SIGMA
STANDARD INSPECTION GUIDELINES FOR MICROLIGHT AIRCRAFT
AMENDMENT RECORD

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CHAPTER ALPHA

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INTRODUCTION

In October 2005 Safety Recommendation 2005-089 was made by D S Miller, Deputy Chief Inspector of Air Accidents, Air Accidents Investigation Branch, Department for Transport to the Civil Aviation Authority which said:

“It is recommended that the British Microlight Aircraft Association review and regularly update their document entitled ‘Guidelines for the Inspection and Maintenance of Microlight Aircraft’.

The BMAA response was to accept the recommendation to its fullest by completely rewriting this document, the result of which you are now reading.

Traditionally these guidelines, formerly entitled the “Guidelines for the Inspection and Maintenance of Microlight Aircraft”, have always focused on both aspects of microlight airworthiness – inspection and maintenance.

It is apparent that these two activities can mutually conflict if conducted by one person where safety critical components are involved, because it is a basic axiom of continuing airworthiness practice that an inspector cannot sign off his own work when vital points such as primary structure and control systems are involved.

This conflict of purpose may have arisen some 25 years ago when the CAA originally granted the BMAA approval to oversee microlight continuing airworthiness as a Maintenance Organisation, based on CAP 553 BCAR Section A “Airworthiness Procedures where the CAA has Primary Responsibility for Type Approval of the Product” Chapter A8-15 Aeroplanes and Rotorcraft not exceeding 2730 kg - Maintenance Organisations - Group M3.

As of mid-2015 the BMAA achieved BCAR Chapter A8-26 (Organisations Supporting Recreational Aviation) approval. This expands the potential scope of work that the association may undertake.

For these reasons, these guidelines have been renamed the “Standard Inspection Guidelines for Microlight Aircraft” (SIGMA) and make clear that, whilst advice may be given against findings, the responsibility of maintaining the aircraft is not that of the BMAA Inspector but rests solely with the Owner.

These Inspection Guidelines depart appreciably from their predecessor by covering the wider factors involved in inspecting aeroplanes. Subjects like role definitions, selection procedures, auditing processes, human factors, legal liability, psychology of error and techniques of observation are covered in addition to generic and type-specific inspection procedures.

The early sections of the guidelines contain overviews of all the relevant concepts of inspecting microlight aircraft. These concepts are then developed in more detail in the later sections of the document. The aim of the document is to clarify and record what we do already in more detail and not to “reinvent the wheel”.

Figure 1 - Geoff Weighell BMAA CEO, accepting BMAA A8-26 Certificate from Tony Rapson, CAA Head of General Aviation Unit in July 2015. BMAA is the first organization to achieve this Sporting Approval.
1.1 BMAA SCHEDULE OF APPROVAL

This document contains guidance which is applicable to all types of aircraft administered by the BMAA. The pretext of Microlight has mainly been used historically; consider this to mean all BMAA aircraft unless specifically stated to the contrary.

The scope of the BMAA Schedule of Approval was extended on the 7th of November 2011 as below:

Amateur built or assembled solely for the builder’s education and recreation where the amateur builder’s work-content is a significant amount (i.e. not less than 500 hours or 51% of the work of the construction activities but excluding painting, trimming and the installation of non-essential avionics), not on a commercial or production basis and:

- Within the microlight definition of the Air Navigation Order and where the design has been shown to meet BCAR Section S or
- Up to 750kg weight & within the applicability of CS-VLA but with additional criterion of \( V_d < 140 \) kts, and where the design has been shown to meet, CS-VLA, in consultation with the CAA, or
- As otherwise agreed with the CAA

1.2 THE SPIRIT OF MICROLIGHTING

Microlight flying sets us apart from others founded on the principle that the owner is wholly responsible for operating and maintaining their aircraft safely. We are privileged to be able to re-live those pioneering days where the sky was the limit and our destiny rested in our own hands.

The BMAA’s job, therefore, is to encourage owners to willingly shoulder this responsibility for continuing airworthiness and safe operation of their aircraft through the regular contact and support of the Inspectorate, who are there to provide independent oversight and guidance through the necessary regulation and paperwork.
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2 THE FUNDAMENTALS

2.1 THE DEFINITION OF INSPECTION

A dictionary definition of the word ‘inspect’ gives it in two parts:

- to look carefully, to view closely and critically
- to view or examine formally or officially

The FAA definition of the word ‘inspect’ is:

- the examination by sight and/or touch

This implies a process of preparation, search, discovery and decision carried out in an official capacity. By drawing on this wording and relating it to the inspection of aircraft we have arrived at our definition of an inspection.

The BMAA definition of an inspection is as follows:

“an independent examination of the aircraft’s parts and paperwork from which the inspector will make a judgement as to its airworthiness at that point in time”

It is upon this very simple definition that the rest of this Guide is based.
2.2 THE SCOPE OF THE INSPECTOR

The scope of the inspector’s job is simply to inspect.

- To find the defect – not to fix it
- To monitor the amateur build – not to build it
- To examine the repair – not to repair it
- To look at the modification – not to modify it
- To verify the documentation – not to rewrite it
- To ensure compliance against BMAA standards – not against his own
- To act on behalf of and under the control of the BMAA – not the Owner

The inspector’s findings are the basis on which they can, afterwards, offer advice and guidance to help the owner keep their aircraft airworthy.

The guiding rule is:

The Inspector finds the defects and the Owner (or their contractor) fixes the defects.

The scope of the inspectors’ authorisation can be applicable to all types of aircraft administered by the BMAA, i.e. for both Microlight and VLA types.
2.3 AIRWORTHINESS

The Inspector’s job is to inspect the Owner’s aircraft in order to determine whether it is airworthy or not. This would be required during an amateur build, when a modification that alters the aircraft, when a repair involves a fabrication process or alternative material, and at the annual validation of the Permit to Fly. Only after carrying out an independent inspection, and upon finding no defects or discrepancies, can he certify that the aircraft is fit to fly at that point in time.

To be airworthy an aircraft:

- **must be legal by conforming to approved data and all pertinent regulations**
- **must be serviceable by its acceptable condition, known life and origin of parts**

2.3.1 LEGALITY

This is attained when the aircraft configuration and build state conforms to its approved documentation and to the Type Approval/Acceptance Data Sheet/Homebuilt Aircraft Data Sheet (for amateur built aircraft) and that a record of the required maintenance has been seen and properly certified. The documents that the Owner is obliged to hold by law relating to the airworthiness rather than operation of the aircraft will be checked by the Inspector to see they are applicable and genuine, as will the aircraft identification plate and registration lettering, and the limitation and warning placards. But insurance documents do not need to be shown to the Inspector.

Because the BMAA is not the holder of the detailed specification and drawings on each type, conformance to the intended design is determined by comparison with other physical examples in the fleet.

Care must be taken to ensure that all modifications, whether minor or major, and repairs, whether simple repairs by replacement or complex repairs using a fabrication process, have been correctly approved by the right party, before implementation.

Repairs by strict replacement are approved and certified by the Owner but subject to appropriate logbook entries and second inspections where required. Repairs involving irreversible fabrication processes require prior approval by the BMAA Technical Office and inspection by a BMAA Inspector.

2.3.2 SERVICEABILITY

This depends on the condition of the aircraft in relation to wear and deterioration. The Inspector will use his judgement to determine whether or not the aircraft is fit for service based on its observed condition, remaining life and provenance of parts.

- **Serviceable by condition**
  Parts must be in serviceable condition. This implies that the Inspector can exercise judgement in his assessment of the condition.

- **Serviceable by retirement**
  All life-limited parts must be positively identified and their residual serviceable life calculated by reference to the manufacturer’s maintenance schedule. If mandated by the aircraft manufacturer, no time-expired components may be incorporated into the aircraft. Recommended life limits may be extended on condition, if an appropriate case for equivalent safety is accepted by the BMAA.
• **Serviceable by provenance**

The inspector can ask to see evidence of the origin of any parts he thinks to be unserviceable by virtue of their provenance (source). Usually purchase receipts are sufficient for components and fabricated assemblies bought from a suitable supplier, but certificates of conformity are generally sought for whole aircraft, amateur build kits, material specifications and propellers as proof of provenance, even if the supplier is unapproved. Exceptions are dealt with individually.

Only parts approved either by the aircraft manufacturer (where they are the Type Approval Holder), or by the BMAA Technical Office or CAA against a formal modification or repair scheme, should be used for the replacement of safety-critical items.

### 2.3.3 ASSURANCE

Having established that the aircraft is 'legal' by conforming to type, and is 'serviceable', airworthiness is thereby assured. If one or both of these conditions are NOT met, the aircraft is considered UNAIRWORTHY.

### 2.4 IMPLICIT UNDERSTANDINGS

The Inspector is only inspecting the aircraft as to its airworthiness at the time of the inspection.

The inspection is made on the basis of viewing all external areas he has access to. He is not responsible for the condition of parts within inaccessible areas permanently covered and previously signed for by another inspector, nor for the analysis of un-inspectable components or latent defects hidden from sight (e.g. oil composition, metal alloy composition, internal brackets in wings, improperly laid up glass fibre rovings in supplied parts etc).

If the Inspector’s verdict is a **PASS**, then this implies that NO FURTHER WORK is required to be performed on the aircraft and that it is serviceable.

If, during this inspection, he finds any imperfections or flaws (e.g. normal wear or corrosion), he should bring this to the attention of the Owner and advise him in writing on the Inspection Schedule (Forms BMAA/AW/005, 006 & 007) that it may compromise the airworthiness of the aircraft at a later date. He should NEVER volunteer an estimate of a residual life or fail date for that component.

Under NO circumstances may any defect that renders the aircraft unairworthy at that point in time be conceded on the basis of the Owner promising “to replace it tomorrow”. The inspection decision, **PASS** or **FAIL**, is based on the present moment, not for any future moment.

If the Inspector’s verdict is a **FAIL**, then afterwards he should explain to the Owner the reasons why the aircraft failed its inspection, noting any critical or dangerous defects in the Airframe/Engine Logbook.

Again, he may NOT waive the failed verdict on a condition or a promise that the Owner fixes the defect or changes a part within, say, the next 5 flying hours.

The Inspector should also fail the inspection if the paperwork is inconsistent or incomplete.
# CHAPTER ALPHA

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3 THE INSPECTORATE

3.1 CATEGORIES OF INSPECTOR

The following requirements have been derived from the BMAA Exposition.

3.1.1 BMAA CHIEF INSPECTOR

The Chief Inspector reports to the BMAA Chief Executive with a liaison function with the Chief Technical Officer (CTO) and acts in accordance with his role as defined in the BMAA Exposition and is responsible for the following:

- **Inspector Appointments**
  The appointment of Inspectors by assessment of applications for the position of Inspector from individual BMAA members. Applicants must each show evidence of integrity, competence and technical suitability to carry out inspections on microlight aeroplanes.

- **Senior Inspector Appointments**
  The appointment of Senior Inspectors to act at the discretion of the Chief Inspector on his behalf or for the audit of work carried out by Inspectors.

- **Inspectors’ Manual (SIGMA)**
  The preparation and updating of the Inspectors’ Manual called SIGMA, the Standard Inspection Guidelines for Microlight Aircraft.

- **Technical Office Coordination**
  Coordinating with the CTO the release of any technical information to Inspectors or members.

- **Occurrence Reports**
  The scrutiny of all Occurrence Reports received in respect of microlight aeroplanes and, where applicable, issuing Defect Alerts to all Inspectors, Club/School Safety Officers, the Safety Officer and the Chief Technical Officer, who will consult the CAA as required.

- **Defect Reports**
  The preparation of indexed and collated summaries of Defect Alerts, General Notes, etc, for issue to BMAA Inspectors and Safety Officers.

- **Owner Authorisation**
  Authorising the inspection, by an Inspector, of their own aircraft.

- **Minor Modifications**
  Approving the design and incorporation of minor modifications in liaison with the Chief Technical Officer.

- **Record Keeping**
  Initiating and maintaining registers/records of minor modifications.

- **Project Allocation**
  Allocating Inspectors to oversee particular projects, particularly amateur built aircraft.

3.1.2 BMAA SENIOR INSPECTOR

A Senior Inspector is appointed by the Chief Inspector and has, in addition to the responsibilities of a BMAA Inspector, the following responsibilities:

- **Audits**
  Conduct audits of Inspectors at the request of the Chief Inspector.

- **Knowledge Base**
Contribute to and review, the knowledge base of inspection techniques incorporated into these Guidelines.

- **Representation**
  May represent the Chief Inspector for specific purposes when requested to do so.

- **Assessments**
  May be required to conduct assessments in place of the Chief Inspector for specific purposes when requested to do so.

- **Apprenticeships**
  Will be required to assist new BMAA Inspectors with their integration into the Inspectorate.

### 3.1.3 BMAA INSPECTOR

An Inspector is appointed by the Chief Inspector and has the following responsibilities:

- **Annual Validation**
  Authorised to inspect BMAA members’ aircraft for recommending the annual validation of the Permit to Fly.

- **Amateur Built Aircraft**
  Authorised, on an individual basis by the Chief Inspector, to inspect required stage inspections of amateur built aircraft.

- **Modifications and Repairs**
  Authorised to inspect all modifications and repairs to aircraft with BMAA Technical Office approval.

- **Weighing of Aircraft**
  Authorised, on a control type basis, to weigh and submit reports regarding the weighing of aircraft.

### 3.2 CATEGORIES OF AUTHORISATION

The scope of authority of a BMAA Inspector is constrained by Authorisation Categories granted by the Chief Inspector and by the CAA approved Technical Procedures Manual (TPM) and BMAA Technical Information Leaflets (TILs) published on the BMAA website at [http://www.bmaa.org](http://www.bmaa.org). It is incumbent on the Inspector to refer to the latest issues at all times.

Inspectors are individually approved to inspect microlight aircraft in each of the weightshift, three axis, hybrid and powered parachute control systems types and construction categories.

The authorisation categories under which an Inspector is able to work on behalf of the BMAA can be grouped by aircraft control category (**A**, **B**, **C**, **D**), by engine category (**E**, **F**), by primary structure category (**G**, **H**, **I**, **L**) and by specialist category (**O**).

**Control Group** authorisation (which includes weighing of that category):

- A  Flexwing Aircraft
- B  Three Axis Aircraft
- C  Hybrid Aircraft
- D  Powered Parachutes

**Engine Group** authorisation:

- E  Two Stroke Engines
- F  Four Stroke Engines

**Material Group** authorisation:

- G  Wood Structures
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H All-Metal Structures
I Metal Frame, Tube & Fabric Covered Structures
L Composite Structures

Miscellaneous Group authorisation:
O Own Aircraft Inspection Privilege
Type Specific A type specific authorisation, allowing inspection of a single type or model (e.g. Shadow)
Avionics Authorisation for overseeing changes to instrumentation and new avionics or systems.

TIL050 Aircraft Inspection Categories contains a list of all BMAA administered types, amateur-built and type-approved along with the necessary categories to complete a revalidation inspection on each airframe. For each modification and repair submitted via the BMAA Technical Office, the overseeing inspector is verified as having an appropriate level of authorisation.

3.2.1 TYPES OF STRUCTURE

Aircraft structures can be further classified as follows:

PRIMARY
Is one that is critical to the safety of the aircraft. To inspect primary structure the inspector must hold the appropriate material category (e.g. for a CTSW you must have composites ‘L’ authorisation).

SECONDARY
Is one that, if it were to fail, would affect the operation of the aircraft but not lead to its loss.

TERTIARY
Is one in which failure would not significantly affect the operation of the aircraft. All inspectors by definition are authorised to inspect any type of tertiary structure.
3.3 BECOMING A BMAA INSPECTOR

The BMAA appoints Inspectors by virtue of their integrity, technical ability and experience.

Internal procedures and processes are described below for selection, qualification, training and validation of Inspectors.

The process can be summarised in three stages:

- **STAGE 1:** Initial Application
- **STAGE 2:** Assessment
- **STAGE 3:** Apprenticeship

Each appointment is for up to one year and is reviewed annually.

### 3.3.1 STAGE 1: INITIAL APPLICATION

Initial applications are made on form AW/008-Initial; the only prerequisites being that the applicant must be 18 years of age at appointment and have a minimum of 2 years microlight experience as an owner, licensed pilot, instructor, amateur builder, distributor, working for a microlight manufacturer, etc.

The application will record the name of the applicant and contact details as well as listing qualifications and practical experience that they feel relevant to the application. Formal academic qualifications are not a prerequisite for making an application and all applicants will be considered equally.

The applicant is required to include two references with the initial application. The references should support claimed qualifications, experience and vouch for the integrity of the applicant. At least one of the referees must be a current BMAA Inspector or other person with practical experience of the BMAA airworthiness system and who is known to the BMAA, such as an Instructor, microlight manufacturer, supplier, etc.

On receipt of the application the BMAA Chief Inspector will review the content and inform the applicant whether or not their application has been accepted. If the application has not been accepted then the reasons will be given. If the applicant is not successful with their first attempt, they are free to reapply, there is no limit to the number of times this can be done.

Successful applicants will be sent details of the next steps in the application process and suitable advice as to how to prepare for the assessment. At this stage the applicant will also have to comply with the following:

- Become a member of the BMAA (if not already).

### 3.3.2 STAGE 2: ASSESSMENT

Successful initial applicants will be required to undertake an individual assessment of their inspection skills and their understanding of the BMAA Inspector system and its associated scope of limitations. The BMAA Chief Inspector, or a person nominated by the BMAA, will carry out the assessment.

The candidate is expected to have gained a sufficient level of knowledge and practical ability prior to applying for an assessment. Practical experience can be gained by shadowing one or more current BMAA Inspectors. Other appropriate steps such as attending training courses and seminars and reading all the BMAA Technical Information Leaflets is also expected, as is a thorough understanding of SIGMA.
The assessment is a practical demonstration of ability and will require the candidate to satisfy the following modules:

- **Conduct a Permit to Fly revalidation** inspection of an aircraft and complete all the applicable paperwork.
- **Conduct a weighing** of the aircraft inspected and complete all the applicable paperwork.
- **Conduct an inspection of a standard minor modification** fitted to the aircraft inspected and complete all the applicable paperwork.
- **Undertake an oral examination** to demonstrate knowledge of construction techniques, inspection techniques and possible failure modes of the material type of the microlight inspected.
- Undertake an oral exam to demonstrate an understanding of the engine type fitted to the microlight inspected.
- **Undertake a written exam** to demonstrate an understanding of the BMAA Inspector system and in particular the limitations of any authorisation.

The Assessment will usually be conducted throughout a single day, although with prior arrangement it may be possible to separate certain elements if required. All modules of the assessment must be passed before an authorisation can be granted. If a candidate fails any section of the assessment a partial pass can be awarded and a retest of the failed module/s undertaken at a later date.

At this point candidates who successfully pass the assessment will be invited to join the BMAA Inspectorate and issued with an Inspector number.

### 3.3.3 STAGE 3: INITIAL APPOINTMENT & APPRENTICESHIP

The final stage of the process is to serve an apprenticeship under the oversight of an appropriately qualified BMAA Inspector(s). The aim of this is to assist the candidate’s integration into the Inspectorate. It is the candidate’s responsibility to find an Inspector who is prepared to be their supervisor and mentor. The supervising Inspector(s) can be of the candidate’s choice as long as the Inspector they choose has the necessary authorisations. A map of current Inspectors can be found on the BMAA website [www.bmaa.org](http://www.bmaa.org).

Initial appointment will be limited to the categories tested during the assessment and be subject to a period of supervision by a BMAA inspector. Initial authorisations will include those gained through the assessment process:

The minimum supervision requirement to gain the first authorisation within any of the groups is a total of three supervised inspections (to note the initial assessment counts as one). Once a group has been acquired, subsequent additional authorisations (within that group) only require a single satisfactory supervised inspection. All supervised inspections/audits are to be recorded on **AW/053 ‘Inspector Authorisation Record’**.

This final stage is implemented at the discretion of the Chief Inspector depending upon the candidates’ performance during assessment, profession, background and overall experience.
3.4 AUDITING OF INSPECTORS

3.4.1 SCOPE

Audits of BMAA Inspectors will cover all aspects of the BMAA inspection system including the general condition of microlight aircraft, repairs, maintenance, documentation, roles of Inspectors and Senior Inspectors, modification approvals, etc.

3.4.2 STANDARDISATION

The audit is not designed to remove individuals from the Inspectorate but to encourage Inspectors to standardise and to provide a consistent service to BMAA members. Inspectors that do not meet the standards required by the BMAA will be given a fair chance to raise their standards, either through training or coaching. Inspectors still unable to reach the standards required by the BMAA will have their authorisation withdrawn. Please note this process is two-way, if you feel the BMAA could do things in a better way then please contact the necessary people. Continuous improvement is the overall goal.

Training courses and seminars are organised for the Inspectorate to standardise audit and inspection techniques as well as to provide aircraft type specific information.

3.4.3 FREQUENCY OF INSPECTOR AUDITS

All Inspectors are audited on a quadrennial cycle. Inspector authorisations are rescinded automatically on the audit expiry date until such time as a new audit is conducted. This is considered to be an absolute minimum, the BMAA encourages regular auditing in order to improve standardisation.

In order to maintain the quadrennial cycle, it is acceptable to pre-empt the audit expiry date by up to 3 months without loss of the renewal date. This is in keeping with other aspects of the BMAA Airworthiness System, such as CoV renewals.

AUDITING PERSONNEL

Inspectors may be audited by any Senior Inspector, the BMAA Chief Inspector, and the BMAA Chief Technical Officer. Or by another Inspector or person with the prior consent of the Chief Inspector.

Senior Inspectors may be audited by any Senior Inspector, by the BMAA Chief Inspector or by the BMAA Chief Technical Officer: or by an external auditor with the prior consent of the Chief Inspector.

Senior Inspectors are expected to consent to auditing other Inspectors when asked by the auditee and when requested to do so by the Chief Inspector.

The BMAA Chief Inspector may additionally perform and record ‘top-up’ or Short Audits of Inspectors when observing or intervening on an inspection matter using form AW/060.

3.4.4 SENIOR INSPECTOR AUDITS

Senior Inspectors will be audited, as above, to ensure that they are carrying out the inspections to an acceptable standard. Reference may be made to any of the records held by the BMAA on the aircraft he has inspected or Inspectors he has audited.
3.4.5 CHIEF INSPECTOR AUDIT
The Chief Inspector is audited annually by the CAA (or at any opportunity deemed suitable).

3.4.6 PLACES OF AUDIT
Audits may take place at an appropriate place mutually agreed upon by the auditee and auditing Inspectors.

3.4.7 AUDIT FOR EXISTING CATEGORY AUTHORISATIONS
Every 4 years each Inspector must be audited in order to maintain their currency. This will be conducted by a Senior Inspector or if requested the Chief Inspector. The auditing inspector will assess the audited inspector to satisfy themselves that they have demonstrated practical application of their knowledge, experience, competence and skill to an adequate standard and that they have sufficient knowledge to be able to safely examine any microlight aircraft presented to them for the purposes of inspection within the existing categories they hold. They will also identify any areas of knowledge that may require remedial training.

3.4.8 AUDIT FOR ADDING CATEGORY AUTHORISATIONS
Any inspector wishing to add a category to their existing authorisations may do so by demonstrating an adequate knowledge of the category to be added using form AW/076 ‘General Audit for Additional Categories’. Note that the auditing inspector must be suitably authorised and experienced.

3.4.9 THE AUDITED KNOWLEDGE REQUIREMENTS
The following list comprises a summary of the expected knowledge base to be assimilated by a practising Inspector and is common to both form AW/057 ‘Quadrennial Audit for Existing Categories’ and form AW/076 ‘General Audit for Additional Categories’. Their knowledge is assessed as satisfactory (√), gaps evident (?) or unsatisfactory (×). The specific knowledge areas are amplified later in SIGMA Section 6 entitled “Inspector Engineering Knowledge Requirements”.

The auditor will work through the form, consisting of a list of topics about which searching questions can be formulated, drawing upon material from these Guidelines. They may strike through an item on the form to indicate it is not applicable. Each topic is elaborated below.

