

12.

Composite Technician

Certificate Course

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A 4 ½-5 quarter credit class has been developed with considerable industry guidance and is designed to prepare a student for entry level employment within the composite industry. This course has a basic information component as well as a manufacturing and a repair component. There is significant lab and hands-on experience incorporated in the course.

The following outline will caption the subject blocks for this paper:

1. Justification
2. Development Process
3. Delivery
4. Training Objectives
5. Course Material
 - a. Foundation
 - b. Manufacturing
 - c. Repair
 - d. Safety
6. Assessment
7. Lab Projects
8. Material/Equipment

Justification:

The Puget Sound area has been an early and active participant in the composite industry before it was even recognized as a significant industry in its own right. Even if we limit our comments to the definitions and applications of modern composites we find this Pacific Northwest area has been innovative in the advancement of composite use in manufacturing a wide range of products from prosthetics to sports equipment to aircraft.

The local marine industry embraced the advantages of advanced composites early in the history of composites when polyester resin and fiberglass were the only readily available products. Recreational yacht hulls and large commercial boat hulls, including tugs, are now molded in local construction yards. Other related components and accessories are also locally manufactured.

The homebuilt aircraft industry found many advantages in the use of advanced composites and, with the designs of Burt Rutan as incentive, helped develop an engineering data base. Through the 70's and 80's the Arlington airport was a center of innovation and experimentation with the use of advancing composite material and processes. New propellers and accessories were produced as the work lead to expanding confidence and application. A composite sportplane manufacturer is in production on the field.

Concurrently, Boeing was able to utilize the local expertise of the University of Washington Aeronautical Engineering Department as well as their own in-house engineers to gain military contracts and associated experience which would lead to the incorporation of advanced composite components into their transport aircraft. As the experience and data base expanded more components, including some critical to safe flight, were being designed of advanced composite materials.

Boeing proposed a new commercial transport category aircraft built primarily of composites. Major structural components such as wing spars, fuselage, fuel tanks and control surfaces would be made from a carbon-fiber reinforced composite. Boeing considered many locations for the construction of the new aircraft. Everett, Snohomish County and the State of Washington aggressively solicited the Boeing Everett Plant as the most beneficial location for Boeing as well as for the local economy. To help make this area more attractive the local negotiators emphasized the strong composite industry already in the area with major world-wide suppliers here. The State also offered to help screen and train a new work force for the construction of the 787 Dreamliner. Boeing did decide to build their new airplane

at the Everett Plant and as start-up orders were taken the process to develop the trained work force began.

A course was needed which would take new-hire employees from zero experience to a basic understanding of the unique characteristics of the material being used to build the new aircraft as well as give them an opportunity to work with composites before arriving on the production floor. The students would be taught basic skills in hand layup and the use of common industry tools. In addition the course would prepare people entering other areas of the composite industry with a basic understanding of the diverse materials and methods used to work with composites. As the early development of the course progressed Boeing contributed an initial investment to fund the early research and development and to formalize the structure. With that encouragement the Edmonds people submitted a grant proposal to the Department of Labor. DOL agreed to provide additional funding for course development with the understanding that the course would be available to other regions and schools to encourage training in composite technology and to meet the training needs of the composite industry across the nation.

Development Process:

Edmonds Community College had developed a two year Associate Degree program in Material Science designed for students interested in transferring to the University of Washington for a four year or graduate degree in the same discipline. That program did have a strong composite component but it was mingled with other training objectives for a more diverse exposure to materials than was required by Boeing or other composite industry employers. There appeared to be a need for a more focused and shorter training program to quickly move under-qualified job applicants into a productive employee. A certificate program seemed more in line with the immediate needs of the industry.

Everett Community College faculty had composite training experience in their aviation maintenance training program and other instructors at Everett had experience in aspects of manufacturing. Representatives from the two colleges teamed with Boeing people to explore the development of a new course. Over time, as the purpose of the committee became known and as recruiting was accomplished, the committee expanded to include industry engineers, a University of Washington engineering professor, two representatives from material suppliers, two manufacturing industry representatives and several temporary resource people from Boeing.

