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## Validated Typical Professional Tasks in the European Aircraft Industry



This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.



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## **1. Production of metallic components for aircraft or ground support equipment**

Aircraft mechanics produce components for the structure of the aircraft (e.g.: stringers, cuts, skin plates) including the equipment (e.g.: Hydraulic lines) according to the valid construction specifications, standards and concretizing rules. In addition, they produce components for ground support equipment. The bases for the production of the varying components are plates, steel strips or semi-finished products. After careful planning, processing takes place predominantly via the application of cutting or (re-)forming procedures (e.g., sawing, filing, cutting of interior or external thread drills (e.g. with hydraulic cables)). Manual and mechanical manufacturing procedures are used. The manual procedures take place using not only the technical designs but partially with the help of devices such as contour templates. In particular during the process of elaboration of large plates before the execution of reforming manufacture processes a heat treatment is necessary to increase the level of reformation / the strain. Heat treatments additionally are used for changing material properties. Since in the aircraft construction it is of a central importance that the weight of the used components is as low as possible the wall thicknesses are optimized for a lot of components (e.g. by chemical abrasion) of material or surface milling. The marking of these components as well as the quality inspection and the documentation of orders are integrative elements of this Typical Professional Task. The quality inspection already occurs during the production process (e.g. for cracks during forming). Damaged parts are repaired or replaced – depending upon the degrees of damage. Recurring faults, that are not yet documented, are additionally reported to the responsible design department. The task ends with the further transport or the preparation of the further transport of the finished components.

## **2. Production of components of plastics or composite materials for aircraft or ground support equipment**

Besides metallic components, an increasing amount of plastic or composite material is used in the aircraft production (e.g.: Carbon fiber reinforced plastics, glass-fiber reinforced plastic, mixed constructions made of plastic and metal). With these components the production process contains not only the processing of composite material or plastics but already the production of the semi-finished products (e.g.: Connection of different materials to composite materials, embedding the fabrics into the resin-hardener-mixture, sticking the varying materials, filling in the core-insulating-material, production by means of “Prepeg” procedures). Within the cutting processing steps matched procedures must be used that are matched on the respective material and/or on the material combination. In particular the gluing procedures and laminating techniques that are used for this Typical Professional Task set special requirements for health and environmental protection. The marking of the components, the material and quality inspection as well as the documentation of orders are integrative elements of this Typical Professional Task. The task ends with the further transport or the preparation of the further transport of the finished components.

### **3. Operating and monitoring of automated systems in the aircraft production**

Although in the aircraft construction the single and small-batch manufacturing dominates, for the production of recurring components automated manufacturing plants are used (e.g. laser cutting machines, water cutting machines, erosion systems, cutting processing machines or rivet systems). After the systems were equipped with the necessary semi-finished products or pre-products and tools, the manufacture parameters or the pre-programmed program have to be selected and set. The manufacturing process must be monitored completely by the help of the different control-instruments and optimized if necessary. Finally the produced sections are examined regarding their quality. The documentation of the accomplished work and the quality inspection is an integrated element of this Typical Vocational Task. In addition the skilled workers implement maintenance and repair tasks for the systems or are involved in them. The task ends with the further transport or the preparation of the further transport of the finished components.