3.4.10 GENERIC CONSTRUCTION KNOWLEDGE
Establish the auditee’s knowledge of:

- **Mechanics** – mass, inertia, force, acceleration, stress, strain, tension, compression, torsion, bending, etc.
- **Structure** – struts, ties, beam-columns, shells, monocoques, membranes, truss, loads, stiffness, etc.
- **Joints** – fixed, sliding, pinned (rotating), welded, fastened (clamping loads), bonded, etc.
- **Fasteners** – bolts, screws, rivets, Velcro, zip fasteners, etc.
- **Electrics** – volts, amps, ohms, watts, fuses, switches, rating, batteries, alternators, etc.
- **Instrumentation** – minimum instrumentation requirements for aircraft, their mounting, tubing, static vents, magnetic influence, electromagnetic interference, etc.
- **Covering** – Betts test, UV degradation, chemical degradation (washing) etc.
- **Controls** – cable runs, guides, tension, pulleys, safety guards, freedom of movement, control surface locking, etc.
- **Wire Rope** – inspection for corrosion, swaging, thimble deformation, strand breakage, slippage, fibre core etc.
• **Corrosion** – types of, identification, prevention, significance, etc.
• **Locking Devices** – chemical, mechanical, and their areas of application and avoidance e.g. Nylocs near hot exhaust, rotating components etc.
• **NDT techniques** – dye penetrant, magnifying devices, illumination, etc.
• **Safety Practices** – ignition isolation, propeller hazards, fuel handling, fire extinguisher types, etc.

### 3.4.11 CONTROL GROUP & CATEGORIES
Establish the auditee’s knowledge of the topics below, use the appropriate Inspection Worksheet to assist:

**Category A: Flexwing Aircraft** – weightshift, billowshift, lufflines, washout rod, trim, APS, bungees, etc.
**Category B: Three-Axis Aircraft** – aileron, rudder, elevator, flaps, trim, etc.
**Category C: Hybrid Aircraft** – wing warping, hybrid controls, etc.
**Category D: Powered Parachute** – parachute controls, etc.

### 3.4.12 POWERPLANT GROUPS
Establish the auditee’s knowledge of the topics below, use the appropriate Inspection Worksheet to assist:

**Category E: Two-stroke Engines & Propellers** – ignition, fuel, exhaust, gearbox, lubrication, servicing, propeller CoCs, etc.
**Category F: Four-stroke Engines & Propellers** – ignition, fuel, exhaust, gearbox, lubrication, servicing, propeller CoCs, etc.

### 3.4.13 MATERIAL GROUP & CATEGORIES
Establish the auditee’s knowledge of the topics below, use the appropriate Inspection Worksheet to assist:

**Category G: Wood Structures** – material properties and failure modes.
**Category H: All-Metal Structures** – material properties and failure modes.
**Category I: Metal Frame/Fabric Covered Structures** – material properties and failure modes.
**Category L: Composite Structures** – material properties and failure modes.

### 3.4.14 BMAA GUIDELINES, PROCEDURES AND POLICIES

**MAINTENANCE**
Establish the auditee’s knowledge of acceptable practices in maintenance – viz. Microlight Maintenance Schedule (TIL 020), consumables, lubrication, cleaning, checking, measuring, servicing, torque checks, the procedures for the repair or replacement of critical and non-critical parts. Establish the auditee’s knowledge of what constitutes an approved part.

**REPAIRS**
Establish the auditee’s knowledge of the system of “prior approval”, the role of the Technical Office, the role of the Type Approval Holder, the purpose of the Manufacturer’s Letter of “No Technical Objection”, limited authority of kit importers, fabrication process, strict replacement etc.
INDEPENDENT INSPECTIONS
Establish the auditee’s knowledge of independent inspections, what they are and when are they used – viz. use after control system rejoins, changes to vital points, modifications or repairs to primary structure.

LEGAL
Establish whether the auditee understands the importance of signature validity, dual signatures, duty of care, that aviation law is classified as criminal law, and keeping accurate records. Inspectors will be audited to ensure that they are carrying out the inspections to an acceptable standard, and that they are also keeping accurate records of the inspections or work that they have carried out.

TOOLS
Establish whether the auditee possesses, if required, a Bettsometer, lighting apparatus, magnifier, mirror, dye penetrant kit etc.

WORKPLACE SAFETY
Establish whether the auditee is aware of health and safety issues in the workplace like lighting, stepladders, electric hazards etc.

HUMAN FACTORS & PREPARATION
Establish whether the auditee knows how to perform a Self-Fitness check and assess personal minimums before commencing inspection.

LOGBOOKS
Establish the auditee’s knowledge of Engine/Airframe Logbooks – viz. legitimate logbooks, record of data, correct use, servicing, maintenance, etc.

APPROVED DATA
Establish the auditee’s knowledge of where to find approved data and his understanding of their purpose and content:

- TADS: Type Approval/Acceptance Data Sheets
- HADS: Homebuilt Aircraft Data Sheets for amateur built aircraft BMAA/Manufacturer Service Bulletins
- AAN: CAA Airworthiness Approval Notes
- MPD: Mandatory Permit Directives and his ability to find and access the document on the CAA website and his understanding of their purpose and importance.
- MAAN: Microlight Airworthiness Approval Notes and where they are held

BMAA INSPECTION FORMS
Establish the auditee’s understanding of how to fill in airworthiness forms appropriate to their inspector authorisations, a list is available on the BMAA website:

BMAA Forms

Standard Minor Modification Forms

AIRCRAFT DATA
Establish the auditee’s knowledge of Pilot’s Operating Handbook, Aircraft Maintenance Manual, Supplements, Placards, etc.

ADMINISTRATION
Registered & Subscribed to Inspector’s internet forum & receiving notifications.
3.4.15 REMEDIAL ACTIONS
Continuous learning is a necessity in the fast-moving world of microlight aviation so any recommendations for further study or refresher training should not be considered to be a ‘black mark’ in the audit. Ideally both parties will agree on any ‘weaknesses’ or gaps in knowledge and together decide what remedial activity should take place. The auditor will then write down the agreed training, reading or practical skills acquisition that is required and the completion dates. Such entries are a positive indication of personal growth and sound attitudes towards safety.

3.5 THE ANNUAL RENEWAL PROCESS
Two months before the annual renewal date which currently is the end of March, an authorisation reminder letter will be sent out to every inspector notifying them of their expiry date, date of last audit and any other special notices. Note that this is the renewal of an already current authorisation.

3.5.1 LAPSED BMAA INSPECTORS
Lapsed BMAA Inspectors may reapply to get their status back. This is done on form AW/008-renewal.

3.5.2 CONTINUING DEVELOPMENT TRAINING
In order to remain current with legislation, procedures and practice Inspectors will be invited to attend training seminars and will be audited, at minimum, once every four years using form AW/057 ‘Quadrennial Audit for Existing Categories’.

3.5.3 APPEALS & SUSPENSION
A candidate who fails to qualify for or an existing Inspector who is suspended is entitled to appeal. Inspector authorisations can be withdrawn at the discretion of the Chief Inspector.

3.5.4 CATEGORY O – OWN AIRCRAFT INSPECTION
It is possible for an Inspector to receive authorisation to inspect their own aircraft for its revalidation of the Permit to Fly. This privilege is applied for on form AW/064. The only aircraft not eligible for this are those with hiring exemptions, being operated i.a.w. TIL032 BMAA Code of Practice for Aircraft Hire.

The terms and conditions for holding this authorisation are that the inspector undertakes not to sell the aircraft in question (including any shares) until it has been re-inspected and the logbook signed to that effect by an independent BMAA Inspector.

If the Certificate of Validity has expired at or before the time of sale (of the aircraft or shared aircraft) the Inspector undertakes not to sign for the inspection of that aircraft for Permit to Fly revalidation purposes for one calendar year from that expiry date.

This Category ‘O’ authorisation is reviewed annually during the normal Inspector Renewal process and may be withheld subject to the inspector’s activity in the preceding year.
### 3.6 SPOT INSPECTIONS

Spot inspections on aircraft will be carried out from time to time to ensure that the aircraft in question does in fact conform to the requirements for which the validation of the Permit to Fly was issued.

The spot inspection will not only be carried out to ensure that the aircraft is as per the relevant data sheet but also that the condition of the aircraft and its associated documentation are correct. The spot inspections will be carried out on a random basis, and where the BMAA or CAA or other approved company believes the aircraft or its documentation to be suspect.

Spot inspections of homebuilt projects will also take place can be conducted at any stage of the construction process or flight test program.

### 3.7 AMATEUR BUILT PROJECTS

Any BMAA amateur built microlight must be constructed under the supervision of an appropriately experienced BMAA Inspector. For more information see the next section (4) for more details on Inspector responsibilities.

The builder must register the project with the BMAA using form BMAA/AW/022 ‘BMAA – Details of Homebuilt Aircraft Project’ on which they will propose a BMAA Inspector to oversee the project. The BMAA Chief Inspector will either accept or reject the proposal based on the Inspectors’ experience.

For more details about this process please see TIL039 Amateur Build Kits – Process Guide which is available on the BMAA website ([www.bmaa.org](http://www.bmaa.org)) or by contacting the Tech Office.
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This section contains guidance which is applicable to all types of aircraft administered by the BMAA. The pretext of Microlight has mainly been used historically; however consider this to mean all BMAA aircraft unless specifically stated to the contrary.

4.1.1 MANUFACTURER AND TYPE APPROVAL HOLDER

The term ‘manufacturer’ denotes the holder of the type approval granted by the CAA under Primary Companies Group A1 in Chapter A8-1 of CAP 553 - BCAR Section A - Airworthiness Procedures where CAA has Primary Responsibility for Type Approval. The two terms are synonymous with each other.

4.1.2 AUTHORITY OF THE AIRCRAFT MANUFACTURER

The authority of the Type Approval Holder, is paramount. It is the Type Approval Holder who is responsible for issuing Service Bulletins when design or manufacturing defects are discovered. The BMAA, as the Type Approval Holder for all ‘orphan’ microlight types, will be the organisation that performs this function in lieu of a manufacturer that has gone out of business.

4.1.3 ‘AIRCRAFT MANUAL’ VERSUS ‘ENGINE MANUAL’

All engine maintenance should be carried out according to the schedule laid down in the Aircraft Manual. It follows that if it makes a variation or addition to that recommended in the engine manufacturer’s standard Engine Manual, then the Aircraft Manual takes precedence.

If the Aircraft Manual explicitly defers to the engine manufacturer’s standard Engine Manual, then the owner should be guided by the Engine Manufacturer’s maintenance schedule.

4.1.4 ‘MANDATORY’ VERSUS ‘DISCRETIONARY’ MAINTENANCE

In the context of the owner’s maintenance of his aircraft, the interpretation of the words ‘required’ and ‘recommended’ is as follows:

REQUIRED

Required maintenance and servicing is mandatory and must therefore be performed at the specified time and certified by the Owner in the airframe logbook by signature and date. The replacement of life limited parts is a mandatory requirement, unless supported by a life extension on-condition protocol. Conformity to the control deflections within the tolerances specified in Section 9 of the TADS/HADS is also mandatory, unless cleared by the Type Approval Holder. All other airframe components may be assessed on-condition. The Inspector assumes full accountability if he passes an aircraft inspection where there is no Logbook certification by the Owner that all mandatory maintenance has been carried out. The words ‘must’, ‘shall’ and ‘will’ also reflect mandatory intent. The word ‘should’ indicates a recommendation. The word ‘may’ indicates an option. The word ‘will’ is used to express a future action.
RECOMMENDED

Recommended maintenance and servicing is **discretionary** and may be performed ‘on-condition’ at varying time intervals. The Owner assumes full accountability when delaying recommended maintenance actions. Taking advice and exercising options is for the owner to decide. The words ‘may’, ‘should’ and ‘can’ also reflect discretionary intent.

Without exception, all maintenance and servicing of non-certifed engines in microlight aircraft is at the Owner’s discretion and inspected on-condition. The Inspector is not equipped or trained to examine the internals of the engine, other than infer the condition from information such as oil consumption, oil filter debris, magnetic plugs, bearing play and compression loss that he may possess.

4.1.5 ‘ESSENTIAL’ MAINTENANCE

In October 2005 another Safety Recommendation 2005-088 was made by D S Miller, Deputy Chief Inspector of Air Accidents, Air Accidents Investigation Branch, Department for Transport to the Civil Aviation Authority which said:

**AAIB Recommendation 2005-88**

It is recommended that the British Microlight Association (BMAA) ensure, through the issue of the Permit to Fly, that microlight aircraft are fitted with the correct placards and are maintained in accordance with either the manufacturer’s or BMAA recommended maintenance schedule and that all maintenance is recorded in a Civil Aviation Authority approved logbook.

**BMAA Response:**

We refer to **CAP 482 - BCAR Section S - Small Light Aeroplanes**, Sub-Section G Operating Limitations, paragraph S1529: Maintenance Manual [(See AMC S 1529)] which says:

“A maintenance manual containing the information that the applicant (Type Approval Holder) considers essential for proper maintenance must be provided. The applicant must consider at least the following in developing the essential information.”

From the list provided the **essential** maintenance would include:

- **Lubrication instructions** setting forth the frequency and the lubricants and fluids which are to be used in the various systems;
- **Tolerances and adjustments** necessary for proper functioning, including control surface travels;
- Methods of balancing control surfaces, and maximum permissible values of play at hinge pins and control circuit backlash;
- **Frequency and extent of inspections** necessary for proper maintenance;
- **Statement of service life limitations** (replacement or overhaul) of parts, components and accessories subject to such limitations;

The word **essential** means ‘vitally important, absolutely necessary, basic, fundamental or indispensable’.

As a general guideline the Inspector should encourage the Owner to certify all essential maintenance actions in a Civil Aviation Authority approved logbook (CAP398/399 Aircraft/Engine Logbook or BMAA/AW/036 Pooleys Microlight Airframe and Engine Logbook), approved under CAP 659 - Amateur Built Aircraft, Section 8.3 Log Books and Appendix 7 Useful Publications. Should the Inspector elect to PASS the aircraft ‘on-condition’ without any written evidence of essential maintenance being carried out, which he is of course permitted to do, then he is laying himself open to being held accountable for the airworthiness of that aircraft.
An Inspector need not accept an owner’s reasons for not complying with, or certifying, a recommended maintenance schedule and can walk away from the inspection or FAIL it.

4.1.6 ‘CERTIFIED’ VERSUS ‘NON-CERTIFIED’ ENGINES

CERTIFIED
Certified engines, being constrained by warranty liabilities, require mandatory compliance to the maintenance schedules using licensed mechanics, more for commercial and legal reasons rather than for safety. Time between overhaul exists in order to transfer liability to the overhauler at a defined time interval. Certified engines often tend to suffer from injected effects as a result of intrusive and over maintenance.

If a certified engine is fitted to an aircraft operating under a Permit to Fly it effectively becomes an uncertified engine and can never be subsequently refitted to an aircraft carrying a Certificate of Airworthiness.

NON-CERTIFIED
Non-certified engines, which are fitted to all microlights, however, are maintained ‘on-condition’ only. If a maintenance schedule exists, then these are by convention treated as guidelines only and the Owner may elect to adhere to the recommended maintenance schedules, or not, by formulating his own alternative.

The BMAA considers the maintenance of all uncertified engines to be at the Owner’s discretion but subject to the individual judgment of a BMAA Inspector as to its condition at the time of the inspection, with the caveat that any rebuild from salvaged or time expired components be supported by a simple safety case or alternative means of compliance verbally articulated by the Owner to the Inspector.

4.1.7 DANGERS OF MAINTENANCE ERROR DURING ENGINE OVERHAULS

The term “overhaul” has the very specific meaning of taking an engine back to zero hours. In the context of microlight flying it has no application and it is more accurate to replace it by the term “rebuild”, as there is no such thing as a mandatory overhaul period for an uncertified engine.

This is clearly illustrated in the interpretative material in CAP 482 - BCAR Section S - Small Light Aeroplanes, Sub-Section E - Powerplant, AMC S 903 where evidence of safe and satisfactory operation of the engine, exhaust system and propeller combination in the aeroplane for a period of 25 hours’ flying without significant problems is an acceptable means of demonstrating compliance.

However, when it is known that an engine has been rebuilt, or has high hours, the Inspector would be well advised to ensure that these engines are supported by an informal safety case, consisting, for example, of its regular usage, airfield environment, hangar protection, quality of fuels and lubricants, and its service history. Details of any intermediate rebuilds should be recorded in sufficient detail in the logbook, supported by worksheets.

The reuse of time expired engines, from certified aircraft, is an example of legitimate microlight practice and should be fully disclosed in the Engine Logbook. Similarly, engines rebuilt from salvaged parts, on-condition, may well have been treated as ‘time zeroed’ in the logbook for record keeping purposes, but this does not imply a formal overhaul has taken place. If this situation is found the Inspector should ensure that sufficient detail of the rebuild has been provided in the Logbook and associated Worksheets.

A balance between the risk of failure due to neglected maintenance versus the risk of failure due to maintenance error has to be struck. The following diagram illustrates the increasing risk of interventionist maintenance on components that have increasing reliability. The likelihood of the component failing due to maintenance error increases dramatically with increasing reliability of the component [30].
4.1.8 LOGBOOK REPLACEMENT

If a logbook has been lost, destroyed, stolen, or is unavailable for any other legitimate reason, the Owner must obtain a replacement and submit it to the Chief Inspector for acceptance. In practice, under CAP 659 - Amateur Built Aircraft, Section 8.3 Log Books, there are currently only two sets of approved logbook for use with microlights: the Pooleys combined Microlight Airframe and Engine Logbook (Form BMAA/AW/036) or the CAA published logbooks (CAP398 for aircraft, CAP399 for engines and CAP400 for variable pitched propellers).

The following entries should be made in the replacement logbook(s) by the owner to re-establish the maintenance and modification status:

1. Constructor and Type (Aircraft, Engine, Propeller), Serial Number, Construction Date
2. Nationality and Registration Marks
3. Current and previous Owner’s/Operator’s Name and Address (G-INFO Registration History)
4. Reason for the loss of the original Logbook
5. Total Time since new
6. Details of maintenance work and certificates of Release to Service, as far as can be substantiated (e.g. Certificate of Validity [CA962], Validation of Permit to Fly [AW001], Flight Release Certificate [AW003], Certificate of Clearance for Flight for Test Purposes [AW029] and any lifted suspensions of Certificates of Validity or Certificates of Clearance [AW026]).
7. Details of rebuilds, repairs, replacements, inspections and modifications, as far as can be substantiated
8. Details of Mandatory Permit Directives and Service Bulletins that have been carried out
9. Clearly state if time in service is a best estimate

The Owner must then ensure that all outstanding applicable Mandatory Permit Directives and Service Bulletins are carried out before the next flight. If a permit suspension has been issued on Form BMAA/AW/026 then the Owner must arrange for a BMAA Inspector to inspect the whole aircraft and release it to service, before it can be flown again.
If an Owner is able to furnish the Inspector with a scanned copy or photocopy of his missing logbook(s) then the recorded maintenance work and servicing will be considered to be sufficient evidence of it having been carried out. Any other Maintenance Actions, Service Bulletins or MPDs must be verified by examination of the aircraft by the Inspector.

The logbook(s) should then be posted to the Chief Inspector at the BMAA Offices in Deddington.

On receipt the logbook(s) will be endorsed by the Chief Inspector with the last known airframe hours and approved modifications/repairs taken from the aircraft file held at the BMAA Administration Office and stamped with the following legend:

The BMAA accepts that the original Log Book is lost / destroyed / unavailable and certifies that these airframe hours / have been taken from the aircraft file held at the BMAA offices in Deddington / are a best estimate.

No records exist of any maintenance work, overhauls, repairs, replacements or modifications incorporated or satisfied on this aircraft. All applicable Mandatory Permit Directives and Service Bulletins must be carried out before the next flight.

BMAA Chief Inspector ………………………………… Date ………………………

The endorsed logbook(s) will then be returned to the owner.

At the Chief Inspector’s discretion, a spot inspection of the aircraft in question may be instigated.
4.2 TYPES OF INSPECTION

The character of inspections a BMAA Inspector can be invited to perform varies widely. One way of characterising them is as either inspections of the whole aircraft or just part of it.

Whole aircraft inspections would be Annual Permit Revalidations for a certificate of validity, Final Amateur Built inspections for a certificate of clearance for test flight, Major Modification inspections for a flight release certificate and Major Repair inspections for the lifting of a suspension of the Certificates of Validity for permitted aircraft or Certificates of Clearance for damaged aircraft.

Aircraft inspected following a repair or modification by a Manufacturer can be released back to service by that Manufacturer under their approval system, providing the Certificate of Validity for the Permit to Fly is still current.

Part inspections, where only the parts affected would be inspected, would be for Minor Modifications, Standard Minor Modifications, Minor Repairs, Maintenance, Weight Reports and Fuel Flow measurements.

Below the various types of inspection are introduced. They are elaborated in more detail later.

4.2.1 INSPECTION FOR REVALIDATION OF PERMIT TO FLY

A BMAA Inspector is authorised to perform an annual inspection for the validation of the Permit to Fly of any BMAA type approved, type accepted or amateur built microlight, in accordance with his authorisation category.

The inspector’s first job is to verify the identity of the aircraft he is inspecting and select the correct TADS number and issue to work with. Then he will check the aircraft conforms with the details requested on the first page of Form BMAA/AW/007, which he may fill in for the Owner.

The Inspector will ensure that the aircraft complies with the requirements of all modification approvals, copies of which must be present in the aircraft documentation. He inspects the aircraft against the appropriate TADS or HADS, recording which datasheet number and issue he used.

He will ascertain that all required maintenance has been carried out and properly certified, and that all mandatory permit directives have been acted upon.

He also makes sure that the weighing report is current and is held with the aircraft records, and that, taking into account all documented modifications and repairs, in his estimation the aircraft does not exceed the W&CG requirements of the type. Re-weighing might be necessary for the purposes of revalidating the Certificate of Validity if there is insufficient information available to satisfy the requirements. This decision is made by the Inspector.

He then inspects the condition of the whole aircraft as presented, and on the basis of viewing all areas he has access to, determines whether the aircraft is in an airworthy condition and complies with the mandatory requirements applicable to the type at the time of the inspection. He is not responsible for the condition within inaccessible areas (e.g. engine internals, tube internals etc.), nor areas now covered or closed that were previously signed off by another BMAA inspector.

If, during this inspection, they find any imperfections or flaws (e.g. normal wear or minor corrosion), or low residual time left on a life-limited component, etc. They can bring this to the attention of the Owner as an advisory, pointing out that while acceptable at this time and not requiring immediate attention, it may compromise the airworthiness of the aircraft at a later date.
The Owner’s responsibility is to declare that the supplied information is correct to the best of his knowledge, and that no repairs (except repair by strict replacement with approved parts) or modifications have been carried out without the knowledge of the BMAA. He also states that he understands that if unauthorised modifications or repairs are made, the Permit to Fly will be rendered invalid and that, after a reportable accident, the Permit to Fly ceases to be valid until once again declared airworthy by a BMAA Inspector and where necessary check pilot. He undertakes to keep the aircraft in an airworthy condition by maintaining it in accordance with the Aircraft Maintenance Manual and certifying each required maintenance action in the aircraft logbook and operate it within the permitted limitations, and understands that failure to do so will invalidate the Permit to Fly.

The permit renewal application is not complete until the Owner’s Declaration has been signed by the Owner, whose responsibility it is to ensure that the paperwork reaches the BMAA in time. They may sign it before or after the Inspector does, the order is not significant.

If the Inspector determines that the aircraft is in an airworthy condition and complies with the mandatory requirements applicable to the type at the time of the inspection and is in an approved modification state, he shall declare that the inspection has PASSED and release the aircraft for a check-flight within the next 60 days if the current CoV has expired.

If the Inspector determines that the aircraft is in an un-airworthy condition and/or does not comply with the mandatory requirements applicable to the type at the time of the inspection and/or is in an unidentified modification state, he shall declare that the inspection has FAILED.

