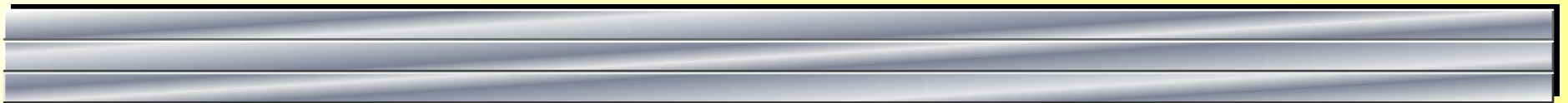


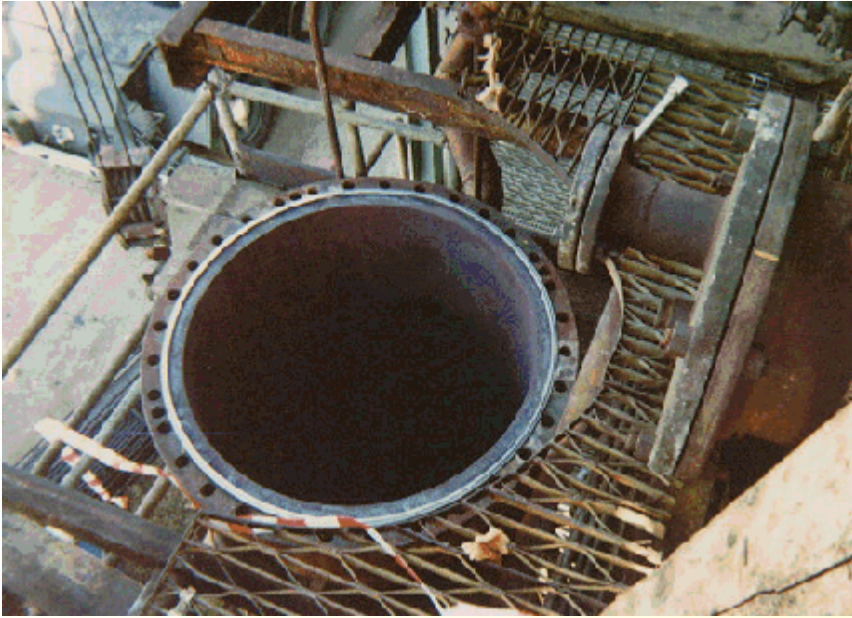
Evaluating Live Loading of Bolted Joints to Improve Gasket Performance Life

Presented by

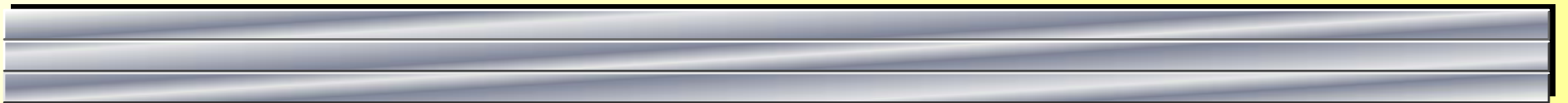
**Ron Frisard
Development Engineer
AW Chesterton**