The committee began a jobs skills analysis by researching the lesson objectives of similar courses offered around the country by other colleges and commercial training facilities as well as in-house courses offered by industry companies themselves. The skill set requirements were more narrowly defined as committee members visited and interviewed regional employers of composite technicians. By touring many facilities and interviewing many composite techs and their employers the specific skills and knowledge base needed by the composite technician began to take shape.

It was an interesting development to discover that a very high percentage of the composite technicians in this region are trained on-the-job which reinforced the initial justification for the course. A new-hire would be assigned to a production crew and would be taught by peers in the old watch-and-learn or make-a-mistake-and-get-yelled-at school. The time to bring an employee to a productive level could be dramatically reduced by providing a formal training opportunity.

A core group of the committee met often to whiteboard the required knowledge base into a progressive flow and to associate the skill sets into related groups. The course began to take an outline with several obvious and related blocks of knowledge which are apparent as we progress further into the lesson objectives and the course material.

With a fairly sophisticated outline as reference, committee members began gathering related training materials such as graphics, photos, videos and specific knowledge items. Many of the graphics, photos and videos were made specifically for this course by members of the committee and the copy write is owned by EDCC while others are used with permission of the copy write holder. Trade magazines, conference papers and industry experts contributed to the information to be covered in the course and an effort is being made to provide current information.

Delivery:

Choosing to use the PowerPoint format as part of the course delivery was also an aid in the course development since a story board could be built in bite sized pieces around individual objectives. An objective could be met in a specific number of slides with information bullets prioritized and repeated if emphasis is important. PowerPoint has many graphic aids available to help keep the material interesting (such as imbedded videos) and to reinforce important points.

Using PowerPoint also provides a built-in instructors manual with the notes portion under the slide. Additional, expanded or related information has been provided the instructor to take the course beyond the basic information provided on the slide. In the presentation, a good instructor should be prepared to use the slide and its knowledge bullets for an outline of the additional information available in the notes. The answer to a question asked in one class can be added to the notes section of a slide to be used in the next class as expanded knowledge. By using this technique an instructor can personalize the course to his/her own experience and knowledge and can keep the course current with advances in composite technology. Having a hard copy manual of the slide and notes pages is very beneficial during the presentation so the instructor does not have to flip the screen and so there is a handy location for handwritten notes as the class progresses. Many instructors have also found that a remote control and a laser pointer are also helpful during a presentation to keep the flow smooth and the presentation to professional standards.

The delivery of the hands-on or lab project portion of the class is very important. The most competent and knowledgeable presenter can lose all credibility if the lab experience is not successful. Quite often, it appears, the good presenter and the skilled craftsman are not always the same person. A critical and honest examination of an instructor's strong points and weak points should be part of the decision in the offering of this or similar courses. The instructor will need to demonstrate some of the lab techniques and the use of most of the tools. A good example is the heat blanket controller or hotbonder. Incorporating this tool into the course for a hot cure, along with the vacuum bagging experience, gives the students a significant advantage when entering the work force. The instructor needs to be familiar with the particular hotbonder being used and how to program it to the appropriate cure cycle for the prepreg material being used.

The lab projects are designed to go from the simple to the more complex giving the students a chance to build on previously learned skills. The first and easiest project is to build a positive mold with foam and plaster. The projects continue to the final and most demanding one which is a taper sand repair technique on a sandwich panel. An instructor can modify the projects to fit local needs and material availability as well as fitting his/her expertise. The lab experience has been a major factor in the success of this course in previous offerings and the quality of this part of the presentation should not be discounted.

Training Objectives:

The training objectives were designed to be observable and measurable for each skill set and for each knowledge block. Each objective relates to a specific job task as documented by expressed industry needs.

