AIPS
Airbus Process Specification

Surface Preparation for Thermosetting parts before structural bonding

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1 Scope

This Airbus Process Specification defines the Engineering requirements for for the processing of surface preparation of thermosetting composite parts before bonding.

This specification does not give detailed instructions; these are given in the Process Instructions (PI) / Airbus Process Instruction (AIPI) and the Work Instructions.

This specification shall not be used as an inspection document.

It shall be applied when mentioned in the relevant standard, material specification or Definition Dossier.

2 Normative References

Only normative references cited in the text are listed hereafter.

The latest issue of the publication referenced shall be used.

A1091	Airbus Requirements for the management of Hazardous Substances
AIMS12-00-000	Ancillary Materials – Technical Specification - General requirements
AIMS12-00-000 Part 100	Ancillary materials acceptance testing technical specification
AIMS12-01-000 Part 2	Airbus Material Specification – Anchillary Materials – Part 2: Qualfication program / bacth release testing – Peel Ply for structural bonding – Technical Specification
AIMS12-01-001	Airbus Material Specification – Peel Ply for structural bonding (dry fabric) – Material Specifiation
AIMS12-01-002	Airbus Material Specification – Prepreg Peel Ply for structural bonding – Material Specification
AIPS06-02-006	Airbus Process Specification – Structural bonding of Thermoset and Thermoplastic matrixes Composite parts
AIPS09-01-002	Airbus Process Specification – Cleaning with liquid non aqueous agents including vapour phase
AITM1-0019	Airbus Test Method – Determination of tensile lap shear strength of composite joints
AITM1-0022	Airbus Test Method – Wettability test
AITM1-0025	Airbus Test Method – Fiber-reinforced Plastics – Flatwise tensile tests for composite sandwich panel.
AITM1-0053	Airbus Test Method – Carbon Fiber-reinforced Plastics – Determination of fracture toughness energy of bonded joints – Mode I. G_{IC} Test.
AITM6-3004	Airbus Test Method – Visual Inspection
CMH-17-3G	Composite Materials Handbook, Volume 3: Polymer matrix composites materials usage, design and analysis.
EN2243-3	Aerospace series. Structural adhesives. Test methods. Part 3. Metal-honeycomb peel tests.
EN2743	Fibre reinforced plastics – Standard procedures for conditioning prior to testing un-aged materials
EN2823	Fiber-reinforced plastics. Test method for the determination of the effect of exposure to humid atmosphere on physical and mechanical characterisics.
EN ISO 14644-1	Cleanrooms and associated controlled environments – Part 1: Classification of air cleanlinesss
EN ISO 14644-3	Cleanrooms and associated controlled environments – Part 3: Test methods
EN9103	Aerospace series - Quality management systems – Variation management of Key charateristics
RP1027786	Level 2 document “Compatibility structural adhesives – validated combinations”

3 Definition, Applicability and Limitations

3.1 Definition

ABS	Airbus Standard (here: semi-finished Product Standard)
Abrasion	A process that is used to prepare surfaces before adhesive bonding in order to give a fine mat appearance. Only the resin layer shall be abraded
Adherend	A structural element, part or component, which is bonded to another element, part or component, so another adherent, by the aid of an adhesive.
Adhesive	A reactive polymer resin blend, which solidifies (cures) and develops permanent adhesion to specifically prepared surfaces by chemical cross-linking reaction. Once the solidification and adhesion development are completed the adhesive can transfer considerable loads between those surfaces it adheres to.
Adhesive film	An adhesive in the form of a film based on a thermosetting resin, which cures at elevated temperatures.Often it contains a textile fabric as carrier material.
AIMS	Airbus Material Specification
Auxiliary materials	Materials used during manufacturing that are not incorporated into the finished part.
AP	Airbus Procedure
Bonding process	Manufacturing process where a structural element or part, called adherend, is permanently connected to another structural element for load transferby means of a polymer resin blend, called adhesive, which – when placed between these both adherends – either solidifies and adheres to these by chemical crosslinking reaction.
CER	Composite Engineering Requirements
Clean room	As per AIPS03-02-019 chapter 4.3
CMR	Composite Manufacturing Requirements
Co-bonding process	A bonding process in where the curing of one of the adherends coincides with the curing of the adhesive.
Co-curing process	Manufacturing process in which the curing and bonding of the system formed by un-cured prepreg materials and adhesives is made in one single autoclave operation.
Compatibility	Compatibility implies within the context of adhesive bonding that the combination of the specific triple of surface preparation, individual adhesive product and individual composite adherend material leads to a durable and sound structural bond fulfilling requirements following this process specification.
Curing	Solidification of a liquid or pasty polymer resin blend by chemical crosslinking (i.e. thermosetting) reactiondepending on temperature and time parameters, which have to be kept within specified limits (curing cycle).
CFRP	Carbon Fibre Reinforced Plastic.
Functional Class (FC)	The Functional Classification of airframe parts - so called "Functional Class (FC)" is required to define the level of inspection quality requirements for the manufacturing. The purpose of this way forward is to ensure safe operations and quality connected to the manufacture of airframe structure parts.
GFRP	Glass Fibre Reinforced Plastic

Grit Blasting	Operation of forcibly propelling a stream of abrasive particulate material against a surface under pressure to remove material from a surface and modify its roughness
Hot-forming	Forming of un-cured prepreg laminates at temperatures above Normal Work Conditions.
Inner Quality	The Inner Quality of a composite part is described by typical quality characteristics (e.g. porosity, cracks, fibre volume content, delaminating, disbonds, fibre undulations), which can be determined by NDI methods or microscopic examination of cross sections.
IPS	Individual Product Sheet of a material qualified according to Airbus Material Specification
Laminate	Any fibre-reinforced composite consisting of plies with one or more fibre orientations with respect to a reference direction
Lay-up	Stack of semi-finished material, such as prepreg or dry reinforcing textiles, and/or polymer resin films, such as prepreg peel plies, film adhesives or surfacing films,depositted in specified order and orientation including auxiliary materials such as bagging foils, breather material and others, required for processing of a composite part or element.
Manufacturer	The company or organization responsible for producing the part against an Airbus drawing.
Manufacturing shop	The specific work shop intended for manufacture according to this process specification.
MEK	Methyl Ethyl Ketone
Normal Work Conditions	Range of temperature and relative humidity conditions at which cutting, lay-up, forming, bagging, consolidation or any other handling of un-cured material has to be carried out as defined in this process specification.
PBM	Pre-Bond Moisture - Humidity up-taken by a composite element or part from the environment, that diffuses into the adhesive and prepreg laminate (in co-bonding) during the bonding respectively curing process thereby affecting the development of the structural bond. Also humidity diffusing into fresh adhesive and/or prepreg (relevant in co-bonding) during delivery, storage and handling is considered as PBM.
Peel ply	A woven fabric (could be dry or even be pre-impregnated with resin like a prepreg material called “wet peel ply”) placed as first or last ply on a fibre laminate stack to be teared off after the laminate cure and late as possible before the bonding for surface treatment purpose, creating a new clean surface ready for adhesive bonding.
Preimpregnated material (prepreg)	Woven fabric or unidirectional tape impregnated with a matrix resin and suitably processed (e.g. B-staged) for storage, handling purposes and curing by heat and pressure without further additives.
Process Control Specimens	Process control specimen shall control all critical process steps for the bonding process to indicate catastrophic failures and to monitor the curing of the bondline
Process Instructions (PI)	A document that provides a complete and detailed description of a specific manufacturing process. It specifies all relevant process parameters, measures for quality assurance and inspection schedules for equipment and production facilities. A process instructions could be supplemented by additional documents like part related work instructions. It is a complete detailed in house process instruction and shall be used in conjunction with the drawing and relevant Airbus Process Specification (AIPS).
PTFE	Polytetrafuorethylene
Quality Assurance	Quality assurance department responsible for the manufacturing shop entrusted with the manufacturing according to this process specification.
Reference Manufacturing Shop (RMS)	A manufacturing shop selected in order to develop a manufacturing process and to improve on current processes.

