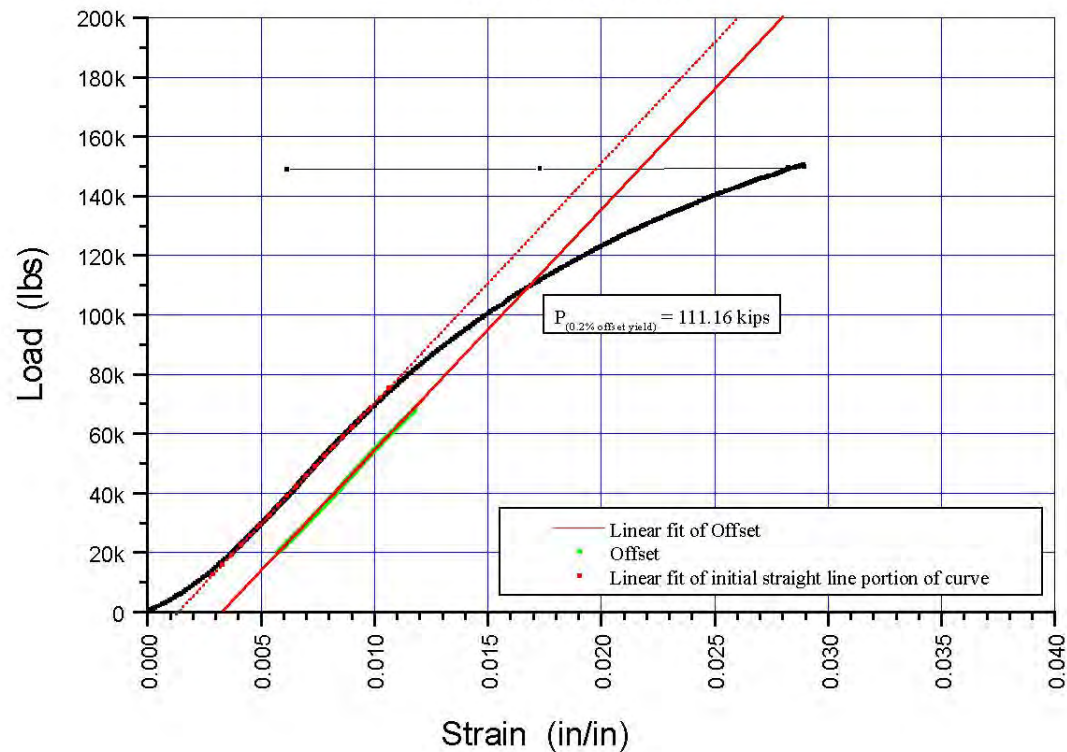


The State of Test standards from the point of view of a Material Test lab

October 13, 2005

Load vs Strain

Spec. ID: XXXX-XXXX



Materials Test Lab Accreditation



For those of you not familiar with Intec we are an advanced Materials Center.....a multidiscipline solution provider for manufacture, design, and testing of advanced materials and products, with a strong focus on composites.

We are fortunate to work with a wide cross section of clients, from small sporting goods manufacturers like Werner Paddles and K-2 to the big Aerospace guys like Boeing, Lockheed, Northrop, and Bell to the famous NASA.

We have worked on the Mars Rover, the 787, 777, Global hawk, RLV, JSF, V-22 etc... all the way to K-2 inline skate frames, large composite light poles, and one of the weirdest tests of all, the official State of Washington Department of Corrections Official Hangman's Rope, (Tested it for tensile strength, cruel and unusual punishment etc) it was a new thick Hemp rope that was quite stiff to handle and smelled like vaguely like kerosene.

NADCAP Certification



(National Aerospace and Defense Contractor Accreditation Program)



ISO/IEC 17025- NADCAP Materials
Test Lab Accreditation



NADCAP 2004 – SAE AS-7101

Mechanical Testing Facility

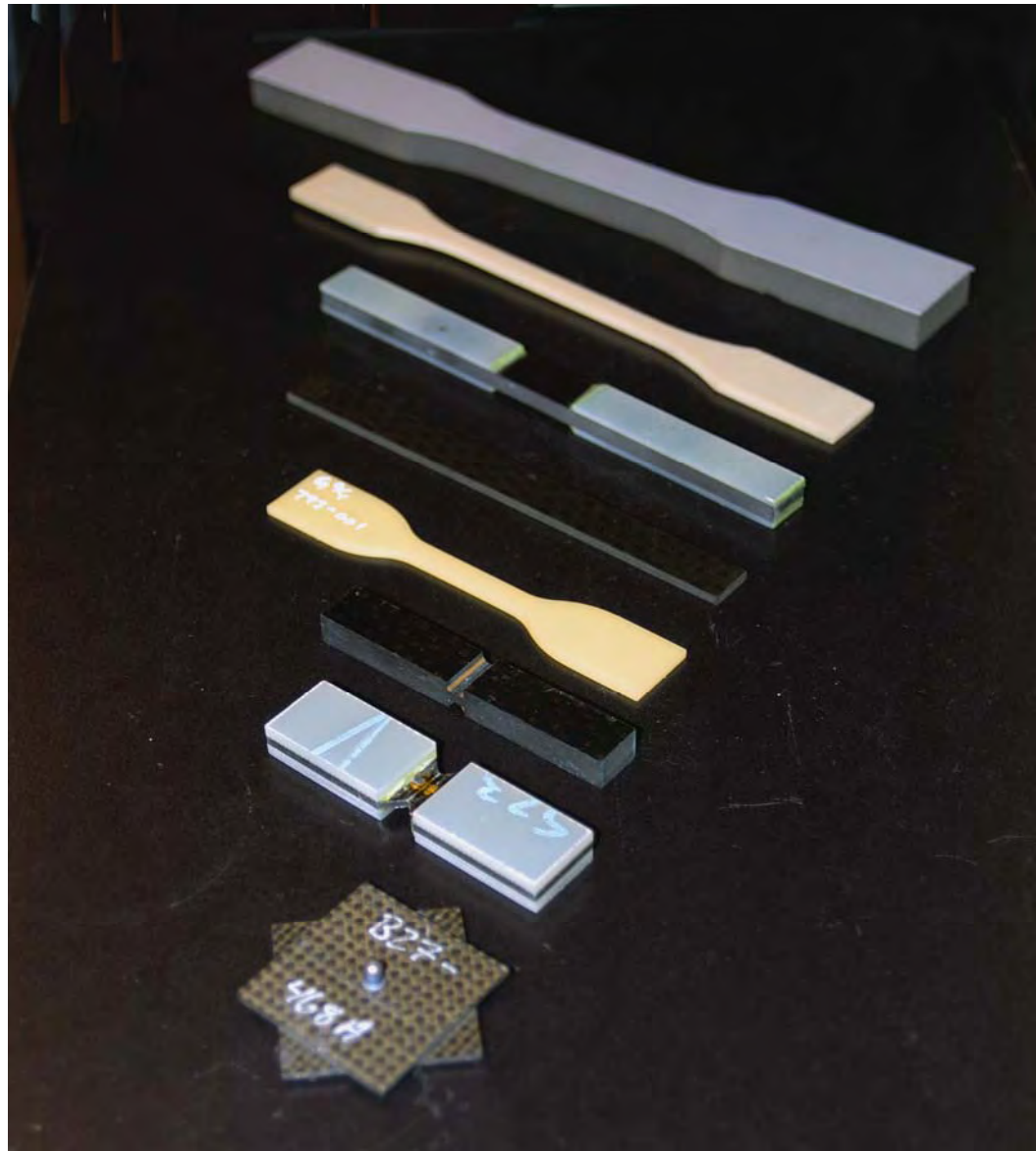
Clean, environmentally controlled atmosphere..