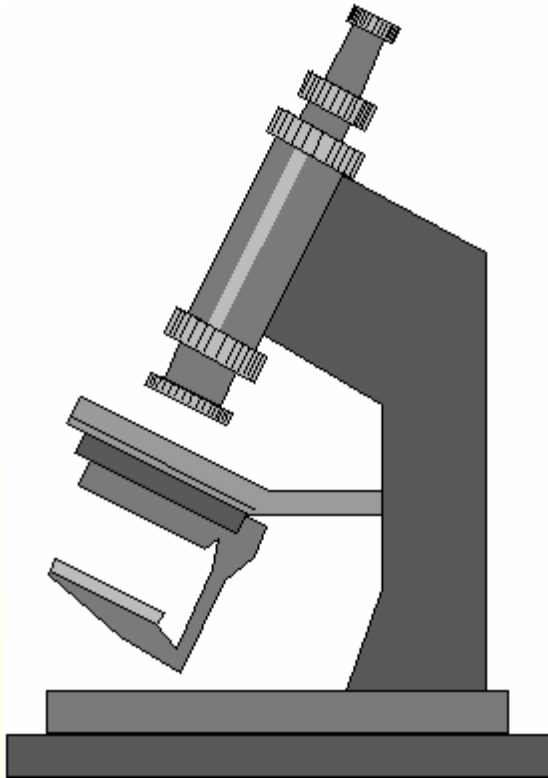
Real World Success for Live Loading



Hard to find real lab data
on Live Loading

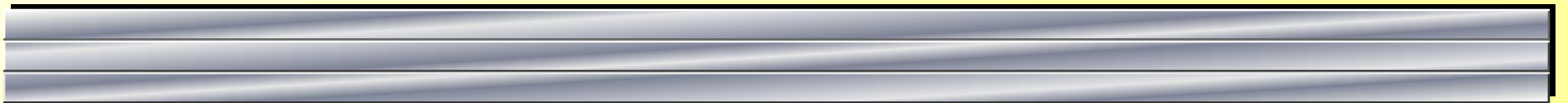


Matrix testing



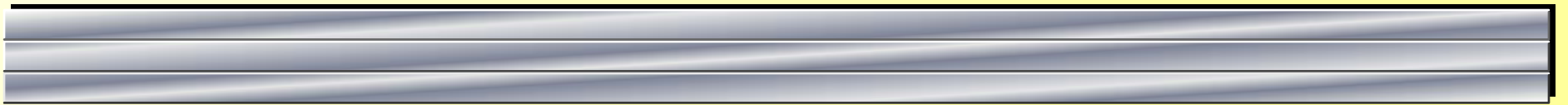
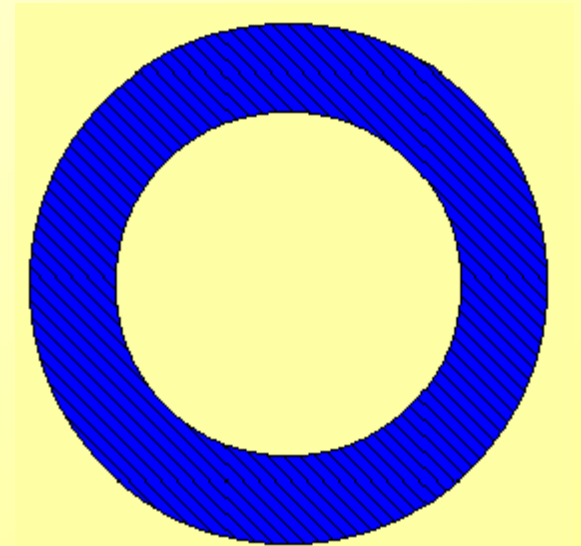
Factors:

- Materials
- Gasket Stress
- Live loading
- Thermal cycling
- Thermal Shock



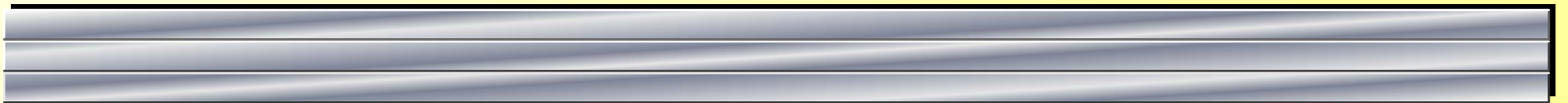
Gasket Preparation

- 1/16" Thickness
- Cut by a Steel roll die
- ANSI 1¼" 600 Lb Class raised face flange (1.66" x 2.500" ~ 2.74 in²)