Reference manufacturing shop group (RMSG)	A group of experts responsible for a manufacturing process. This group is in charge of the validation of the technical requirements and technical qualifications. For each manufacturing process, a reference manufacturing shop group is nominated.
Responsible Design Office	Engineering (Stress, Design) and supporting functions (Materials & Processes) responsible for design and certification of a part.
Rework	Removal of production and assembly related non-conformances with the aim of reaching the required component condition defined in the engineering documents.
Sanding	The act of manually abrading a surface to remove material and modify its roughness through use of an abrasive material such as “emery paper” or “sand paper”
Secondary Bonding	Same as bonding process, but in aerospace composite industry and certification an established term, which emphasizes that readily cured composite elements are bonded (for differentiation from co-bonding).
Specific Work Conditions	Specific combination of temperature and relative humidity which deviates from Normal Work Conditions (including tolerances). Specific Work Conditions may effect the Work-Life and therefore need to be validated by Airbus Materials & Processes and could require specific qualification activities.
Storage Conditions	Environmental conditions, in particular temperature (e.g. T ≤ -18 ºC) under which uncured material is kept in store before given out to Manufacturing.
Storage Life	The maximum period of time at storage conditions as specified in the relevant Material Specification, excluding work life needed for manufacturing.
Structural Adhesive Bonding	For composite/composite bonding. Bonding is a joining process, where the parts to be joined are connected to each other using the surface adhesion and the inherent strength (cohesion) of the adhesive layer.
Structural materials	Materials incorporated into a structural part during manufacturing.
Tack Life	The maximum period of time at work conditions as specified in the relevant Material Specification, that the remaining material has sufficient tack to be used for manufacturing. This shall be defined by Manufacturing Engineering and agreed by the material supplier.
Unidirectional tape	Semi-finished reinforcement material with the reinforcing fibres oriented in the same direction.
Work Conditions	Environmental conditions, in particular temperature and relative humidity, under which uncured material is processed before start of cure.
Work Life	The maximum period of time under work conditions as specified in the relevant Material Specification, that the material can be used for manufacturing. This includes all time from removal from fridge for films and prepregs, and mixing for pastes, until initiation of the curing time. Deviations of work conditions as hot forming process or application of heat for tack improvement may affect the Work-life and therefore need to be validated by Airbus Materials & Processes. This might require specific qualification activities. For two-part paste bonding this time applies to the mixed paste.
Woven fabric	A cloth consisting of an areal network of carbon or glass or polymer fibres often referred to as “thread” or “yarn”. The threads which run lengthways are called the warp and those which run across from side to side form the weft. Weaving is the technique by which the woven fabric is generated. Hereby the threads forming the weft are interlaced in an alternating way across and underneath those threads forming the weft.

3.2 Applicability

This AIPS is applicable when invoked by the drawing directly or through another document. When processing to AIPS06-01-003 is required, it shall be invoked on the drawing by the words “Surface Preparation for Thermosetting parts before bonding to AIPS06-01-003”. Process instructions shall not be called on drawing.

This specification is applicable to surface preparation of monolithic thermosetting composite parts and of thermosetting composite skins of sandwich structures. Application of this document is mandatory for the manufacture of class 1 and 2 parts to be submitted to surface preparation before structural bonding operations.

This specification is applicable to prepare thermosetting parts surfaces using surface operations qualified according to this AIPS06-01-003 before adhesive bonding processing in order to produce durable adhesion of adhesive film or paste adhesive to the composite adherents.

3.3 Limitations

This specification is not applicable to surface preparation of sandwich core materials (e.g. honeycomb, rigid foam core).

This specification does not cover surface preparation of thermoplastic matrix composite materials. Surface preparation of thermoplastic matrix composite materials is specified by AIPS06-01-002.

4 Engineering Requirements

Engineering requirements are minimum requirements specified by Responsible Engineering to ensure optimal performance of the manufacturing process.

All Engineering requirements have to be met and controlled in production.

NOTE: Any deviation from the requirements established here may require a requalification of the manufacturing process according to the relevant AP.

4.1 Compatibility

As a basic principle regarding structual bonding material and process qualification, validation testing of the specific triple of 1st the surface preparation, 2nd individual adhesive product (defined by IPS) and 3rd individual composite adherend material (defined by IPS) is mandatory. Thereafter,”compatible” identified combinations of surface preparation, adhesive and adherend material shall be stated in technical documentation issued by Airbus Materials & Processes.

Only compatible combinations are allowed in bonded composite assemblies. Compatibility requirements addressing structural bonding are defined in AIPS06-02-006. Compatible triple configurations are identified in RP1027786.

4.2 Material Moisture Content

Measures shall be implemented in processing (i.e. composite adherend fabrication, surface preparation, bonding), storage and delivery, which will prevent any critical impact on bond strength caused by moisture migrating from the composite adherend and/or the adhesive into the bond-line, so called pre-bond moisture PBM.

Measures such as drying and handling procedures that define a maximum exposure time to the environment (“open time”) require definition and validation testing as defined in AIPS06-02-006. This can be with or without protection by a moisture barrier either at shop floor conditions or outside (including the delivery chain). Procedural documentation and relevant key parameters have to be fixed in the related process instructions.

4.3 Structural Materials

Structural materials have to be qualified in accordance with the relevant Airbus Material Specification.

Structural materials shall be stored according Storage Conditions stated in the relevant Airbus Material Specification.