Up to 1.2 Million Pound Capability.



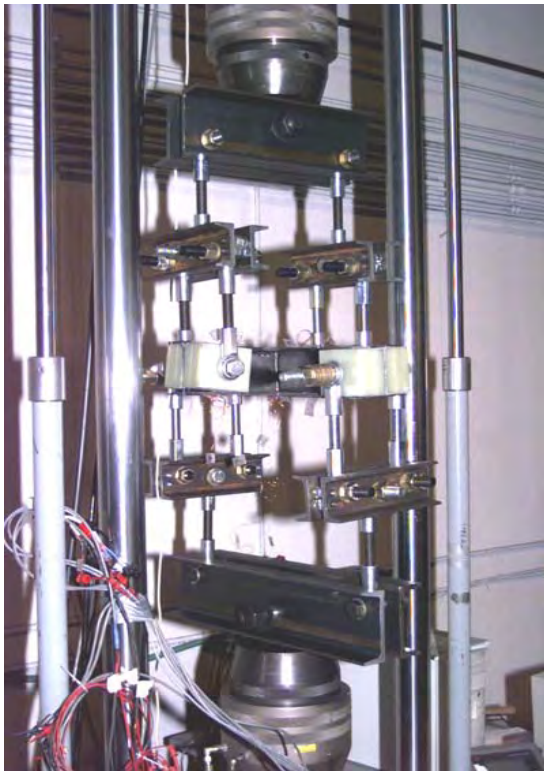
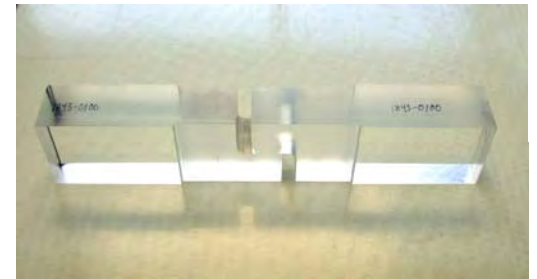
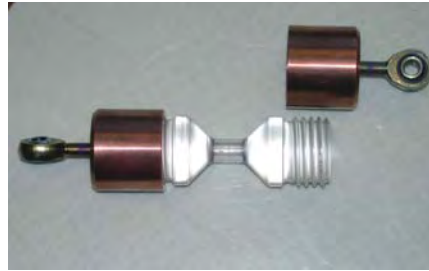
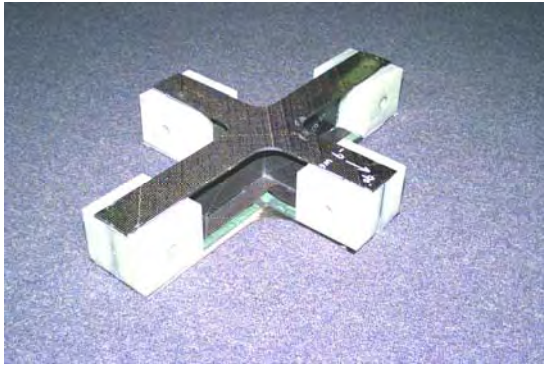
- **We run into lots of spec's ASTM, SACMA, ISO etc.....**
- **Every Lab does things differently by nature, the POV changes in localities.**
- **There is always room to interpret a way to do some things and then there is Tribal Knowledge. The, “we have always done things this way”.**
- **The big pitfall is not the omission of an step, that usually only a mistake and can be tracked and controlled by a good Quality System,**