If it is known that a previous permit inspection was abandoned or resulted in a FAILED decision, then there should be consultation between both Inspectors. The BMAA will not process renewal paperwork until the original inspector has been consulted or the new inspector has specifically addressed the failed items and detailed the action that was taken to rectify them.

### 4.2.2 INSPECTION OF AMATEUR BUILT AIRCRAFT PROJECTS

A BMAA Inspector is authorised to perform a progressive inspection of an amateur built project under the supervision of the Chief Technical Officer. An Inspector must be specifically nominated for the purpose of overseeing an amateur built project and approved by the Chief Inspector. This Inspector then performs each Stage Inspection at the appropriate point in the build, as laid down in the type specific version of Form BMAA/AW/022 issued to the Builder by the Tech Office.

Each stage shall be signed off both by the Owner and the Inspector when they are completed satisfactorily.

The Owner must notify the BMAA Technical Office at the earliest opportunity if there are to be any changes in the build away from the build manual before modifying the aircraft. If appropriate, the BMAA Technical Office will issue supplemental stage inspection sheets for those changes, for the Inspector to sign off. The Inspector is not authorised to issue supplementary inspection requirements.

Similarly the Owner must notify the BMAA Technical Office at the earliest opportunity if another Inspector takes over the project at any stage. After the Chief Inspector approves of the change, the Technical Office will require confirmation that the new Inspector has communicated with the old Inspector and ascertained whether there are any outstanding issues or defects associated with the build at that stage.

At the completion of the build, the Owner is responsible for sending the completed documents to the BMAA – viz:
The Owner and Inspector must then sign the application for the Certificate of Clearance for Flight for Test Purposes under CAA B-conditions (Form BMAA/AW/029) confirming that the aircraft is in the configuration described in the draft MAAN before the first flight of the aircraft. This application form will be sent to the Owner with the draft MAAN.

Advice is given in TIL 039 “Amateur Build Kits – Process Guide”.

4.2.3 INSPECTION OF MODIFICATIONS

Modifications, however insignificant, must go through an approval process either with the BMAA Technical Office or with the appropriate Type Approval Holder i.e. the Aircraft Manufacturer. Modifications are classified as major or minor, and further sub-divided as standard/series or non-standard.

OWNER INITIATED MODIFICATIONS (STANDARD & NON-STANDARD)

All applications to the BMAA to approve modifications are initiated by the Owner on Form AW/002a, with the exception of Standard Minor Modifications which have their own individual forms (TIL100 series).

After the Owner has applied for any non-standard modification to the BMAA it will be classified, assessed and then issued with a BMAA Microlight Airworthiness Approval Note (MAAN) for the Inspector to inspect against. Minor modifications applicants will be issued with an Approval and Record Form AW/004 for the inspection. Standard Minor Modifications each have their own one-shot inspection form.

MANUFACTURER INITIATED MODIFICATIONS

All modifications initiated by the Manufacturer via a mandatory Service Bulletin (supported by a MPD – Mandatory Permit Directive) will have the inspection requirements specified by the Manufacturer. The use of a BMAA Inspector to verify the incorporation of the modification is only allowed with the agreement of the BMAA Chief Inspector after reviewing the Service Bulletin before publication.

The Owner may choose to fit a Manufacturer’s Optional Approved Modification [TADS/HADS Annex B] whenever they choose. In this case the inspection will be done by a BMAA Inspector, unless the Manufacturer deems otherwise. The inspection is recorded in the appropriate logbook to this effect.

TWO STAGE INSPECTION

The process for applying for modifications (standard/series or non-standard) involves two BMAA inspections and is covered in TIL 002 ‘Applying for a Modification’. This means that it should be completed before the Permit revalidation inspection begins.

It proceeds in two stages:

ONE: It begins with a preliminary inspection of the aircraft to allow the Inspector to offer his opinion as to the impact of the modification on various aspects of the aircraft’s structure, control, propulsion, manuals and weight. The application Form BMAA/AW/002a “Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Modification” is then signed the Owner and sent to the Technical Office.
TWO: Once the application is approved, the modification may be implemented by the Owner. To complete the process a follow up visit by the same Inspector is made to enable him to inspect the work and then record the fact on Form BMAA/AW/004 “Approval and Record of a Minor Modification”, which will have been sent out to the Owner earlier with the approval.

Where an inspector has inspected a modification that has been fully fitted and load tested during the preliminary inspection phase, provided the aircraft has not been flown since its incorporation and the modification does not change as a result of the application assessment and approval process, then a follow up visit to view the modified aircraft is not necessary, so long as the logbook is signed off by the Inspector with the Modification number on receipt of the modification clearance form.

Note that approval is not guaranteed if a modification that has already been implemented required stage inspections, because the BMAA would have had no formal oversight of the implementation of the work. Most major modifications cannot be satisfactorily inspected after the fact.

ONE STAGE INSPECTION

In the case of standard minor modifications, only one BMAA inspection is required, using the checklists in the TIL 100 Series, where the Inspector declares that the information is correct and the installation is fit to be flown. Therefore, this can be done at the same time as a Permit revalidation inspection.

The inspection of major, minor and standard modifications is described in more detail in later sections.

4.2.4 INSPECTION OF REPAIRS

If invited by the Owner to assess a damaged aircraft, it most important that the Inspector makes it quite clear to the Owner that no repair work should commence without the approval of the BMAA Technical Office. The damage assessment phase is elaborated in Section 4.9.1.

Note that approval is not guaranteed if a repair that has already been implemented required stage inspections, because the BMAA would have had no formal oversight of the implementation of the work. Most major repair cannot be satisfactorily inspected after the fact.

Repairs are classified as major, minor or by replacement. Following an occurrence where significant damage is incurred by the aircraft, if the repair involves some sort of irreversible fabrication process it will always require prior approval by the Technical Office. Owners are advised to submit a damage report together with their proposed repair scheme to the BMAA Technical Office for classification. Repair schemes that fall outside of this requirement typically involve simple replacement using correctly specified parts and can be certified by the Owner, and any Qualified Person if an independent check is required.

REPAIR BY REPLACEMENT

Seeking prior approval from the BMAA is not necessarily required with some repairs, as the Owner is free to replace parts on his aircraft using parts known to have been previously approved by the BMAA Technical Office on that specific aircraft, or on aircraft types where the BMAA is the Type Approval Holder, or with the appropriate Aircraft Manufacturer’s approval.

While repair by replacement with manufacturer specified parts are an owner certifiable maintenance activity, it only applies for assembly and disassembly of components using threaded fasteners. Minor ‘fettling’ activity like fitting, filing, reaming, de-burring etc. is also permitted.

REPAIRS BY FABRICATION

Almost all repairs involving a fabrication process (see Section 9: Terminology for a full definition) will be classed as Major Repairs and require approval by the BMAA Technical Office and a letter of no technical
objection from the appropriate holder of an A1 approval, a.k.a. the Type Approval Holder or Aircraft Manufacturer, and be supported by documentary evidence of approval by the appropriate authority (e.g. BMAA AAN or CAA AAN).

The exceptions to this rule are during strict replacement of riveted parts or minor weld repairs to mild steel exhaust pipes, non-structural pop-riveting as documented by a manufacturer supplying approved replacement assemblies, and stitching of sails with tears below the thresholds outlined in TIL015 ‘Guidelines for Sail Repairs’.

Whoever carries out the repair is not dependent on it being major or minor. The owner is free to nominate any experienced person to carry out a major repair, provided the BMAA approve the repair scheme. If the repair is classified as minor, the owner or their nominee may carry out the inspection himself. Major repairs require an inspection by a BMAA Inspector.

Major Repair inspections for the lifting of a suspension of the Certificates of Validity for Permits to Fly, or Certificate of Clearance for Flight for Test Purposes under CAA B-conditions, may only be carried out by a BMAA Inspector following an approved repair as a result of an earlier accident or non-compliance. The certificate of validity/clearance ceases to be suspended only after the form has been signed and the inspection and check flight recorded in the airframe/engine logbook. It should then be posted promptly to the BMAA.

If the aircraft fails its inspection then the suspension remains in force and the BMAA Inspector must make a certified entry in the airframe/engine logbook to the effect that he has inspected the aircraft and found it to be un-airworthy, giving reasons for the failed inspection, in order to communicate this decision to any inspector or check pilot who might be approached to re-inspect the repair.

4.2.5 INSPECTION OF WEIGHT AND BALANCE

For the purposes of airworthiness an aircraft must have a weight report, additionally for 3-axis types this report must consider centre of gravity limitations. Any and all changes that alter the basic empty weight, actual empty weight or empty CG position (of a 3-axis aircraft) must be accounted for on the weight report. The BMAA may also require this if, in the opinion of the Technical Office, weight and CG limits are likely to be exceeded. A BMAA Inspector should be present at the weighing. Full guidance notes on the subject of weighing are laid down in TIL012 ‘Weight, Balance & Weighing’.

CHANGES TO BMAA WEIGHING POLICY IN 2015

Prior to 2015 BMAA aircraft had to be weighed every 5 years irrespective of whether anything significant on the aircraft had changed or not. And the primary purpose of the weighing appeared to become to ensure that the aircraft did not exceed the empty weight limit. The most important thing - ensuring that the pilot knows what the aircraft’s actual empty weight is - seemed to be forgotten.

Therefore, the BMAA has undertaken a review of its weight and balance policy, and has agreed with the CAA:

- That aircraft on the BMAA fleet no longer need to be routinely re-weighed. Before 2015 UK Microlight aeroplanes had to be re-weighed every 5 years. This does not mean that aircraft should not be reweighed occasionally to ensure the Actual empty weight is known.
- That an aircraft whose Basic empty weight drifts over the Basic empty weight limit for the type can continue to fly legally. Therefore, once an aircraft is in service, the Basic empty weight need only be considered if the aircraft is modified or repaired.
- Some exceptions to having to comply with the Basic empty weight limit should an aircraft need to be modified or repaired in service. All exceptions to compliance with the Basic empty weight limit following modification must be agreed by the Technical Office.
BASIC EMPTY WEIGHT
Also known as the Zero Fuel Weight (ZFW). This is a design definition from BCAR Section S, it simply states that the empty weight, of a Microlight, in addition to two occupants (2 x 86kg) plus one hour’s fuel at max continuous rpm will not be greater than the maximum take-off weight permitted. The aircraft must be able to achieve flight in this condition, so all necessary items for flight must be included, as well as unusable fuel in the system. Centre of gravity is not considered with this requirement.

ACTUAL EMPTY WEIGHT
This the empty weight of the aircraft in its flying or operational state, this can be greater than the basic empty weight (aka ZFW) as previously described. It is this weight with all desired equipment that the aircraft must be placarded and operated in accordance with. Critically it is in this condition that balance is considered and checked for all legal loading conditions. The actual empty weight must be known accurately so the pilot can load their aircraft legally within its maximum take-off weight.

EMPTY CG POSITION
This is the balancing position of the aircraft in the actual empty weight condition. From this measurement it is possible to determine whether the aircraft remains within the published CG range for all given legal loading conditions.

CG RANGE & LIMITATIONS
Addition of fixed ballast does not necessarily require prior Technical Office approval, but will require a new weight report to ensure that the weight and CG is still within limits. The Inspector must also verify that any lead weights or ballasting objects are securely attached to the aircraft meet the load cases, and certify this in the aircraft logbook together with the weighing result.

EQUIPMENT INVENTORY
It is compulsory to establish exactly what state the aircraft is in during the weighing process. i.e. all equipment fitted at the time of weighing. Any future change in actual empty weight and balance can be accommodated by amending the inventory accordingly. If this is not conducted correctly the only way to truly determine the weight and balance is to physically reweigh the aircraft, which is time consuming. All items must be logged on the inventory.

ANNUAL REVIEW
The inspector will be tasked with annually reviewing the weight and balance of each aircraft as a part of the annual revalidation process. Upon reviewing the aircraft logbook and weight report they must satisfy themselves that everything present on the aircraft has been accounted for and that the weight report and placards are fit for purpose. Amendments can be made during this process, however if there is any doubt over the validity of the weight report, the aircraft must be reweighed. The BMAA keeps records of weighing dates for all aircraft and recommends that the maximum time between reweighs of 10 years.

INITIAL WEIGHING
During initial construction, either by a type approval holder or amateur builder, compliance with the basic empty will be demonstrated and prior to flight approval determination of the actual empty weight. For 3-axis types balance will also have to be determined.

SCALES
TIL012 ‘Weight, Balance & Weighing’ provides the requirements for scales. Initial weighings require calibrated (traceable to a national standard) load cells with a minimum resolution of 0.1kg. For repeat weighings ‘in the field’ it is highly recommended to use scales of the same minimum specification.
WEIGHT REPORTS
Prepare the weight report using form BMAA/AW/028 'Microlight Aircraft Weight and CG Report' following the guidance notes in TIL012 ‘Weight, Balance & Weighing’.

The spreadsheets are written using MS Excel. There are two versions of each spreadsheet available: one .xls version for old versions of MS Excel; one .xlsx version for newer versions of MS Excel. The spreadsheets are written to be able to run on Windows, Mac, IOS and Android devices.

After completion of the calculations for the Weight Report, by hand or using the BMAA spreadsheet tool, the Inspector should ensure that the actual empty weight (wheel weights) and empty CG position (3-axis) are recorded in the airframe logbook and additionally in the Pilot’s Operating Handbook/Aircraft Manual where appropriate. All placards must be updated to correctly reflect any changes.

If you have any questions about the BMAA weighing procedure, process, requirements or spreadsheet please do not hesitate to contact the BMAA Technical Office for assistance.

4.2.6 INSPECTION OF FUEL FLOW REQUIREMENTS
Generally, this inspection is only required for any new amateur built aircraft or, if mandated by the BMAA Technical Office, when modifications or replacement of the powerplant or fuel system. The Inspector will satisfy himself by testing that fuel flow is adequate at maximum demand before the aircraft is flown. This process is described in more detail later in paragraph 4.16.

This test is not necessarily required, but is recommended, when a modified fuel pump is fitted that has been approved for replacement to a particular serially numbered engine. e.g. CAA MPD: 2007-003 R1 ROTAX Fuel Pump Replacement (Rotax Service Bulletin SB-912-053UL) where no fuel flow test per installation was mandated.

4.2.7 INSPECTION OF MAINTENANCE RECORDS OF HIRED AIRCRAFT
Hire of BMAA administered aircraft is allowed subject to certain conditions, as described by the CAA. The rules for hiring are explained in TIL032 ‘BMAA Code of Practice for Aircraft Hire’.

All scheduled maintenance checks – of interval 50 hours / 6 months or greater – performed on aircraft exempted for hiring must be certified by a BMAA Inspector by means of a Maintenance Review statement entered into the Aircraft Logbook.

This process is described in more detail later.
4.3 PREPARING TO INSPECT AN AIRCRAFT

4.3.1 THE DUTY OF AN INSPECTOR

The Inspector has an obligation to ensure that his activities and actions are not negligent or contrary to law, regulations, standards or procedures. He is responsible to the BMAA for inspecting the aircraft according to the standard guidelines laid down herein and, after carrying out the inspection, may be expected to share some accountability with the owner for the safety of the general public.

In law, this is known as “duty of care”. (Covered in a later Section).

For example, the accountability of an inspector with respect to the maintenance of a machine on the day of its inspection would look something like this:

<table>
<thead>
<tr>
<th>MAINTENANCE</th>
<th>LOGBOOK</th>
<th>CONDITION</th>
<th>ACCOUNTABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>None or unknown</td>
<td>Maintenance actions NOT certified by Owner</td>
<td>Judged unsatisfactory &amp; failed</td>
<td>Owner</td>
</tr>
<tr>
<td>None or unknown</td>
<td>Maintenance actions NOT certified by Owner</td>
<td>Judged satisfactory &amp; passed</td>
<td>Inspector/Owner</td>
</tr>
<tr>
<td>Ad-hoc maintenance done</td>
<td>Maintenance actions evident but NOT certified by Owner</td>
<td>Judged satisfactory &amp; passed</td>
<td>Inspector/Owner</td>
</tr>
<tr>
<td>Ad-hoc maintenance done</td>
<td>Maintenance actions certified by Owner</td>
<td>Judged satisfactory &amp; passed</td>
<td>Inspector/Owner</td>
</tr>
<tr>
<td>Some scheduled maintenance done</td>
<td>Maintenance actions certified by Owner</td>
<td>Judged satisfactory &amp; passed</td>
<td>Inspector/Owner</td>
</tr>
<tr>
<td>All scheduled maintenance done</td>
<td>All maintenance actions certified by Owner</td>
<td>Judged satisfactory &amp; passed</td>
<td>Owner</td>
</tr>
</tbody>
</table>

The inspection is made on the basis of viewing all external areas he has access to. He is not responsible for the condition of parts within inaccessible areas permanently covered and previously signed for by another inspector, nor for the analysis of un-inspectable components (e.g. oil composition, metal alloy ratios, internal bracketry, improperly laid-up glassfibre-rovings in supplied parts, etc).

He is obliged to inform the Owner of any defects or non-conformities he finds and he is free to draw to the attention of the Owner areas of normal wear, low residual time on life-limited components etc. that, while acceptable now, may render the aircraft un-airworthy before the next inspection is due, providing he doesn’t make any specific hours-based recommendations regarding on-condition parts. He may also point out to the Owner any products that can be fitted, or methods or techniques that can be deployed, to reduce wear and corrosion e.g. aircraft covers, storage ventilation, corrosion inhibitors, cleaning agents etc.

With the owner’s permission the Inspector may dismantle safety critical parts of the aircraft for closer inspection, provided he does not reassemble them again himself. The parts must be subsequently re-inspected in their assembled state and undergo a second inspection to complete the process.

Permission is not required if the parts are designed to be routinely deriggable and therefore can be dismantled as part of the aircraft inspection, provided the Aircraft Manual is followed when the derigged items are reassembled, e.g. battens, hang bolt, wing folding etc.
4.3.2 INSPECTION ETHICS

An Inspector is expected to be honest and trustworthy, and fully disclose any observations and safety concerns to the Owner, and to the Chief Inspector if asked to.

4.3.3 ACTIONS OF INSPECTION

In Chapter 1.2 we defined an inspection as an independent examination of the aircraft’s parts and paperwork from which the Inspector will make a judgement as to its airworthiness.

The Inspector will use his senses and his brain to carry out a number of actions:

- **Inspect** – look carefully, closely and critically, in a formal, systematic and official manner
- **Search** – scan a mechanical artefact for defects
- **Examine** – use sight and touch to assess an object
- **Check** – to verify proper operation
- **Verify** – confirm the function meets the stated requirement
- **Validate** – ensure that the requirement is valid (correct SB Issue, Logbook identity etc)
- **Look** – use eyes in adequately illuminated conditions
- **Test** – find defects by operation or use
- **Ensure** – make certain, positively ascertain
- **Obtain** – get or retrieve information or object
- **Record** – write down in a legal document
- **Question** – verbally investigate
- **Assess** – judge the quality, condition or status of something
- **Calculate** – perform mathematical operations
- **Identify** – determine a part’s origin with respect to a paper document
- **Sign** – the personal mark of an Inspector which is legally admissible for certification purposes
- **Disassemble** – to separate a mechanical assembly into its disparate components

4.4 TOOLS AND RESOURCES OF INSPECTION

4.4.1 TOOLS OF INSPECTION

The following is a list of some of the tools that an Inspector *may* wish to deploy in the course of his work to make his task more effective:

- Back board
- Bettsometer
- Borescope
- Cable tensiometer
- Camera
- Clipboard/portable work surface
- Compression tester
- Conrod bearing clearance tester

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1 After disassembly and inspection of the components, if an inspector reassembles the parts he automatically disqualifies himself from certifying the subsequent inspection of the assembly.
• Dye penetrant kit
• Light source e.g. LED torch
• Hydrometer (specific gravity measurement of coolant or battery acid)
• Jerry Can/Petrol Container
• Magnet, telescopic arm
• Magnifying glass x10
• Mirror on extensible arm with light
• Notepad & pencil
• Plug spanner
• Pressure Gauge
• Protractor, articulated
• Refractometer (to check water/glycol ratio in coolant)
• Screwdrivers to remove panels & fairings
• Short step ladder
• Spirit Level/Laser Level
• Syphon
• T-piece & tubing
• Torque wrench
• Trolley jack
• Tyre pressure gauge
• Vernier calipers
• Weighing scales/supports
• Work table, portable

4.4.2 RESOURCES OF INSPECTION

See section 7 for full details.

4.4.3 CONDITION OF INSPECTION TOOLS

The Inspector should ensure that his tools are fit for purpose and used in accordance with manufacturer’s instructions. Homemade tools should be calibrated against commercial equivalents.

4.4.4 REGIMES OF INSPECTION

Maintenance is the responsibility of the Owner who is permitted, and obliged, by virtue of the aircraft being a microlight, to undertake all of it by himself unless he resorts to using a subcontractor. Indeed, the Owner may also build a microlight at home, modify it and repair it, provided approval is sought beforehand from the BMAA. However, the degree of rigour applied to the inspection of his work depends on the criticality of the components being inspected. This determines who can inspect it and how many times it has to be done.

Often the work need only be inspected once by a suitably Qualified Person, typically the Owner, and not necessarily by a BMAA Inspector. This applies when non-safety critical parts are replaced on the basis of “form, fit and function” when only one inspection is required. (A Qualified Person is someone the Owner considers to have sufficient knowledge and experience to inspect work done against a published requirement e.g. BMAA Inspector, Licensed Microlight Pilot).
When safety-critical parts such as control systems or primary structure are disturbed, or replaced by approved components, then two inspections are required, both by Qualified Persons, unless they are designed to be de-rigged and re-rigged by the pilot between flights.

But if control systems or primary structure have been modified, or an approved fabrication process has been involved in a repair, or a new approved material incorporated, of the two inspections required, one of them must be by a BMAA Inspector.

For clarification refer to the signatory and inspection matrix later in this section.

4.4.5 SINGLE INSPECTIONS

At the very simplest level a single inspection is carried out by the pilot prior to flight, and need not be entered into the logbook. If the microlight has been re-rigged normally after transport to an airfield, a higher degree of rigour is required during the pre-flight inspection, but if no defects are found, this too would not need to be logged.

For maintenance by replacement, where this affects non safety critical components, only one inspection is required. Similarly modifications or repairs classified by the BMAA Technical Office as minor would also qualify for a single inspection.

4.4.6 SINGLE INSPECTION BY QUALIFIED PERSON

Maintenance by Replacement involving the replacement of components by 'form, fit and function' with fully interchangeable parts approved by the manufacturer, not affecting airframe control systems or primary structure, would require only a single inspection by a Qualified Person. A typical example of this would be after the replacement of items as such as spark plugs and filters. Disturbance to an engine control now only requires a single inspection by a Qualified Person.

4.4.7 SINGLE INSPECTION BY BMAA INSPECTOR

This is required at the annual revalidation of the Permit to Fly, incorporation of a Minor Modification or a Standard Minor Modification, and during a Weight and Balance check, to ensure compliance against legal requirements and approved modification schemes.

4.4.8 SECOND INSPECTIONS

The use of two inspections is a safety technique used throughout aviation. These are formally known as ‘duplicate’ inspections on aircraft with Certificates of Airworthiness and involve three people – the one who does the work and two who inspect the work. For BMAA aircraft only two people are involved. The person who does the work, also inspects it, then another inspects the work a second time. We shall refer to this technique as a Second Inspection.

So, for aircraft operating on a Permit to Fly, the second inspection is with respect to the work, not to the Inspector. The second person must not have been involved in the maintenance, modification or repair (i.e. be independent) of the part being inspected and must be a Qualified Person.

In general, second inspections should be made following any disturbance to a vital point or safety critical part on an aircraft where a single mal-assembly could lead to catastrophe, such as a control system by which the
flight path, attitude, or propulsive force\(^2\) of an aircraft is changed (unless designed to be de-rigged and re-rigged between flights), or primary structure that carries flight loads or ground loads, even if the changes were made during routine maintenance. After flight control disturbances both inspections must be recorded in the logbook, but engine control disturbance only requires one inspection.