The time, materials are kept in store shall not exceed Storage Life as stated in the relevant Airbus Material Specification (see Figure 1).

Structural materials shall be processed under Work Conditions stated in the relevant Airbus Material Specification.

The time, materials can be processed before start of cure, not exceeding the Work Life, based on certain Work Conditions, as stated in the relevant Airbus Material Specification (see Figure 1)

Structural Materials shall only be used within their relevant Storage-Life and Work-Life (see Figure 1) as indicated in the relevant Airbus Material Specification.

Normal Work Conditions (including tolerances) as indicated in Figure 2 are considered for the determination of Work-Life as part of a material qualification according relevant Airbus Material Specification.

Specific Work Conditions can be established in order to consider deviations from Normal Work Conditions (including tolerances) during manufacturing (e.g. hot-forming cycle). Specific Work Conditions may effect the Work-Life and therefore need to be validated by Airbus Materials & Processes and could require specific qualification activities.

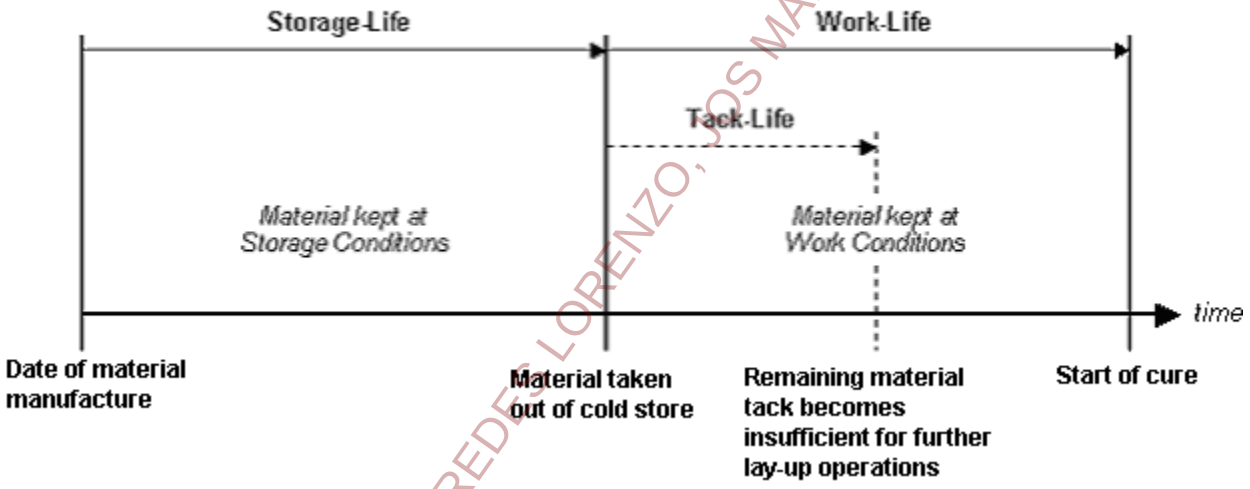

Figure 1: Storage Life and Work Life

For materials that need to be stored in a freezer, a log shall be kept recording date and time of each transfer of the material in and out of the freezer and the remaining work life.

Structural materials shall be cured according to cure cycles stated in the relevant Airbus Material Specification.

When different materials being in direct contact are cured, it has to be assured that only compatible materials are combined herein. Compatibility of simultaneously curing materials has to be validated by Airbus Materials & Processes through specific qualification tests. Compatible structural material combinations are stated in relevant documents issued by Airbus Materials & Processes. Chapter 4.1 of this specification, AIPS06-02-006 and RP1027786 address compatibility of the materials and processing forming a bonded joint, only.

Cured parts shall not be exposed to UV-radiation during manufacturing, transport and storage without adequate protection to avoid ageing.

4.4 Auxiliary materials as per AIMS12-00-000

Only qualified materials according to AIMS12-00-000 or specifically approved by Airbus shall be used. AIMS12-00-000 distinguish between auxiliary materials in direct contact with the uncured structural materials (Type A) and auxiliary materials that are not in direct contact with the uncured structural materials (Type B). Any auxiliary which could affect the structural behavior needs to be qualified according Type A. Type B material are listed in the AIPI06-01-003 and type A materials are listed in Annex A of this AIPS.

Auxiliary materials acceptance testing following AIMS12-00-000 Part 100 is mandatory.

For peel ply, reference to the relevant Material Specification (ABS/AIMS) must be included in the drawing.

The specific materials to be used in each part shall be identified in the Process Instructions.

No change of material is allowed without specific indication in the drawing set and associated documentation.

Materials with PTFE (spatulas, rolls, cutting tables, etc.) are prohibited if not specifically approved for a particular application.

All auxiliary materials to be placed in direct contact with any uncured materials must be stored in sealed polyethylene bags and handled using qualified gloves.

Materials shall be stored in accordance with the requirements of the applicable MS and IPS, or of the material data sheet provided by the supplier, in order to avoid manufacturing problems during the cure cycle or even lack of final quality of the part.

All auxiliary materials shall only be used within their relevant Storage-Life and Work-Life, in case this has been limited.

4.5 Surface preparation area

Surface preparation shall be performed in clean, dry and preferably isolated areas to prevent pre-treated materials from contamination. For the same reason, it is mandatory to use qualified gloves and clean work cloth for any operation within these areas.

Surface pre-paration rooms must have controlled temperature and humidity to ensure processing of the materials within their limited Work-Life under the given Work-Conditions.

The floor shall be paved with easily cleaned materials, and the walls shall be coated with non-releasable washable material.

In order to prevent any contamination coming from the outside, it is recommended that a minimum of 5,0 [Pa] overpressure to be held inside the cleanroom.

It is also recommended for this area to be equipped with a twin-door type gate system.

Shops to be qualified according AIPS06-01-003 shall fulfil Normal Work Conditions (incl. tolerances) for surface preparation areas according to Figure 2.