Typical Coupon Level Specimens



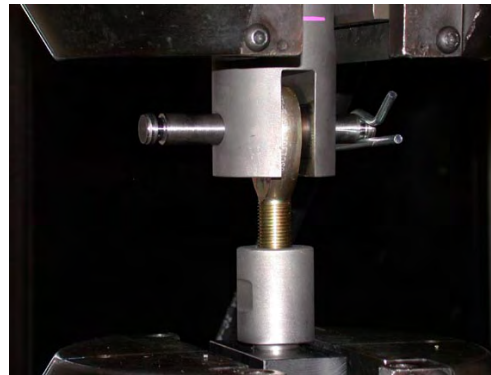
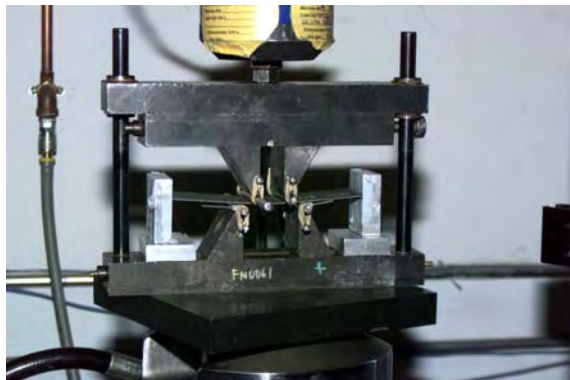
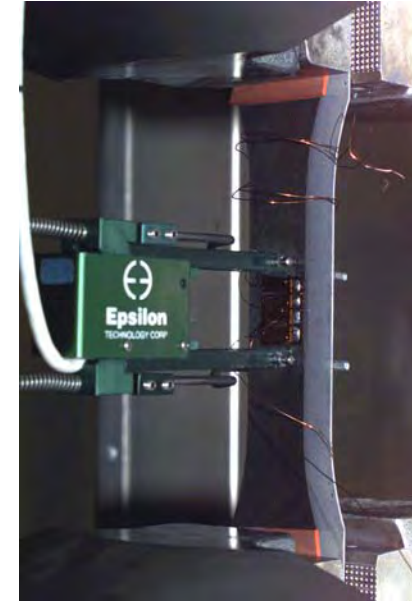
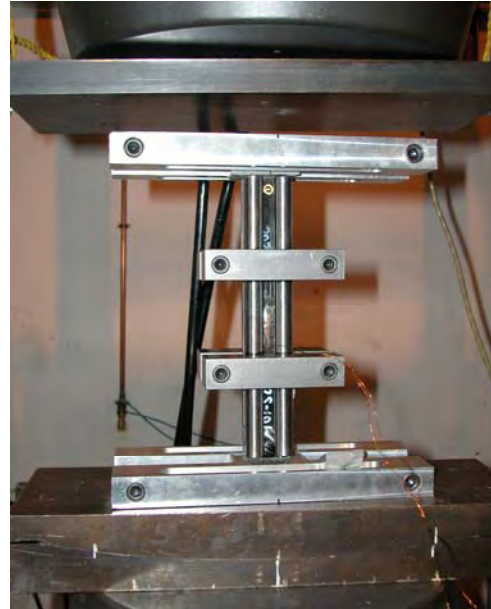
- **The real problem is someone not understanding the testing and the limitations of the test specification. There is then the opportunity to “IMPROVE” or “TIGHTEN” the spec up to do really good job.**
- **This can often seem like a good thing to do at the time, it often cleans up the scatter in the testing and tightens up the test itself.**
- **However, down the road a ways, this action will effectively back you in a corner as you progress to part/production testing. This “ADJUSTMENT” makes it very difficult to get this level of accuracy out of something made in production.**

Not so Typical Coupon Level Specimens



- **Once started, this chain of events causes the QC testing to grow in cost and time and becomes a significant headache.**
- **The point of this is that although people in general think that test specifications are fairly controlled and tight, there is still a lot of room for interpretation in them and that is where the science can fall through the cracks.**

Coupon Level Mechanical Testing



Coupon Level Mechanical Testing



- **Here are some general observations:**
- **..... “There is no substitute for sound engineering judgment”**
- **Often specs are tailored to one material, when there is the inevitable change in materials or application, the test is not as applicable.....even though the specification suggests it is.**
- **.....Aerospace companies often issue new specs under their name with a specific goal in mind.**
- **Immature company authored specs often do not use an ASTM etc. spec as a foundation.**
- **It is easy to make the mistake of not addressing a related, mature industry specification and to attempt to use it as a basis.**

- **Because this is a new spec in a new application they are often not very well vetted,**
- **Intec has found that it is relatively common, when looking at individual coupon level test specs, for them to have basic mistakes in their formulation; these specs are now over 10 years old and firmly entrenched in the system.**
- **In addition, often there are no resources available to keep the internal specs current with recent changes in materials and applications.**

Servo Hydraulic Mechanical Test Frame

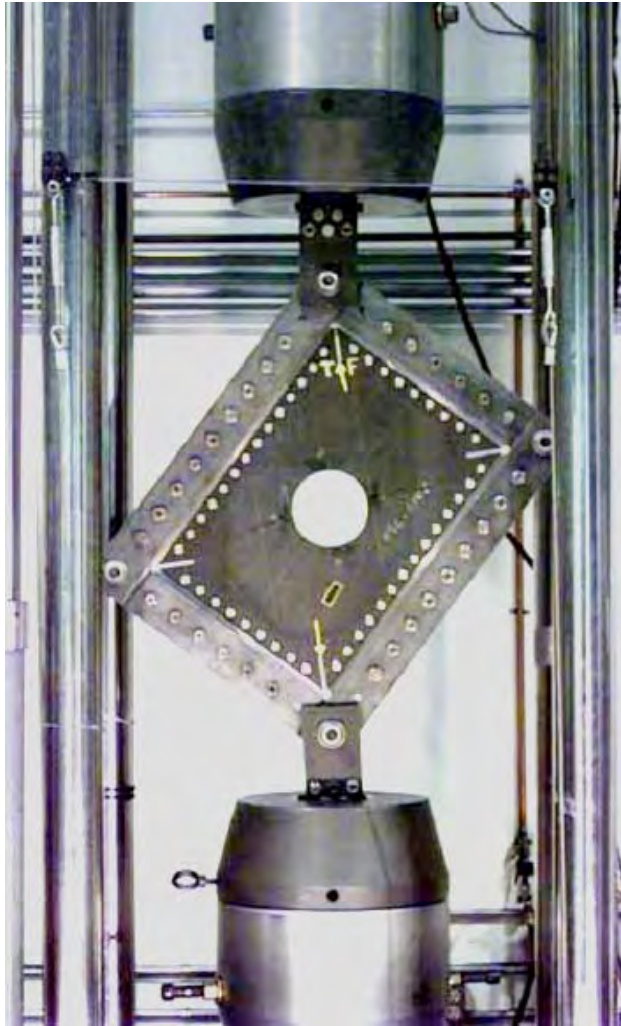


Up to 600 KIP Test Frame
Fatigue Capability.

