

# Carbon Fiber Technology Facility

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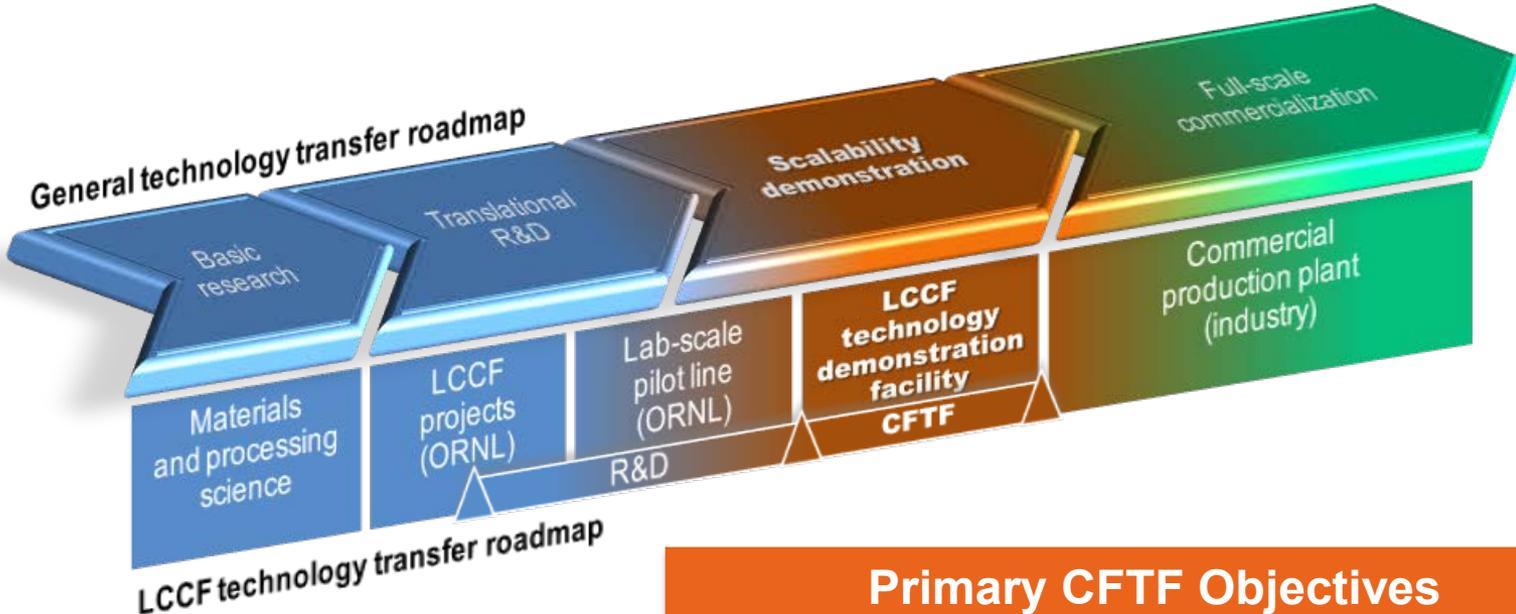
# Carbon Fiber Technology Facility (CFTF) ARRA CAPITAL Project Overview

## Timeline

- Funds received FY10Q2
  - Scheduled finish FY13Q4
  - Forecast finish FY13Q2
  - Currently in equipment fabrication and installation
- **Barriers addressed**
    - Cost
    - Inadequate supply base
    - Manufacturability
  - **Interactions/ collaborations**
    - Capital project – subcontractors
    - Future operation - extensive
  - **Project lead - ORNL**
- **\$34.77M Budget**
    - No cost share
  - **All funds have been received**
    - ~ 47% of baseline costed thru Feb
    - All subcontracts to US companies