- MTech 159: Course Objectives
- The student will be able to demonstrate foundational knowledge of the composite industry and to identify common composite materials and their properties

- Unit 1: Objectives
- Identify the advantages and disadvantages of composites
- Identify differences working with metals versus composites
- Identify and describe where composites are used in aerospace and other industries

- Unit Two: Objectives
- Students will be able to:
- Identify glass, aramid and carbon fibers
- Describe the following for each fiber
 - Processing
 - Properties
 - Applications
 - Proper storage and handling
 - Environmental effects/concerns

- Unit Three: Objectives
- Students will be able to:
- Identify the following for common resins
 - Properties
 - Applications
 - Proper storage and handling
 - Processing
 - Environmental effects/concerns
 - Safety

- Objectives for Unit Four
- The student will be able to:

- Identify the most common types of core, proper handling of core, and core applications

- Objectives for Unit Five
The student will be able to:
 - Define the interface
 - Identify the importance of the interface in composites
 - Identify the importance of surface preparation in composites

- Objectives for Unit Six
 - Identify the health hazards of working with composite materials
 - Recognize the importance of following EPA and OSHA regulations
 - Demonstrate and assess safety considerations when working with composite materials

These are typical examples of the course and unit objectives. MTech 159 is the foundation course which familiarizes the student with vocabulary and with the fundamental properties of the composite family of materials.

It bears repeating that throughout the three courses required for the composite technician certificate each objective is linked to a specific job task. There was also a hierarchy established for each job task based on the emphasis given to our interviewers and the number of times a task was repeated by different employers. The hierarchy determined the level of training emphasis and the level of assessment required to be successful.

Course Material:

The complete certificate requires completion of three courses: MTech 159, sixteen hours covering the foundation or basic information about composites in general, MTech 169, 24 hours of presentation with a manufacturing orientation, and MTech 189, 32 hours covering repair and inspection techniques. The courses are not stand-alone and are taken in order since the information builds through the certificate program. The program earns 4½ to 5 quarter academic credits.

Following is an outline format for the subjects within each course:

■ MTech 159 Course Overview

Unit 1: Why Composites? --20 PowerPoint subject slides

Identify the advantages and disadvantages of composites
Identify differences working with metals versus composites
Identify and describe where composites are used in aerospace and other industries

Composite defined:

A composite is made up of two or more materials that when combined retain their original characteristics and exhibit properties above and beyond what these original materials had by themselves

Wood is a Natural Composite

Mesa Verde Adobe Cities

Concrete and Cement

Composites Across Industries

From Hockey Sticks to Medical Devices and Prosthetics

From Space to Under Water...

Advantages and Disadvantages
of Modern Composites

Evolution of Composites

First Composite Aircraft

1940

Spitfire Fuselage

- made of flax fibers and phenolic resin
- was structurally tested, but never flew
- still exists in a Museum in England

Evolution of Composites

1950's

Rapid expansion of fiberglass in sporting goods, boats, cars, etc.

Evolution of Composites

1960's

Evolution of Composites

1970's

Evolution of Composites

1980's

Stealth Military Aircraft

Evolution of Composites

1990's

1994 Boeing 777 first flight had an all-composites horizontal tail

Largest market is transportation--trains, buses, trucks, etc.
Evolution of Modern Composites
49% of the Boeing 787 will be made from composites
Aerospace/Aircraft industry only represents 10% of the composites market

(Each of the subject areas in the following course units and in the units contained in the other two courses have similar subject outlines. Additional information is provided in the instructors notes attached to each slide and in the full outline available with the full course materials)

Unit 2: Fibers -- 64 PP slides

Unit 3: Resins -- 33 PP slides

Unit 4: Core – 13 PP slides

Unit 5: The Interface and Surface Preparation – 11 PP slides

Unit 6: Safety and Handling of Materials – 22 PP slides

■ MTech 169 Course Overview

Unit 1: Hand Lay-Up with Vacuum Bagging, Ply Cutting and Autoclaves/Ovens – 47 PP slides