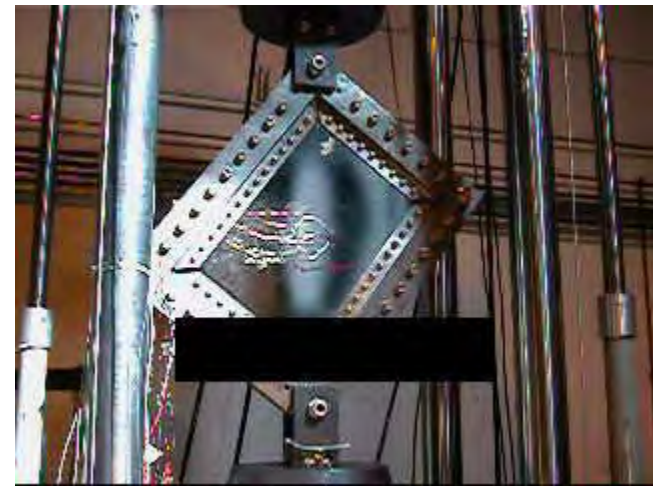
- **So.....it sometimes gets tricky..... The Specifications that you must use need to be looked into pro-actively; you cannot assume that they are the perfect answer to your needs.**
- **1. Specifications are great but: there are some easy traps to fall into,..... immature spec, political influence**
- **2. When possible, use the Industry generated specifications, they are more vetted and were generated with a larger and more diverse population over more time.**
- **3. It is easy to OVER interpret the spec... and it is easy to UNDER interpret the specs,**

Specialized Coupon & Element Testing

Large Shear Panel Testing



Static and
Fatigue
Evaluation of
Simulated
Ballistic
Damage

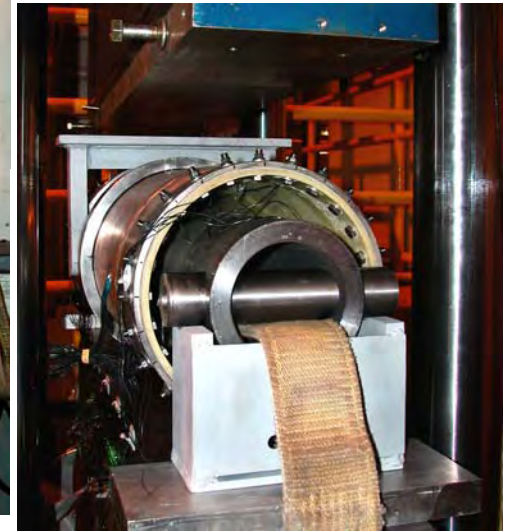
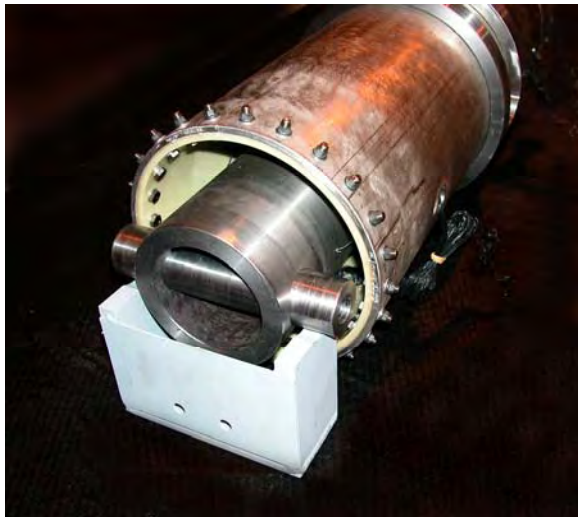
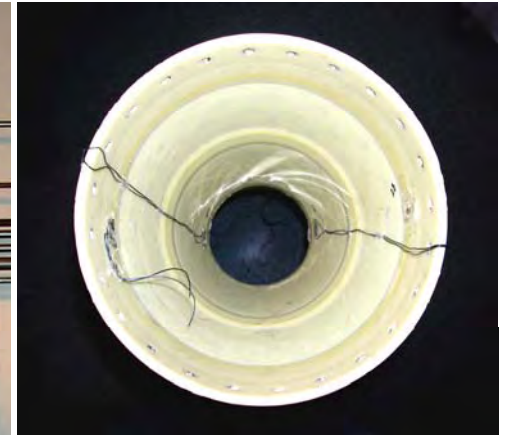
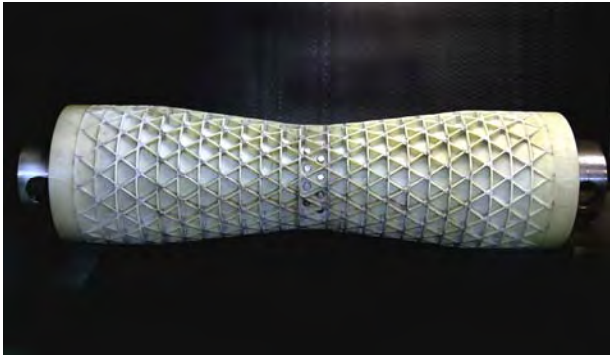


- **Here is an example of over interpreting a specification to provide a most perfect specimen despite the cost and time to produce it.**
- **When manufacturing a standard, tabbed, tension coupon,.....usually the panel is made, machined / tapered tabs of G-10 or equiv. are bonded to it, the panel is cut into individual specimens, measured /inspected and the coupons are then tested.**
- **This is pretty straight forward and somewhat of an industry standard.**