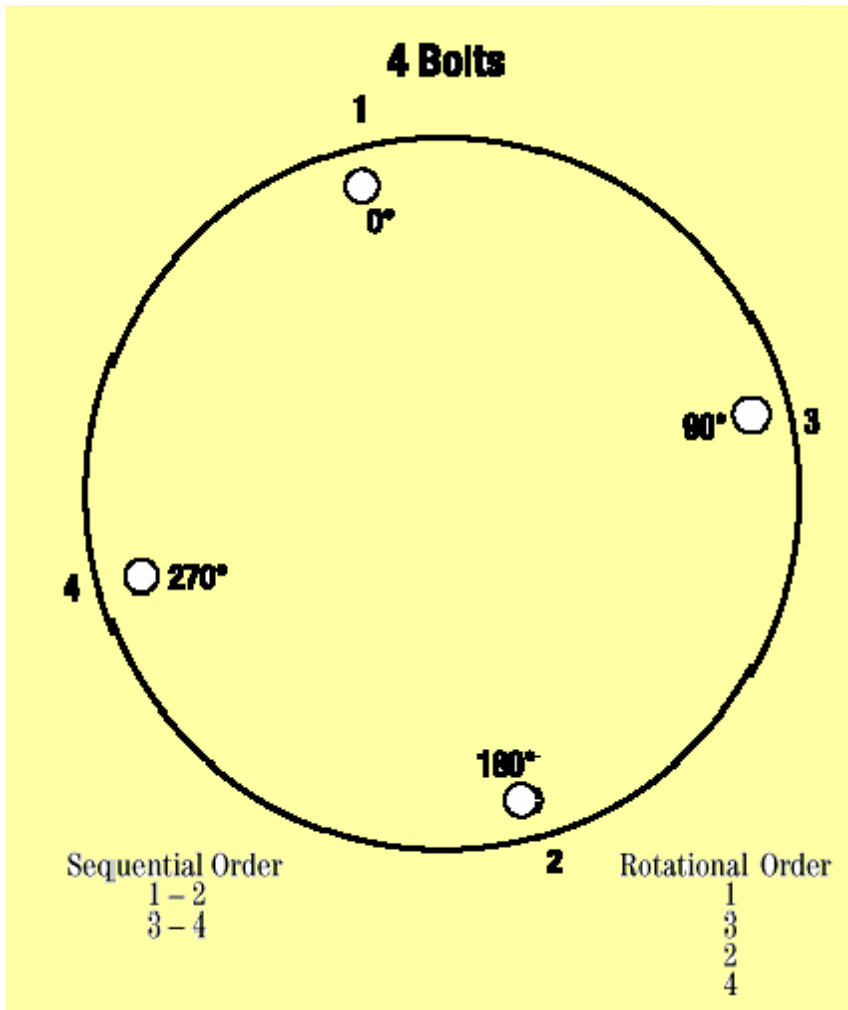


Gasket Fixture

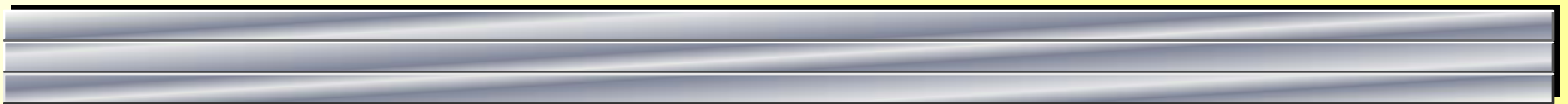
- Two raised face flanges with 4 - 5/8" B7 bolts.
- 125 ml of water in reservoir
- Blowout protector



Tightening Procedure

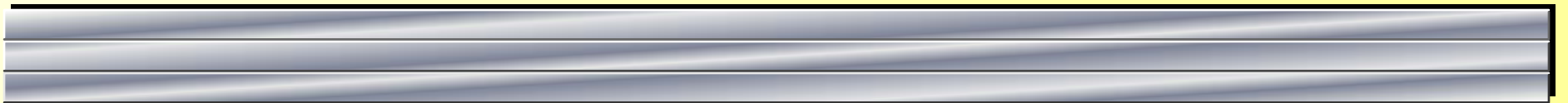


- Calibrated Torque Wrench
- Bolting Pattern
- 3 step torque levels
- No retorquing done