Unit 2: Liquid Composite or Infusion Molding – 25 PP slides

Unit 3: Filament Winding and Automated Tape Lay-Up – 25 PP slides

Unit 4: Compression Molding and Pultrusion – 25 PP slides

Unit 5: Shop Safety – 10 PP slides

Labs: Flat Lay-Up, Outside Curved Surface, Inside Curved Surface, Simulated Panel

■ MTech 189 Course Overview

Unit 1: Classifications of Damage – 16 PP slides

Unit 2: Inspection and Documentation of Damage – 21 PP slides

Unit 3: Repair Techniques -- 17 PP slides

Unit 4: Repairing the Composite Part – 37 PP slides

Labs: (1) Surface Damage Repair; (2) Potted Compound Repair; (3) Replacement of Core

The course material includes demonstration videos embedded in the slide as well as graphics and drawings to help the students visualize many of the concepts.

Assessment:

Each of the Units within each course has a quiz on the PowerPoint presentation. The quizzes are usually not graded but are used as a teaching opportunity and reinforcement for information which will be seen later in a course final exam. The quizzes can be addressed by the class as a group or each student can be given an answer sheet and the question are later covered by the instructor after the students have made a commitment to an answer.

A graded course final is given by the instructor at the end of each of the three MTech courses. The three course exams are averaged for a final grade. A minimum average score of 80% is required with no single exam score less than 70% to receive a certificate.

The lab projects must be repeated until acceptable quality, as defined by the instructor, is achieved.

An example of the MTech 169 course final follows:

MTech 169 Final Exam (40 points)

1. When hand lay-up with vacuum bagging is used, and the part is to be heated in an oven or autoclave, list in order the materials needed to be placed in the tool after the release agent has been applied to the tool surface: (6 points)
2. What is the maximum pressure that can be achieved in an oven at sea level? (1 point)
3. What are 3 ways that ply-cutters can cut material? (3 points)
4. What can the autoclave do that the oven cannot do? (1 point)
5. In what condition are the fibers or fabric when they are placed in a mold that will be infused with resin? (1 point)
6. What are the full names of the infusion molding processes discussed in class? (2 points)
7. How many tool surfaces will a RTM part have? (1 point)
8. What are three advantages of VARTM? (3 points)
9. List at least four examples mentioned in class where filament winding can be used: (4 points)
10. What type of material is generally used in automated tape lay-up machines? (1 point)
11. How is the material that is used in compression molding cured? (1 point)
12. How many tool surfaces are there in compression molding? (1 point)
13. The degree of edge finishing required for a part made in compression molding is: (1 point)
 - a. Very little
 - b. A lot
 - c. None
 - d. 90 degrees
14. The cross section of a part made in the pultrusion process will have what kind of shape? (1 point)
 - a. Constant
 - b. Inconstant
 - c. Hot
 - d. Liquid

15. What are two things that are done to the cured material after it leaves the pultrusion die? (2 points)
16. Why do tools need to be logged in and out of a tool box? (1 point)
17. What are two things that could happen if a tool is not tethered? (2 points)
18. Is it OK to move scaffolding without help? (1 point)
19. When working inside a confined space what are two things a buddy could do for you? (2 points)
20. If you see a switch that has a lock out tag on it should you remove the tag? (1 point)
21. Should the sanding of a part be done in a cleanroom? (1 point)
22. When working with volatile materials, what are two ways you can protect yourself from inhalation of the vapors? (2 points)
23. Safety is _____ responsibility! (1 point)

The exam questions can be changed or rewritten at the discretion of the instructor to reflect the important and relevant information to a local industry.

Lab Projects

As with the exams, the lab projects can be replaced or modified to meet the local needs or to conform to the available training material and equipment.

Two of our lab project sheets follow:

Student Project 1
MTech 169

Flat Lay-up

At the end of the project the student will be able to:

1. Identify polyester and epoxy resin and know how to mix them correctly.
2. Weigh the fabric and then mix the correct amount of resin for the correct ratio of resin to fabric.