- **We once had a customer that built their own test panels, in an effort to build a perfect and beautiful specimen, they engineered and fabricated the specimen with the ply drop taper for the tabs built in.**
- **As you can imagine, this makes for a beautiful specimen, but this also makes each specimen expensive and very labor intensive to produce. This also generates higher material properties from the testing that then is transferred into the material receiving spec.**
- **Usually there is a material manufacturers test and also an incoming test for the end user of the material. No problem with providing the allowable properties for the material providers, they have been doing this right along and it is very repeatable**

Specialized Coupon & Element Testing

Isogrid Nozzle Shear Test



Testing

[Return](#)

[Next](#)



- **.....when it comes to the incoming receiving inspection there is a built in failure scenario for this process. The buyer is probably not going to make the specimens the same way, they will interpret the spec as most of us do.**
- **They will fabricate machined,.... tapered tabs out of what ever they might have around and adhesively bond them to the specimens. Although this is done to the spec, there will be a good possibility that these specimens will not test as high and the material may be rejected or at least some additional time and \$ spent on getting it to pass.**

- **Here are the essential and key characteristics of a good technical specification:**
- It must be strong technically
- Broad enough
- Focused enough

600 Kip Hydraulic Test Frame

Four 60kip
actuators on
top and
bottom



Specifications:

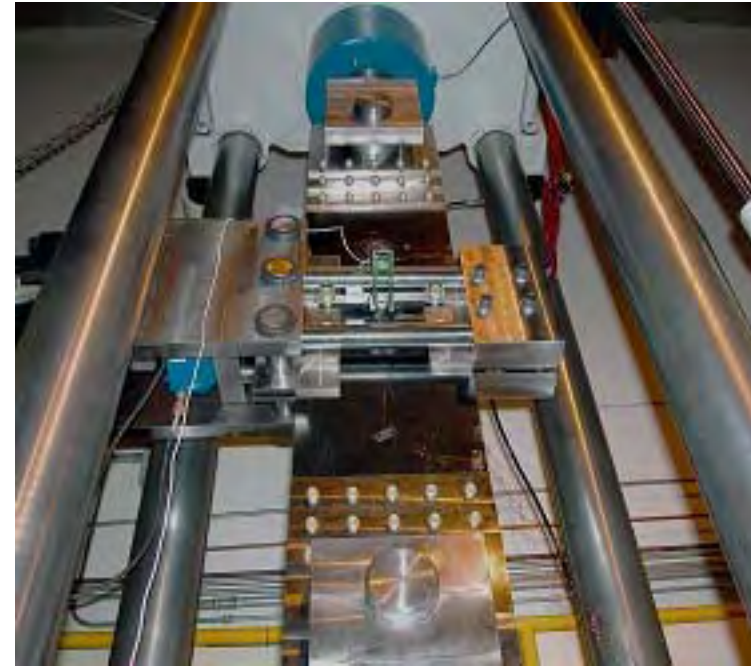
- Tension & Compression up to 600kips.
- Hydraulic grip area up to 30" wide and 4" tall
- Specimen capacity unlimited width, 3" thick, and 95" tall.

Quick Grips often enable efficiency gains over traditional fastened fixturing of 1000%.

Also.....

- **it must be applicable to the material**
 - **Example: if you are doing compression testing and using a compression fixture that has been optimized for a Graphite material..... all will be well until you try and use the same set of rules for testing Kevlar. Using this example you might actually run out of room in the fixture before you can properly test the specimen.**
- **In general: the test specification needs to be a living document**

Specialized Coupon & Element Testing Transverse Tension



Free floating transverse load to follow specimen as it is loaded-actual tension loads up to 600 KIPS

Transverse:-max load transverse 120kips

- **Another example of having some time and expertise available to get proper testing:**
- **Recently we did a series of 4 pt flex testing, this is a pretty common test, been around a long time, we have all done a bunch of them.**
- **In this case the material had been improved and was behaving quite differently than things in the past. In this case it took 3 full days with 3 engineers working together to get a proper failure.**
- **This was accomplished by having a good specification, experience to draw from, a representative from the customers company on site and permission from the customer to vary the details of the testing to get this to happen.**

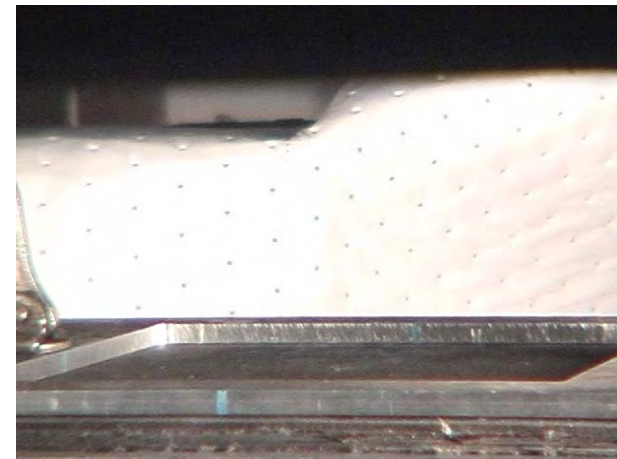
Dynatup Full Scale Impactor



Drop Tower
Instrumented
Impactor 1



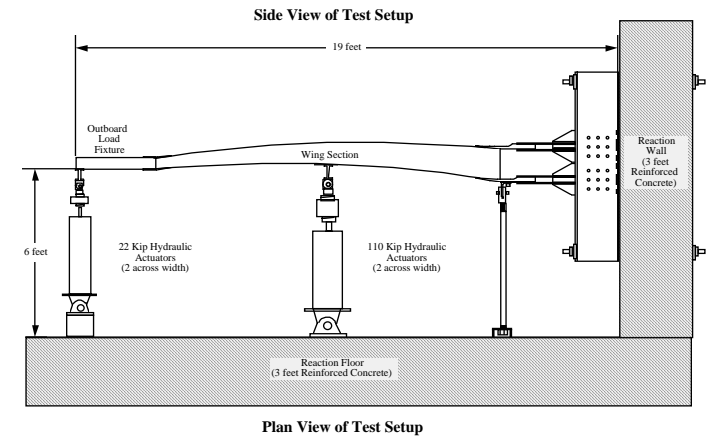
High Speed
Data
Collection
(over 1M
points per
second)