# CFTF is the Bridge from R&D to Deployment and Commercialization

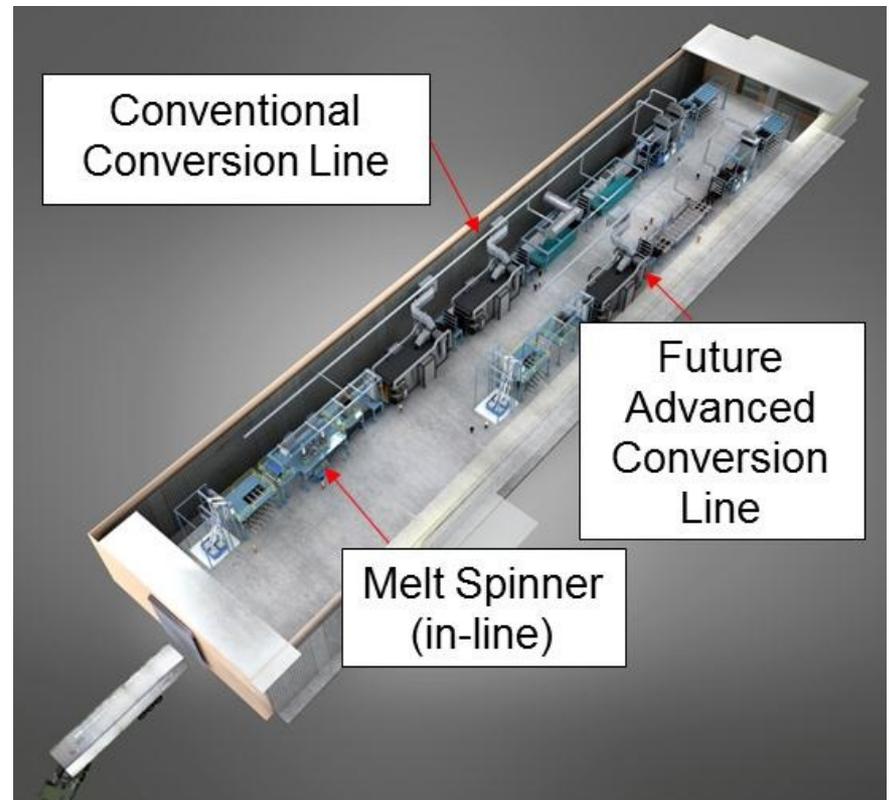


## CFTF Mission and Capabilities are Unique to the World

Primary CFTF Objectives	
Demonstrate low-cost carbon fiber (LCCF) technology scalability with the last scaling step before full-scale commercial production	Produce quantities of LCCF needed for large-scale material and process evaluations and prototyping