The engine is not regarded as a safety critical system on a microlight, since all microlight pilots are trained to assume that the engine might fail at any time and thereby take steps to prepare for this eventuality while in flight.

Primary structure is any structure that carries flight loads or ground loads, and without which the ability of the remaining structure to carry these loads is lost or significantly compromised.

Primary structure includes lifting surfaces and their fabric elements.

- **Flight loads** are aerodynamic loads generated by lifting surfaces – including horizontal and vertical stabilising/control surfaces (both moving and static surfaces) – and reacted by the weight or acceleration of significant masses in the aircraft – including, but not limited to, the engine, occupants, fuel and primary structure.

- **Ground loads** are loads exerted by the ground on the undercarriage and reacted by the weight or acceleration of significant masses in the aircraft.

### 4.4.9 SECOND INSPECTIONS BY QUALIFIED PERSONS

General Owner maintenance by replacement of control systems or primary structure, such as flying wires purchased from the aircraft manufacturer, requires only a Qualified Person to perform the second inspection.

Repairing or replacing tyres, although classified as ground load bearing primary structure, are exempted from the requirement of a second inspection, as in C of A aircraft.

Maintenance or repair involving a fabrication process, however, requires BMAA Technical Office approval beforehand and will need the second inspection to be carried out by a BMAA Inspector (see next section). There is a special case for rivet replacement, which although requires no direct BMAA Technical Office approval, must be conducted under the scrutiny of a BMAA Inspector to a published procedure (see next Section 4.3.7.2: Second Inspections by BMAA Inspectors).

Non-structural welding (e.g. mild steel exhaust systems), and glass fibre filling is regarded as a minor maintenance not requiring prior approval. Marginal reaming of holes to accommodate imperial size bolts is permitted if prescribed by the manufacturer. Inserting bushes after substantial reaming (>0.010\(^\circ\)), however, requires BMAA Technical Office approval beforehand.

Similarly, after the disassembly and reassembly of any airframe control systems or primary structure not specifically designed for routine derigging, a second inspection is also required by a Qualified Person.

- Examples of control systems: aileron, elevator and rudder control cables, and their associated hinges, pulleys, couplings.

- Examples of primary structure: flying wires, ‘A’ frame uprights, tailplane upper/lower bracing wires, and their associated fittings and fasteners.

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\(^2\) Other components may affect the propulsive force of an engine; here we are only concerned with disturbances to control systems, such as throttle cables, choke mechanisms or starting carburettor enrichening circuits.
4.4.10 SECOND INSPECTIONS BY BMAA INSPECTORS

The BMAA ‘Guide to Airworthiness Procedures’ mandates second inspections using a BMAA Inspector for amateur built projects and whenever major modifications and repairs affecting control systems or primary structure are approved.

As part of the normal approval process, the BMAA Technical Office and Type Approval holders will identify alterations and modifications that affect primary structure in their Service Bulletins and other change documents which will also require second inspections by BMAA Inspectors. Note that kit importers are not type approval holders and cannot do this, nor can they authorise changes to the design.

Maintenance or repairs involving a fabrication process (defined above in Section - Inspection of Modifications and Repairs) do not automatically qualify as examples of maintenance by replacement and the BMAA Technical Office should be approached for classification and approval before work is commenced.

The exception to this rule is for rivet removal and replacement, because while it is still considered to be a fabrication process, it does not require prior approval by the Tech Office provided a BMAA Inspector ensures no damage is caused during the removal phase and no drilling is required on the replacement part or existing mating parts, other than that required for the precise fitting and alignment of panels and parts which are supplied undrilled or pilot drilled, and that the work is done according to a published procedure. The relaxation of this protocol is due to this being a common element of the amateur-build process.

After any BMAA approved modifications and repairs of primary structure, the first inspection can be made by the Owner or another Qualified Person but the second inspections must be made by a BMAA Inspector.

Any other work classified as a major modification or repair after application to the BMAA Technical Office would require a second inspection by a BMAA Inspector.

Only parts that meet the specification of, or are approved by either the Type Approval holder, or by BMAA Technical Office against an approved formal modification or repair scheme, may be used for the replacement of safety critical items.

4.4.11 EXAMPLES OF INSPECTION REGIMES

EXAMPLE OF A PRE-FLIGHT INSPECTION BY THE PILOT:

The rigging of controls and/or primary structure in accordance with standard rigging practices defined in the Pilots Operating Handbook/Aircraft Manual would be inspected by the Pilot and need not be entered in the logbook nor involve an Inspector.

EXAMPLE OF A SINGLE INSPECTION BY A QUALIFIED PERSON:

Replacement of an oil filter approved for use by the aircraft manufacturer, would require only one inspection, typically by the Owner (or the owners nominated service person or organisation), who would enter the details in the Engine logbook or in a separate worksheet referenced to the engine log book. In general maintenance and replacement of all non-vital parts requires only one inspection.

Note: In the first and second editions of the Pooleys Microlight Airframe and Engine Logbook (incorrectly referred to as Form BMAA/AW/306 instead of 036) a lot of owners tend to only use the airframe section of the logbook and omit the engine section and enter the engine hours in the column provided next to airframe hours. If this is found to be the case, advise the Owner that if they ever want to sell the engine separately from the aircraft, they will be faced with transferring all the information into the engine section prior to separating it to go with the engine.
EXAMPLE OF A SINGLE INSPECTION BY A BMAA INSPECTOR:
The annual inspection for the Revalidation of the Permit to Fly requires only one inspection, but this must be performed by a BMAA Inspector, as does any approved minor modification or repair, or a Service Bulletin or MPD that requires the aircraft to be released back to service by a BMAA Inspector after an inspection check is successful.

EXAMPLE OF ONE INSPECTION BY A QUALIFIED PERSON FOLLOWED BY A SECOND INSPECTION BY ANOTHER QUALIFIED PERSON:
Disassembly and reassembly of any primary structure not specifically designed for routine disassembly, like replacing the flying wires, will require a second inspection afterwards by a Qualified Person. Both inspections would have to be certified in the logbook.

EXAMPLE OF ONE INSPECTION BY A QUALIFIED PERSON FOLLOWED BY A SECOND INSPECTION BY A BMAA INSPECTOR:
A major repair to the wing structure would require two inspections, the second by an independent BMAA Inspector. The embodiment of any Service Bulletin or Mandatory Permit Directive that involves changes to the primary structure or disturbance to a control system and requires the aircraft to be released back to service by a BMAA Inspector.

4.4.12 EXAMPLES OF PRIMARY PARTS

<table>
<thead>
<tr>
<th>Flexwing:</th>
<th>Three-Axis:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trike:keel tube/snoot</td>
<td>- fuselage/wing frame/substructure</td>
</tr>
<tr>
<td>- pylon/monopole/duopole</td>
<td>- stressed skins</td>
</tr>
<tr>
<td>- front strut</td>
<td>- wing skins</td>
</tr>
<tr>
<td>- engine mount</td>
<td>- control surfaces</td>
</tr>
<tr>
<td>- landing gear/suspension/steering</td>
<td>- engine mount</td>
</tr>
<tr>
<td>- seat frame</td>
<td>- landing gear/suspension/steering</td>
</tr>
<tr>
<td>- seat belts/mountings</td>
<td>- seat frames</td>
</tr>
<tr>
<td>Wing:</td>
<td>- seat belts/mountings</td>
</tr>
<tr>
<td>- keel tube</td>
<td>- control systems and supporting structure</td>
</tr>
<tr>
<td>- leading edge tubes</td>
<td>- lift struts</td>
</tr>
<tr>
<td>- cross tubes</td>
<td>- lift/landing wires</td>
</tr>
<tr>
<td>- fabric covering</td>
<td>Powered Parachute</td>
</tr>
<tr>
<td>- uprights</td>
<td>- trike as per flexwing including:</td>
</tr>
<tr>
<td>- base tube</td>
<td>- life plate</td>
</tr>
<tr>
<td>- flying wires</td>
<td>- wing: all parts</td>
</tr>
<tr>
<td>- pitch wires</td>
<td>- landing wires</td>
</tr>
<tr>
<td>- landing wires</td>
<td>- king post</td>
</tr>
<tr>
<td>- king post</td>
<td>- luff lines</td>
</tr>
<tr>
<td>- luff lines</td>
<td>- hangpoint</td>
</tr>
<tr>
<td>- hangpoint</td>
<td></td>
</tr>
</tbody>
</table>
4.5 RULE OF THUMB

- Do not sign off routine maintenance work using your Inspector number, as routine maintenance is the responsibility of the owner.
- Do not sign off a Permit Revalidation of your own aircraft without authority from the BMAA Chief Inspector.
- Do not sign off a Permit Revalidation if you’ve modified primary structure.
- Do not sign off any Repair by Replacement to primary structure if the actual work was done by yourself, without obtaining a second inspection.
- Do not sign off a Service Bulletin, Major Modification or Repair or Build if the actual work was done by yourself – ask another independent BMAA Inspector.
- You can sign off approved Minor Modifications and Standard Minor Modifications and Minor Repairs, even if the work is done by yourself.
- You cannot be the sole signatory if you disturb a Flight Control System or the assembly of Primary Structure, get a second signature.
- Only a BMAA Inspector can sign off the Flight Release Certificate (Form AW/003) to return an aircraft to service following incorporation of series approved modifications. The Inspector may not be Owner without gaining prior permission from the BMAA Tech Office.
- Only a BMAA Inspector may lift the suspension of a Certificate of Validity for Permits to Fly or Certificate of Clearance for Flight for Test Purposes, using Form BMAA/AW/026, following a satisfactory inspection after an approved repair has been carried out as a result of an earlier accident or non-compliance. The certificate of validity/clearance ceases to be suspended only after the form has been signed and the inspection and check flight recorded in the airframe/engine logbook. It should then be promptly sent to the BMAA Tech Office.
- If an aircraft, whose C of V has been suspended, fails its inspection then the suspension remains in force and the BMAA Inspector must make a certified entry in the airframe/engine logbook to the effect that he has inspected the aircraft and found it to be unairworthy, giving reasons for the failed inspection, in order to communicate this decision to any inspector or check pilot who might be approached to re-inspect the repair.
- If the Permit to Fly Certificate of Validity is still current or not suspended, the Type Approval Holder’s A1 Approved Company (TPM 9.1.4) can release an aircraft after a Modification or Repair has been instituted under the Manufacturer’s approval system.

3 Note this is not referring to the maintenance review procedure as described at the end of this section.
### 4.6 SIGNATORY & INSPECTION MATRIX

The following is a summary of the rules for first and second inspections and the signing of specific forms.

<table>
<thead>
<tr>
<th>Approved Activity</th>
<th>Required Signatures</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORMS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Validation of Permit to Fly [AW001]</td>
<td>Owner / Trustee</td>
<td></td>
</tr>
<tr>
<td>Flight Release Certificate [AW003] Inspection Worksheets [AW005, AW006 or AW007]</td>
<td>Qualified Person(s)</td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td>Amateur Built Aircraft Project [Form AW022]</td>
<td>Owner / Trustee</td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td>Lifting of a Suspension of a Certificate of Validity for a Permit to Fly or Certificate of Clearance for Test Flight Purposes using Form AW026</td>
<td>Owner / Trustee</td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td>Weight &amp; Balance measurement [Form AW028 Excel Spreadsheet]</td>
<td></td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td>Certificate of Clearance for Flight for Test Purposes [AW029]</td>
<td>Owner / Trustee</td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td>Aircraft Change of Data Sheet CDS [AW030]</td>
<td></td>
<td>BMAA Inspector</td>
</tr>
<tr>
<td><strong>MODS &amp; REPAIRS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STANDARD Minor Modifications [TIL 101 etc.]</td>
<td>Owner / Trustee</td>
<td></td>
</tr>
<tr>
<td>MINOR Modifications/Minor Repairs [Form AW002a/b &amp; AW004]</td>
<td>Owner / Trustee</td>
<td></td>
</tr>
<tr>
<td>MAJOR Modifications &amp; Repairs [AW002a/b / MAAN / AAN]</td>
<td>Owner / Trustee</td>
<td></td>
</tr>
</tbody>
</table>
### Approved Activity

<table>
<thead>
<tr>
<th>Approved Activity</th>
<th>Required Signatures</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Review of Hired Microlights [TIL032]</td>
<td>Owner / Trustee</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualified Person(s)1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BMAA Inspector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Two inspections: The person completing the work &amp; BMAA Inspector satisfies themselves that the correct inspection checks &amp; maintenance actions specified in schedule have been recorded in the relevant logbooks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dis/Reassembly of Primary Structure, not De/Rerigging</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>BMAA Inspector</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td>■</td>
</tr>
<tr>
<td>Two inspections*: Duplicate inspection must be by a Person who is not the Assembler. *Manufacturers may perform both activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance by Replacement(^4) of Primary Structures [AMM/EMM/IPC(^7)]</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>BMAA Inspector</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td>■</td>
</tr>
<tr>
<td>Two inspections*: Duplicate inspection must be by a Person who is not the Assembler. *Manufacturers may perform both activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance by Replacement(^4) of Control Systems [AMM/EMM/IPC(^7)]</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>BMAA Inspector</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td>■</td>
</tr>
<tr>
<td>Two inspections*: Duplicate inspection must be by a Person who is not the Assembler. *Manufacturers may perform both activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance by Replacement(^4) of all else [AMM/EMM/IPC(^7)]</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>BMAA Inspector</td>
<td>■</td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td>■</td>
</tr>
<tr>
<td>One inspection: Only a logbook entry is required by the Maintainer(^8). *Manufacturers may perform both activities.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### KEY

1. ‘Qualified Person’ is someone the Owner considers to have sufficient knowledge and experience to inspect work done against a published requirement.
2. The first inspection may be by the person who did the work, the second inspection must be made by a BMAA Inspector who did no work.
3. For an initial Permit to Fly application, a person appropriately authorised by the Manufacturer may sign this report.
4. ‘Manufacturer’ is the Type Approval Holder of the aircraft with a current CAA A1 approval. The BMAA is the Type Approval Holder for orphaned types.
5. The first inspection is by the person who did the work, then a second inspection is performed by an independent person who did no work.
6. ‘Maintenance by Replacement’ means replacement of components with fully interchangeable parts approved by the manufacturer satisfying ‘form, fit and function’.
8. The BMAA always recommends a second inspection, even of non-safety critical structure, it is a wise habit to develop.
The Permit Validation Inspection is required by the Civil Aviation Authority annually to assure that the aircraft is in an airworthy condition and complies with the certification basis of the aircraft, that all required (i.e. mandatory) maintenance has been complied with and logged, is in an approved modification state, and that all Mandatory Permit Directives have been acted upon.

This requires complete inspection of the whole aircraft at one time, on the basis of viewing all areas he has access to, and results in a signed declaration as to its conformity or non-conformity. He is not responsible for the condition of parts within inaccessible areas permanently covered or requiring tools and significant dismantling to gain access that have been previously signed for by a BMAA inspector.

The Inspector is looking for deterioration caused by operation and the forces of weather, friction, overloads, heat and vibration amongst other things.

### 4.7.1 REQUIRED BMAA PAPERWORK

The forms and data sheets required for the inspection can be printed off the BMAA website or directly accessed electronically during the time of the inspection.

- Form BMAA/AW/001 ‘Application for Annual Validation of a Microlight Permit to Fly’.
- Form BMAA/AW/005, 006 or 007 ‘Microlight Inspection Schedule’.
- Form BMAA/AW/028 ‘Weight and CG Report’ if needed.
- Form BMAA/AW/030 ‘Change of Data Sheet CDS’ if needed.
- Appropriate Aircraft Data Sheet (TADS or HADS) for the type.

### 4.7.2 REQUIRED AIRCRAFT PAPERWORK

The Owner will need to show the Inspector:

- The Airframe/Engine Logbook(s) fully updated
- The CAA Registration document
- The Permit to Fly/Noise Certificate (included in the Permit for Type Approved microlights)
- A copy of the Weight Report or date and details entered in the Logbook
- All relevant Service Bulletins (the Inspector will have to use his judgment based on his knowledge of the type to ensure that the Owner has copies of all applicable SB’s and has acted upon them).
- All applicable Mandatory Permit Directives.
- The Pilots Operating Handbook/Aircraft Maintenance Manual suitably updated (i.e. the original version supplied with the aircraft with supplementary Service Bulletins, or the version referred to in the TADS, or any later version yet to be referenced in the TADS).
- The Batten Plan (if relevant)
- Receipts/Certificates of Conformity/Form AW/046 for new or replacement parts
- Copies of Modification and Repair Approvals
- Maintenance worksheets duly referenced in the logbook
### 4.7.3 INSPECTOR PREPARATION

#### Personal Checklist

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>My authorisation is current and I have been audited within the last 4 years.</td>
<td>My experience is appropriate for the type I am inspecting</td>
</tr>
<tr>
<td>I am authorised for the categories of inspection required (compare TIL 050 with Inspector Card)</td>
<td>I am a paid up BMAA Member</td>
</tr>
<tr>
<td>My experience is appropriate for the type I am inspecting</td>
<td>I am a paid up BMAA Inspector</td>
</tr>
<tr>
<td>I am ready to show my Inspector’s Card if requested to do so by the Owner</td>
<td>I have access to the Pilot’s Operating Handbook/Aircraft Manual &amp; Maintenance Manual</td>
</tr>
<tr>
<td>I have access to the latest issue of the TADS/HADS for the type</td>
<td>I have access to all applicable MAANs/AANs for the aircraft provided with the aircraft manual</td>
</tr>
<tr>
<td>I have accessed the BMAA Inspectorate Private Forum for Defect Alerts &amp; Notices</td>
<td>I have asked the Owner to furnish copies of all Service Bulletins and Mandatory Permit Directives</td>
</tr>
<tr>
<td>I have tried my best to establish that I have been given all the latest Service Bulletins by the Owner</td>
<td>I have asked the Owner to furnish all approvals of Modifications &amp; Repairs</td>
</tr>
<tr>
<td>I have not compromised my signing authority by implementing a Service Bulletin that requires signature from an independent Inspector.</td>
<td></td>
</tr>
</tbody>
</table>

### 4.7.4 PRE-INSPECTION PAPERWORK CHECKLIST

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have the latest issue of the inspection schedule BMAA/AW/005, 006 or 007</td>
</tr>
<tr>
<td>I have seen the Owner’s copy of the operators and maintenance manual and relevant supplements</td>
</tr>
<tr>
<td>I have the aircraft logbooks in my possession</td>
</tr>
<tr>
<td>I have seen a current weight report and logbook entry for the aircraft</td>
</tr>
<tr>
<td>I am aware of any snags or notes entered in the logbook</td>
</tr>
</tbody>
</table>
4.8 THE OWNER’S PRESENTATION

4.8.1 PRE-INSPECTION PREPARATION

The Owner will prepare his aircraft for inspection by presenting it in a clean condition and suitable environment, in accordance with the Guide to Airworthiness Procedures published on the BMAA website. He shall declare that the aircraft documentation information is correct to the best of his knowledge and that all modifications have been disclosed to the BMAA Technical Office and properly inspected to completion.

Should there be any unapproved modifications on the aircraft, or incomplete approved modifications (i.e. no record of inspection exists), these should either be removed to allow the permit validation inspection to proceed, or the inspection abandoned until approval is granted by the BMAA Technical Office for them to be properly incorporated.

The inspection of modifications, except Standard Minor Modifications (which can be done “on the spot”), is not part of the Annual Permit Validation and cannot be dealt with at the same time. These should be dealt with before the annual inspection commences.

It is the Owner’s responsibility to be know what the recommended maintenance actions are and which components have service lives.

4.9 THE INSPECTOR’S DIAGNOSIS

4.9.1 THE INSPECTION PROCESS

An inspection has a beginning, middle and an end. It starts with the aircraft in an unknown state and finishes with it in a known state. That state is either AIRWORTHY or NON-AIRWORTHY.

A study\(^1\) on inspection performance looked at the Search-plus-Decision model and defines five generic inspection functions.

- Initiate inspection e.g. calibration, documentation
- Access area to be inspected e.g. by removing access hatches/panels.
- Search area by successive fixations or probe movements (or visual scans)
- Decision on whether indication exceeds standard
- Response by signing inspection as complete or recording defect

A great deal of research\(^2\) has been done into the classification of inspection errors into search errors and decision errors, by videoing inspectors to see whether they passed quickly over a crack defect (search error) or whether he paused to examine the defect more closely before either reporting it or moving on. The latter is a decision error, either a miss or a false alarm. The conclusion was that search performance was consistently poor whereas decision performance was better, but highly variable. The two skills were statistically unrelated. Suggested interventions are to improve lighting to support search, and

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Encourage inter-inspector feedback to reduce variability in decisions (e.g. BMAA Online Forums, SIGMA Audits and Inspector Seminars).

If the aircraft is assessed as AIRWORTHY, this means no further work needs to be done. Only expected wear and normal deterioration, that does not compromise airworthiness at the time of the inspection, are acceptable at this point.

The inspection should be made without disturbing the assembly of the aircraft except for the removal of inspection access covers, fairings, and removable cowlings as required, or for the normal de-rigging of the aircraft. If the Inspector suspects hidden damage or corrosion, with the owner’s permission, he may dismantle safety critical parts of the aircraft for closer inspection, provided he does not reassemble them again himself. The parts must be subsequently re-inspected in their assembled state to complete the process and undergo a second inspection. (e.g. monopole damage behind fuel tanks, pylon bolt holes, inside engine mount brackets)

4.9.2 I’VE STARTED SO I’LL FINISH

In order for decision making to be standardised across the BMAA Inspectorate the inspection process must be systematic and process driven.

THE BEGINNING

Before the Inspection commences:

1. Only one Inspector shall perform an inspection from start to finish, except when under training.
2. The Inspector may refuse to begin an inspection for any reason.
3. The Inspector may negotiate payment for the inspection he is rendering.
4. The Inspector shall positively identify the aircraft in relation to its logbook.
5. The Inspector shall take possession of the Airframe and Engine Logbooks and make the entry:
   - Inspector Name & Number
   - Start Date

THE MIDDLE

6. The Inspector then inspects the aircraft and documentation presented to him according to the appropriate BMAA Inspection Schedule Form BMAA/AW/005, 006 or 007 (see Section 4.5)
7. Using the Inspection schedule the Inspector records the state of each line item as satisfactory or unsatisfactory.
8. The Inspector does not allow the Owner, if present, or other Parties to interrupt or distract him while inspecting, and turns off his mobile/cellular telephone.
9. If a fault is found he shall inform the Owner of it after the inspection is completed.

THE END

10. Upon completion of the inspection, the Inspector shall record their PASS/FAIL decision on the appropriate Inspection Schedule Form and by making an entry in the Airframe and Engine Logbook as appropriate, as follows:
    - Finish Date
    - Result
    - Reasons for failure, if appropriate
    - Signature (against Name and Number written down at the beginning of the inspection)

11. Following a FAILED decision, the Inspector should physically point out all defects to the Owner, if present. The Inspector is entitled to expect payment, even for a failed inspection.
12 Following a PASSED decision, the Inspector may advise the Owner, if present, any areas of normal wear that are nevertheless acceptable, pointing out that while they do not require immediate attention nor compromise airworthiness at this time, they should be regularly checked.

13 Following a prematurely terminated inspection, whatever the reason, the Inspector should make the following logbook entry: “INSPECTION TERMINATED, NO BMAA PAPERWORK PRODUCED” and return the logbook immediately to the owner.

14 Finally releasing the logbook back to the Owner (ANO Part 7: Documents and Records Article 91 Preservation of documents, etc.).

15 The aircraft can continue to be flown up to the end of the expiry date of the existing Certificate of Validity, if it is found to be airworthy.

16 The Owner is responsible for organising the Check Flight and for sending the completed paperwork in to the BMAA Office.