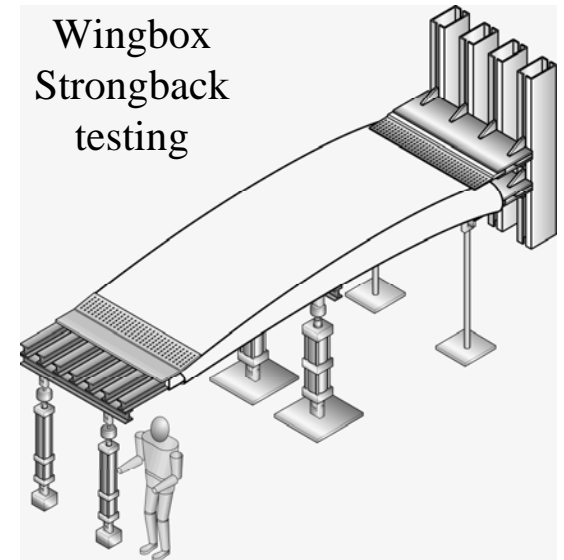
For testing to be successful we have a few suggestions:

There is no substitute for sound engineering judgment, the more you participate,the better things will go. If you are sending a new engineer or an engineer with a lack of testing experience, it might be wise to have them work on a standard test and not something that is new.

Large Scale Testing Wingbox Test Setup



Large
Pressurized
Wingbox
Strongback
testing



[Return](#)

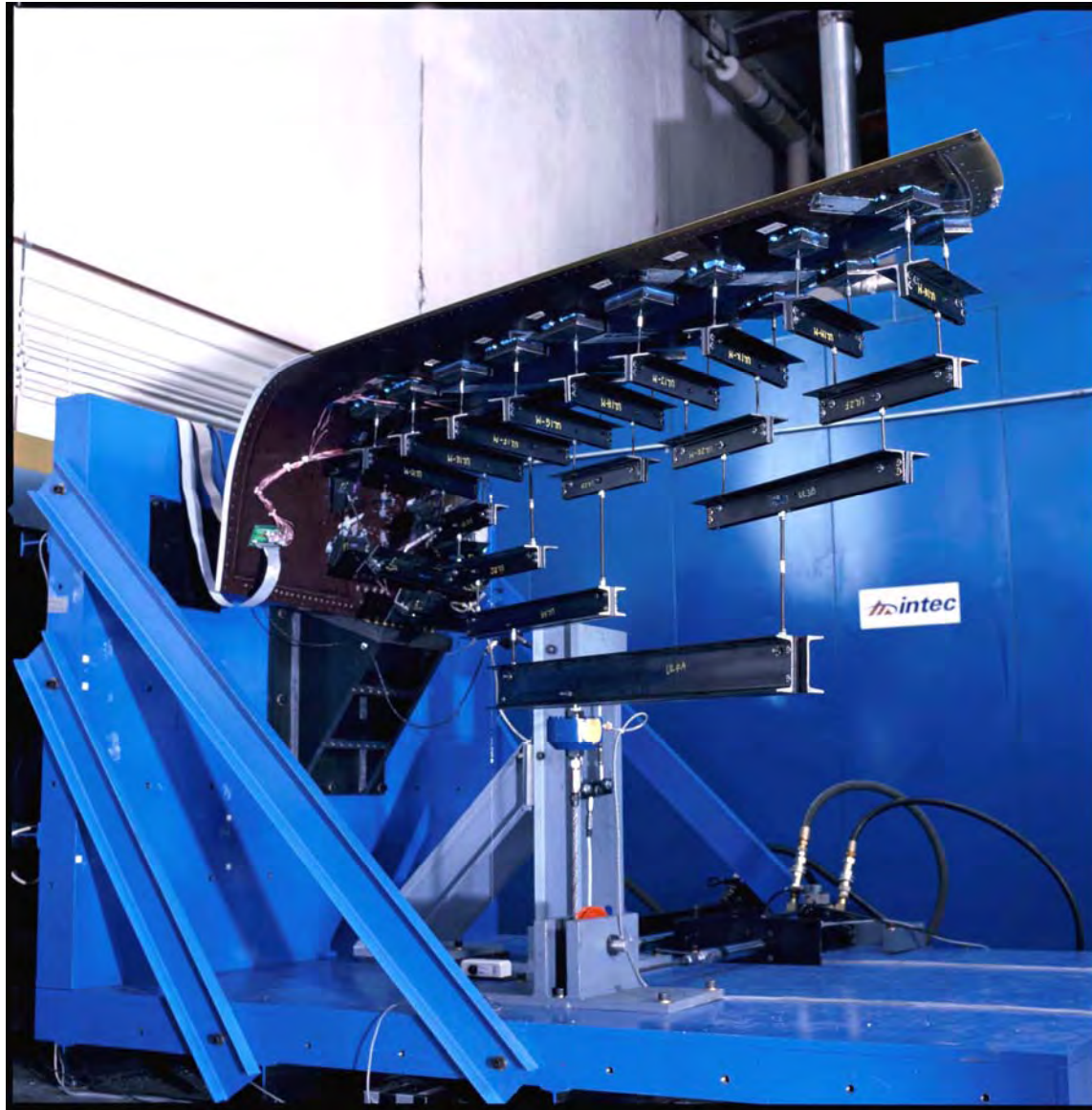
Large Scale Testing

[Next](#)



Large Scale Testing

737 BBJ Winglet Test Setup



The certification tests for APB's 737-BBJ blended winglet.

Multiple actuators applied load through 3 waffle trees and 40 load pads to simulate aerodynamic loads.

Reaction fixtures were designed for more than 500,000in-lbs bending moment with less than 0.02" overall fixture deflection.

The specific aim of this test was to show compliance with FAR 25.305 (a)(b) and 25.307.