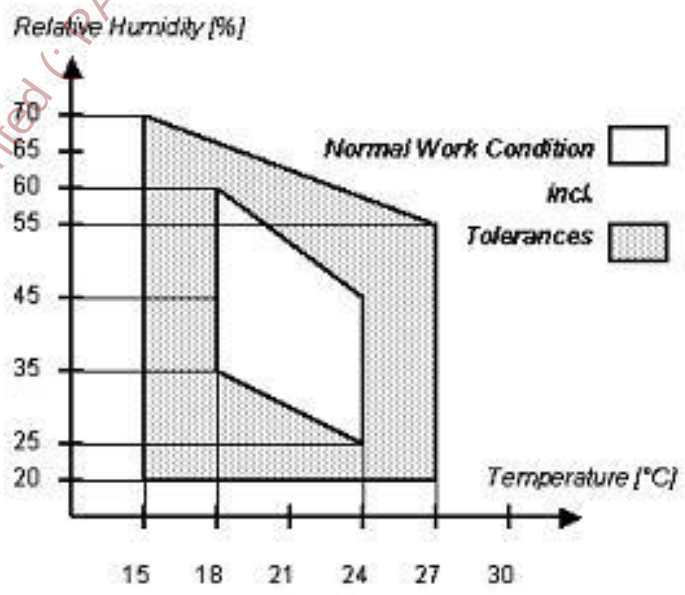

Figure 2: Normal Work Conditions for surface preparation areas

In surface preparation areas, the following is strictly forbidden:

- Any application of agents in the form of aerosol or any other kind of spray (excluding water spray applied for waterbreak test according to chapter 7.2).
- The use, handling and application of uncured liquid release agents.
- The use of equipment that releases oils, greases, lubricants, fumes or any other type of contaminant.
- The use of tools and utensils that have not been cleaned and maintained appropriately.
- Eating, drinking, smoking and the use of waxes or non-polymerised silicones or any other substance detrimental to good adhesion of the materials.
- Cleaning and maintenance of tools.
- Any container and contents that can contaminate the surface preparation area.

4.6 Processing

The surface pre-treatment is one of a number of elements of the adhesive bonding process chain, which are crucial for the development of a strong and durable structural bonding of thermosetting composite adherents. Certain critical processing operations have to be closely controlled to check, whether the required surface condition (e.g. cleanliness, activity, roughness) was achieved by the pre-treatment process. Compatibility, specific requirements and limits must be stated in relevant Process Instructions.

4.6.1 Process Parameters

Process parameters shall be specified in the Process Instructions for each individual combination of surface preparation, adhesive and adherent material. The range of permissible process parameters is subject of this process qualification test programme and has to be stated in the Process Instructions. It has to be considered as a general principle that the processing requires continuous and close monitoring and control.

4.6.2 Pre-treatment by peel ply removal

A peel ply comprises a woven fabric which is dry or pre-impregnated with resin, known as “wet peel ply”. This is placed as the first or last ply on a fibre laminate stack to be torn off the surface after laminate curing. This removal should be as late as possible before bonding in order to create a new clean surface that is rough and textured ready for adhesive bonding.

Peel plies are classified by their composition and use as outlined in Table 1.

Table 1: Types of peel-ply

AIMS12-01-001	AIMS12-01-002
Peel ply for structural bonding (Dry Fabric)	Prepreg peel ply for structural bonding (Wet Peel Ply)

For Peel plies according to AIMS12-01-001 (dry fabric) or according to AIMS12-01-002 (pre-impregnated) it is usually not necessary to abrade the surfaces, but the following requirements must be met:

Compatibility of the individual peel ply product with the thermosetting adhesive/composite material is a basic engineering requirement (4.1) and consequently must be assured. Compatibility evaluation has to follow the requirements of AIPS06-02-006. Source document for the listing of allowed combinations of adhesive, adherend and surface treatment (in this case, peel ply) is RP1027786.

Special attention shall be taken during storage and handling of peel plies avoiding any lack of protection.

The peel ply to be used shall be called out on the drawing or in the associated document.

Only peel plies qualified according to AIMS12-01-000 and which successfully passed acceptance testing AIMS12-00-000 Part 100 shall be used.

The peel ply shall be within the storage and work life limits indicated in its relevant Material Specification. Wet peel ply material shall be considered and handled as a structural prepreg material due to the fact that, after removal of the peel ply fabric, a part of the wet peel ply resin remains on the composite surface.

A schematic of the general processing with peel ply pre-treatment is given in Figure 3.

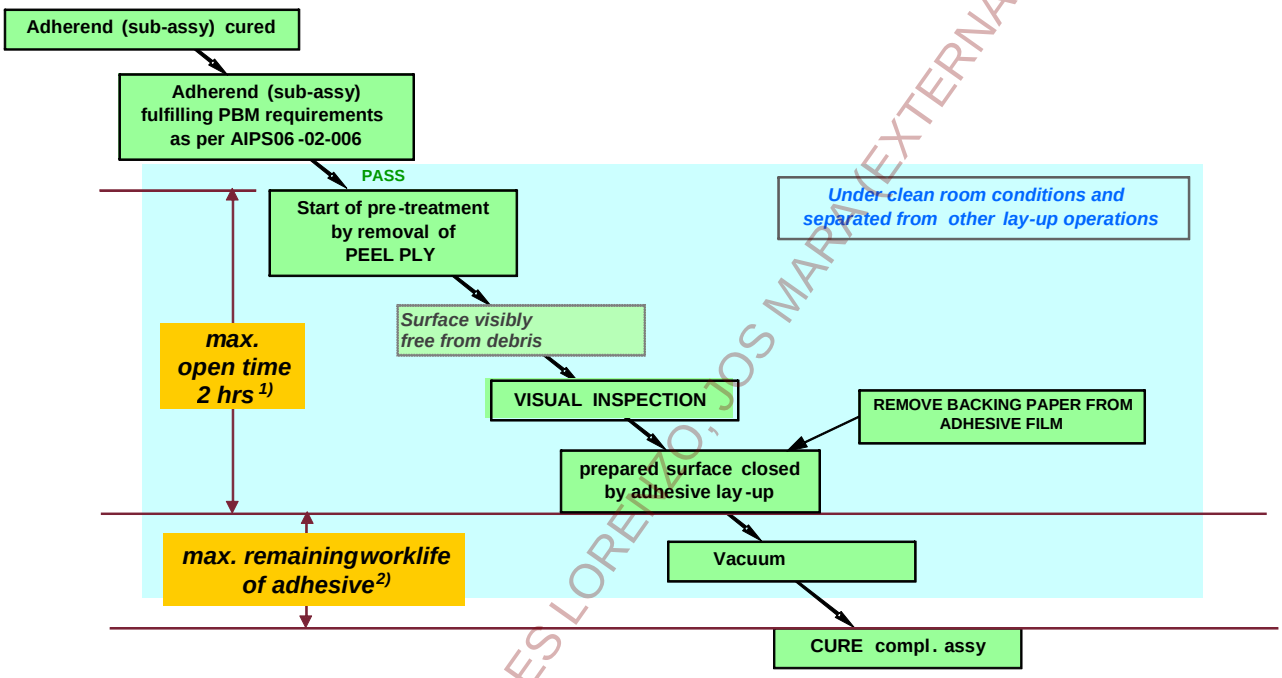

Figure 3: Work flow - Pre-treatment by peel ply and bonding of composite adherend parts

NOTE 1: If not otherwise qualified and stated in Process Instruction or chapter 4.6.2.1.