#### **4. Joining and dissolving of structure components and aircraft airframes**

Complex structure components and structure assemblies (e.g. Landing flap commands, shell elements or bearing area structures) and whole aircraft-airframes are produced out of single components. For this purpose the single parts or components have to be selected out of most varying materials on the basis of technical information. The operational funds needed for joining must be selected likewise. During the process of adaptation and joining the given gap and profile sizes have to be kept. For joining major components, the major components must be transported, lifted and positioned as well. A main topic of the joining processes in the aircraft construction is the manual and mechanical setting of rivets. Depending upon material, combination of materials (e.g. mixed construction of metal and composite) and stress different rivets are used (e.g. hi-lok, lock bolt or hi-shear). For the preparation of a rivet joint holes and lowerings are produced and sealants are applied on the joining areas. Apart from riveting with rivet hammer or rivet press there are also automated production systems used for riveting at standardized components manufacturing plants. As further joining processes there are used screwed connections, safety elements according to aviation standards and splicing tapes as well as most varying welding methods (e.g. laser-welding and friction agitating welding) in order to connect assemblies. Also the liaison methods and processing at these procedures depend on material, material combination and stress of the component. Some further processing steps must be accomplished at the finished assemblies (e.g.: Stems of tons, position and measure from grounds). The connections that are established in the context of this task of work are subject to a permanent inspection. If defective connections are determined, then an immediate exchange occurs. In addition the actual connection is first solved and then replaced afterwards by a new connection. In the maintenance and repair the solving is accomplished with the disassembly of structure components. Due to adjustment and optimization work this part of the task of work is important in addition, for the first assembly. Since the solving of structure components in most of the cases doesn't occur without deconstruction it requires much experience of the skilled worker that no unnecessary damage occurs at the components. The documentation of the orders, the gap and profile sizes and possible construction deviations ranks likewise among this Typical Professional Task. After conclusion of the joining processes the surface of the components must be protected. This work procedure is accomplished depending upon Labour Organization independently as next Typical Professional Task or directly after conclusion of the joining work.



## **5. Assembly and disassembly of equipment and systems in/at the aircraft airframe**

With this Typical Professional Task the equipment and the accoutrement of the aircraft are installed in the context of the final equipment. This assembly work takes place either on the aircraft airframe or on complex assemblies of the aircraft. Here is the coordination and communication with the colleagues and supervisors of special concern, due to the complexity of the component parts. On the one hand, different instruments and systems (e.g. kitchen and toilet modules, engines, landing gear, brake of the landing flap) or sub-systems (e.g. hydraulic lines or electric conductions) are installed. On the other hand, already integrated components of systems or instruments (e.g. hydraulic, pneumatic, electro mechanic or electronic components) are connected with each other. For that purpose joining elements or plugs have to be installed. After the assembly, the systems and the instruments are examined (e.g. for tightness) and if necessary the marking of the equipment labels is carried out. In particular, during the assembly and the examination of electro mechanic or electronic components a close cooperation with specialists of electronics is necessary. The disassembly of instruments and systems of the aircraft airframe is mainly effected in maintenance operations. Due to adjustment and optimisation work this part of the work task is also very important for the prime production. As non-fixed components or tools, which have been forgotten in the aircraft, may influence the flight quality or the airworthiness, the inspection of completeness of the used tools after the termination of the assembly/disassembly work is an elementary part of the Typical Professional Task. The documentation of the orders, possible construction deviations and the serial numbers of the used components, as well as the life delimitation, is also part of this Typical Professional Task. After the termination of the assembly the surface of the components has to be protected. This work step is effected independently, according to work organisation, as the next Typical Professional Task or directly after the conclusion of the assembly work.

## 6. Functional checks and tuning at the aircraft

At the end of the prime production or after the reconditioning of the single aircraft components or the entire aircraft, extensive functional checks and tunings have to be achieved. On the one hand, this guarantees the interchangeability of the single components and on the other hand, to control and optimise the airworthiness in the context of tests which are carried out on the ground. To assure the interchangeability of the single components measurements with varying measurement equipment are accomplished (e.g. micrometer screws, feeler gages, laser tracker, digital photogrammetry) and the components are if necessary adapted. In order to control the airworthiness, functional checks of all systems testable on the ground are effected (e.g.: examination of hydraulic pressures, landing gear test, flap test, examination of the emergency equipment). In case of setting deviations of the individual components are these, if possible, optimised by tuning. Possible malfunctions are documented (e.g. in non-conformance arc/non-conformance blade or a finding report) and are directly repaired or with the support of maintenance specialists. The documentation of the results of the functional check and of the performed settings is, as well as possible optimisation proposals, an integrative element of this Typical Professional Task. Additionally, the used measuring instruments are maintained in the context of this Typical Professional Task.

## **7. Maintenance and inspection of the aircraft**

This Typical Professional Task contains the routinely servicing and inspection of aircrafts after a given number of flying hours. This is accomplished on airports/flight bases or in combination with the reconditioning of aircrafts in servicing or maintenance enterprises. Both during the inspection (e.g. visual inspection, crack inspection, corrosion inspection), the care and the servicing, the prescriptions of the maintenance manual (e.g. Aircraft maintenance Manuel (AMM) or German Air Force Technical Orders (GAFTO)) have to be observed. These documents exist predominantly in the English language. Simple malfunctions can also be eliminated in the context of the servicing and inspection of aircrafts. Depending on the effected maintenance work, function tests can be necessary. These are accomplished either by the concerned craftsman or by the customer (e.g. quality inspection by specialists of the Federal Armed Forces). The documentation of the accomplished work and of the possibly necessary function test is an integrative element of the Typical Professional Task.