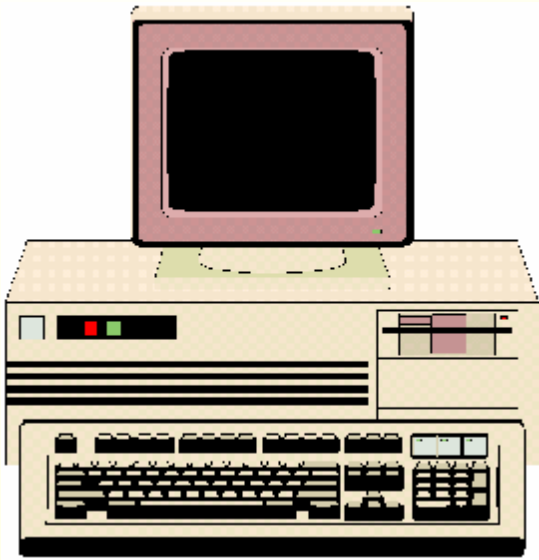
Oven's

- Single cycling oven
 - 22 hour heating cycle
- Gasket Cycling Device Oven
 - 5 thermal Cycles a day with a one hour hold at top temp and one hour hold below 100°F
 - Fixture placed in center



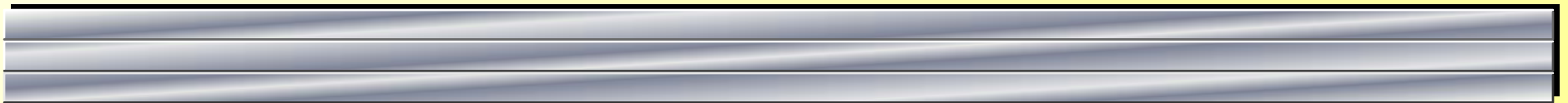
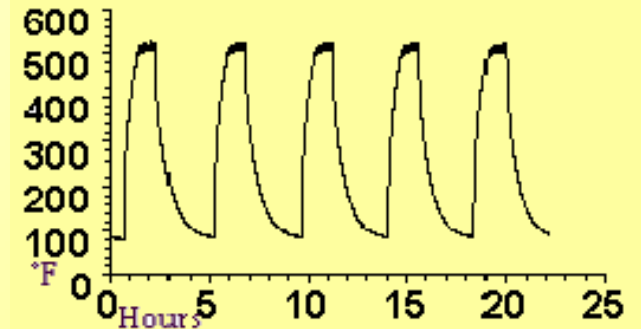
Gasket Cycling Device

How it works..



2 thermocouples measuring the top of the flange & top of the bolt head

Output controlling the oven's Power and the exhaust fan's power



Test Configuration (Phase 1)

- Testing material: 1/16" graphite sheet with a Nickel insert
- Testing temperature: 500°F
- 3 sets of fixtures in a 33 cycle - 792 hour test
 - 1 fixture with bolts torqued to 60% yield (20,000 PSI seating stress) without Live loading
 - 1 fixture with 60% yield with Live loading
 - 1 fixture with 40% yield (13,800 PSI seating stress) with Live loading
- 3 sets of fixtures in a 165 cycle - 792 hour test
 - 1 fixture with 60% yield without Live loading
 - 1 fixture with 60% yield with Live loading
 - 1 fixture with 40% yield with Live loading

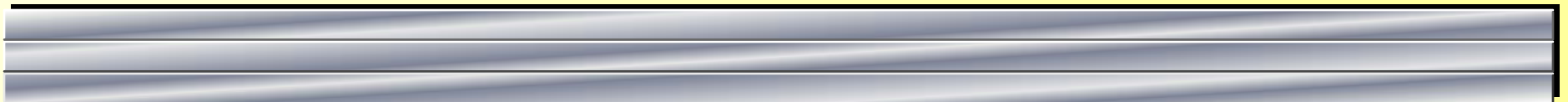


Results Phase 1

Live loading 60% Vs. Without Live loading 60%

Live Loading 60%	33 cycles	.56% loss
Live Loading 60%	165 cycles	.00% loss
Without Live Loading 60%	33 cycles	.80% loss
Without Live Loading 60%	165 cycles	2.23% loss