3. Wet the fabric from the center out so as to minimize voids, resin rich areas and resin starved areas.
4. Prevent voids in future lay-ups.
5. Demonstrate the flexibility of a composite material after it has cured.
6. Use lay-up and support tooling
7. Develop specifications for the project that show the lay up of the material, the resins used and a bagging schedule

Materials Needed:

1. 12" square glass or clear smooth plastic surface.
2. Plain weave, light weight fiberglass cloth, enough for 6 plies cut to 11 ½ in. on each side.
3. Polyester or epoxy resin.
 - a. There should be an equal split with half of the class using polyester resin and the other half using epoxy resin.
 - b. Mixing containers and mixing sticks.
 - c. Small paper cups to pour the mixed resin into.
4. Accurate gram scale.
5. Release film, squeegees, and small resin rollers.
6. PPE required for this lab:
 - a. Gloves.
 - b. Safety glasses,
 - c. Shop coat.
 - d. Respirator.
7. Working area needs to be well ventilated.
8. Ply orientation will be:
 - a. 2@ +or - 45°
 - b. 2@ 0,90°
 - c. 2@+ or - 45°

Procedures:

1. Cut fabric to the dimensions listed above. Mark the plies to keep track of the 45° and the 90° plies.
2. Weigh all layers of fabric together.
 - a. Weigh one ply and record its weight as well.
3. Mix the resin so there will be a 60% to 40% ratio of resin to fabric by weight for all the plies.
 - a. Divide the resin into 6 equal amounts into 6 paper cups.
4. Lay the first layer of 45° cloth on the glass/plastic surface.
5. Empty the first cup of resin into the center of the cloth.
 - a. Do not attempt to wet the entire surface.
 - b. Using the squeegee move the resin around and wet the fabric as much as possible.
6. Lay the next layer of 45° cloth on the first.
 - a. Use one cup of resin for this layer as well.

- b. Start in the center and work out to the outside.
 - c. The edges may not wet entirely.
7. Do the same for each of the next layers.
 - a. Using one cup for each layer.
 - b. Starting from the center and working out to the edges.
 - c. Notice that as each successive layer is wetted more and more resin is getting to the edges of the fabric.
8. After the last layer is wetted out, cover the plies with a release film.
9. With the small smooth roller roll the surface of the lay-up from the center to the edges.
 - a. Notice that more and more of the edges are not wet with resin.
 - b. There may be extra resin at the edges now. Let it cure out of the fabric.
10. Take the empty cups and scrape any remaining resin into one cup.
 - a. Keep this cup for a test to make sure that the resin cures.
 - b. If the resin in the cup does not cure then the project will be no good.
11. From the containers determine the amount of time required for curing.
 - a. This time is a function of:
 - i. Way the materials were mixed.
 - ii. The temperature of the room.
12. Check at the end of the time to see if the materials have cured.

Conclusions:

1. Check the small amount of resin in the paper cup to see if it has cured.
2. Check the lay-up for the presence of voids and other quality control issues.
 - a. QC issues would be voids, resin rich and resin starved areas.
 - b. How might voids be avoided in future lay-ups?
3. Cut the edges of the lay-up smooth.
4. Bend the composite material.
 - a. Can the material be bent double without failure?

Submit your specification sheet and your finished project to your instructor. You will be graded on the completeness of your project and the accuracy of your specification sheet.

