better results.

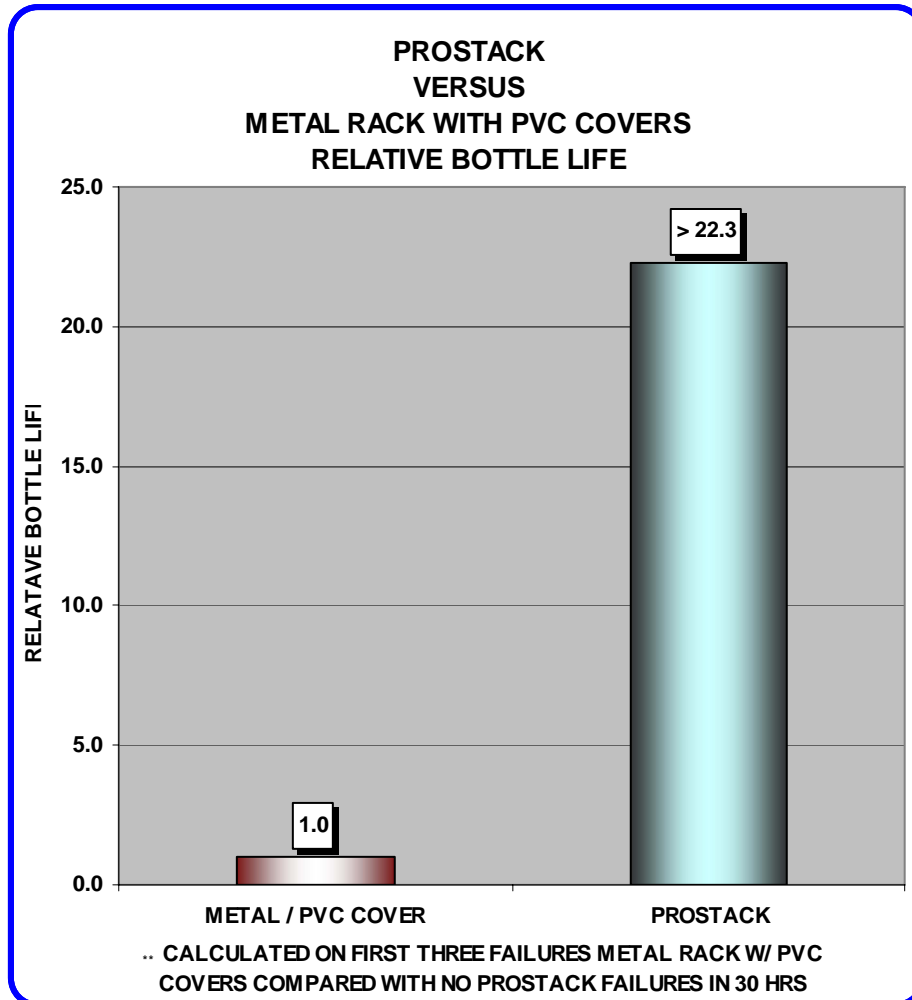


CONCLUSIONS OF STUDIES

In transportation related bottle failures:

Compared with the Metal Rack with PVC sleeves as standard:

The ProStack Rack improved the Relative Bottle Life by > 22.3+ Times



Lightweight Bottles:

- Reduced the overall transportation bottle survival results
- Did demonstrate and reconfirm the improved bottle life provided by ProStack Rack Systems

Using the simulated truck bay

- Improved the lab simulation
- Increased rack and bottle movement

Bottle Pull Test

- Bottle pulled from the rack and returned 500 times without any bottle damage

Validates Customer Rack Testing Experience and Customer Transportation Studies featured on www.prostack.com

ProStack Rack Systems have significantly greater transportation life and fewer failures compared with metal rack systems