- Live loading resulted in less media leakage

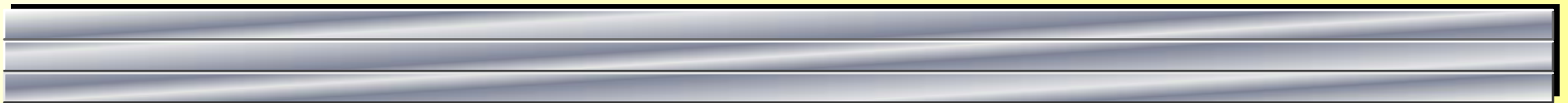


Results Phase 1

Live loading 60% Vs. Live loading 40%

Live Loading 60% - 33 cycles	.56% loss
Live Loading 60% - 165 cycles	.00% loss
Live Loading 40% - 33 cycles	1.10% loss
Live Loading 40% - 165 cycles	.28% loss

- **50% less media leakage with ideal torque**



Test Configuration

(Phase 2)

- Testing material: 1/16" Nitrile sheet reinforce with an aramid fiber
- Testing temperature: 500°F
- 3 sets of fixtures in a 38 cycle - 912 hour test
 - 1 fixture with bolts torqued to 60% yield (20,000 PSI seating stress) without Live loading
 - 1 fixture with 60% yield with Live loading
 - 1 fixture with 40% yield (13,800 PSI seating stress) with Live loading
- 3 sets of fixtures in a 155 cycle - 744 hour test
 - 1 fixture with 60% yield without Live loading
 - 1 fixture with 60% yield with Live loading
 - 1 fixture with 40% yield with Live loading

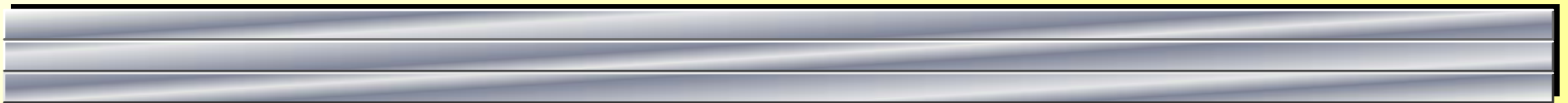


Results Phase 2

Live loading 60% Vs. Without Live loading 60%

Live Loading 60%	38 cycles	.85% loss
Live Loading 60%	155 cycles	.54% loss
Without Live Loading 60%	38 cycles	3.06% loss
Without Live Loading 60%	155 cycles	.71% loss