17 The Inspector is entitled to keep a copy of any inspection paperwork for his own records if he wishes, or record any pertinent observations in his own personal diary/daybook. You are encouraged to inform the Chief Inspector of any unusual observations made. Post-Inspection paperwork checklist

| I have completed and signed the Microlight Inspection Schedule (Form BMAA/AW/005, 6 or 7) |
| I have returned the signed BMAA paperwork to the Owner |
| I have advised the Owner of any issues that have arisen from the inspection |
| I have informed the Chief Inspector of any unusual observations |
| I have returned the aircraft logbooks, manuals and other documentation to the Owner |

4.9.3 FAILED INSPECTIONS AND CHECK FLIGHTS

The owner is responsible for maintaining his aircraft in an airworthy state. All non-conformities, defects, unapproved modifications or mandated maintenance lapses that have been identified in the FAILED inspection must be rectified before the owner re-presents the aircraft for inspection.

If a snag reported by the check pilot or test pilot during the check/test flight appears to be a defect affecting the airworthiness of the aircraft, the Inspector who released the aircraft for flight should be contacted for it to be investigated and classified.

The Check/Test Pilot should not sign off the Check/Test Flight until all snags have been properly diagnosed. The Check Pilot will report all snags and record them in the aircraft logbook. Any snag classified as a defect must be remedied by the owner and the aircraft re-inspected, amending the inspection schedule if necessary. Defects should not be deferred without appropriate liaison with the manufacturer or the BMAA Technical Office.

4.9.4 RE-INSPECTIONS

Where an aircraft has failed an inspection, the Inspector need only re-inspect those areas which failed following subsequent repair or replacement so long as he can be sure that no other part of the aircraft has changed state since the original inspection. Inspectors cannot be assured of this if the aircraft has been rigged, de-rigged, left outside in inclement
weather, transported or flown illegally since the initial failed inspection and so should re-inspect the aircraft in full. This would also apply should there be a significant gap (at the judgement of an Inspector) between the two inspections, to accommodate other factors like hanger rash, accelerated corrosion or third-party events. Typically, one to two months would be an acceptable interval. Only the same inspector who failed the earlier inspection may re-inspect the aircraft under this procedure.

4.9.5 DELIVERY OF THE DOCUMENTATION

The Owner is now responsible for ensuring that the original signed copies of Form BMAA/AW/001 and Form BMAA/AW/005, 006 or 007 are posted to the BMAA office for processing and retention in the aircraft records. The Check Pilot may offer to do this for them.

Both forms (BMAA/AW/001 Application for Annual Validation and BMAA/AW/005, 006 or 007 Aircraft Inspection Worksheet) must be sent to the BMAA, the greatest time allowed between inspection and check flight is 60 days.

BMAA Permit Renewal Fees are as given in the most recent issue of Microlight Flying Magazine and or the BMAA website.

4.9.6 PROCESSING OF THE DOCUMENTATION

Applications can be emailed to the Technical Office using permits@bmaa.org or posted to the BMAA directly. The BMAA Airworthiness Administrator will check both forms for completeness and accuracy.

Permit Revalidation paperwork will be rejected if any of the following are incomplete/incorrect:

1. Registration, Aircraft Type, Serial Number, MTOW & Manufacturer are all correct according to aircraft Permit to Fly.
2. Airframe Hours (as opposed to engine hours) are entered on the application form as at 31st December last and are not less than previous permit application as per G-INFO.
3. The aircraft has a current weight report. If a new weight report has been completed all details should be checked against aircraft appropriate datasheet.
4. The Owner is registered as the owner of the aircraft on G-INFO or presents evidence to show that the CAA has been contacted to effect a change in ownership, or has already been registered to him.
5. The Owner is a current BMAA member and the BMAA holds their most up to date details.
6. The aircraft, engine & propeller details are completed and are correct as per G-INFO or any AAN/MAANs applicable to the aircraft.
7. If propeller/engine details have changed, a Change of Data form (BMAA/AW030) will be sent to the CAA.
8. The Owner has signed the declaration on the front of the application form
9. Correct payment has been sent (the latest fee tariff can be found on the inside back page of Microlight Flying magazine or via the BMAA website).
10. The latest or appropriate aircraft data sheets have been used for the inspection.
11. An authorised BMAA Inspector who is cleared to inspect the aircraft type and is a current BMAA member has carried out the inspection.
12. The Inspector schedule is appropriate, completed correctly and the declaration signed and dated.
13. The Check Pilot declaration has been signed and the form has been successfully completed.
14. The check flight and inspection were, completed correctly and the declarations signed and dated within 60 days of each other.
15. In cases where the Certificate of Validity has lapsed the inspection must take place before the check flight.
16. If the Owner has inspected the aircraft, it is ensured they are authorised to do so.
Once the paperwork has been checked and is correct the BMAA Office box is completed and a new Certificate of Validity raised via the CAA Permits online system:

a) If previous C of V has expired - date from end of the airworthiness review or previous C of V date whichever is the later.

b) If previous C of V is still current - date from C of V expiry date.

c) If C of V is still valid for more than 60 days – date new C of V runs out until 12 months minus one day from the date of last performed airworthiness review activity (this could be the inspection or the check flight)

E.g. C of V expires on 30/08/19, airworthiness review completed on 29/05/19 therefore new C of V runs until 28/05/20.

This certificate is stored on the BMAA airworthiness system and a copy is forwarded by email to the owner.

4.9.7 REJECTION OF THE DOCUMENTATION

Any errors found in the documentation will be identified and the documentation returned to the Owner for correction, with appropriate Inspector input.
4.10 FILLING OUT FORM AW/001 ‘BMAA APPLICATION FOR ANNUAL VALIDATION OF AN AIRCRAFT PERMIT TO FLY’

All fields in the ‘Application for Annual Validation of an Aircraft Permit to Fly’ (Form BMAA/AW/001), including the Owner’s details and signature, must be completed.

BMAA Permit Renewal Fees are as given in the most recent issue of Microlight Flying Magazine or the BMAA website.

If the aircraft is owned by a syndicate, or registered in a company name, the nominated Owner’s Name and BMAA membership number is required information. The names of the additional owners are requested by the BMAA for membership research purposes.

The CAA recognise a Trustee of the Group as the nominated Owner for purposes of correspondence. But all syndicate members of a Group Owned Aircraft are jointly and severally responsible for keeping the aircraft airworthy. If the aircraft is owned by a Limited Company, then the Company Secretary is liable. Sometimes the names of joint owners are explicitly listed on the Registration Document when there are only a few in the Group. Notwithstanding this, the pilot in command is still obligated to ensure the aircraft is fit for flight.

4.10.1 OWNER’S DECLARATION

The permit renewal application is not complete until the Owner’s Declaration has been signed by the Owner, whose responsibility it is to ensure that the paperwork reaches the BMAA in time. They may sign it before or after the Inspector does, the order is not significant.

The Owner must affirm the validity of the above details and sign and date the following declaration.

“I apply to the BMAA for the issue of a Certificate of Validity for the aircraft described above.

I have not withheld or falsified any information relevant to the application.”

4.11 FILLING OUT FORMS AW/005/006/007 ‘INSPECTION WORKSHEET’

All checklist entries in the ‘Inspection Worksheet’ (Forms BMAA/AW/005, 006 or 007) must be checked off as satisfactory or unsatisfactory (with comments) before the final decision and signature by the Inspector is made. It must then be countersigned by the Owner.

For standardisation purposes please use the following checklist annotations:

4.11.1 CORRECT USAGE

Upper or lowercase variants are recognised:

For satisfactory: SAT, OK, YES, ✓

For unsatisfactory: UNSAT, NOT OK, ✗

For not applicable: N/A

Do not use a dash, slash or ditto symbol for satisfactory, or exclamation or question marks for unsatisfactory. An unsatisfactory decision should be accompanied with a brief descriptive comment. Comments that imply uncertainty should be couched in terms that limit liability.
Ensure all boxes are completed, blank entries will result in the application being rejected.

When errors are made on the form, cross out the mistake and initial the new entry. Do not use correction fluid (Tippex etc.) as this will result in the application being rejected.

Under NO circumstances should an Inspector enter an estimated residual life or projected fail date for any component. The inspection decision - PASSED or FAILED - is based on the present moment, not for any future moment.

4.11.2 AIRCRAFT DETAILS SECTION

REGISTRATION [ALL]
Enter detail off the CAA Registration document. Compare this entry with the fire proof data plate, the registration letters present on the aircraft and G-INFO - see Box 1.11 below.

TYPE [ALL]
Enter detail off the CAA Registration document. Comparison required of inspected example with other similar types, the aircraft data sheet and G-INFO.

SERIAL NO. [ALL]
Enter detail off the CAA Registration document. Compare this entry with the fire proof data plate, the registration letters present on the aircraft and G-INFO - see Box 1.11 below.

DOES AIRCRAFT REFLECT DATA ON G-INFO? [ALL]
Check that the pertinent data on G-INFO matches the state of the aircraft in the field:

- **Status** – Must be “Registered”, if not the owner must call CAA Aircraft Registration Department immediately.
- **Type** – If this is different, then a new Permit to Fly Certificate must be obtained before the check flight.
- **Serial No.** – This should never change.
- **Aircraft Class** – For some types it is now possible to change between Microlight and Light Aircraft.
- **Engine** – If this is different, then a new Permit to Fly Certificate might be required before the check flight.
- **Propeller** – If this is different, then a new Permit to Fly Certificate might be required before the check flight.
- **MTOW** – Reason for any change needs to be established as well as checking for a new weight report.
- **Total Hours**
- **Permit Status** – This must read “Permit to Fly” if it is “BLANK” or says “Suspended, Revoked or Airworthiness certification may not be required for this class of aircraft” then do not allow the aircraft to be check flown and contact the BMAA Technical Office for assistance/clarification.
- **Ownership Status** – Should concur with the current owner.
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Use TIL074 ‘SPECIAL’ PERMIT REVALIDATION INSPECTIONS for extra guidance on Permit Status. This guide offers general advice as well as covering the following specific scenarios:

- SSDR returning to the Permit to Fly system.
- Aircraft returning to the UK register from abroad.
- Aircraft registered as “Destroyed”.
- Aircraft returning to service after a long lay-off.

Finally use AW/030 Change of Data to inform the BMAA of any changes that need to be made to G-INFO.

DATE OF LAST WEIGHING [ALL]

Enter date of last weighing. Compare weight report with entry in logbook for consistency.

A/F HRS AS PER LAST 31ST OF DEC [ALL]

Enter the total airframe (not engine) hours at 31st December of the preceding calendar year. This is required for important BMAA statistical analysis.

A/F HRS AT INSPECTION [ALL]

Enter the total airframe (not engine) hours at the date of inspection. This information is required by the CAA.

AIRCRAFT DATA SHEET & AMATEUR-BUILD APPROVAL NOTE(S) [ALL]

Enter the appropriate TADS/HADS and issue number against which the inspection is being conducted.

For Amateur-builds enter all approving MAANs (some aircraft may have multiple MAANs due to upgrade/type change) and issue numbers (Microlight Aircraft Approval Note) for that actual aircraft, again used for the purposes of the inspection.

4.11.3 SECTION 1 - GENERAL & DOCUMENTATION [ALL]

<table>
<thead>
<tr>
<th>General &amp; Documentation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Obtain Logbook and record start of inspection</td>
<td>✓</td>
</tr>
<tr>
<td>1.2 Registration Document / Permit to Fly / Noise Certificate</td>
<td>✓</td>
</tr>
<tr>
<td>1.3 Weight Report &amp; logbook entry</td>
<td>✓</td>
</tr>
<tr>
<td>1.4 Relevant POH / AMM is available</td>
<td>✓</td>
</tr>
<tr>
<td>1.5 All relevant MPDs (inc. CAP 661) complied with and certified</td>
<td>✓</td>
</tr>
<tr>
<td>1.6 Lifted parts replaced/extended only if allowed</td>
<td>✓</td>
</tr>
<tr>
<td>1.7 Airframe &amp; Engine hours properly recorded &amp; totalled</td>
<td>✓</td>
</tr>
<tr>
<td>1.8 All Mandatory Maintenance &amp; SBs certified in logbook</td>
<td>✓</td>
</tr>
<tr>
<td>1.9 Original and fitness of replacement parts</td>
<td>✓</td>
</tr>
<tr>
<td>1.10 MAANs and Modifications approved &amp; certified in logbook</td>
<td>✓</td>
</tr>
<tr>
<td>1.11 Registration Marks, Airframe SN &amp; Engine SN checked</td>
<td>✓</td>
</tr>
<tr>
<td>1.12 Placards checked against TADS/HADS/MAANs</td>
<td>✓</td>
</tr>
<tr>
<td>1.13 Ballen Plan is marked with Aircraft Registration letters</td>
<td>✓</td>
</tr>
</tbody>
</table>

BOX 1.1 OBTAIN LOGBOOK AND RECORD START OF INSPECTION [ALL]

The Inspector records the start of the inspection by making an entry in the Airframe Logbook as follows:

- Date, Inspector Name & Inspector Number
Inspect the logbook(s) for entries from other Inspections. Ensure that you read any previous Inspectors notes. Check all entries for date and signature. References to all worksheets should be present in the logbook(s). Comment on the quality of logbook usage.

The ANO currently requires that a separate CAA approved logbook be kept for the airframe, for each engine fitted and for each in-flight variable pitch propeller (if fitted). Where the Pooleys logbook is used, the engine section of the book can be removed and kept with the engine if the engine is sold.

Acceptance of electronic logbooks (computer databases etc.) requires assurance of an adequate backup and archiving system. Where possible an electronic entry for the inspection must be typed in by the logkeeper or owner to say “Annual Permit Renewal Inspection commenced by Inspector XXX at HHMM hours on DD/MM/YYYY”. The Inspector should then browse through all the electronic records, just like a paper logbook. A printout of the commencement and completion entries can be obtained, if the inspector so wishes.

Replacement logbooks should be approved by the Chief Inspector who will certify the transferred hours by reference to the aircraft records held at the BMAA Offices.

**BOX 1.2 REGISTRATION DOCUMENT / PERMIT TO FLY / NOISE CERTIFICATE [ALL]**

These documents should be held by the Owner and presented to the Inspector. However, there may be circumstances in which it is not possible for the Owner to do this at the time of inspection. It may also be that any documents presented are out of date (i.e. do not reflect a recent change in ownership or change of wording on the Permit to Fly.

If the aircraft is undergoing a change in ownership at the time of the inspection remind the Owner that the BMAA will check to see that the aircraft is registered in his name and that it has a valid Registration document before issuing a Certificate of Validity, and that he should ensure he receives the original copy of this document from the CAA. The CAA will issue a new Registration document on receipt of their CA1 Form.

Ensure that the aircraft is in the possession of a non-expiring Permit to Fly and a Noise Certificate. If not contact the BMAA Tech Office, if the Owner tells you that a replacement has been applied for, then note this on the form so that the BMAA can follow it up with the CAA.

**BOX 1.3 WEIGHT (& CG FOR 3-AXIS) REPORT + LOGBOOK ENTRY [ALL]**

Check that there is an up-to-date weight report entered in the logbook. Ensure all changes since the last inspection have been accommodated on the report. Decide if the weight report correctly reflects the current state of the aircraft, if not a reweigh will be required. This is a process requiring annual review.

If a fuel trade-off placard exists, check it is valid and reflects the current weight report. Check all weight related placards on the aircraft for validity.

**BOX 1.4 RELEVANT POH/AMM IS AVAILABLE [ALL]**

If the Owner cannot furnish the relevant Pilots Operating Handbook / Aircraft Maintenance Manual then the inspection cannot be completed.

Ensure that the POH and AMM are suitably updated (i.e. the original version supplied with the aircraft with supplementary Service Bulletins and Amendment pages, or the version referred to in the data sheets, or any later version yet to be referenced in the TADS) and any other recommended manuals (e.g. the Engine Manual) approved for use with the aircraft.
Some aircraft have had updated manuals issued to allow operation under different conditions or at a higher weight (e.g. with a maximum continuous power limitation). If an aircraft is being operated at a higher max all up weight than originally assigned to the aircraft, ensure that the correct version of the manual is in use. (i.e. Pegasus Quantum up-issued to allow increase in weight from 390kg to 409kg MAUW, similarly Cyclone AX2000).

**BOX 1.5** ALL RELEVANT MPDS (INCLUDING CAP 661) COMPLIED WITH AND CERTIFIED [ALL]

Ensure all Mandatory Permit Directives have been complied with and appropriately certified in the airframe/engine logbook(s).

**BOX 1.6** LIFED PARTS IDENTIFIED AND REPLACED/EXTENDED ON CONDITION [ALL]

Ensure all life limited airframe components have been certified as being replaced or extended on-condition, according to the manufacturer’s protocol and appropriately certified in the airframe/engine logbook(s).

**BOX 1.7** AIRFRAME & ENGINE HOURS PROPERLY RECORDED & TOTALLED [ALL]

Check to see that both airframe and engine hours are being logged and totalled properly, looking for obvious anomalies.

For the Pooleys Airframe/Engine logbooks, the owner must record the engine hours separately in the rear section of the book (as well as in the front airframe section if they wish). Technically only a daily summary is required for the engine. Airframe hours are normally considered equal to engine hours to take into account ground loads and vibration fatigue on the airframe. Some Hobbs meters and digital instruments can compute the airborne hours automatically per flight – take off to touchdown based on an airspeed trigger, and the cumulative total usually lags the engine total. Engine Management Systems, like the Rotax Flydat, give engine hours.

*Note:* a lot of owners tend to record both airframe and engine hours only in the airframe section of the logbook, and forget or omit to fill out the rear section for the engine. *If this is the case point out to the owner that if ever they want to sell the engine separately from the aircraft, they will be faced with transferring all the information into the engine section prior to splitting the logbook to go with the engine.*

**BOX 1.8** ALL MANDATORY MAINTENANCE ACTIONS & SBS CERTIFIED IN LOGBOOK [ALL]

Inspect the logbook for details of maintenance and repairs. Maintenance entries may refer to worksheets (e.g. Form BMAA/AW/068 Aircraft Worksheet). Take note of any recent repairs and inspect their condition. Check the maintenance records against the maintenance schedule for the airframe, cross checking the dates against the relevant service intervals and ascertain whether all maintenance requirements have been complied with and properly certified. All airframe life limits must be observed or otherwise extended on condition according to the manufacturer’s recommendations. Ensure all wing strips have been certified in the logbook at their expected mandatory intervals and that all known mandatory Service Bulletins have been similarly certified.

*It is the owner’s responsibility to be know what the recommended maintenance actions are and which components have service lives.*

If any scheduled maintenance has been omitted by the Owner, challenge the Owner to give reasons for the omission. The Owner may have neglected to follow the recommended engine service intervals for an uncertified engine and formulated his own alternative schedule or means of compliance. He should be encouraged to justify his decision to the Inspector by articulating a simple verbal safety case for the deviation. The Inspector is free to accept or reject the explanation and should record his decision the inspection schedule. No formal approval for the Owner’s deviation is required (by the BMAA.
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Technical Office or CAA) unless the maintenance action has been mandated by the CAA but the aircraft logbook shall reflect the change from any recommended maintenance action.

Similarly, if you know that the engine has been recently rebuilt or replaced, establish the informal safety case with the Owner for prolonging the life of any engine components. In listening to the Owner’s safety case, consider things like its condition, usage history, airfield environment, hangar protection, bearing play, quality of fuels and lubricants, and its service history.

In determining the condition of an engine the Inspector may wish to consider a more thorough assessment of its external and internal condition, oil consumption and compression, and will want to look at how often the engine is run, where it is stored and what fuel and oil has been consumed.

- **External Condition**: The engine should be examined externally for obvious defects such as a cracked crankcase, excessive play in the propeller shaft, overheating and corrosion.
- **Internal Condition**: Significant information concerning the internal condition of an engine may be obtained from an examination of the oil filters and magnetic plugs, for metal particle contamination. These checks may be sufficient to show that serious wear or breakdown has taken place.
- **Oil Consumption**: Since the oil consumption of an engine may have increased as it gets older, an accurate check of the consumption over the last 10 flying hours would show whether its consumption exceeded the manufacturer’s recommended maximum.
- **Compression Check**: Piston ring or cylinder wear, or poor valve sealing could, in addition to increasing oil consumption, result in a significant loss of power. A cylinder compression check is a method of determining, without major disassembly, the standard of sealing provided by the valves and piston rings. This should be carried out in accordance with the engine manufacturer’s recommendations.
- **Usage Cycle**: An engine that is run at frequent and regular intervals is conducive to a longer life.
- **Storage and climatic environment**: A dry hangar, away from the sea for example, will reduce the effects of corrosion.
- **Fuel and lubricant history**: Use of higher quality fuels and lubricants, in accordance with the engine manufacturers’ specifications will prolong the life.
- **Servicing history**: Regular decoking, coolant replacement, oil changes etc. will extend its life.

**BOX 1.9 ORIGIN AND FITNESS OF REPLACEMENT PARTS [ALL]**

Look in the logbook or worksheets to identify the origin of any recently replaced parts. During the aircraft inspection check to see that these parts meet fit, form and function and conform to the notional design specification (by comparison with other examples in the fleet). If necessary, ask to see Purchase Receipts, Certificates of Conformity where relevant, or Details of Removed Aircraft Part Form BMAA/AW/046 if you believe the parts do not meet the approved specification of the manufacturer to determine their origin.

**BOX 1.10 MAANS AND MODIFICATION APPROVED & CERTIFIED IN LOGBOOK [ALL]**

Ensure all modifications to the aircraft are approved, whether introduced as repairs, major modifications, minor modifications or standard minor modifications. If the aircraft contains any modifications from original state then identify the relevant MAAN(s), Series MAAN(s), BMAA AANs, CAA AANs, Minor Modifications, Standard Minor Modifications and Manufacturer Optional Modification numbers and ascertain whether they are or not listed on the data sheet as optional. Note that MAANs must be approved at their Final Issue state not draft.

Describe any other visible modifications on the Inspection Worksheet.
If both the Owner and the Inspector cannot identify a piece of equipment or permanently modified structure, then the inspection must halt and be declared a FAIL.

**BOX 1.11 REGISTRATION MARKS, AIRFRAME S/N & ENGINE S/N CHECKED [ALL]**

Ensure that a fire proof metal plate, bearing the aircraft’s nationality (G for Great Britain) and a 4 letter registration, is fitted to the wing or airframe (as required by the Air Navigation Order) and that the corresponding registration letters are displayed on the wing and fuselage (if required).

Check that the Airframe Serial Number is the same as that recorded in the front of the Airframe Logbook and printed on the Registration document. If different inform the Owner and terminate the inspection. If the data plate cannot be found record this determination on the form and continue.

It is recommended that if you have not inspected this aircraft before, or know that the engine has been changed, check that the Engine Serial Number is the same as that recorded in the front of the Engine Logbook. If different inform the Owner and ensure that he starts a new logbook. If the data plate cannot be found record this determination on the form and continue.

**BOX 1.12 PLACARDS CHECKED AGAINST TADS/HADS/MAANS [ALL]**

Ensure that all placards listed and illustrated in Section 10 of the TADS are present and correct.

Below is a list of examples:

- **Flight Limitations** – [TIL075 LIMITING SPEEDS, ASI CALIBRATION & MARKINGS](#) provides full guidance on the correct marking of Air Speed Indicators ASIs.
- Engine Limitations
- Aircraft Weights Limitations
- Baggage Limitations
- Fuel Type, Capacity and Mix Ratio
- Fuel Cock On/Off Positions
- Ignition Switch On/Off Positions
- Propeller Pitch Setting
- Hand Throttle
- Wiring Loom Disconnection Warning
- Trimmer Setting
- Tip Turn Adjusters
- Latch Locking
- Oil Type and Quantity
- Fuel Load Limitations
- Occupant Warning (this is provided on the new Permit reminder sticker)

**BOX 1.13 BATTEN PLAN IS MARKED WITH AIRCRAFT REGISTRATION LETTERS [PP & FLEX]**

If the wing uses removable battens (evident by the presence of external batten pockets) ensure that the Batten Plan is furnished by the Owner. Tuning changes made to the batten profiles must be recorded on the Batten Plan with a signature and referenced in the logbook, and the Batten Plan marked with the aircraft’s own registration letters to guarantee unique identification.
4.11.4 **SECTION 2 - TRIKE STRUCTURE [PP & FLEX] / AIRFRAME & FLYING CONTROLS [2/3 AXIS]**

The owner should remove all aircraft covers, inspection panels, rings and ports, fairings, cowlings, caps, lids for the inspection. Check the condition of the Velcro pads, zips, locks, etc. of the covers.