# Carbon Fiber Technology Center (CFTF) Snapshot

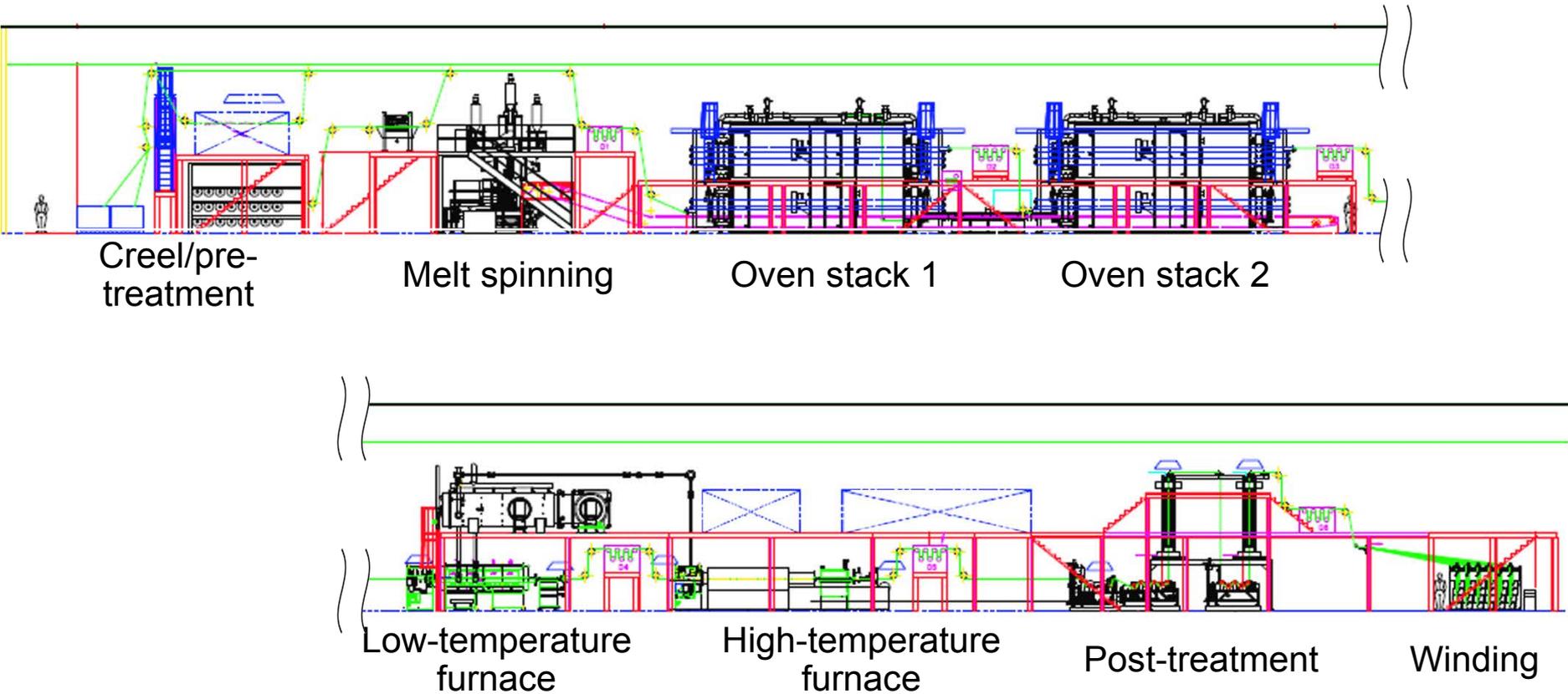
- Highly instrumented, highly flexible conventional carbon fiber line for “any precursor in any format”
- Melt-spun fiber line to produce precursor fibers
- Provisions for additional future equipment
- Produce up to 25 tonnes/year of carbon fibers
- Demonstrate technology scalability
- Train and educate workers
- Work in partnerships with industry