- **Live Loading resulted in less media leakage**

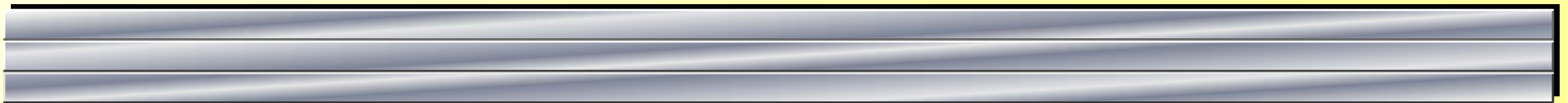


Results Phase 2

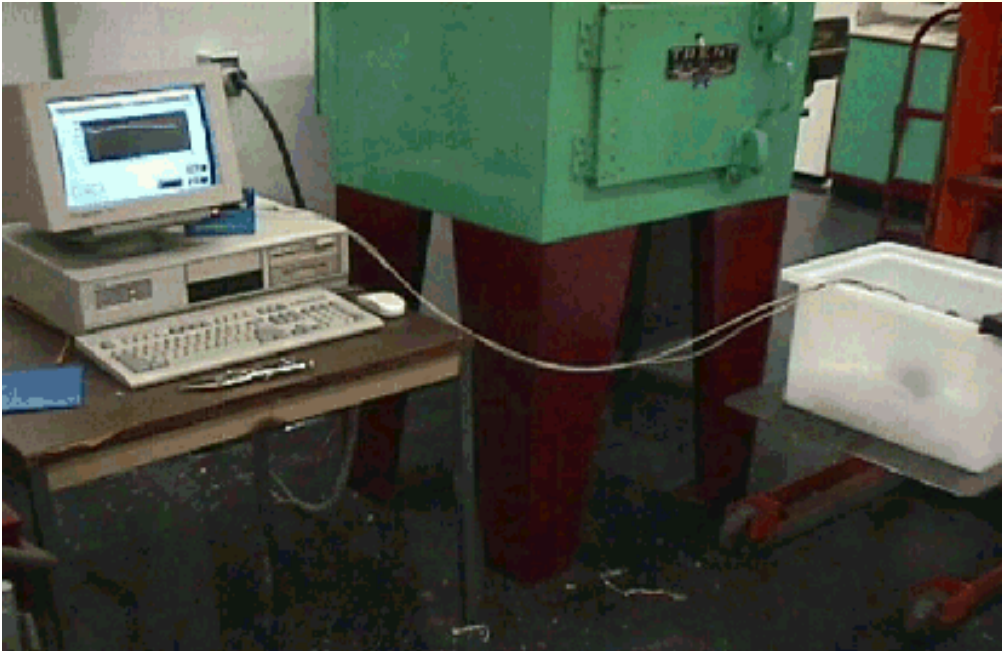
Live loading 60% Vs. Live loading 40%

Live Loading 60% - 38 cycles	.85% loss
Live Loading 60% - 165 cycles	.54% loss
Live Loading 40% - 38 cycles	1.42% loss
Live Loading 40% - 165 cycles	.80% loss

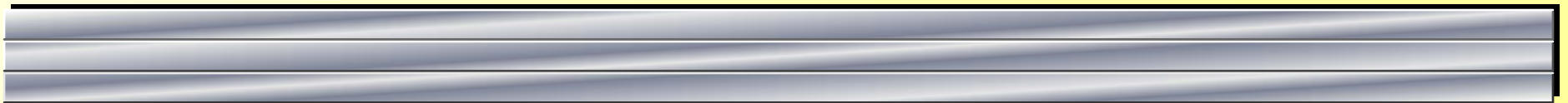
- **Joints loaded at 60% yield performed much better than the joints at 40%.**



Thermal Shock testing



- The three fixtures from the Gasket cycling oven were used from phase 2
- Computer monitoring Bolt and flange temperatures
- Utilizing Dry ice reduced the cooling cycle by a factor of three.

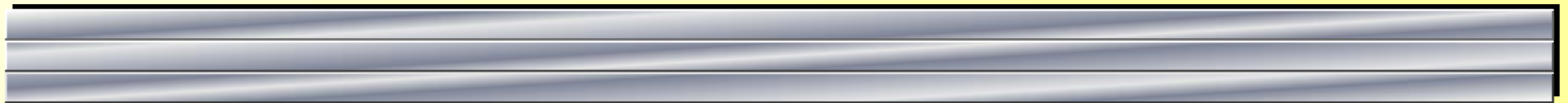


Thermal Shock Testing Results

<u>Flange</u>	<u>net loss after shock</u>
No live loading - 60%	.85%
Live loading - 40%	.54%
Live loading - 60%	.27%

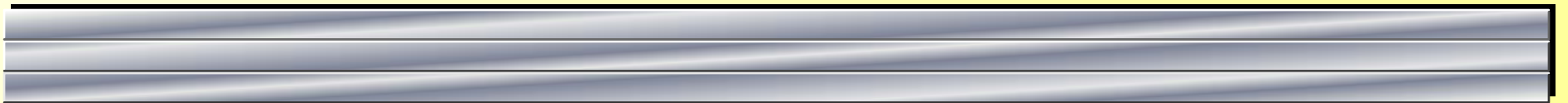


Results from the dry ice testing reflects that the Live Loading fixture handled the shock best. It can be derived that the Live Loading aided in the loss of gasket load, in turn resulted in a tighter seal.



Conclusions

The testing that was conducted and summarized in this report has shown a definite benefit to flange live loading. This benefit was seen for both graphite and nitrile sheet materials in high thermal cycling areas.



Future Testing

A test utilizing a 1/8" Graphite sheet gasket at an elevated temperature of 650°F.

A test using a nitrile binder sheet 1/8" sheet at 550°F.

A test with filled PTFE 1/8" and 1/16" with a cycling temperature of 515°F.