## **8. Analysis and reconditioning of malfunctions at system components**

In the maintenance division the analysis of malfunctions of defective components of the aircraft belongs to the central tasks. As malfunctions can already occur during the production process, this vocational work task is also to be done at work locations which are primarily active in the aircraft production. The basis of the vocational work task is an appropriate work order, a maintenance manual (e.g. Aircraft Maintenance Manual (AMM) or German Air Force Technical Orders (GAFTO)) as well as a report of malfunction (e.g. non-conformance arc/non-conformance blade or finding report arc (all BB)) of specialists of other departments, customers or pilots. These documents are partly available in the Intranet and exist predominantly in the English language. The work task starts with an initial finding, where malfunctions are recognized and logged in the finding report. Thereto different inspection methods (e.g. visual inspection and functional check) are applied which support the judging and locating of the malfunction. For examining the components, also crack inspections can be essential. These inspections are carried out in co-operation with craftsmen of quality assurance. Afterwards, the malfunctions have to be analysed and their rectification has to be planned and operated. For reconditioning the damaged system or component is dismantled and exchanged or repaired. The reconditioning is accomplished independently by the craftsmen or in co-operation with the internal or external professional garages. The reconditioning process is documented accordingly in the technical brochure and the constructional drawings are modified if necessary.

## **9. Analysis and reconditioning of damage on structure components**

During the operation of an aircraft, the different components (e.g. structure components) or assemblies can be damaged. In addition, the damage can already occur in the production process or in the further processing and/or - working. Typical damage is e.g. cracking, delaminations or too large tolerances. During the reconditioning the original resistance and therewith operational readiness of the component have to be achieved again. This is done on structure components e.g. with the setting up of repair units (Patches), using rivets. The reparations are effected either directly on the aircraft or in the reconditioning location. All repair procedures are carried out on the basis of the maintenance manuals (e.g. Aircraft Maintenance Manual (AMM), Structure Repair Manual (SRM) or German Air Force Technical Orders (GAFTO)). These documents exist predominantly in the English language. Furthermore, the repair is to be documented in the technical brochures as a construction deviation. In particular, special repair procedures and adhesive technologies have to be used for the reconditioning of carbon fiber reinforced plastics components (CFK) which are partly still in the development stage. Hence, a close co-operation with the specialists of the material inspection, the design department and the quality assurance is essential. If the reconditioning of the damaged component is no longer possible or too expensive, the damaged component is replaced by a new section.

## 10. Reconditioning of accessory equipment

The different accessory equipment of engines (e.g.: water pump, heat exchanger) is reconditioned in separate technical departments. The accessory equipment consists of components with partly very small dimensions. Thus, both for the evaluation of damage and of the quality after the reconditioning process very precise measurements are necessary. As a measurement procedure for the quality of the evenness e.g. an interferometric evenness measurement is applied. The labour organisation is carried out in the same way to the damage evaluation and the reconditioning of engines. As a reconditioning method manual and mechanical cutting procedures (e.g. lapping) are applied. The accessory equipment is partly also reconditioned by the renewal of single components. The disassembly and assembly of the accessory equipment is effected by craftsmen of the reconditioning division. For the functional check the reconditioned accessory equipment is transferred to the appropriate division and afterwards they are available for the assembly to the engine. The documentation of the accomplished work and the quality inspection is an integrative element of the Typical Professional Task.

## **11. Independent quality inspections**

As a result of the high requirement to the operation reliability of aircrafts, a foreign inspection of the product and the process quality is indispensable apart from the self-checking. While the self-checking is a component of each accomplished work task of an aircraft mechanic, the independent inspection is a self-contained task of the component and assembly acceptance by craftsmen who are not involved in the production and the reconditioning procedure. Here, varying non-destructive inspection methods are used like e.g. visual inspection and cracking inspections by means of eddy current or ultrasonic inspections. The documentation of the accomplished work is an integrative element of this Typical Professional Task.