Inspect each area for cracks, corrosion and looseness.

**BOX 2.1  FUSELAGE STRUCTURE [ALL]**

Examine All-Metal structures for cracks, dents, popped rivets, corrosion, etc.

Examine All-Composite structures for manufacturing defects, moisture penetration, cracks, impact damage, heat defects, dis-bonding, de-lamination, chemical deterioration, chafing, specific or multi-site damage, osmosis and repairs.

**BOX 2.2  BRACKETS, FITTINGS, PLATES AND JOINT ASSEMBLIES [ALL]**

Examine all brackets, fittings, plates and joint assemblies for cracks, distortion, hole elongation, security and locking.

**BOX 2.3  TUBES AND STRUTS – GENERAL [ALL]**

All tubes should be true and show no sign of stressing, usually indicated on aluminium as whitening or crazing of the anodising. Drilled holes should not show evidence of excessive elongation and there should be no play between adjacent assemblies. Look for ovaling of the section from overtightened bolts, and for any dents. Look for cracks emanating from drilled holes and attachments. Examine welds for cracking and evidence of fatigue damage. Look for any newly drilled holes. Note that tubes comprising primary structure may not be drilled or altered in any way unless specific approval has been obtained from the Type Approval Holder/BMAA Technical Office or CAA.

Look for signs of deformation around eye bolts and for signs of over tightening and compression of the tube. Check they are straight and free from dents or defects along their length. Look for illegal addition of jury struts.

**BOX 2.4  KEEL TUBE(S) AND SNOOT [PP & FLEX]**

Check that the keel tube(s) is/are true and that there is no sign of stressing, usually indicated on aluminium as whitening or crazing of the anodising. Drilled holes should not show evidence of excessive elongation and there should not be any play between the snoot (if fitted) and the trike keel. Look for cracks emanating from drilled holes and the seat frame lower attachments. Examine welds on the snoot elbow for cracking and evidence of fatigue damage.

**BOX 2.4  COCKPIT STRUCTURE [2/3 AXIS]**

Look for evidence of twisting, such as curving of support tubes. Check that the keel tube is true and that there is no sign of stressing, usually indicated on aluminium as whitening or crazing of the anodising. Drilled holes should not show evidence of excessive elongation. Look for cracks emanating from drilled holes. Check Fuselage cockpit tubes for distortion.

Look at condition and finish of cockpit tubes. Look for evidence of distortion and twisting. Check for overstressing, excessive elongation of drilled holes and for cracks.

**BOX 2.5  TOP PLATE [PP]**

Check for distortion of the top plate.
Check that the monopole/duopole is true and that there are no signs of stressing, usually indicated on aluminium as whitening or crazing of the anodising, particularly about the seat frame abutment and engine mountings. Drilled holes should not show evidence of excessive elongation or play between the pylon(s) or hang point reinforcement. Examine pylon backup cable/strap especially around lower attachment. Some pylons require the inner sleeve to be removed for proper inspection. If this is done the Inspector must call upon the Owner or a Qualified Person to re-sleeve it in order to maintain independent.

Look at condition of brackets and fixings. Look for evidence of distortion and twisting. Check for overstressing, excessive elongation of drilled holes and for cracks. Check for correct assembly and engagement in these critical areas, visually check geometry.

Examine front wires for looseness, wear and stretching of the thimbles. Look for broken strands and signs of corrosion – usually seen as bulges in the cables or outer covering. Ensure that swages appear correctly formed and that the cables are not damaged where it enters the swage. Ensure that the cables have not been restricted in their movement by over-tightening of the cable attachment bolts.

Look for signs of cables jumping out of pulleys or guides and becoming trapped.

Check that the front strut is true, and that there are no signs of stressing, usually indicated on aluminium as whitening or crazing of the anodising. Drilled holes should not show evidence of excessive elongation and there should be no play between components in a multi-tube front strut. Carefully examine the front strut attachment lugs for signs of cracking and wear. Look for excessive scoring between the front strut and the control frame. Advise the Owner he may fit removable padding or sacrificial material to the strut to prevent light scoring from getting worse without applying for a modification.

Ensure that long control runs are in their correct position and are not fouling other structure or other control connections. Check that nothing is missing.

Examine the steering head(s) to ensure that they operate smoothly and that excessive play is not apparent. Ensure that the front forks are straight and that the axle holes are not excessively worn. Suspension springs, if fitted, must not be worn or elongated.

Check all pivot bolts for security and the pilot’s controls for full and free movement. Check they operate the control surfaces. Check control bolts are secured by positive non-friction fasteners.
BOX 2.9 SUSPENSION, DRAG LINKS AND BRACING TUBES [ALL]

Suspension springs, if fitted, must not be worn or elongated.

Check that the tubes show no signs of stressing, usually indicated on aluminium as whitening or crazing of the anodising, particularly about the wing attachment plates, seat frame abutment and engine mountings. Drilled holes should not show evidence of excessive elongation or play between the pylon(s) or hang point reinforcement. Examine backup cable/strap especially around lower attachment if present.

Examine the drag links for signs of stressing – usually indicated on aluminium as whitening or crazing of the anodising – and that drilled holes do not show evidence of excessive elongation and that the undercarriage is firmly supported and not free to move. Look for cracks around drilled holes and attachment lugs. Examine the attachment lugs for splaying out.

BOX 2.10 MAIN U/C, NOSEWHEEL, TAILWHEEL & STEERING [ALL]

Examine the undercarriage for excessive play and wear. Check that all undercarriage tubes are true, and that there are no signs of stressing – usually indicated on aluminium as whitening or crazing of the anodising. Drilled holes should not show evidence of excessive elongation or wear. Pay particular attention to the attachment areas and axle connections.

If present, examine the undercarriage wires for signs of elongation and fraying, particularly at the thimble ends. Pylon-to-undercarriage support wires should be tight with the trike unit fully rigged. Examine any lightweight tensioners for wear or cracking.

Check for inadequate clearances and foreign objects trapped in control runs, linkages or hinges. Check operation and travel limits of any steering controls.

BOX 2.11 WHEELS, WHEEL BEARINGS, AXLES, TYRES & BRAKES [ALL]

Examine wheel assembly for cracks and the axle for end float. Check tyre pressures, remaining tread and look for creep marks. Examine the tyres for cuts, splits, bulges, signs of perishing and uneven wear. Ensure that brakes are correctly adjusted and operating correctly. Ensure pivot bolt not too tight. Look out for heavy non-standard tyre substitutes.

BOX 2.12 SEAT FRAMES, DOORS, CANOPY & WINDSCREEN [ALL]

Look for cracks at the seat frame attachments and in the frame itself for bending deformation and GRP seat mouldings for cracks.

Check seat adjustment mechanism and sliders are operating correctly and are not worn. Check condition of doors, bracing, hinges, latches, CV panels. Do the doors conform to the original design?

BOX 2.13 SEAT HARNESSSES, BUCKLES & FABRIC [ALL]

Examine the seat harnesses and seat fabric, ensuring that all attachments are serviceable and that the seat harness can be released under load. Seat harnesses must not be “roped up” but should lie flat across the occupants lap. Examine the stitching and look for signs of fraying or abrasion. Ensure that the seat harnesses are not contaminated with oil or fuel and that they are correctly routed. Examine the baggage compartments for holes or defective zips.

Examine baggage compartment area.
BOX 2.14  PODS, SPATS, FAIRINGS & FABRIC SKIRTS [ALL]

Examine the spats and fairings for cracks, delamination, damage and security – if fitted. Examine fabric skirts for wear and security. Straps must not have long loose ends as these could be caught by the propeller. Pay particular attention to drilled holes in fibreglass as these readily crack.

BOX 2.15  INSTRUMENTS AND ELECTRICS [ALL]

At the Master Switch onwards, check its operation and that all mandatory instruments as listed in the TADS or HADS are fitted and appear to be working. Electrical cables must be secure and, in general, fuses must be fitted to all independent circuits to provide overload protection for each item of electrical equipment (ask Technical Office for specific exceptions if unsure). Examine cable terminations for signs of over/under-crimping, or signs of overheating. Check that the required placards are fitted correctly. Ensure switches operate in the sense UP = ON and DOWN = OFF and are placarded as to sense and function. Inverse operation (unless exempted by the Technical Office) is a violation of Section S and is inadmissible.

For more information and guidance, the following Technical Information Leaflets can be consulted:

TIL027 Instruments & Avionics
TIL059 Electronic Flight Information Systems

To note unless full backup instrumentation is present, EFIS units should have the accompanying placard:

‘IN CASE OF DISPLAY FAILURE LAND AS SOON AS PRACTICABLE’

BOX 2.16  CONTROL CABLES, PUSHRODS & HORNS [ALL]

Examine all control cables for looseness, wear and stretching of the thimbles. Look for broken strands and signs of corrosion, usually seen as bulges in the cables or outer covering. Ensure that the cables have not been restricted in their movement by over-tightening of the cable attachment bolts. Look for bent or binding pushrods and for control direction, throw, play and deflection under pressure. Check for inadequate clearances and foreign objects trapped in control runs, linkages or hinges.

Inspect for evidence of distortions of all bellcranks, cross-members, control horns etc. with control column hard on stops right and left, fore and aft.

BOX 2.17  ENGINE FRAME, PROP GUARD, WIRES, VENTS & DRAIN EYELETS [ALL]

Examine the engine frame for signs of cracking at the welds. Look at the condition of the powder coating. Check any wire bracing.

Boxed-in structures should be adequately ventilated. Ensure that vents and drain holes, where specified by the manufacturer, are of the correct size and are unobstructed.

BOX 2.18  SERVICING / CHECKS UP TO DATE (TRIKE) [FLEXWING]

Ensure that the owner has maintained the trike structure in accordance with the appropriate service schedule. It is the Owner’s responsibility to be know what the recommended maintenance actions are and which components have service lives.
For hired aircraft, subject to an exemption, the Inspector must satisfy himself that the correct inspection checks & maintenance actions specified in schedule have been carried out, ensuring that they are recorded in the relevant logbooks. The previous 50 hour check / 6 month (or greater interval check if that was the most recent maintenance check) must have been signed for by a BMAA inspector. See Section 4.14: Inspection of Maintenance Records of Hired Microlights and TIL032 ‘BMAA Code of Practice for Microlight Hire’.

4.11.5 SECTION 3 - POWERPLANT [ALL]

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The engine installation observation (Upright or Inverted) refers to the relative orientation of the engine to its mounting points, rather than a description of the engine internals (In-Line, Horizontally Opposed, Radial or Vee cylinder configuration) which we know already from the model. Some early aircraft types had two mounting orientations so this information is needed.

The presence of an Engine ID Plate is not mandatory but is nevertheless highly desirable, in order that the correct Service Bulletins can be applied. If it does exist the Engine Serial Number should be the same as that recorded in the front of the Engine Logbook. If different the Owner will have to start a new logbook. If the data plate cannot be found record this determination on the form and continue.

Ensure that the propeller type, number of blades, diameter and pitch correspond to that as given in the appropriate data sheet, by observation, legend or measurement.

BOX 3.1 ENGINE MOUNTING AND ATTACHMENTS / COWLINGS AND FIREWALL [ALL]

Ensure that the engine is securely mounted and that the mounting bolts are not excessively corroded. Examine the engine mount for cracks and distortion. Ensure that there is no excessive play between the mounting and the airframe structure and that all bracing wires are serviceable and free from wear. Check engine for damage and leaks as well as vibration chafing.

Remove cowling and inspect for cracking/heat damage, chafing, evidence of oil leaks and damaged nut-plates. Inspect firewall for distortion and cracks and check firewall mount bolts.
BOX 3.2 FLEXIBLE MOUNTINGS [ALL]
Ensure that all anti-vibration (AV) mountings are serviceable and not perished. Examine for distortion and permanent set. Pay particular attention to the AV mount safety washers; contact between the washers and the AV mount attachment bolts or airframe are a positive indication of heavy landings.

BOX 3.3 EXHAUST SYSTEM, SILENCER AND SUPPORTS [ALL]
Examine the exhaust for cracks, loose baffles, leaks and general security. Check that securing springs and loops are not worn or stretched. Ensure that exhaust spring locking wires are long enough and do not restrict the spring operations. Spring wear is commonly prevented by the application of bathroom sealant to damp out the high frequency vibrations. Ball joints should be checked to ensure that they have not seized up, as this causes cracking. Ensure appropriate lubrication. Welded repairs to mild steel exhaust systems are classified as minor and so may be accommodated subject to condition at the time of inspection and the provision of adequate lock wiring and security in the event of weld failure.

BOX 3.4 GEARBOX OR REDUCTION DRIVE [ALL]
Examine the gearbox/reduction drive for security. Belt reduction drives should be checked for wear on the gears and belt as well as for belt tension. Examine the reduction gear mounting holes for security and locking. Look for cracks and signs of mechanical contact between surfaces, particularly on belt drives. Look for leaks. On the Rotax ‘A’ box the backplate is prone to coming loose allowing the torsional loads to shear the bolts. Look for grey paste at the backplate mounting lugs as a sign of fretting.

If you know that the gearbox has been changed check that it has the correct gear reduction ratio for the propeller/engine combination as specified in the TADS. Note also that the early Rotax 2-stroke provision ‘4’ engines were fitted with the A gearbox, and the early B gearboxes, with the 8-spring torsional shock absorber. Provision ‘8’ engines, providing the 8 bolt pattern for the stronger Rotax B, C, or E gear boxes, incorporate the 12 spring torsional shock absorber. The 12 spring conversion on an A gearbox can be recognised by a marking groove on the shaft flange.

BOX 3.5 CRANKCASE, PROP-SHAFT, FLANGES, BOLTS [ALL]
The engine should be examined externally for obvious defects such as a cracked crankcase, excessive play in the propeller shaft, overheating and corrosion and any signs that the propeller shaft, flanges and bearings may be worn, damaged or cracked. Ensure that all bolts are correctly secured and free from corrosion as far as is possible.

BOX 3.6 PROPELLER (APPROVED COMBINATION?) [ALL]
Examine the propeller for cracks, chips and loose tape. Check propellers for de-lamination and that the propeller is the correct type, diameter and pitch according to the values in the TADS/HADS or, if modified, as published in the relevant BMAA MAAN or AAN or CAA AAN. Note that in general fixed pitch props have the pitch value stated in inches and variable props as an angle which can be measured more easily.

Ensure that all bolts are correctly secured and that the propeller bosses are not over-tightened. Do not accept repairs in propellers unless approved or, if the damage is of a superficial or cosmetic nature, ensure that the maintenance was carried out using current aircraft engineering practice. Check for signs of fretting between propeller and flange.

BOX 3.7 CARBURETTOR, AIR INTAKE, SECURITY [ALL]
Check the carburettor(s) for wear and damage especially around the flexible mountings. Verify in the logbook whether the needle(s) have been checked for signs of wear according to the service schedule, and examine them yourself only if called
up by a Service Bulletin (a second inspection will be required). Ensure that the air-filter(s) are secure and clean. Check the carburettor heat system for security and/or leaks. Check the carburettor manifold rubber intake boots for cracks by feeling for any ‘give’ in them. The crack can often be hidden from sight by the clamp or if they are internal. Ensure equaliser, breather and vent lines are not kinked or blocked.

BOX 3.8 FUEL TANK, CAP AND VENT (DRIP TRAY) [ALL]
Examine the fuel tank(s) for abrasion, leaks and security. Check vent is functioning and routed safely and that drip tray drains are clear (if fitted on tanks mounted above the engine). Check for wear on filler cap bayonet lugs, if present, and for seal compression when fastened. Check sump for water and debris. Inspect tank mounts for security and chafing.

BOX 3.9 FUEL LINES, FILTER, FUEL COCK, PUMP [ALL]
Ensure that all fuel lines are serviceable, the fuel filter(s) are clean, and that the pump vent is clear. Check that the fuel filter is suitable and that jubilee clips are sufficiently tight. Check rubber fuel lines for cracking due to aging and that the primer bulb (if fitted) is working properly. PVC fuel lines, made of Poly-Vinyl Chloride, are not permitted. Ensure that the fuel tap can be operated and that all the required placards are fitted. Look for any corrosion, chafing and leaks. Ensure there are no loose hoses and adequate use of cable ties.

PVC tubing is normally transparent and flexible when supplied, but progressively discoulours and hardens with age and exposure to gasoline fuels and vapour. Commercial types of PVC tubing contain a coarse-mesh nylon thread reinforcement, woven on the 45 degree bias, which is visible within the tube. However, it should be noted that some kinds of commercial tubing incorporating the 45 degree bias woven reinforcement, whilst looking indistinguishable from PVC tubing, are not manufactured from PVC and therefore acceptable. If in doubt feel for hardness and ask to see purchase receipts or other documentation.

See also MPD: 1998-019-R1 Light Aircraft Flexible Fuel Tubing applies to all permit aircraft and calls for immediate replacement of any PVC fuel tubing by tubing of an alternative material (e.g. from polyurethane) which does not harden and shrink with age. See Chapter B ‘Engineering Knowledge’ for more details.

Inspectors should satisfy themselves that the specification and quality of the fuel tubing, its cleanliness, the bore size of any replacement fuel tubing, and its fit onto the various end connections are suitable for the application. Suitable hose clips or equivalent must be used at the end connections, which provide adequate grip and prevent leakage of fuel vapour. Ensure that the routing and security of the tubing is such as to avoid engine hot spots and inverted ‘U’s in the pipe runs, after any tubing has been replaced. Ensure adequate free flow and correct engine functioning at all power settings during the engine ground run.

BOX 3.10 COOLING SYSTEM [ALL]
For liquid cooled engines, check coolant pipes are not kinked and that coolant contents are adequate. Check rubber hoses for cracking. Check any interconnections of heat exchangers or thermostatic valves. Check the expansion tank and overflow bottle or vent for constrictions and security. Ensure hoses are not kinked, crushed or worn, and are positioned securely over any spigot fittings. Ensure jubilee clips are not loose or overtight. Visually inspect air duct and cooling fins on the cylinder and cylinder head for obstruction and damage.

For air-cooled engines, check that the cowling is secure and, for forced air systems, that the fan belt tension is correct and its condition satisfactory. Visually inspect air duct and cooling fins on the cylinder and cylinder head for obstruction and damage.
BOX 3.11  OIL SYSTEM [ALL]

Check oil pipes are not kinked and that oil contents are adequate, and that the oil tanks and radiators are serviceable and secure. Check hoses for security and abrasion. Check that the filter is the correct type and is seated properly. Check any interconnections of heat exchangers or thermostatic valves.

BOX 3.12  ENGINE CONTROLS (THROTTLE(S), CHoke(S), MIXTURE IF FITTED) [ALL]

Ensure that all controls function and do not lock when operated together. Examine all control runs for wear, kinks and signs of corrosion. Ensure that all controls that are friction-set are not prone to slippage. Examine the splitter box — if fitted — for ease of operation. Check end stops are set correctly and not attempting to over stress the carburettors. Check routing of cables. Note that the failure mode of the carburettor springs can be different depending on the type of aircraft, generally most fail to fully open, some (mainly on Flexwing trikes) normally fail to idle (in order to prevent ground runaways).

BOX 3.13  STARTING SYSTEM [ALL]

Ensure that the hand starter system, if fitted, is operating smoothly and that the cord is routed correctly and not worn. For electric starters, verify the motor conforms to type. Be on the lookout for modified starter mechanisms, moved handle anchor points and alternative motors.

Observe whether a Soft Start Module has been fitted and carried a modification approval if not standard Rotax part. Be aware that the unit comes with either a 6 way plug or 4 way plug configuration and the relevant plug configuration depends on the engine serial number and the part number of the Rotax Electronic Module fitted to the engine. Background of Rotax 4-stroke engines). In recent years Rotax have incorporated this feature as a part of the engine build standard.

Be aware than an Airworthiness Directive No. 33 exists for all under 5700kg aircraft (first issued in 1949 and re-issued on 23 October 2003) that identifies a fire risk due to starter motors burning out and electric cables becoming overheated as a result of starter relay contacts jamming. This hazard was originally circumvented by the battery master switch, but other methods of prevention include a starter isolation switch in series with the starter relay contacts, provision of two starter relays in series and provision of a warning light to warn that the circuit is still energised and that the pilot should not attempt to take off.

BOX 3.14  ELECTRICAL GENERATING SYSTEM, CHARGING, LOW TENSION, BATTERY [ALL]

Examine as far as possible all low tension cables, lighting circuit, regulators, earthing straps and battery for security and connectivity up to the Master Switch.

BOX 3.15  IGNITION SWITCHES, PLUGS, LEADS [ALL]

Check that the ignition switch(es) operate correctly and in the right sense. Ensure correct pattern of spark plugs is in use. Externally examine high tension leads for wear and plug caps for security by feel. Ensure that inverted engines have plug cap locking ties to prevent them unseating from the spark plugs.

BOX 3.16  OPTIONAL: COMPRESSION TEST & CONROD BEARING CLEARANCE TEST [ALL]

This test is purely optional.

*** CAUTION *** After ensuring that the ignition is SWITCHED OFF and all plug caps have been removed, check that the compression is even by slowly rotating the propeller through each top dead centre. Also listen for any unusual sounds indicating possible piston wear or damage etc. If uneven or suspect, inform the Owner and, optionally, perform a compression test by the differential pressure method.
Optionally the proprietry Cyclone conrod bearing clearance tester (CCBCT) can be used on all Rotax two stroke engines to check big end and small end bearing clearances without disassembly of the engine. The unit is a piece of test equipment to monitor wear and warn of the possibility of impending big end or small end bearing failure before it occurs.

Its use does not have the ability to pick up the failures of the bearing surfaces (pitting) as they occur extremely rapidly (however large clearances normally exist prior to surface failure). It does not have the ability to check main bearings. Readings must only be taken on cold engines.

After testing all cylinders remove the CCBCT and replace the spark plugs (torquing to the correct value) refit the plug caps and, following normal procedures, test run engine. Note that indicated values take into account angular differences between piston travel and dial gauge travel on engines with angled spark plugs.

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<th>Indicated Maximum</th>
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<tbody>
<tr>
<td>277</td>
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</tr>
<tr>
<td>377</td>
<td>0.08mm (0.0032&quot;)</td>
</tr>
<tr>
<td>447</td>
<td>0.08mm (0.0032&quot;)</td>
</tr>
<tr>
<td>462</td>
<td>0.08mm (0.0032&quot;)</td>
</tr>
<tr>
<td>503 CB</td>
<td>0.08mm (0.0032&quot;)</td>
</tr>
<tr>
<td>503 DCDI</td>
<td>0.09mm (0.0035&quot;)</td>
</tr>
<tr>
<td>532</td>
<td>0.10mm (0.004&quot;)</td>
</tr>
<tr>
<td>582</td>
<td>0.081mm (0.00325&quot;)</td>
</tr>
</tbody>
</table>

**BOX 3.17 SERVICING / CHECKS UP TO DATE (ENGINE) [ALL]**

Ensure that the owner has maintained the engine in accordance with an appropriate service schedule. It is the Owner’s responsibility to be know what the recommended maintenance actions are and which components have service lives.

Where an Owner wishes to develop an alternative means of compliance to the recommended maintenance schedule, the agreement of a BMAA Inspector will be required after the Owner has verbally articulated the safety case for doing so. The aircraft logbook shall reflect the change from the recommended maintenance action.