When selecting a test lab:

- Ask Questions up front. Discern in advance of letting out a contract that the lab has enough engineering background and judgment to get you through the program.**

Monitor the process watch the first specimen of each type

Large Scale Testing

Titanium Sine-Wave Stir-Welded Floor Beam Test



12-foot Spar Bending Test

Component Testing

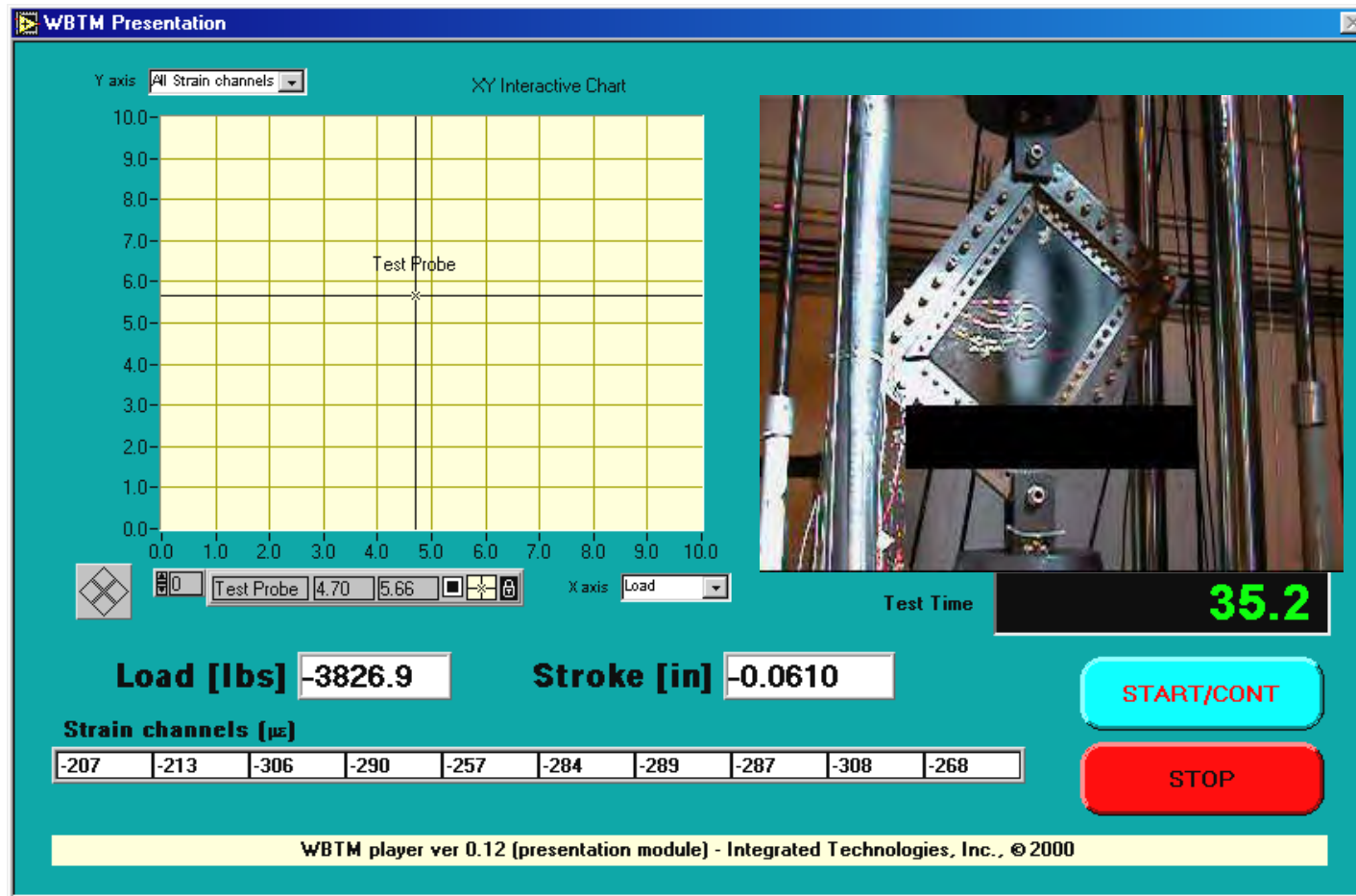
Large, Medium, and Small Notch Panel Test Fixtures



Custom Testing Fixtures

Test Fixtures

Web Based Test Monitoring Capabilities



WBTM uses a synchronized video/sound signal along with digital test data (load, stroke, & strain) to provide clear picture of the test and test data as it is occurring.

Physical Properties Test Lab



Thermal analysis:

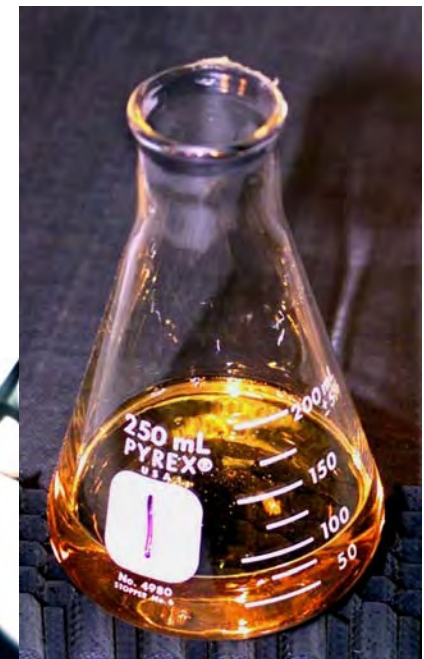
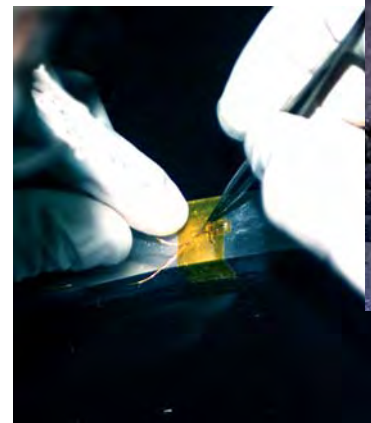
- DSC, DMA, TGA, FTIR, TGA, CTE