NOTE 2: Or shortest remaining work life of any other polymer material to be cured in the same cycle (co-bonding), if this ends earlier than the one of the adhesive.

After removal of a peel ply for structural bonding from a sufficiently dry (following AIPS06-02-006) composite adherend part, the surface has to stay visibly free from debris. Only validated cleaning procedures for removal of debris from surfaces shall be applied. Their definition in AIPI06-01-003 is mandatory.

Debris cleaning device pre-requisites are:

- The working principle is based on aspiration.
- The cleaning devices must not touch the pre-treated surface.
- Emission of any substances that could contaminate the treated surface or the environment is prohibited.
- Devices have to undergo regular cleaning and maintenance strictly controlled by Quality.
- Devices and procedures have to be validated according to this specification and the related process instruction.

Cleaning a surface from which peel ply has been removed, using agents such as solvents is a non-acceptable procedure and shall be avoided, mainly due to HSE reasons.

Pre-treated components shall be handled with extreme care. Handling shall only be undertaken with validated and clean cotton gloves. The adhesive has to be applied as soon as possible and within a maximum allowed time ("open time"), which has to be qualified by validation testing and documented in the Process Instruction and CMR. The maximum open time is at least 2hrs. Qualification of longer open times is possible to allow process flexibility in industrial processing.

Once this open time is exceeded, structural bonding of such a surface is no longer allowed. Sanding or grit blasting, as outlined in chapter 4.6.4, are to be then considered as opportunities for re-activation of the expired surface, as long as these methods are qualified.

The maximum time between adhesive lay-up and start of cure of the bonded assembly, called "delay time", is restricted by the remaining work-life of the adhesive applied, or by the shortest remaining work life of any other polymer material being cured in the same cycle.

4.6.3 Processing requirements for specific bonding configurations

In this sub-chapter stated requirements apply exclusively to bonded configurations consisting of the following material and treatment variants only:

Adhesive:	FM300 at all grades as per IPS10-01-006-02.
Adherend:	M21E prepreg at all grades as per IPS05-27-002-01, IPS05-27-002-03, IPS05-27-002-04, IPS05-27-002-05.
Pre-treatment:	Peel ply IPS12-01-002-04, IPS12-01-002-05.

After removal of a peel ply for structural bonding from a sufficiently dry (following AIPS06-02-006) composite part, the adhesive has to be applied within a maximum allowed time ("open time") of 8hrs.

4.6.4 Processing by abrasive methods such as Sanding or Grit Blasting

Surface pre-treatment by an abrasive method must fulfil compatibility requirements as per 4.1 of this specification. Compatibility evaluation has to follow the requirements of AIPS06-02-006. Source document for the listing of allowed combinations of adhesive, adherend and surface treatment is RP1027786.

The abrasive method shall be tailored so that it reliably removes contaminants or other substances from the adherend surface which could affect subsequent bonding. This will condition the surface's topology, but must not not adversely affect the composite material (fibres and matrix) even if applied on an already pre-treated surface.

Good surface treatment quality can be obtained when utilising corundum (aluminum oxide) cloth type sandpaper of appropriate grades. It is crucial for the operator to understand the function of each step of this process and be well trained in performing this work. Manufacturing quality shall establish measures which maintain correct operator knowledge, awareness and workmanship.

Good practice and recommended parameters for sanding of CFRP part surfaces are:

- Perform sanding in steps starting with a coarse grade of sandpaper, P100. In special cases P80 can be used, for example:
  - Resin enriched surfaces such as those from which peel ply was removed
  - Laminates that have been made from highly toughened interleafed prepreg systems
  - Liquid composite moulded parts.
- Sand carefully until the surface is fully mat, but avoid sanding of fibre reinforcement.
- When sanding by hand, start in a diagonal direction to the fibre orientation of the adherend surface and then end by sanding parallel to the fibre direction before switching to the next most finer grade sandpaper.

- Continue with finer grade sandpaper (P150 or 180) and end with a final step using P240. Always start diagonal to the fibre orientation of the adherend surface and then end parallel to fibre direction.
- The first sanding step with P80 or P100 can be conducted in wet or dry mode but all subsequent sanding steps with the finer grades are to be done in wet mode. After each sanding step rinse thoroughly with tap water.

After this surface preparation, check the surface quality and when the part is sufficiently dry (following AIPS06-02-006), the adhesive shall be applied as soon as possible. This will be within a maximum allowed time (“open time”), which has to be qualified by validation testing, documented in the Process Instruction and included in the CMR. The maximum open time is at least 2hrs. Qualification of longer open times is possible to allow process flexibility in industrial processing.

If application of adhesive to the pre-treated surface cannot be carried out within the maximum open time, the component’s surface shall be adequately protected against pollution, contamination and moisture ingress by defined and validated means. This shall be defined in the applicable Process Instruction. Under these conditions, pre-treated composite parts may be stored up to a maximum period of time as validated and specified in the Process Instruction. If this period is exceeded, the surface preparation may possibly be repeated, if validated and allowed by qualification.

The process chain, storage and protection means have to be qualified accordingly.

The maximum time between adhesive lay-up and start of cure of the bonded assembly, called “delay time”, is restricted by the remaining work-life of the adhesive applied, or by the shortest remaining work life of any other polymer material being cured in the same cycle.

4.6.5 Cleaning

General requirements for the cleaning process are described in AIPS09-01-002.

Only qualified solvents shall be used in this process. The solvent has to be of a grade “for analysis”.

Use of MEK must be minimized due to HSE as well as technical reasons (see AIPS09-01-002).

4.7 Quality requirements

Quality Assurance shall ensure that the following Quality requirements are met, and that the process qualification procedure in accordance with chapter 5 is performed.

If not otherwise stated in the drawing set and associated documentation for the part to be manufactured, general engineering requirements for the Inner Quality of a monolithic structural composite component can be established as follows:

- Inclusions of foreign objects are not permitted.
- Only the resin layer at the surface shall be abraded. Surfaces shall not be adversely affected by an abrasion method.
- Surfaces of a composite element assigned for structural bonding, according to AIPS06-02-006, shall be free from surface defects whether reworked/repaired or not.

4.7.1 Qualification of the personnel

All steps of the manufacturing procedure must be carried out by authorized, trained and competent personnel as recognized by an approved training programme. This shall be under the control of the Quality department. Certification will be given in form of a competence certificate.

4.7.2 Materials

Materials shall meet requirements as indicated in their respective Airbus material specifications.

A material receipt process controlled by Quality Assurance is required for all structural material batches.

Storage of structural and auxiliary materials shall be performed in accordance with the requirements of this document and the relevant Airbus material specifications.

Excessive stacking or any placing of material in a manner that may cause it damage shall be avoided.