Student Project 4
MTech 169

Small Panel Lay-Up with Core, Fastener and Fixture

At the end of the project the student will be able to:

1. Lay up plies of composite material to a specification.
2. Select the correct curing method for the project.
3. Drill holes in the correct position in the project.
4. Install a special fastener to specifications.
5. Trim the project to the correct dimensions.
6. Finish the project to specifications.
7. Identify proper tools to use in composite manufacturing

8. Assemble parts to specifications
9. Use lay-up and support tooling
10. Develop specifications for the project that show the lay up of the material, the resins used and a bagging schedule

Materials needed:

1. 12" square metal, glass or plastic surface to lay up the project on.
2. Glass fiber cloth.
3. Resin for impregnating the material.
4. Core, foam, or honeycomb, 9' square.
5. Accurate gram scale.
6. Special fastener.
7. Potting material for special fastener.
8. Bagging materials such as:
 - a. Release ply.
 - b. Peel ply.
 - c. Bleeder material.
 - d. Vacuum bag material
 - e. Bag sealant.
9. Drill and trim fixture. You will need air router bits and abrasives for drilling and trimming. The instructor will demonstrate each of these tools and how they are used.
10. Finishing materials.
 - a. An alternant to the glass cloth and the resin would be to use pre preg material for this project. This will be decided by the available materials and the methods of curing available to the student in the lab.
 - b. Another alternant would be to use honey comb for the core as well.
 - c. For the pre preg materials an oven or autoclave would be needed.
11. PPE required for this lab:
 - a. Gloves.
 - b. Safety glasses,
 - c. Shop coat.
 - d. Respirator.

Procedure:

1. Cut 6 pieces of cloth 11 1/2" square.
2. Cut 2 pieces of cloth 11 1/2" X 7"
3. Cut a piece of core 9" square.
 - a. Bevel the edges to 40°
4. Weigh the cloth.
5. Measure resin so as to have a 60% resin to 40% fabric ratio.
6. Cover the metal, glass surface with release ply.
 - a. Tape in place on the back side.
7. Lay up the first 4 layers of fabric at:
 - a. 1 @ 45+
 - b. 2 @ 0 90
 - c. 1 @ 45-

8. Wet each layer as it is laid down, making sure that the right amount of resin is used for each layer based on the weight of the fabric.
9. Place core in the center of the materials so that there is at least 1 inch of material around the core.
10. Place the two layers of 11 1/2"X7" fabric over the core at 0-90.
11. Lay the last two layers over the core at 45 +-
12. Cover the lay up with peel ply, bleeder material and then vacuum bag.
13. At the end of the cure cycle remove the bagging materials and remove the part.
14. Place part in the drill and trip fixture.
15. Drill the holes listed on the specification sheet.
16. Install special fastener at the location specified by the specification sheet.
17. Trim the edges to the trim fixture.
18. Finish per specification sheet.
19. Submit to QC examination.

Conclusion:

1. The student will experience laying up material to a specification.
2. The student will experience drilling and trimming a part to a specification.
3. The student will experience the installation of a special fastener.
4. The student will experience finishing a part to a specification.

5. The student will appreciate all the people who make parts so they don't have to.

Submit your specification sheet and your finished project to your instructor. You will be graded on the completeness of your project and the accuracy of your specification sheet.

Material and Equipment List

The following equipment list is provided as a guide and example and is used when this course is offered by Edmonds Community College.

Mtech 159-189 Equipment and Expendables

Lab Equipment (provided by course vendor)

8 pieces of 12" square x 1/8" glass or clear plastic

Safety glasses

4 dual zone hot bonders with printout-- or -- programmable oven-- or -- 8 single zone hot bonders with printout

Heat lamps (optional but useful)

Bandsaw
6" or larger disc sander
Sanding booth or table
Shop vacuum
120 psi shop compressed air source
Vacuum shop source if an oven is used or the bonders do not have venturi suction
2 weight scales in grams with .01 increments
4 work tables -- at least one with a cutting surface 66" long

Storage

Lockable storage cabinet - 4' wide, 7' high, 24" deep labeled Composite Certificate Program for
expendables, hot bonders, tool boxes, etc.
1 tool box for the instructors kit
1 tool box for each 2 student team
1 flammable storage cabinet for solvents and resins
1 zero-degree freezer for storing prepreg material and film adhesive
6' wide storage rack for multiple fabric bolts