Physical Properties

- Void, density, volume fraction, flammability, out gassing, ultrasonic pulse echo and TTU

Photography

- Stills, high resolution digital, microscopy, high speed video, shadow moiré, in-plane moiré, photoelasticity



Thermal Analysis

Differential Scanning Calorimeter: DSC

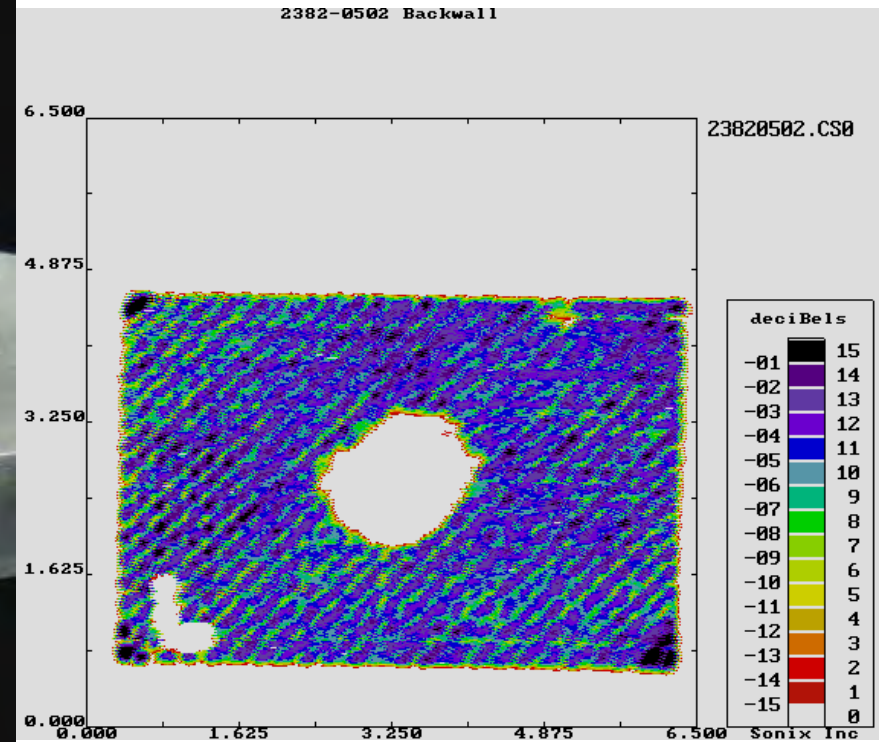
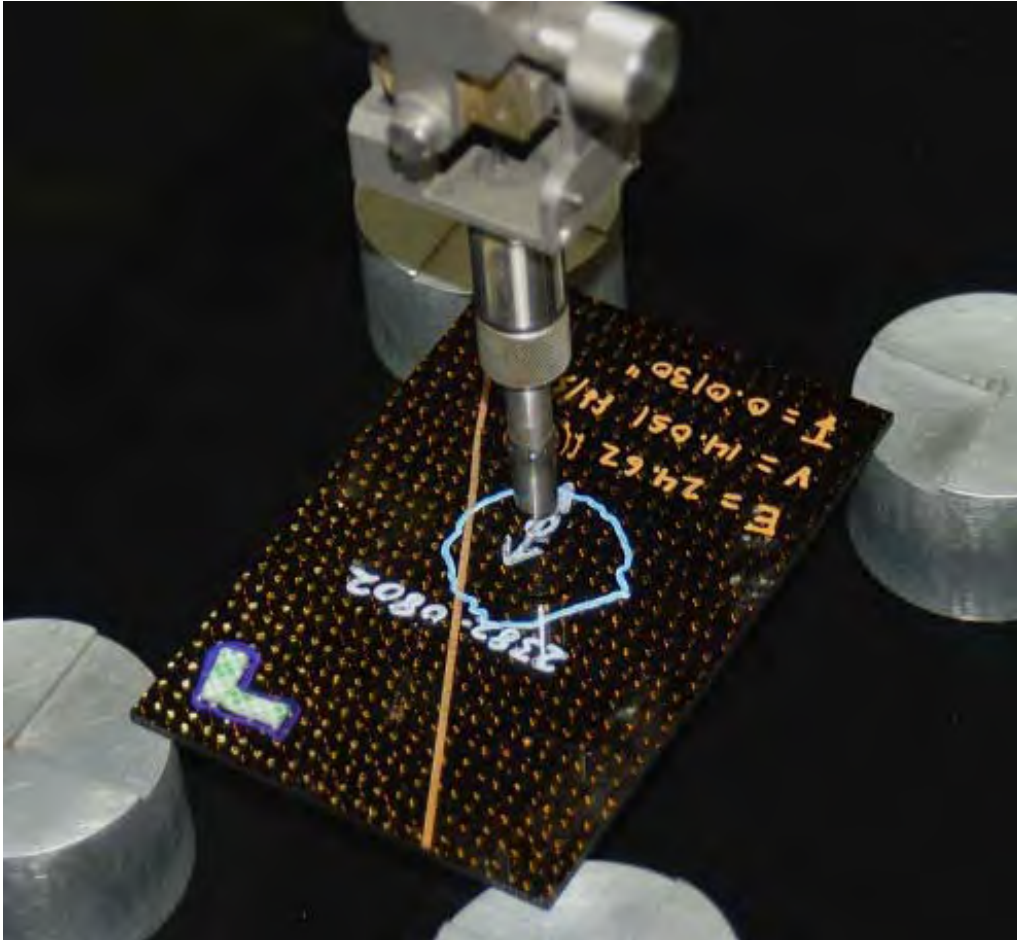
Dynamic Mechanical Analyzer: DMA



Physical Properties Laboratory

Ultrasonic Inspection

A-Scan, C-Scan, Pulse-Echo, TTU



Physical Properties Laboratory

Digital Photomicrographs



Thank You