## **12. Production of bunched circuits for aircraft systems**

The production of wires and bunched circuits (for energy, signals and data) for aircraft systems is one of the principal tasks of the profession. The basics of the production of bunched circuits are engineering drawings, technical regulations and dimensional sketches. Examples for activities are to crimp and to plug contacts and connectors and to seal connectors. The requirements concerning functionality and quality of wires or bunched circuits have to be considered and checked during production. After finishing the production of a certain circuit, it has to be checked carefully. Two examples of these checks are isolation and continuity tests. The rigorous rules (by VDE, Electrical engineers syndicate) concerning “health protection” and “safety at work” have to be considered during the checks, especially when working with high voltages.



### **13. Production or modification of electric devices**

Elementary electric devices like switching units or light fixtures are produced or modified by aircraft electricians. The basics of the production or modification of electric devices are engineering drawings, manufacturing instructions and lists of material. When producing or modifying devices, electrical manufacturing instructions (e. g. soldering components or crimping contacts) have to be taken into account as well as mechanical ones (e. g. assembling structural parts). This professional task ends with the final inspection of the produced or modified devices by testing isolation, function and continuity.

#### **14. Passing bunched circuits in aircraft systems**

When producing new aircraft systems mainly bunched circuits are passed. When modifying an aircraft single wires are passed too. Basics for passing bunched circuits or wires are valid manufacturing instructions concerning the respective aircraft. First of all the bunched circuit has to be checked separately. While passing the circuit the technical and structural conditions (e. g. bending radii, joints, cable clips, protection of edges) have to be taken into account. Not only the bunched circuits but also the cable clips, decal information and danger notices have to be mounted. The skilled worker inspects the passed bunched circuit again and marks it according to the valid instructions. The documentation of the accomplished work is an integrated element of this professional task. Depending on the respective manufacturing order final inspection of the passed wires or bunched circuits is either done by the skilled worker or by the quality assurance.

## **15. Assembly and disassembly of subsystems and devices at aircraft systems**

Assembling and disassembling of subsystems or devices is necessary when producing or modifying aircrafts. The basics of this professional task are engineering drawings, manufacturing instructions and a manufacturing order. The function of the affected subsystems or devices has to be considered when assembling or disassembling it. First the subsystem or device that will be disassembled has to be localised. Then the device(s) that will be assembled are chosen, inspected and installed according to the instructions. Before assembling a subsystem or device isolation, electrical resistance and bonding are checked. After assembling it another inspection, consisting of visual, isolation, function and continuity checks is performed. Usually mechanical activities (e. g. securing with a wire, mounting / demounting closure panels) are part of assembling electrical devices or subsystems. The documentation of the accomplished work is an integrated element of this professional task. Depending on the respective manufacturing order final inspection and release are either done by the skilled worker or by the quality assurance.

## **16. Modification of aircraft systems**

During maintenance and modification of aircraft systems outdated electric systems are renewed or new systems or components are added. Basics of this professional task are engineering drawings, dimensional sketches, manufacturing instructions and an analysis of the initial state. Based on this initial state electric systems are upgraded according to actualised engineering drawings. Besides the addition or modification of electric components the installation of updated software is part of this professional task. The documentation of the accomplished work is an integrated element of this professional task. Depending on the respective manufacturing order final inspection is either done by the skilled worker or in close cooperation with the quality assurance.

## **17. Functional checks and system audit of supply units and control systems**

Functional checks are part of any production, modification or maintenance of an aircraft. The function of each supply unit and control system must be checked when modified or installed. To control the dispersability, functional checks are performed with all supply units and control systems (e. g. fly by wire, defroster, engine fuel supply) testable on the ground. The results of these checks are documented. When not passing the functional check, the concerned aircraft, unit or subsystem has to be transferred for analysis and repair to skilled workers of the respective department. After maintenance, functional checks are repeated. When all functional tests and the system audit are passed, final inspection is done in close cooperation with the quality assurance.