For materials which have to be stored in a freezer, a log shall be kept. This will record the date and time of each transfer of specific material in and out of the freezer, thereby remaining work-life will be tracked.

Processing of prepregs, adhesive films and auxiliary materials shall be performed in accordance with the requirements of this document, the relevant Airbus material specifications and the relevant Process Instructions.

All auxiliary materials used shall be products qualified or approved by Airbus. Special care shall be taken to only use peel plies qualified according to the AIMS12-00-000 specification.

Following CMH-17-3G, Quality Assurance shall ensure in detail:

- Materials are properly identified by name and specification
- Materials are stored and packaged to preclude damage and contamination
- Perishable materials, prepregs and adhesive films are within the allowable storage life at the time of release from store and within the allowed work life at start of cure.
- Appropriate procedures for the thawing of materials which have been removed from a freezer (in order to prevent any moisture from condensation on the cold material).
- Pre-packaged kits (e.g. pre-consolidated laminates, pre-cured parts for co-bonding) are properly identified and inspected.

4.7.3 Inspection of production facilities and measuring equipment

All production facilities, tooling and equipment used in the manufacturing process shall be certified. These will also be inspected regularly under the responsibility of Quality Assurance.

Cleaning and an inspection schedule of the lay-up areas shall be established in Quality Assurance documents.

The positive overpressure of Cleanrooms in order to prevent any external contamination shall be controlled with a suitable differential pressure-measuring device.

Procedures for periodic checking of pressure in the vacuum hoses and their connections shall be established in order to guarantee their performance.

Measuring equipment for autoclaves, curing presses, ovens etc. shall have the capability to continuously record the temperature, pressure and vacuum, as applicable. If continuous recording is not possible, recording at maximum intervals of 10 minutes is recommended. Monitoring systems shall be driven by the lowest thermocouple as long as the highest is considered.

Thermocouples shall be checked electrically before the curing operation. The accuracy of the thermocouple splice box and the recorder must be +3ºC between 50ºC and 210ºC.

4.8 Key Characteristic

Key Characteristics acc. to EN9103 are defined by Responsible Engineering based on a risk analysis for parts manufactured by this process. Key Characteristics shall be defined at product level and, if necessary, also at process level.

They shall be subject to variation control by production organisation according to EN9103.

Key Characteristics do not relieve the production organization from meeting all engineering requirements defined in this document.

Table 2: Key Characteristic

Product Key Characteristic			Process Key Characteristic		
No.	**Designation**	**Requirement/ Limit**	**Sub.-No.**	**Designation**	**Requirement/ Limit**
1	Bond line performance	AIMS / CER	1.1	§4.1 Processing Apply individual & qualified combination of pre-treatment, adherent and adhesive, only	Drawing, AIMS
2	Bond line performance	AIMS / CER	2.1	§4.2 Material moisture Content (“pre-bond moisture”)	Acc. to AIPS06-02-006 and process instruction
3	Ageing of material, bondline performance	AIMS / IPS	3.1	§4.3 wet peel ply storage life	acc. IPS
			3.2	§4.3 wet peel ply worklife	acc. IPS
4	Bond line performance	AIMS / CER	4.1	§4.5 shop condition temperature	Max. 27°C
					Min. 15°C
			4.2	§4.5 shop condition humidity	Max.70%r.h.@15°C, max. 55%r.h.@27°C
					Min. 25%r.h.
5	Bond line performance	AIMS / CER	5.1	§4.6.1 Process Parameters	Acc. to process instruction
6	Bond line performance	AIMS / CER	6.1	§4.6.2/3 opentime of pre-treated surface until adhesive application	max.2h, if not other specified in CMR
			6.2	§4.6.3 Pre-treatment storage period	Acc. to process instruction
			6.3	§4.6.2/3 Delay time	Max. remaining adhesive work-life

5 Technical Qualification

The Technical Qualification shall be carried out in accordance with the relevant Airbus procedure.

Qualification tests, as described in the following chapter, are required if a new Process Instruction is required or an existing Process Instruction is to be changed significantly. They are not required for new part related work instructions.

The qualification documents, shall clearly define the scope and limitations of the individual qualification project.

5.1 Definition of Parts/Specimen for Qualification Tests

Parts and specimens for Qualification Tests shall be agreed between the Qualification Project Leader and the manufacturing shop responsible for their production. The parts and specimens will be stated in the Qualification Test Program (QTP).

The manufacturing shop shall produce parts/specimens for qualification tests by working to the Process Instructions under qualification. Serial production facilities shall be used under serial production conditions.

The qualification tests shall be made on:

- Coupon specimens.
- Generic or serial production part First Part Qualifications (FPQ) in accordance with the relevant AP.

The manufacturing shop shall use composite materials, suitable pre-treatment processes and adhesives according to the relevant Airbus Material Specifications. Tests shall be launched, with the surface preparation to be qualified, so that each specific combination of adherent, pre-treatment and adhesive is covered.

5.2 Qualification Tests

All required qualification tests must be carried out by the manufacturing shop working to the process subject to qualification. The tests must be performed using series production facilities working under serial production conditions.

Stages of the procedure are as follows:

- Provision of materials.
- Acceptance of materials and delivery of the acceptance report.
- Manufacturing of parts/specimens.
- Inspection and test of parts/specimens.
- Delivery of test report.
- Delivery of the manufacturing definition dossier (new or significantly changed Process Instructions)

If an external manufacturing shop is to run the qualification tests, a test report, manufacturing dossier and a set of test specimens for crosschecks shall be delivered to Airbus Quality department.

Test specimens manufactured and tested by external manufacturing shops will remain available to Airbus throughout the validity period for the qualification in question.

The qualification tests shall be, at least, the following:

5.2.1 Tests on Coupon Specimens

The specific surface preparation methods to be qualified must be controlled and fully defined (e.g. processing parameters, etc.) within the QTP and agreed by the RMSG.

5.2.2 Adhesive pretreatment test programme

Surfaces that are to be bonded shall be free from defects, and contamination. This includes any lubricants, release agents, finger prints, dust or any other polluting substance which could adversely affect the bond strength.

The test programme shall be supplied to the workshop being qualified in the form of a Qualification Test Programme (QTP).

The tests to be conducted on adhesive are given in Table 3 and Table 4. Table 4 matches compatibility testing defined in AIPS06-02-006 with the addition of climbing drum peel testing.