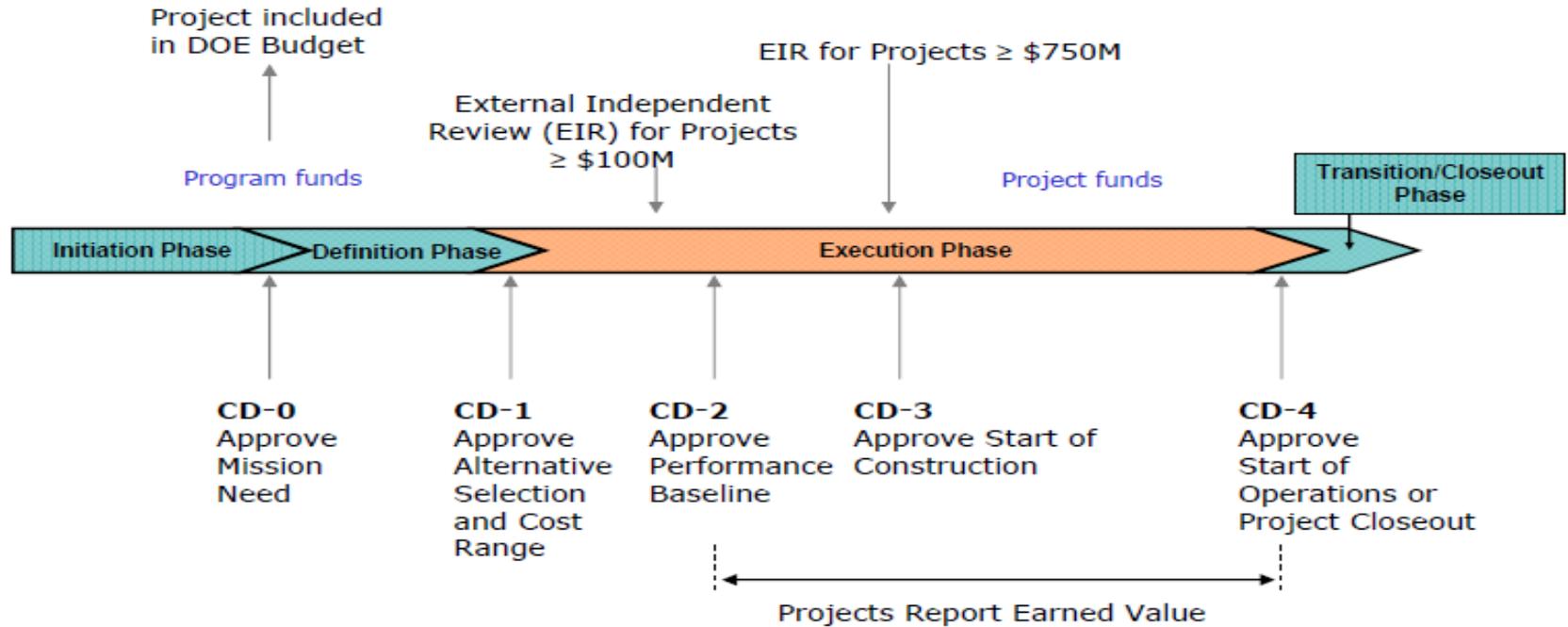
*Facility and equipment perspective*

# Equipment Scale

- Production line length: ~390 ft
- Equipment height: ~25 ft



# Capital Project Executed per DOE Order 413.3b



## Actions Authorized by Critical Decision (CD) Approval

CD-0	CD-1	CD-2	CD-3	CD-4
<ul style="list-style-type: none"> <li>Proceed with Conceptual Design</li> <li>Request PED funding</li> <li>Start monthly PARS &amp; Quarterly Project Performance reporting</li> </ul>	<ul style="list-style-type: none"> <li>Allow Expenditure of PED Funds for preliminary design</li> <li>Approval of long-lead procurement if necessary</li> </ul>	<ul style="list-style-type: none"> <li>Establish Performance Baseline</li> <li>Continue design</li> <li>Request construction funding</li> </ul>	<ul style="list-style-type: none"> <li>Approve expenditure of funds for construction</li> </ul>	<ul style="list-style-type: none"> <li>Allow start of operations or project completion</li> </ul>

# Key Milestones

Milestone	Status
CD-0	Issued Aug 2009
Equipment RFP's	Issued July 2010
Building lease	Awarded Oct 2010
NEPA documentation	Approved Jan 2011
CD-1/2/3 Approvals	Approved Mar 2011
Groundbreaking	Actual Apr 2011
Equipment contracts	Awarded Mar 2011
Building "dry-in"	Required May-12, Actual Nov-11
Equipment fabricated	Required Mar-13, forecast Jun-12
Equipment installed	Required June-13, forecast Aug-12
Equipment operational	Required Sept-13, forecast Jan-13
CD-4	Required Sept-13, forecast Feb-13

# Procurement Strategy

System	Award	Pricing	Performer	Comment
Building	Competitive	Fixed price	R&R Partners	Leased
Support equipment	With building	Cost	R&R Partners	
Carbon fiber line	Competitive	Fixed price	Harper Int'l	
CF equipment unloading	BOA	Cost	ESG Construction	Task order
CF line installation	Competitive	Fixed price	TBD	
Melt-spun fiber line	Competitive	Fixed price	Hills, Inc.	
MSF equipment unloading	Included	Fixed price	Hills, Inc.	
MSF line installation	Included	Fixed price	Hills, Inc.	