## **18. Functional checks and system audit of information and communication systems**

Information and communication systems must be checked when producing, modifying or maintaining an aircraft. Important parts to check are internal and external sensor systems. Subsystems as well as complete systems (e. g. internal communication, intercommunication systems, radar, navigation systems) have to be tested. The results of these checks are documented. When not passing the functional check, the concerned aircraft, unit or subsystem has to be transferred for analysis and repair to skilled workers of the respective department. After maintenance, functional checks are repeated. Depending on the respective system, final inspection is either done by the skilled worker, by quality assurance or in close cooperation with the quality assurance and a pilot. When pilots are involved, test flights should be performed to test the systems under real conditions.

### **19. Analysis and repair of malfunctions at bunched circuits in aircraft systems**

When malfunctions at bunched circuits are found during maintenance or functional checks, these malfunctions have to be analysed and repaired. The basics of this professional task are a respective manufacturing order and a malfunction report (e. g. adjustment sheet). An analysis of malfunctions at systems, bunched circuits and devices can be as well as a functional check the cause of this malfunction report. Malfunction diagnostics in bunched circuits is based on valid connection diagrams and performed by isolation and continuity tests using adapted measuring devices or diagnostic systems. The rigorous rules concerning "safety at work" (e. g. high voltage, fuel) have to be considered. After localising of the malfunction, it has to be repaired or the whole bunched circuit got to be replaced. The skilled worker has to add the repair to the adjustment sheet and the documentation system. The valid connection diagrams must be corrected in close cooperation with the engineering when necessary.

## **20. Analysis and repair of malfunctions at supply units and control systems**

The analysis and repair of malfunctions at devices and systems is a central task when maintaining aircrafts, but this might be necessary too when producing aircrafts. This professional task deals with malfunctions at supply units and control systems. Not only pure electric (e. g. light fixtures), but also electro mechanic, electro pneumatic and electro hydraulic systems are involved. The basics of this professional task are a respective manufacturing order and a malfunction report. At the beginning of this professional task the malfunctions at supply units or control systems are identified and documented in an adjustment sheet. A wide range of test methods (e. g. ground, visual, isolation, electrical resistance, function and continuity checks and the use of diagnostic systems) are applied to localise and analyse the malfunction. Afterwards repair must be scheduled and managed. The malfunctioning device or system has to be removed and repaired or replaced. When repair is possible, it is performed by the skilled worker alone or in close cooperation with the respective department, always according to instructions and regulations. The skilled worker has to add the repair to the adjustment sheet and the documentation system. When all functional tests and the system audit are passed, final inspection is done in close cooperation with the quality assurance.



## **21. Analysis and repair of malfunctions at information and communication systems**

The analysis and repair of malfunctions at information and communication systems is a central task when maintaining aircrafts, but this might be necessary too when producing aircrafts. The basics of this professional task are a respective manufacturing order and a malfunction report by colleagues or pilots. At the beginning of this professional task the malfunctions at information or communication systems are identified and documented in an adjustment sheet. A wide range of test methods (e. g. ground, visual, function, impedance, software checks and the use of diagnostic systems) are applied to localise and analyse the malfunction. To work on this professional task, the experience and the “know-how” of the skilled worker are of great relevance. Afterwards repair must be scheduled and managed. It must be taken into account, that malfunctions at information and communication systems might affect software as well as hardware. The malfunctioning device or system has to be removed and repaired or replaced. When repair is possible, it is performed by the skilled worker alone or in close cooperation with the respective department, always according to instructions and regulations. The skilled worker has to add the repair to the adjustment sheet and the documentation system. When the malfunction is caused by software either new software got to be installed or an external software expert got to repair the program. After passing all functional tests and the system audit, final inspection is done in close cooperation with the quality assurance.

## **22. Maintenance and inspection of aircraft systems**

This professional task deals with the periodic maintenance and inspection (e. g. Pre-Flight-Checks and Post-Flight-Checks) of aircrafts. The maintenance manuals (e. g. Aircraft Maintenance Manuel (AMM) or German Air Force Technical Orders (GAFTO)) must be taken into account. When maintaining or inspecting an aircraft, simple malfunctions are repaired. Serious malfunctions are repaired in close cooperation with the respective skilled workers or the concerned aircraft, unit or subsystem got to be transferred for analysis and repair to the respective department. The worker has to add the maintenance or inspection to the documentation system. At the end of this professional task functional tests are performed and the aircraft is enabled for the next flight.