Table 3: Adhesive pretreatment Physical Test

Physical tests	**Test temperature** (°C)	**Number of test specimens in test specimen set**
Wettability as per AITM1-0022	23	3 test specimens

Table 4: Adhesive pre-treatment Mechanical Tests

Mechanical tests	Unit	Test temperature (°C)	Number of test specimens in test specimen set		
			Initial condition [1]	Conditioned at 85% r.h. till equilibrium [2]	Critical storage- delivery and shop floor exposure parameters + 70°C / 85% r.h. till equilibrium
Interlaminar fracture toughness (G_{1C}) as per AITM1-0053	J/m^2	23	5 test specimens	5 test specimens	5 test specimens
		-55	5 test specimens	---	---
Single lap shear as per AITM1-0019 Type S7	σ (MPa)	23	5 test specimens	---	---
		90	---	5 test specimens	---
Climbing drum peel as per PrEN 2243-3 [3]	Cp (N.m/m)	23	5 test specimens	---	5 test specimens
		80	---	5 test specimens	---

1) As per EN2743
2) As per EN2823. Alternative exposure conditions to be selected by RMSG. Conditioning at 70 or 80°C.
3) Alternative specimen type defined by RMSG.

5.2.3 Tests on generic or serial production parts

The workshop being qualified shall demonstrate the ability to manufacture a monolithic part which meets general engineering requirements. This can be done either by manufacturing a generic part or a serial production part. In both cases, the qualification activity should be in accordance to the relevant AP. The selection of materials for the part being tested will be stated in the Test Program.

5.2.4 Test program and requirementss

The Test Program for demonstration of the ability to manufacture parts shall cover the following aspects:

- Visual inspection (surface quality, etc.)
- Additional mechanical tests on a generic or serial production part can be included in the Qualification Test Program

5.3 Validity period and maintaining qualification

Manufacturing processes, which have been qualified according to this AIPS, shall be applied in the way that they fulfill the requirements of this AIPS. Process parameters, and critical process steps, which might affect the required performances, or the in-service behavior, shall not be changed. In general, no qualification validity limit is given. Qualification will not be withdrawn unless there are reasons to call it into question.

Qualification can be called into question if any inadequacies are observed:

- Poor quality is obtained on finished product;
- The process is interrupted during a continuous period exceeding 6 months;
- When any significant modification is carried out in the facilities, which might affect its operational characteristics;
- New production facilities;
- Process parameters changed (e.g. cure cycle);
- Engineering requirements are modified.

In all cases, when qualification is called into question, a re-qualification may be required.

Specific cases: The revision of the corrective actions originated by the qualification must be carried out frequently.

6 First Part Qualification

Introducing new structural components or major changes into serial production using special manufacturing processes (e.g. composite processes, welding processes) may require a First Part Qualification (FPQ), according to the relevant Airbus procedure. The decision as to whether an FPQ is required will be made by Responsible Engineering. The main objective of an FPQ is to prove that the inner quality of a structural part / component meets the requirements defined in the Definition Dossier. This takes into account materials and key parameters of the manufacturing process as well as tooling.

The FPQ typically uses a combination of Non-Destructive Inspection (NDI) and destructive methods (microscopic examination, mechanical tests, physical/chemical analysis).

An FPQ can be required in the frame of developing and introducing a new structural part / component into serial production or if major changes to the bonding process have been introduced which could have an effect on the assembly quality.

An FPQ can be used to confirm that the quality of the assembly meets the requirements of Responsible Engineering when a new Manufacturing shop is used.

An FPQ can also serve as a feasibility part test during a process qualification (see chapter 5) to verify the ability of a manufacturing shop to carry out the process of structural bonding of composite parts.

As a general rule, a FPQ shall be carried out for parts of “Functional Class” 1 and 2-1 (See Table 5).

Table 5: FPQ vs. FC

Measurement	Functional Class [1)]				
	1	2-1	2-2	2-3	3
FPQ [2)]	X	X	X [3)]	X [3)]	n/a

1) Functional Class as per BOM
2) First Part Qualification project as per part family
3) Not mandatory, based on individual engineering decision

6.1 First Article Inspection

Quality assurance shall initiate planning and ensure performance of a First Article Inspection (FAI) according to the relevant Airbus Directive (ABD) on the first part produced in serial production.

The FAI typically uses a combination of visual inspection, dimensional inspection, NDI methods and process control methods. These verify that the bonding process, as stated in the relevant Process Instructions, has produced an acceptable assembly as defined in the definition dossier.

7 Series Production Inspection

Serial production control of the pre-treatment process is mandatory.

For all parts being bonded, serial production inspection schedules shall be established and defined in the Process Instructions, Quality Instructions, drawing set and/or associated documentation.

Inspections to be made, as well as their criteria and levels, shall defined in the Process Instructions, Quality Instructions, drawing set and/or associated documentation.

The shop shall perform the following Series Production Inspections under serial conditions:

7.1 Surface Quality Check by Visual inspection

Visual inspection (according to AITM6-3004) of prepared surfaces shall be performed for each part to check:

- Whether the processing was carried on the entire surface.
- For homogeneity of the visual appearance of prepared areas (e.g. spots, shadows)
- For any damage to the component surfaces (excessive abrasion, scratches, thermal damage)
- For any visible contamination or foreign debris.

7.2 Surface Quality Check by Water break test

After pre-treatment by abrasion (sanding) or grit blasting a wettability test, also known as a “water break test”, shall be conducted on each bonding area of the part. This will check whether the cleanliness and wetting characteristics have been achieved. The procedure as called out in AITM1-0022 shall be followed. Re-drying after wetting the surface is a mandatory step and shall follow AIPS06-02-006 requirements.

7.3 Surface Quality Check by Surface electrical resistance testing

After pre-treatment by grit blasting, surface electrical resistance testing shall be performed in accordance with AITM2.0031 for each part to check for elimination of the surface resin layer in concert with contamination.

For this purpose the abraded surface shall be scanned with the probe at several locations in compliance with a pattern specifically defined for the pre-treated part. In general, the distance between two measurements selected shall not be larger than the distance between the two electrodes of the probe. The maximum average resistance shall be 3 Ohms, single values may not exceed 5 Ohms. If one or both limit values are exceeded, the abrasive treatment shall be repeated whilst ensuring that no abrasion of fibre occurs.

Surface electrical resistance testing on sanded surfaces is also effective and may be required for specific cases. If surface electrical resistance measurement on sanded surfaces is required, this shall be called out on the drawing. Specific requirements with regard to lightning protection shall be defined for each component.

7.4 Process Control Specimen

Follow as per definitions in AIPS06-02-006.

7.5 Serial Production Inspection Schedule

Generally, for each pre-treated elementary part subjected to structural bonding, a detailed inspection schedule shall be defined by the responsible manufacturing / quality organization. For the purpose of this specification, the “Functional Classification” of the bonded composite part according to their structural responsibility shall be considered. The Functional Class is defined for each Composite elementary part, documented on the Bill of Material.

Taking into account the main “Key Characteristics” of this process (refer to 4.8) and inspection processes to validate the quality of the bonded composite item, the following minimum inspection tasks shall be applied. Depending on its functional class. Table 6 shows, which measurements & controls have to be considered to which extend.