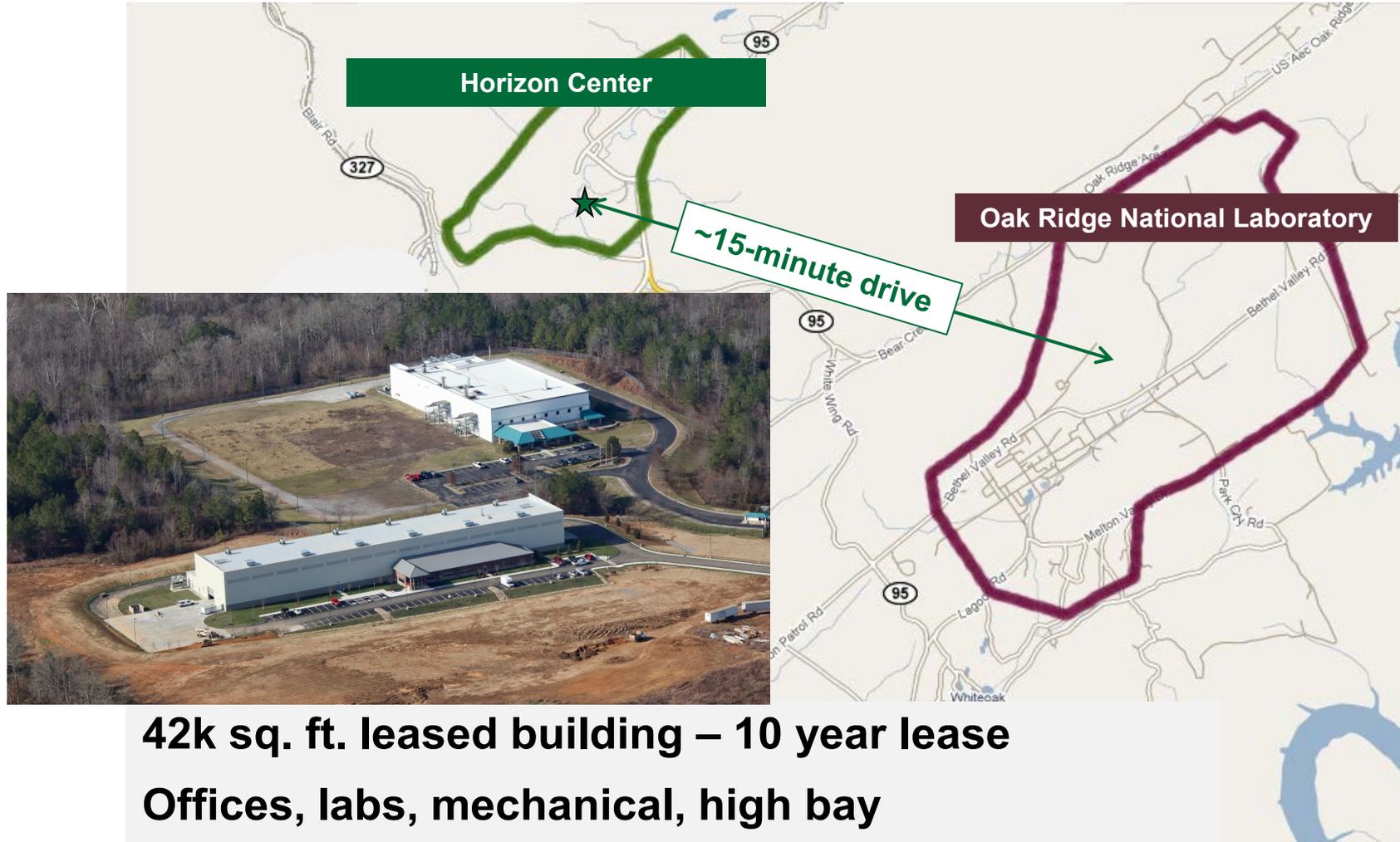
CF = carbon fiber

MSF = melt-spun fiber

BOA = Basic ordering agreement

**All subcontractors are US companies**

# CFTF is Located in an Industrial Park



*Highly accessible to industrial partners, with opportunity to locate other facilities nearby*

# Capital Project is **ON BUDGET** and **SCHEDULE**

- Thru February, MIE budget tracking within 2% of baseline spending profile
- Unused contingency is 26% of unspent baseline
- Building is complete
- CD-4 forecast Feb 2013 vs. baseline Sept 2013
- Estimated equipment arrival dates:

Ox Oven Stack 1	4/20		Ox Oven Stack 2	6/6
LT Furnace	4/17		HT Furnace	5/4
Post Treatment	5/1		Material Transport	5/23
Thermal Oxidizer	4/26		Melt Spinner	6/20

LT = low temperature, HT = high temperature, ox = oxidation

# Building

Beneficial occupancy Nov 2011

Trim & finish completed Mar 2012



Wet Chemistry Lab



Quality Control Lab



Mechanical Room



Production Area



Control Room



Motor Control Center

# Carbon Fiber Line – Tow Transport

- **Capabilities:**
  - Spooled tow, with plans to add boxed tow feed
  - Up to 24 tows in 3k – 24k sizes
  - 80k maximum tow size with less tows
  - Six draw/tension units
  - Driven passback rolls on oxidation ovens
  - 12” wide web conveyance
- **Factory testing Apr 17 (tow drives), Apr 19 (creel), and May 3 (winder)**



Creel

Photos courtesy of  
Izumi International  
and  
Harper International



# Carbon Fiber Line – Oxidation Ovens

- **Capabilities:**
  - 400 °C temperature rating
  - Four thermal zones
  - Parallel, cross, or down-flow (first in the world)
  - Sulfur-compatible zone
  - Tow and web material forms
- **Factory testing completed Mar 29**



# Carbon Fiber Line – Carbonization Furnaces

- **Capabilities:**
  - 1,000 °C and 2,000 °C temperature ratings, respectively
  - LT furnace corrosion resistant with fiber activation capability
  - Tow and web material forms
- **Factory testing Mar 27 (LT furnace), Mar 28 (HT furnace mechanical), and Apr 9 (HT furnace electrical)**