For hired aircraft, subject to an exemption, the Inspector must satisfy himself that the correct inspection checks & maintenance actions specified in schedule have been carried out, ensuring that they are recorded in the relevant logbooks. The previous 50 hour check / 6 month (or greater interval check if that was the most recent maintenance check) must have been signed for by a BMAA inspector. See Section 4.14: Inspection of Maintenance Records of Hired Microlights and TIL032 ‘BMAA Code of Practice for Microlight Hire’.
BOX 3.18 OPTIONAL: ENGINE GROUND RUN [ALL]

This test is purely optional.

*** CAUTION *** Prepare by wearing suitable gear, (helmet, no loose clothing as necessary) and securing harness. After ensuring that the wheels are chocked and the run up zone is clear, ground run the aircraft to ensure that the engine appears to be operating smoothly at expected temperature and pressure and reaches max static RPM value, if given in the TADS (only where practicable, as some aircraft will not hold on the brakes at high power settings). Listen for even gearbox backlash chatter at idle and, where a slipper clutch is fitted, for unusual startup and shutdown noise. Check that all engine instruments are indicating expected values.

Perform a magneto check in accordance with the Pilot’s Operating Handbook and ensure prompt shutdown when both switches are turned off.

4.11.6 SECTION 4 - CANOPY STRUCTURE [PP] WING STRUCTURE [FLEX] WING & EMPENNAGE STRUCTURES [2/3 AXIS]

Note: canopies of Powered Parachutes may only be inspected by BMAA Inspectors who hold Category D authorisation.

BOX 4.1 CABLES, STRAPS, MAILLONS, GATES [PP] NOSE PLATES & CHANNEL [FLEX] WING & TAIL STRUCTURES [2/3 AXIS]

PP - Cables, straps, maillons, gates etc. must be checked as part of the canopy inspection.

FLEX - Examine the nose plate assembly for cracks and distortion. Examine drilled holes for elongation and signs of stress. Examine the Swan-hook channel for wear and cracking.

2/3 AXIS - Examine All-Metal structures for cracks, dents, popped rivets, corrosion, etc. Examine All-Composite structures for manufacturing defects, moisture penetration, cracks, impact damage, heat defects, dis-bonding, de-lamination, chemical deterioration, chafing, specific or multi-site damage, osmosis and repairs.

BOX 4.2 BRAKE LINES, CASCADE & CORE WITHDRAWALS [PP] LEADING EDGES, INCLUDING SLEEVES [FLEX] WING LEADING EDGES [2/3 AXIS]

PP - Brake lines and cascade must be checked for core withdrawals etc. must be checked as part of the canopy inspection.

FLEX - Examine the leading edges for signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Check that there is no play between the leading edges and sleeves. Ensure the leading edges are smooth, without dents of any sort. Look for damage to the leading-edge sail cloth, often a clue to hidden damage to the hidden tube. For a life extension check of main airframe aluminium alloy tubular components, as per Pegasus Service Bulletin 109, unload the primary airframe tubes and check for straightness and signs of permanent set as per the L/600 criterion laid down.

2/3 AXIS - If the wing is rigged examine the leading edge using all means at your disposal and check for smoothness. If the wing is de-rigged check for straightness and any permanent set and dents. Look for damage to the leading-edge sail cloth, often a clue to hidden damage to the hidden tube. Where the wing covering sock is heat shrunk, feel for dents through the fabric. Look everywhere for signs of damage and signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Check that there is no play between the leading edges and any sleeves.
BOX 4.3  LINE ATTACHMENT POINTS, CONNECTOR LINKS [PP] CROSS TUBES, INCLUDING ABUTMENT [FLEX] MAIN SPAR, REAR SPAR & DRAG SPAR [2/3 AXIS]

PP - Lines and their attachment points must be checked along with any connector links for security and serviceability as part of the canopy inspection.

FLEX - Examine the cross-tubes for signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Ensure the cross-tubes are straight without dents of any sort. Examine the attachments for cracks. Examine the cross tube hinge plates for distortion and that the tensioning cables and back up cables are serviceable. Look for abrasion on the ball of the abutment joint and ensure that the socket is still held in place securely.

2/3 AXIS - Look for damage at root and tips of the main spar, rear spar and drag spars, and for elongated bolt holes and ovaling. Check that they are straight and undamaged along their length and free of dents.

BOX 4.4  KARABINERS, SCREW LOCKS, CLEATS, CAM BUCKLE PULLEYS [PP] KEEL (AND BOWSPRIT / FIN TUBE IF FITTED) [FLEX] AILERON / SPOILERON STRUCTURE [2/3 AXIS]

PP - Karabiners, screw locks, cleats, cam buckle pulleys etc. must be checked along with any connector links for security and serviceability as part of the canopy inspection.

FLEX - Check that the keel tube is true and that there is no sign of stressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Check that there is no play between the keel and other airframe members. Examine the attachments for cracks. Pay particular attention to the hang point, nose and king post attachments.

2/3 AXIS - Examine framework and supports. Inspect all hinges, brackets, push-pull rods, bellcranks, control horns, balance weights, cables, pulleys, teleflex couplings, etc. Check (if fitted) condition and operation of roll trimmer. Check all stops and that control cables have correct tension and friction.

BOX 4.5  TRIM LINES, STRETCH CHECK AGAINST AMM [PP] CONTROL FRAME INCLUDING UPRIGHTS & FITTINGS [FLEX] FLAPS STRUCTURE [2/3 AXIS]

PP - Using the Airframe Maintenance Manual AMM, check the trim lines for stretch, referring to the limitations contained within.

FLEX - Examine the control frame for signs of stress especially around the attachment holes. Examine the control frame for bowing and for wear or elongation of the drilled holes. Ensure that attachment bolts are not worn or corroded. Examine attachment brackets for cracks or damage. Check for splaying at the ends of the aerofoil section downtubes. Check for loose or badly placed rivets.

2/3 AXIS - Examine framework and supports. Inspect all hinges, brackets, push-pull rods, bellcranks, control horns, balance weights, cables, pulleys, teleflex couplings, etc. Check all stops and that control cables have correct tension and friction. Check the engagement gates for wear which might allow the flaps to jump out at any stage of selection. Check for excessive play between the control and surfaces.

BOX 4.6  RIBS [PP] KING POST & LUFLINES [FLEX] RIBS & TAILPLANE STRUCTURE [2/3 AXIS]

PP - Ribs and general aerodynamic profile of the wing should be checked as best as possible.

FLEX - Examine the kingpost for compression damage or bending. Examine the drilled holes for elongation or signs of stress.
2/3 AXIS - Ribs and general aerodynamic profile of the wing should be checked as best as possible. Examine the structure for signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Ensure the leading edges are smooth, without dents of any sort. Check bracing wires are secure and nuts are mechanically locked. On surfaces with welded steel tube structures, (e.g. Thruster aircraft, feel through the fabric for loose tubes where welds may have broken.

**BOX 4.7**  SPECIAL AIRFRAME COMPONENTS [FLEX] ELEVATOR, STABILATOR & TRIM TABS [2/3 AXIS]

**FLEX** - Examine any special airframe members i.e. tip sticks, washout rods etc., for damage, cracks or signs of stress. Make sure they have not been reversed for any reason.

2/3 AXIS - Examine framework and supports. Inspect all hinges, brackets, push-pull rods, bellcranks, control horns, balance weights, cables, pulleys, teleflex couplings, etc. Check (if fitted) condition and operation of pitch trimmer. Check all stops and that control cables have correct tension and friction.

**BOX 4.8**  WING TIP STRAPS & WINGLETS (IF FITTED) [FLEX] FIN LEADING & TRAILING EDGE [2/3-AXIS]

**FLEX** - Check wing tip straps and stitching for damage. If present remove winglets and inspect condition of sail anchorage straps etc. Examine the GRP winglets for damage. Ensure that they are secure when reattached.

2/3 AXIS - Examine the leading and trailing edges for signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Ensure the leading edges are smooth, without dents of any sort.

**BOX 4.9**  HANG POINT (DISTORTION AND WEAR) [FLEX] FIN STRUCTURE [2/3 AXIS]

**FLEX** - Examine hang point attachments for cracks, elongation around holes and distortion. Look for signs of stressing and note the hang point position. Pay particular attention to all bolts and examine the thrust washers – if fitted – for wear. Ensure that all wiz pin safety rings are tie wrapped.

2/3 AXIS - Look for damage at root and tips of the fin spar and for elongated bolt holes and ovaling. Examine the leading and trailing edges for signs of overstressing, usually indicated on aluminium as whitening or crazing of the anodised surface, and check that drilled holes do not show evidence of excessive elongation. Ensure the leading edges are smooth, without dents of any sort.

**BOX 4.10**  BATTENS & BUNGEES [FLEX] BATTENS, RUDDER FRAMEWORK & STRUCTURE [2/3 AXIS]

**FLEX** - Ensure that the wing battens have been checked according to the manufacturer’s service schedule, whose period may vary according to whether the wing is kept rigged or derigged. Ascertain that they are not damaged and kinked. If necessary, check that the batten profiles conform to the Batten Plan – but do not adjust to standard trim if battens are inside the manufacturer’s limits. If battens have been deformed, e.g. in storage or by mishandling, ask the Owner to adjust them to the standard profile, or to the amended profile if these have been annotated on the batten plan after the wing was tuned.

2/3 AXIS - Examine framework and supports. Inspect all hinges, brackets, push-pull rods, bellcranks, control horns, balance weights, cables, pulleys, teleflex couplings, etc. Check all stops and that control cables have correct tension and friction. Check battens for uniformity.

**BOX 4.11**  SERVICING / CHECKS UP TO DATE CANOPY / WING / TAIL [ALL]

Ensure that the owner has maintained the canopy / wing / tail in accordance with the appropriate service schedules.
For hired aircraft, subject to an exemption, the Inspector must satisfy himself that the correct inspection checks & maintenance actions specified in schedule have been carried out, ensuring that they are recorded in the relevant logbooks. The previous 50 hour check / 6 month (or greater interval check if that was the most recent maintenance check) must have been signed for by a BMAA inspector. See Section 4.17: Inspection of Maintenance Records of Hired Microlights and TIL032 ‘BMAA Code of Practice for Microlight Hire’.

4.11.7 SECTION 5 - RIGGING [ALL]

<table>
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<tr>
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<th>Comments</th>
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<tbody>
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<td>5.1 Cables, thimbles, swages and tangs</td>
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<td>5.2 Tangs, turnbuckles, toggles and clamps</td>
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<tr>
<td>5.3 Suspension &amp; Control lines condition</td>
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BOX 5.1 STRUCTURAL CABLES, THIMBLES, SWAGES AND TANGS [ALL]

Examine cables for looseness, wear and stretching of the thimbles. Look for broken strands and signs of corrosion – usually seen as bulges in the cables or outer covering. Pay particular attention to areas subject to change of direction over pullies and fairleads. Ensure that swages appear correctly formed and that the cables are not damaged where it enters the swage. Ensure that the cables have not been restricted in their movement by over-tightening of the cable attachment bolts. If cables have been overstretched, when released of tension they tend to form into a spiral.

Fibre cored cables are not acceptable to the BMAA, unless specified by the manufacturer, so the presence of a fibre, cotton, asbestos or polyvinyl plastic core would generally indicate the use of an unapproved part. This is underlined by the AAIB Safety Recommendation below:

**Safety Recommendation 2006-126**

The British Microlight Aircraft Association should promulgate the information that fibre-cored cables should not be used on aircraft, unless specified by the manufacturer, and that the Nicopress swaging tool was not designed for fibre-cored cables and will therefore not produce a correctly swaged joint.

**AAIB Bulletin: 2/2007 G-MYWW EW/C2006/06/03**

BOX 5.2 TANGS, TURNBUCKLES, TOGGLES AND CLAMPS [ALL]

Examine tangs, toggles and clamps for excessive wear and ensure that turnbuckles are in ‘safety’ and locked.

BOX 5.3 SUSPENSION & CONTROL LINES CONDITION [PP]

Examine the lines for condition.

BOX 5.3 SWAN CATCH [FLEX]

Examine the swan catch for wear and signs of stressing. Ensure that the drilled holes are not elongated and that the shackle is securely locked.

BOX 5.3 WING/STRUT/CABLE ATTACHMENTS [2/3 AXIS]

Check attachment brackets for safety and condition. Look for any distortion from wing folding.
4.11.8 **SECTION 6 - CANOPY [PP] SAIL [FLEX] COVERING & PANELS [2/3 AXIS]**

**Note:** canopies of Powered Parachutes may only be inspected by BMAA Inspectors who hold Category D authorisation.

**BOX 6.1  STITCHING & SEAMS [ALL]**

Examine the stitching for signs of ageing or degradation, and test for strength using a Bettsometer to the published values in the TADS/HADS/POH. Ensure that the stitching can withstand a moderate amount of abrasion without failure. Pay particular attention to the keel pocket, leading edge attachments and areas of re-enforcement. Do not test primary stitching directly, recommend to pull less critical stitching in close proximity to such areas, i.e. batten pocket, or secondary stitching.

**BOX 6.2  DAMAGE, ABRASION SPOTS, TEARS [ALL]**

Look for evidence of abrasion or breaks. Pay particular attention to areas of re-enforcement and high tension. Look for signs of inadequate repairs to the sailcloth. It is not normal to accept home repairs to the trailing or leading edges, contact the manufacturer or BMAA Technical Office for advice. Note the limitations laid down in TIL015 ‘Guidelines for Sail Repairs’ with regards to minor “in the field” repairs.

**BOX 6.3  DEGRADATION & FIRMNESS [PP] SAIL TESTING [FLEX & 2/3 AXIS]**

**PP** - Test the mechanical properties of the fabric for firmness and note any degradation.

**ALL** - Identify the covering material and examine its general exterior and interior condition. Examples of fabrics are those made from woven polyester fibre (Dacron, Poly-Fiber and Ceconite), extruded polyester sheet film (Mylar) and para-aramid synthetic fiber (Kevlar) to make Kevlar scrim/Mylar film laminates (GTS Ultralam or Trilam). Examine the fabric for signs of ageing or degradation.

Examine the fabric and stitching for signs of ageing or degradation. Test the strength of the sailcloth with the Bettsometer using the load specified in the Type Approval Data Sheets/Type Acceptance Data Sheets (TADS) and Homebuilt Aircraft Data Sheets (HADS), remembering that once the desired figure is reached the sail has passed. **Do not continue to exert further force.** Sails should be tested with the sail under normal rigged tension in both the weft and warp directions. Similarly test the stitching.

Note that the test load for the stitching may be different from that used for the sailcloth and that more than one sailcloth type may be present with different test values.

If the specified test load is missing in the TADS/HADS then consult TIL071 'Laminate Sailcloth Testing', if no guidance there contact the manufacturer or the BMAA Technical Office. Tests should be made on both the upper and lower surfaces, 1 to 1.5 metres in from the tips and 1 to 1.5 metres from the root of the wing, on each aileron, flap, elevator, stabiliser, and the fin and rudder, testing both sides and each coloured fabric.

The inspector must record the test values and corresponding result on the inspection worksheet in the boxes provided.

The BMAA Technical Office has produced a TIL offering advice on the UV degradation of covering materials. The inspector should be aware of this guidance and assist with its promulgation to owners and members:

**FLEX SPECIFIC** - Modern sails tend to feature additional reinforcing areas and bands. Generally, these must also be tested in accordance with the manufacturers’ requirements.
FOR EXAMPLE:

All P&M aviation wings that feature this material must be tested using a Brooksmeter (more information in Chapter Bravo)

http://www.aaiu.ie/sites/default/files/report-attachments/REPORT%202014-014.pdf

For more information on the Brooksmeter and testing procedures please refer to the following:

http://www.pmaviation.co.uk/admin/upload_pdf/SB131Iss2%20Wing%20Testing_All%20Wi.PDF

The requirement for such testing came about due to a series of accidents, it is imperative that such testing be implemented correctly. If you have any questions you must contact the manufacturer or the BMAA Technical Office.

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**BOX 6.4 DISCOLORATION, UV DAMAGE [ALL]**

Look for discoloration or colour fading that might indicate UV degradation and test such areas with the Bettsometer (if appropriate) to ascertain the strength of the sail. Other acceptable methods include testing of sacrificial panels. Please note most canopies are ‘lifed’ by hours and or on a calendar basis – if in doubt check with the manufacturer or the BMAA Technical Office.

The BMAA Technical Office has produced a TIL offering advice on the UV degradation of covering materials. The inspector should be aware of this guidance and assist with its promulgation to owners and members:

TIL068 ‘Ultraviolet Degradation of Aircraft Coverings’

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**BOX 6.5 DEBRIS IN TRAILING EDGE [PP] BATTEN POCKETS & BUNGEES [FLEX & 2/3 AXIS]**

**PP** - Check that debris has been removed and has caused no damage.

**FLEX & 2/3 AXIS** - Examine batten pocket stitching. Look for holes in the pocket that would allow the batten to rotate or be incorrectly fitted. Ensure that all bungee cords are not fraying nor have lost their elasticity, and are correctly tensioned and knotted, or tensioned securely by the spring loaded/over centred locks if fitted to the battens. Use of plastic cable ties is not permitted as a substitute to knotting bungees together unless specified in the POH or approved as a modification.

---

**BOX 6.6 DIMENSIONS [PP] SAIL ATTACHMENTS [FLEX & 2/3 AXIS]**

**PP** - Measure top and bottom surface width and ascertain top to bottom surface span differential, using a tape measure, and record this value.

**FLEX & 2/3 AXIS** - Examine all sail attachments for wear, ageing, corrosion and distortion. Examine any ‘D’ rings for corrosion, distortion or wear. Check lacing for signs of fraying or cuts.

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**BOX 6.7 REGISTRATION LETTERS [ALL]**

Ensure registration letters are as documented and to the correct CAA specifications in CAP523 The Display of Nationality and Registration Marks on Aircraft: Guidance for Owners.

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**BOX 6.8 POROSITY & PERMEABILITY [PP] KEEL POCKET & STRAP [FLEX] PANELS [2/3 AXIS]**

**PP** - If there is localised discoloration of the fabric perform a fabric permeability check in accordance with standard parachute practice, looking for variation between the upper and lower surfaces. This is normally an indication of performance as opposed to strength.
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FLEX - Examine the keel pocket for damage, discoloration or frayed stitching.

2/3 AXIS - Check GRP skin panels for delamination and voids using the tap test with a coin. Check metal skin panels for popped rivets, cracked and deformed skin. Check fabric skin panels for condition.

4.11.9 SECTION 7 - GENERAL CONDITION & CONFORMITY [ALL]

<table>
<thead>
<tr>
<th>Box 7.1</th>
<th>FASTENERS – NUTS, BOLTS, PIP PINS, RIVETS &amp; THEIR SECURITY [ALL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Fasteners - nuts, bolts, washers, pip pins, rivets</td>
</tr>
<tr>
<td>7.2</td>
<td>Welds</td>
</tr>
<tr>
<td>7.3</td>
<td>Corrosion levels</td>
</tr>
<tr>
<td>7.4</td>
<td>General rigging and symmetry</td>
</tr>
<tr>
<td>7.5</td>
<td>Overall condition of aircraft</td>
</tr>
<tr>
<td>7.6</td>
<td>Configuration state – no omissions from basic design std.</td>
</tr>
<tr>
<td>7.7</td>
<td>Configuration state – no unauthentic parts/equip’t evident</td>
</tr>
</tbody>
</table>

During the inspection ensure all bolts are serviceable and relatively free from corrosion. Examine nuts for security and locking. Bolts that are subject to rotation must be positively locked e.g. with castellated nuts and split pins, not friction nuts, unless it is a standard manufacturer’s solution (e.g. the C42 has a hinged bolt secured with a Nyloc). Nylocs or Stiff-nuts should not be regularly undone, and replaced if so. Bolt threads must protrude through the nut but also beware of too many protruding threads indicating the bolt may have bottomed out with the nut tightened on the shank. A general rule of thumb is that bolt heads should be uppermost or face windward, unless the manufacturer specifies differently, as is often warranted. Look for signs of over-tightening usually seen by crushing of tube walls.

Pip pins should be a flush fit.

Examine all rivets for looseness (smoking) and signs of dissimilar-metal corrosion around the heads.

<table>
<thead>
<tr>
<th>BOX 7.2</th>
<th>WELDS [ALL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examine all welds visually for cracking at the toe of the weld, that is, the boundary between a weld face and the parent metal or between weld faces, and for evidence of fatigue damage.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>BOX 7.3</th>
<th>CORROSION LEVELS [ALL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record the overall level of corrosion on the inspection worksheet. This is amplified in the following section on Engineering Knowledge.</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>BOX 7.4</th>
<th>GENERAL RIGGING AND SYMMETRY [ALL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examine the rigging of the aircraft. Any difficulty in rigging must be investigated to ascertain whether or not the aircraft is incorrectly assembled or adjusted. Check that the symmetry of the aircraft appears normal, and look for leans, twists or geometric distortion in the trike chassis or airframe. Check the wing for symmetric reflex and washout.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BOX 7.5</th>
<th>OVERALL CONDITION OF AIRCRAFT [ALL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand back and judge the overall condition of the aircraft against all the available information and record it on the Inspection Schedule. Ask yourself the question “Is this owner looking after his aircraft properly?”</td>
<td></td>
</tr>
</tbody>
</table>
BOX 7.6  CONFIGURATION STATE – NO OMISSIONS FROM BASIC DESIGN STANDARD [ALL]

Ensure that the aircraft you have examined has no missing components or equipage that forms part of the basic design standard.

BOX 7.7  CONFIGURATION STATE – NO UNAUTHENTIC PARTS OR EQUIPAGE EVIDENT [ALL]

Ensure that the aircraft you have examined has no unproved or unauthentic components or equipage fitted.

Be conscious of the “infant mortality phenomenon” and the bathtub curve. New does not necessarily mean better.

4.11.10 SECTION 8 - FLIGHT & ANCILLARY CONTROLS

<table>
<thead>
<tr>
<th>8</th>
<th>Flight &amp; Ancillary controls:</th>
<th>Comments</th>
<th>✓</th>
<th>×</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>Check controls for full and free movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Check range, operation and sense of trim system if fitted</td>
<td></td>
<td></td>
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</tbody>
</table>

Check balance weights for security and controls for no slop. Check hinges and rod end bearings for serviceability and ensure that the controls are properly rigged and at the correct tension. Check all control stops for security. Check trim control is properly rigged and that all trim control surfaces, hinges and rod end bearings are serviceable. Check for frayed cables and cracked or seized pulleys. Check for safety and condition.

Check for full and free movement and that the controls are free running. Check for any excessive free play between ailerons and between aileron and control column.

Check control deflections match those specified on the TADS, using an articulated protractor, such as the one supplied by Warp Drive, to the tolerances detailed therein. Take into account the precision of measurement when evaluating the tolerated deviation. An assistant may be required for this task.

Check that absolutely no repairs have been carried out to the control surfaces of “hot ships” like the CT or Dynamic, unless the mass balance of the surface has been checked and reinstated to within the tolerances of the control mass balance report. Flutter is a very powerful force and could result from an incorrectly repaired control surface.

If for any reason a control is disturbed, ensure the correct inspection requirements are satisfied on reinstallation/connection (i.e. second inspection).

BOX 8.1  CHECK CONTROLS FOR FULL AND FREE MOVEMENT [ALL]

Check for full and free movement of hand held control lines. Check for any excessive free play between control surface and control column. Check control deflections match those specified on the TADS to the tolerances detailed therein. Take into account the precision of measurement when evaluating the tolerated deviation. An assistant may be required for this task. Check that control cable tension is adequate, or correct for type.

BOX 8.2  CHECK RANGE, OPERATION AND SENSE OF TRIM SYSTEM (IF FITTED) [ALL]

Check range, operation and sense of trim system (if fitted). Check the indication system for correct operation if fitted.

BOX 8.3  CONTROLS – CHECK END STOPS [ALL]

Check for control end stops and that they are functioning correctly.
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**BOX 8.4 CONTROLS – CHECK PLACARDING IF/WHERE REQUIRED [ALL]**

Check for control placarding is suitable against the aircraft data sheet and POH if required.