Table 6: Minimum Inspection Requirements vs. FC

Measurement	Functional Class [1)]				
	1	2-1	2-2	2-3	3
Confirm application of Peel Ply type acc. to Definition Dossier	X	X	X	X	X
Pre-bond moisture prevention & monitoring	X	X	X	X	X
Assure shop condition temp. & humidity	X	X	X	X	X
Visual Inspection	100%	100%	100%	100%	100%
Open time control of pre-treated surface until adhesive application	X	X	X	X	X
Waterbreak test	100%	100%	100%	100%	100%
Process Control Semi panel	X	X	X	X	N/A
1) Functional Class as per BOM					

8 Rework (“surface re-pre-treatment”)

Rework of pre-treated surfaces, for the purposes of this AIPS, constitutes solely the application of a qualified (acc. to this AIPS) surface pre-treatment on an already pre-treated surface (acc. to this AIPS). This shall be known as surface “re-pre-treatment”. Such surface re-activation of an already pre-treated surface is required after occurrence of one of the following incidents:

- Exceeding one of the validated in-process time restrictions relevant for pre-treated surfaces. For instance;
  - Max. time of unprotected exposure to shop environment (“open time”, KC 6.1)
  - Max. storage time of treated surface. (KC6.2)
  - Max. remaining adhesive work-life (“delay time”, KC 6.3)
- Pre-treated part leaving the clean room type shop floor conditions (equivalent to AIPS06-02-006) whilst not being effectively protected by measures that have been validated and qualified according to this AIPS.
- When the visual inspection has failed.
- Rework or repair in terms of AIPS03-08-003 or 05-04-002 (lamination, resin filler) occurring on previously pre-treated surface. Special care has to be taken to ensure that materials applied for rework or repair fulfil compatibility requirements (AIPS06-02-006). Furthermore, a case by case decision by Engineering shall be recorded through non-conformity management to assess whether bonding on such a deffective surface is acceptable.

- Contamination by finger prints, water spills, lubricants, dust or by any other polluting substance which violates process specifications or instructions. Again, a decision by Engineering shall be recorded through non-conformity management to assess whether bonding on such a deffective surface is acceptable.

It is mandatory that re-activation of a pre-treated surface extends over the complete area (Figure 4) even if the incident affects the pre-treated area in a localised zone only.

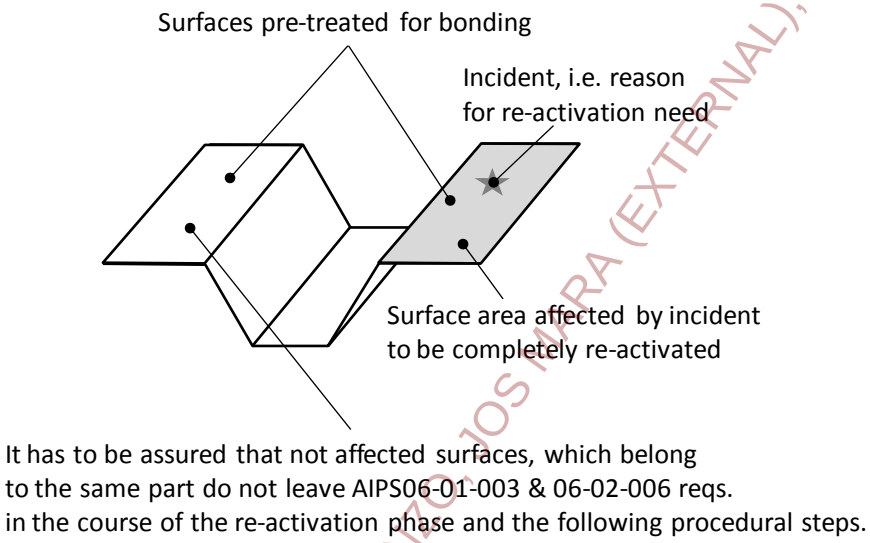

Figure 4: Re-Pre-Treatment of complete affected surface

It has to be assured that non-affected surfaces on the same part do not leave AIPS06-01-003 & AIPS06-02-006 requirements during the course of the re-activation phase of the affected areas and following bonding steps.

Furthermore, parts that contain of a mix of initially pre-treated and subsequently re-activated surfaces shall still meet AIPS06-02-006 requirements, e.g. mating part tolerances for secondary bonding.

9 Environment, Health and Safety

The manufacturing process shall be in line with Airbus Health and Safety and ecoefficiency policies.

Compliance with A1091 shall be ensured for all materials, substances and/or articles implemented during process.

In particular, targeted substances according to A1091 shall not be used, if a safer alternative is available.

Uses made of all substances involved in the process shall be documented in Safety Data Sheet as required by REACh regulation (Registration Evaluation and Authorization of Chemicals).

Annex A
Auxiliary material list

Nº	Auxiliary material	Application *(Type of material)*	Trade name *(Manufacturer)*	Remarks [1] *(IPS)*	Storage life [2]
1	Peel plies	Not allowed as structural bonding pre-treatment (TyA)	60-B/R (Tygavac Advanced Materials)	Nylon / 205ºC (IPS12-01-003-01)	12 Months
			081111650DPO000 (F-08111 old denomination) (NCV Industries. Porcher)	Polyester (IPS12-01-003-02)	
			PFG Code 60001 Style 60001/060/0005, /0006, /0008 (Precision Fabrics Group; PFG)	Polyester (IPS12-01-003-03)	
			Hexforce T0098 (Hexcel Comp.)	(IPS12-01-001-01)	
			Release Ply G (Airtech)	(IPS12-01-001-04)	
		For structural bonding pre-treatment (TyA)	As indicated in CER (or relevant specification). See applicable MPSL (Material&Process selection list)		See corresonding IPS

1) Fluorinated materials (FEP, ETFE, PVF, PTFE, …) in direct contact with uncured structural materials including spatulas, rolls, cutting tables and tools are prohibited if not specifically approved for a particular application.
2) Storage at 5-28ºC/ 40-60% R.H (unless otherwise stated) in original containers and not exposed to U.V. light (see Material Technical Data Sheet for materials with no specifc information)

RECORD OF REVISIONS

Issue	Clause modified	Description of modification
1 06/06		New standard
2 11/08	Chapter 1 Chapter 2 Chapter 4.3 & 4.7.3 Chapter 4.7.2	Update Re-worded in line with Airbus procedure Titles changed, and documents added which appear with AIPS ISO14644-1 and ISO14644-3 added MIL-HDBK-17-3F added
3 04/10	4.8	Implementation of Key characteristics
4 07/12	All chapters	Complete revision
5 12/12		