Low temperature furnace assembly



High temperature furnace assembly

# Carbon Fiber Line – Post Treatment

- **Capabilities:**
  - Electrolytic surface treatment
  - Space allocated for future dry surface treatment
  - Sizing for aerospace and commodity resins
- **Factory testing Apr 10**



Surface treatment equipment



Sizing bath

# Melt-Spun Fiber Production Line

- **Capabilities:**
  - > 10 kg/hr throughput
  - 2,000 m/min tow speed
  - 12” wide web direct-fed to carbon fiber line
  - Runs most melt-stable polymers, rated to 450C
  - Multi-component filaments
- **Equipment fabrication and assembly proceeding on schedule for factory testing and shipment in June**



Platform assembly



Mounted spinhead assembly



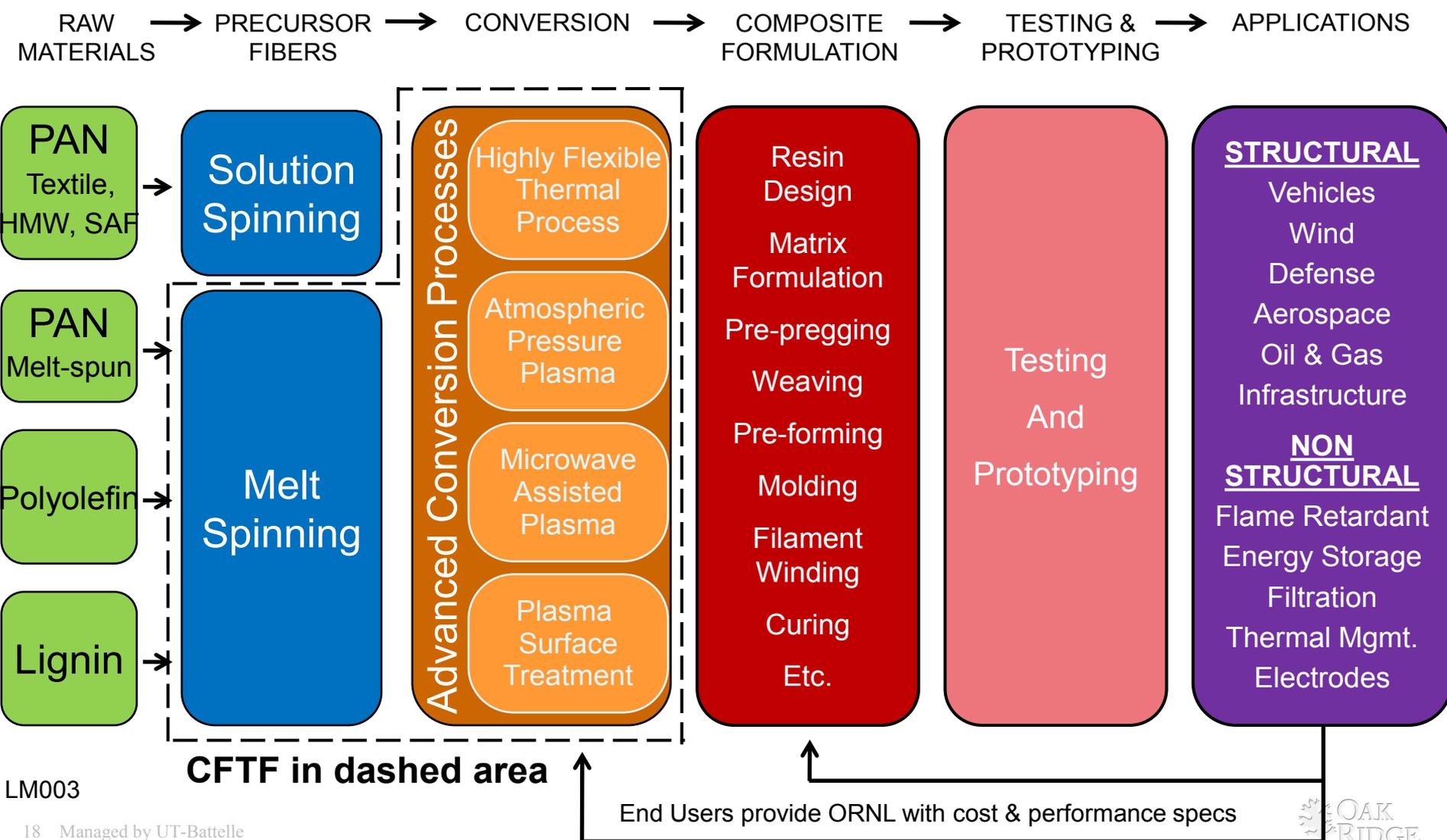
Screw & barrel

# Hazard and Operability Analysis Completed

- Describe system (unit operation)
- Postulate loss scenarios (sequences of events leading up to potential or actual losses, incidents or accidents)
- Define Risk = severity + likelihood
- Evaluate controls, barriers, safeguards
  - Planned/existing
  - Additional
- Over 75 actions were documented and being tracked to closure