Student Kit (provided by course vendor in a tool box. 1 kit for each team of 2 students)

Tool box
Flashlight with batteries
6" dia plastic bowl
Drill motor, pneumatic
Putty knife
Dotco type sander with 1' and 2" sanding mandrel
10x magnifying loupe
Dial/digital calipers with .001 readout
Scissors
12" scale with fractional and .01 readout
Sharpie brand markers in multiple colors
Protractor
Divider
Exacto type knife handle and blades, straight and chisel
Cleco pliers
Cobalt twist drill bits ***
ST type drill bits ***
Drill guides ***
10 Clecos for each drill size ***
3-step reamer - .002" larger than selected fastener diameter

*** - sizes dictated by the selected fastener size. Pilot hole typically #40, middle size if needed, then final drilled hole the same as fastener diameter. Holes then reamed .002 oversize for clearance in composite.

Instructor Kit

Large tool box

1 set circular drawing templates - 1", 1 1/2", 2", 2 1/2", etc up to and including 7"

2 routers, laminate trim electric or pneumatic

1" and 1 1/2" circular routing templates

1/8" and 1/4" rabbiting router bits

Electric drill motor with 3/8" chuck

Pneumatic drill motor

Flashlight with extra batteries

8 vacuum bagging ports

8 vacuum gauges

4 heat blankets, 6" square

4 heat blankets, 12" square

40 thermocouples

4 jitterbug sanders, pneumatic

4 aluminum caul plates 6" square x .016"

8 aluminum caul plates 12" square x .020"

1" and 1 1/2" diamond edge hole saws

Expendables (supplied by course vendor - quantity based on an 8 student class)

Particle masks

Gloves, non-allergenic and non-powdered, vinyl or rubber

Box of D cell batteries

30 sanding disks, dotco, 1" x 80 grit

30 sanding disks, dotco, 1" x 120 grit

30 sanding disks, dotco, 2" x 80 grit

30 sanding disks, dotco, 2" x 120 grit

1 package (500) 3.5 oz non-waxed paper cups

1 box of stirring sticks (popsicle type)

20 plastic squeegees (3-3 1/2")

8 special fasteners (Spencer Aircraft Catalog #A34630-12, NAS #1834-3-400)

16 disposable 5cc plastic syringes

8 rolls of flashtape

Release wax or spray, 1 can

1 pint kit of epoxy potting compound or adhesive *

1 gallon MEK *

1 gallon acetone *

1 gallon polyester resin and catalyst *

2 gallons epoxy resin and hardener *

8 pieces of 8" square core material, honeycomb or foam, 1/2" to 3/4" thick

48 linear yards of bag edge sealant putty

40 square yards 4-6 oz (lightweight) fiberglass cloth #

56 square yards 3 mil nylon bagging film #

30 square yards breather mat #

30 square yards peel ply #
10 square yards release film #
10 square yards perforated release film #
20 square yards 250 degree cure prepreg carbon or glass fiber **
4 square yards film adhesive **
2 square feet foaming adhesive (optional) **
Hi-Lock bolts and collars , 64 each ^^
4 Allen wrenches ^^
4 combination wrenches ^^
8 titanium plates, 1 1/2" x 6' x .10"

* = store in flammable storage cabinet

= store on rack in clean room

** = store in zero-degree freezer

^^ = sized according to the fastener selected. A -8 diameter is recommended.

The entire team is very proud of the finished certificate course and feels that it is the most comprehensive and focused course available to the new-hire or to a person interested in entering the composite industry. The feedback from students completing the course has been consistently positive.

The DOL Grant mandates this course be distributed to other interested public schools, high school or college, and to interested industry employers. As the Beta test instructor, as well as a committee member, I am available to answer questions or consult if you would be interested in offering this course. Feel free to contact me at any time. Mary Kaye Bredeson, with Edmonds Community College is the Grant administrator and will coordinate access to the course for those interested.

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