Likelihood ↑	D (frequent)	3	2	1	1
	C (probable)	4	3	2	1
	B (remote)	4	4	3	2
	A (improbable)	4	4	4	3
	<b>Risk Ranking</b>	A (Slight)	B (Moderate)	C (Severe)	D (Catastrophic)
		Severity →			
		Accomplishments			

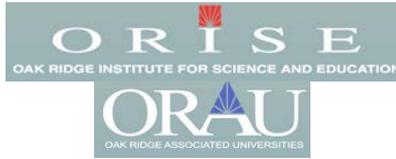
# CFTF Engages the Composites Value Chain to Develop/Validate Low-Cost CF Composites Mats & Mfg Technologies & Grow the Supply Base



LM003

# Collaboration in Workforce Training

## Mission Area Beyond ARRA Capital Project



### Pool of Candidates

- DOL grant funded
- Located at ORNL
- Industry focused training
- For qualified unemployed or under-employed

### Technician Internship Program

- High-quality STEM learning experience
- Collaboration with researchers in field of interest
- Growth of S&T talent
- Hands-on experience on complex CF line
- Learn S&T underpinning ORNL research
- Develop skills directly transferrable to industry

### *Longer term Vision:*

- Develop workforce training system for future carbon fiber manufacturing partners*
- Develop internship and other training programs from high school through university graduate level*



Photo courtesy of Michael Patrick & Knoxville News-Sentinel

# Significant Industry Engagement is Ongoing

- Five industry-led proposals to Advanced Manufacturing Office's Innovative Manufacturing Initiative include significant prototyping at CFTF
  - Polyolefin fibers (1)
  - Functional lignin fibers (1)
  - Textile PAN fibers (3)
- Serious discussions are ongoing with an equipment supplier on processing trials that will exploit unique CFTF capabilities
- We receive frequent inquiries and are in multiple discussions that cannot yet be termed “serious”

# Plans for the Next Year

- **Complete equipment fabrication & factory testing**
- **Complete equipment installation**
- **Conduct site acceptance testing for all unit operations and system commissioning**
- **Hire and train staff for commissioning**
- **Secure CD-4 approval and commence operations – forecast for Feb 2013**
- **Continue building and executing industrial partnerships**

# Summary

- **CFTF is an essential asset for scaling and deploying low-cost carbon fiber technologies**
- **CFTF addresses cost, inadequate supply chain, and manufacturability barriers**
- **CFTF is a CAPITAL project and is currently within schedule and budget**
- **Within the next year, we expect to complete equipment fabrication, installation, commissioning, and commencement of operations**
- **CFTF is driving significant industrial and educational collaboration**

# ORNL Carbon Fiber R&D Tech Team



***Felix Paulauskas***



***Amit Naskar***



***Frederick Baker***



***Soydan Ozcan***



***Mohamed Abdallah***



***Nidia Gallego***



***Cliff Eberle***



***Robert Norris***



***Dave Warren***



***Ken Yarborough***



***Fue Xiong***



***Brian Eckhart***



***Tomonori Saito***



***Daniel Webb***



***Marcus Hunt***

# ORNL Carbon Fiber R&D Tech Team (2)



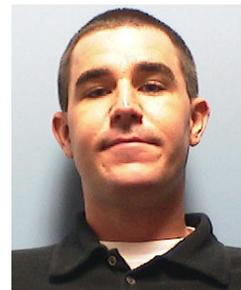
***Vlastimil Kunc***



***Pol Grappe***



***David Jackson***



***Lex Nunnery***



***Mike Kaufman***



***Orlando Rios***



***Tim Bigelow***



***Phil Pesavento***



***Stephanie Diem***



***Frederic Vautard***



***Dipendu Saha***



***Joshua Perkins***



***Shane Harton***



***Jimmy Mays***



***Mark Dadmun***