**4.11.11 SECTION 9 – FORM & PROCESS COMPLETION [ALL]**

<table>
<thead>
<tr>
<th>9</th>
<th>Form &amp; Process Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>Record end of inspection in logbook &amp; return to owner</td>
</tr>
<tr>
<td>9.2</td>
<td>Complete AW1005 &amp; give to owner</td>
</tr>
<tr>
<td>9.3</td>
<td>Advise owner of any advisory items found during inspection</td>
</tr>
<tr>
<td>9.4</td>
<td>Ensure all inspection panels are replaced</td>
</tr>
</tbody>
</table>

**BOX 9.1 RECORD END OF INSPECTION IN LOGBOOK & RETURN TO OWNER [ALL]**

The Inspector records his decision by making an entry in the Airframe Logbook below his initial entry, as follows:

- Finish Date
- Result
- Reasons for failure, if appropriate
- Signature (beneath Inspector Name & Inspector Number entered at start of inspection)

**BOX 9.2 COMPLETE INSPECTION WORKSHEET & GIVE TO OWNER [ALL]**

Ensure all appropriate parts of the form and all boxes are filled in before signing the Inspector’s Declaration.

**BOX 9.3 NOTIFY THE OWNER OF ANY ADVISORY ITEMS FOUND DURING INSPECTION [ALL]**

An advisory is a note on the Inspection Schedule that advises the Owner of items that have only just passed the inspection, and will need to replaced or repaired in the near future.

**BOX 9.4 ENSURE ALL INSPECTION PANELS ARE REPLACED [ALL]**

Ensure the Owner’s declaration is signed and all boxes are filled in before signing the Inspector’s Declaration.
4.12 INSPECTOR’S DECLARATION & PERMIT FLIGHT RELEASE CERTIFICATE (PFRC)

Based upon the condition of the aircraft at the time of inspection, the Inspector now declares whether the aircraft PASSED or FAILED the inspection. The Inspector must inform the Owner of the decision, and in the case of a FAIL, may wish to point out that it must not be flown until it achieves a PASS in the next inspection and that, furthermore, any current permit to fly will be invalid until that time. He ensures that all defects have been entered into the aircraft logbooks and noted any advisories on the inspection schedule.

When you have made your final decision as to the airworthiness or not of the aircraft, sign and date the following declaration, adding your Inspector Number and BMAA Membership Number:

I have inspected the aircraft in accordance with the requirements of SIGMA for the revalidation of a Permit to Fly

In the case where the certificate of validity has expired, the inspector declaration acts as a Permit Flight Release Certificate to clear the aircraft for a check flight:

This schedule also acts as a Permit Flight Release Certificate (PFRC) in cases where the Certificate of Validity has expired.

4.13 INSPECTION OF AMATEUR BUILT AIRCRAFT PROJECTS (INITIAL BUILD)

4.13.1 INTRODUCTION TO THE AMATEUR BUILT PROCESS

The inspection, testing and approval of an amateur built aircraft follow a well-defined process.

Broadly, the steps are as follows:

Step 1: The Inspector provides details of the amateur built project

Step 2: The inspector supervises each construction phase

Step 3: The BMAA Technical Office issues a draft Microlight Airworthiness Approval Note

Step 4: The Inspector releases the aircraft for flight test purposes

Step 5: The BMAA Test Pilot test the aircraft in flight

Step 6: The BMAA Technical Office approves a final Microlight Airworthiness Approval Note
4.13.2 **STEP 1: DETAILS OF AMATEUR BUILT PROJECT**

The Owner will first nominate an Inspector to oversee the whole of his/her project. Then the Inspector, together with the Owner, will complete the details of the project on Form BMAA/AW/022 and register it with the BMAA. The Inspector must confirm that he is prepared to inspect this project and has inspected and considered satisfactory the build location / workshop facilities and declares he is able to take-on supervision the entire project. This requires the signature of the nominated Inspector before the form is sent to the BMAA. On receipt at the BMAA, the details of the project are noted on the Homebuilt Register and the nominated Inspector is checked against his records and, if found suitable, approved by the BMAA Chief Inspector, or in his absence, the Chief Technical Officer.

The BMAA allocates a ‘Homebuild’ number BMAA/HB/####, which becomes the aircraft’s serial number, and sends the Owner confirmation of the project registration along with the following:

- A covering letter indicating the aircraft’s designation
- Stage inspection sheets for that aircraft type
- A copy of the latest HADS for the type
- A copy of TIL027Avionics
- A copy of form BMAA/AW/041 (non-Rotax engines only)
- A copy of form BMAA/AW/028 (weight and balance form)
- A list of others building the same type
- CAA aircraft registration form

Provided that the aircraft has been given a designation, the Owner may then register the aircraft with the CAA using the form provided. Once the project is registered with the BMAA, the Owner will arrange for the Inspector to complete Stage Inspection 1 (this is always the kit and workshop inspection). The Owner then proceeds with the project build as per the build manual with the Inspector completing the Stage Inspections at the appropriate points in the build.

4.13.3 **STEP 2: STAGE INSPECTIONS FOR CONSTRUCTION OF AMATEUR BUILT TYPE**

The Inspector, together with the Owner, will commence the build project using the type specific version of Form BMAA/AW/022(Type) which will be sent to them at commencement by the BMAA technical Office to record each staged inspection. The following steps describe how to complete the stage inspection sheets for an amateur built project.

**OWNER / BUILDER’S DETAILS**

Record the Builder’s Name, Membership Number, Address, Home Telephone, Work Telephone and Email Address.

**INSPECTOR’S DETAILS**

If the Inspector or other project detail changes during the course of the project, the BMAA must be informed immediately by submitting a new BMAA/AW/022 project registration form. If another Inspector takes over the project at any stage the Owner must notify the BMAA Technical Office at the earliest opportunity. After the Chief Inspector approves of the change, the Technical Office will require confirmation that the new Inspector has communicated with the old Inspector and ascertained whether there are any outstanding issues or defects associated with the build at that stage.

**AIRCRAFT DETAILS**

Record the BMAA Home-build Number (BMAA/HB/####), Aircraft Registration, Kit number and the HADS HM Number and Issue Number that was used. The build must proceed in accordance with the Build Manual. The HADS will list all optional modifications permitted. All changes must have been agreed before construction with the BMAA Technical Office. The Inspector must ensure that the Owner does not arbitrarily add ‘features’ to his aircraft. There is no extra charge for changes to the configuration. The process is described in [TIL039 ‘Amateur Build Kits – Process Guide’](#).
POWERPLANT
Record the engine type, number of cylinders, whether 2 stroke or 4 stroke, its capacity and horsepower, the exhaust system, intake system, gearing system, propeller type, number of blades, diameter, pitch (if known), source and any history of the engine. The purpose of this data is to enable the BMAA Office to verify whether the powerplant is the same as a previously approved variant and to confirm the final powerplant configuration.

MAIN STAGE INSPECTIONS
At every stage milestone the Inspector must have overseen that stage before signing it off and proceeding to the next stage. Each stage shall be signed off both by the Owner and the Inspector when they are passed.

Typically, the staged inspections for a 3-axis aircraft are:

Stage 1  Check kit paperwork, (inc. current HADS and construction manual). Confirm that no assembly has started and that the Owner has checked all kit contents for condition and against the packing list. Confirm that workshop facilities are fit for purpose.

Stage 2  Fuselage-framing, Wings, Ailerons, Slats, Flaps, Fin, Tail, (horizontal and vertical components), \textit{without} skins.

Stage 3  Wing assembly and Flying surfaces, Undercarriage, Fuselage, Cabin-framing, Slats, Fin, Tail, (horizontal and vertical components) \textit{with} skins.

Stage 4  Flight controls and control cables, (inc runs, correct attachment and operation, full and free movement, smoothness, etc). Tail and wing attachment to fuselage.

Stage 5  Inspect engine and propeller installation, fuel system, instrument and all electric installations, seats, harnesses, undercarriage and all aircraft ancillaries, (viz, door attachments, pitots, aerials, lights, etc). Overall fitness for flight.

Stage 6  All aircraft documentation (including pilot’s notes, maintenance manuals and placards listed in Section 10 of the HADS, and approved for use with this aircraft, and the airframe/engine logbooks - CAP398 & 399, or BMAA/AW/036. Weight & C of G report prepared and submitted to BMAA office.
Typical stage inspections for an amateur-build flexwing project:

**Stage 1**  Check kit paperwork, (inc current HADS and construction manual). Confirm that no assembly has started and that the Owner has checked all kit contents for condition and against the packing list. Confirm that workshop facilities are fit for purpose.

**Stage 2a**  Trike frame – condition (including all parts), certificates of conformity for all materials, correct assembly.

**Stage 2b**  Wing frame (sail off), condition (including all parts), certificates of conformity for all materials, correct assembly.

**Stage 3**  Engine Installation, fuel system, electrical wiring, instrumentation.

**Stage 4**  All controls, including engine controls and brakes.

**Stage 5**  Complete aircraft, ready to fly.

**Stage 6**  All aircraft documentation (including pilot’s notes, maintenance manuals and placards listed in Section 10 of the HADS, and approved for use with this aircraft, and the airframe/engine logbooks - CAP398 & 399, or BMAA/AW/036. Weight & C of G report prepared and submitted to BMAA office.

**MODIFICATIONS REQUIRED FOR UK APPROVAL**
List the Mandatory Modifications and confirm all areas of special concern (Annex E of HADS) have been addressed.

**APPROVED OPTIONAL MODIFICATIONS (FOR USE AT BUILD STAGE ONLY)**
The installation of all approved optional modifications is to be inspected by a BMAA Inspector and an entry made in the airframe logbook, with HADS Ref. No. (as per Annex B).

**CONTROL DEFLECTIONS [3-AXIS]**
Record the actual deflections of each control against the HADS value.

**INSTRUMENTS FITTED TO THE AIRCRAFT**
List all instruments fitted, listing the instrument type, measured units (e.g. knots), manufacturer / model, minimum scale value and maximum scale value, and check they meet the minimum requirements as listed in the HADS. Check that the required placards are fitted correctly.

**FINAL INSPECTOR DECLARATION**
The Inspector will declare that the aircraft has been checked against the details given on the form BMAA/AW/022 and that the aircraft conforms with those details and complies with the requirements of all modification approvals, copies of which are held with the aircraft documentation.

The aircraft must also comply with the appropriate HADS issue that the Inspector identifies on the form, subject to any changes to the construction standard agreed between the owner and BMAA.

They also declare that a weighing report is at Annex C to the aircraft manual, and the aircraft does not exceed the W&CG requirements of the HADS. A copy of the weighing report is attached to the stage inspections.

The condition of aircraft as presented is inspected and on the basis of viewing all areas they have access to, determines whether the aircraft is in an airworthy condition and complies with the mandatory requirements applicable to the type at the time of the final inspection. If so, the aircraft is released for test flying.

4.13.4 **STEP 3: RAISING OF THE DRAFT MAAN**

Based on the Inspectors declaration and the completed contents of the type specific staged inspection schedule (Form BMAA/AW/022(Type)), the Technical Office will draft a Microlight Airworthiness Approval Note for that aircraft example. This will be sent to the Owner together with a Test Flight Clearance Certificate.

4.13.5 **STEP 4: CERTIFICATE OF CLEARANCE FOR FLIGHT FOR TEST PURPOSES**

After performing a final whole aircraft inspection and finding it satisfactory, the Inspector releases the aircraft for flight test purposes by signing Form BMAA/AW/029: Certificate of Clearance For Flight For Test Purposes, certifying that the aircraft conforms to the declared design standard, that he has inspected the aircraft and that it is fit for flight. He also confirms that all outstanding defects and repairs to this aircraft have been cleared.

The certificate is issued under BMAA B-conditions No. DAI 9809/84, B-conditions number G-80 as defined in the Air Navigation Order schedule 2, BCAR section A chapter A8-9, and Appendix 14 to the BMAA Technical Procedures Manual. Issue of this certificate authorises the following to be carried out without a CAA permit to fly:

a) Testing of an aircraft, its engine(s) and equipment

b) Enabling an aircraft to qualify for the first issue of a permit to fly, revalidation of the permit or the approval of modifications to the aircraft.

c) Movement of an aircraft between authorised airfields where an experiment, inspection, approval, test or weighing is intended for the purposes of a) and b) above.

4.13.6 **STEP 5: THE TEST FLIGHT**

The Test Pilot will then prepare for the test flight, record the detail of the airfield selected, report any faults found on the aircraft before flight, ensure flight test observers are approved, and then conduct the test flight in accordance with the test plan.

4.13.7 **STEP 6: APPROVING THE FINAL MAAN**

Based on the certification by the Inspector and a successful outcome of the test flight, the Technical Office will finalise and approve the final Microlight Airworthiness Approval Note for that aircraft example. This will be sent to the CAA in support of the issuance of the Permit to Fly.
4.13.8 WHEN THINGS GO WRONG

Sometimes, despite the best intentions of both parties, an amateur build project may end up with recrimination between the Builder and the Inspector.

The Inspector is advised to inform the Chief Inspector and or BMAA Technical Office immediately should the Builder depart from or run ahead of the build process. Unapproved modifications or addition of equipment is not to be tolerated without formal application to and approval by the Technical Office.

At project kickoff check all kit contents for condition and against the packing list and ensure that workshop facilities are fit for purpose. If the Builder has already started to unpack and assemble at Stage 1, report this to the Chief Inspector.

Ensure both the Owner and the Inspector sign off each build stage when they are passed to pre-empt misunderstandings.

4.14 INSPECTION OF MODIFICATIONS

The process for applying for a modification is covered in TIL002 ‘Modifications’. These procedures apply to changes that are minor in nature right through to complete restoration or rebuild projects.

Unless qualifying as a Standard Minor Modification, all applications for modification are submitted on the Form BMAA/AW/002a - Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Modification and are completed in two phases. This means they cannot be initiated during the Permit Revalidation inspection, the exception being Standard Minor Modifications where there is only one phase for completion (see Section 4.9 below).

4.14.1 THE MODIFICATION APPLICATION

PHASE 1: APPLICATION

It begins with an application to the Technical Office on Form BMAA/AW/002a "Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Modification", or, in the case of standard minor modifications, using the checklists in the TIL 100 Series.

On form BMAA/AW/002a the Inspector must give an opinion as to whether the modification will affect the integrity of primary structure, the flying controls, the flight handling characteristics, the instruments, the power unit (engine and propeller) and the operators manual. He will estimate the weight change and CG change (3 axis only).

Then he declares that he has checked the aircraft logbook and mod application and has satisfied himself that all information submitted by the aircraft Owner is sufficient and correct, and whether there are, or are not, any outstanding repairs due on the aircraft.

The Technical Office will assess the application, classify it as either Major or Minor, and then process the modification, requesting additional information if required before approving it. The Owner may then proceed to modify his aircraft according to the approved design scheme.

PHASE 2: COMPLETION

The Inspector will compare the modification against the approved requirements and ensure it is correctly installed.

Note that if the modification significantly alters the empty weight of an aircraft, or it is considered likely to alter the empty CG position of a 3-axis aircraft, then a new weight report must be prepared. The BMAA may also require this if, in the opinion of the Technical Office, weight and CG limits are likely to be exceeded. The Inspector should ensure that the Total Empty Weight and Empty CG Position (for 3-axis) is recorded both in the Airframe Logbook and as a supplement to the Pilot’s Operating Handbook/Aircraft Manual.
4.14.2 INSPECTION OF MAJOR MODIFICATIONS
A BMAA Inspector is authorised to perform an inspection for the return to service after a major modification approved by the Technical Office.

The Inspector will compare the modification against the MAAN and ensure it is correctly installed. This will usually have an Appendix detailing any specific checks the Inspector must perform.

Subject to a satisfactory inspection, the draft MAAN is signed off by the Inspector and returned to the Technical Office who will up-issue the MAAN to Issue 1, placing a copy on the aircraft file. A copy will also be sent to the Owner to enable him to resume normal flying.

The Owner may only fly his aircraft once the BMAA Technical Office has approved Issue 1 of the MAAN.

4.14.3 INSPECTION OF MANUFACTURER’S SERVICE BULLETINS
All modifications initiated by the Manufacturer via a mandatory Service Bulletin (supported by an MPD) will have the inspection requirements specified by the Manufacturer. The use of a BMAA Inspector to verify the incorporation of the modification is only allowed with the agreement of the BMAA Chief Inspector after reviewing the Service Bulletin before publication.

The Owner may only fly his aircraft once the inspection criteria defined in the Service Bulletin (and/or in the accompanying Mandatory Permit Directive) have been fulfilled and the aircraft logbook signed by the inspector, be it the Owner, a Qualified Person, another competent inspector or a BMAA Inspector, as specified therein.

4.14.4 INSPECTION OF MANUFACTURER’S OPTIONAL MODIFICATIONS
The Owner may choose to fit a Manufacturer’s Optional Approved Modification [TADS/HADS Annex B] using parts supplied by the manufacturer against a published requirement. Normally the inspection is performed by a BMAA Inspector, unless the Manufacturer deems otherwise. Whomever does the inspection need only make an entry in the appropriate logbook(s).

If the Permit to Fly Certificate of Validity is still current or not suspended, the Type Approval Holder’s A1 Approved Company can release an aircraft to service after a Modification has been instituted under the Manufacturer’s approval system.

If the Permit to Fly Certificate of Validity has expired or been suspended then the Owner may only fly his aircraft once a BMAA Inspector has released it back to service, regardless of who signed off the optional modification.

4.14.5 INSPECTION OF SERIES MAJOR MODIFICATIONS
The process is more streamlined for Series Major Modifications (or Standard Major Modifications). These are major modifications which have previously been approved on an aircraft type and are appropriate for installing on other examples of the type (typically they are raised for powerplant and propeller changes which are not on the TADS). In this case a copy of a previously issued MAAN, classified for serial applicability, will be sent to the Owner together with a BMAA Flight Release Certificate (BMAA/AW/003) for the Inspector to sign.

The Inspector will compare the modification against the MAAN and ensure it is correctly installed.

The Inspector then declares that the aircraft has been checked against the details given in the Flight Release Certificate sent to the Owner by the Technical Office, and that it conforms with the details therein and complies with the requirements of
all modification approvals, copies of which are held with the aircraft documentation. He also reaffirms the TADS/HADS number that the aircraft complies with and releases the aircraft as fit for service and that the approved modifications having been properly incorporated.

The form must be sent to the BMAA as the modification is only valid once it is received by the BMAA. Note that all series major modifications start off by following the normal modification application process above.

The Owner may only be fly the aircraft once the Flight Release Certificate has been signed and returned to the Technical Office, providing the Certificate of Validity is still current.

### 4.14.6 INSPECTION OF MINOR MODIFICATIONS

A BMAA Inspector is authorised to perform an inspection for the fitment of minor modifications or for minor repairs approved by the Chief Inspector or Technical Office.

On receipt of the Approval and Record of the Minor Modification (Form BMAA/AW/004) by the Owner he will contact the Inspector to record the final inspection after the modification is incorporated or the repair completed.

The Inspector must inspect each aspect of the modification listed, applying any special conditions and declare whether it has been fully incorporated or fully removed. All modifications must be carried out using current aircraft engineering practice.

The Inspector also confirms that this minor modification is satisfactory as regards materials, standard of fabrication and installation, and that it has been carried out exactly as detailed in this form. He then declares that the modification(s) have been properly recorded in the appropriate logbook(s) and that aircraft weight and balance is not adversely affected.

The entry would read typically as follows:

**Description:** Inspector No: BMAA No: Signature: Date:

e.g. “Minor Modification No 1069 + (brief description) has been installed on this aircraft in full accordance with the approval granted by the BMAA.”

The Owner may normally fly his aircraft immediately after a BMAA Inspector has signed Form BMAA/AW/004 and the aircraft logbook, unless otherwise stated. This dispensation lapses (again unless otherwise stated) if the form does not reach the Technical Office within four weeks of the flight release.

### 4.14.7 INSPECTION OF STANDARD MINOR MODIFICATIONS

In the case of Standard Minor Modifications, there is only one phase for completion, which means that they can be done during the Permit Revalidation inspection. Applications are made using the relevant form provided for each SMM, numbered from TIL 101 onwards.

A BMAA Inspector is authorised to perform an inspection for the fitment of a standard minor modification. The following SMMs are currently available:

Always check the BMAA website for updates:

**BMAA Standard Minor Modifications List**
The Owner should read the relevant TIL before embarking on the modification. When he completes the modification, he declares that the information supplied is correct to the best of his knowledge and that he will not change the design once approved.

The Inspector should read the TIL and then complete the checklist as he inspects the installation. If it is airworthy, he then declares that the information is correct and the aircraft is fit to be flown.

Once the Inspector has signed the Standard Minor Modification checklist (contained within the TIL itself) the Owner is normally permitted to fly the aircraft immediately, providing he sends the completed paperwork to the BMAA Technical Office and enters the unique reference number issued by the Technical Office into the logbook:

e.g. G-ABCD/TIL106/2015/03123.

The Owner can do this himself over the telephone. The dispensation lapses if the form does not reach the Technical Office within four weeks of the flight release.

### 4.14.8 FILLING FORM BMAA/AW/002A ‘ASSESSMENT OF PROPOSED MODIFICATION’

All fields in the ‘Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Modification’ (Form BMAA/AW/002a), including the Owner’s details and signature, must be completed.

BMAA Modification Fees are as given in the most recent issue of Microlight Flying Magazine or via the BMAA website.

The following headings of the form must be completed as described below:

1. **AIRCRAFT DETAILS**
   - Enter Registration letters, Aircraft Type and Serial Number and the Owner’s Details. On many aircraft the variant is defined by powerplant configuration. If this is the case state the engine make / type, the reduction drive ratio and the propeller make / type, number of blades and pitch setting. State if the engine is inverted. Details should represent the current aircraft configuration (pre-modification).

   Declare whether or not the modification is already implemented on the aircraft. If yes, please note that approval is not guaranteed and that some modifications require stage inspections during implementation (which might be impossible if already implemented).

   Note that it is illegal to fly the aircraft before the modification is approved. As modification approval can take a significant time, remove the modification until approval is granted if you wish to fly in the short term.

   It is not standard practice to apply for modification approval together with an application for revalidation of the Permit to Fly, sometimes exceptions can be made – always contact the Technical Office first for permission.

2. **APPLICANT**
   - The applicant, who need not be a BMAA member, should furnish his contact details here. Most correspondence must be written - email is generally most convenient for all parties concerned.

3. **INSPECTOR**
   - A suitably qualified BMAA Inspector is proposed on the form, ensure they are contacted beforehand.
SIGMA – STANDARD INSPECTION GUIDELINES FOR MICROLIGHT AIRCRAFT

4. NO TECHNICAL OBJECTION (NTO)
Modifications to supported, type-approved (factory built) aircraft that may have a significant effect on airworthiness require the type-approval holder to declare that they have No Technical Objection (NTO) to the modification. When NTO is not required it is nonetheless good practice to approach the designer for his comments or advice.

5. PROPOSED MODIFICATION
Attach document(s) describing the modification in detail. On receipt of this application the BMAA will advise the applicant of any additional information required. If more than three documents, generate a master document to reference all subsidiary documents.

Ensure documents are unambiguously marked with an issue number (or date) to avoid confusion if it is necessary to re-issue them.

State the estimated weight change, and change in the centre of gravity for 3-axis aircraft

State whether the modification exists on any other similar aircraft, and if so, provide details of the approval reference (MAAN No., AAN No., Min Mod No.) or Registration Letters of the other aircraft.

6. TECHNICAL JUSTIFICATION
It is the applicant’s responsibility to demonstrate that the modified aircraft continues to be airworthy and to comply with its approval basis e.g. BCAR Section S. On receipt of this application the BMAA will advise the applicant of what additional information is required.

Any technical justification provided will be reviewed. On receipt of this application the BMAA will advise the applicant of any additional information required. If multiple documents are provided it is recommended to generate a master document to reference all subsidiary documents. Ensure documents are unambiguously marked with an issue number (or date) to avoid confusion if it is necessary to re-issue them.

The applicant is encouraged to consult the BMAA Technical Team, consisting of suitably qualified and experienced BMAA members who have indicated that they may be available to assist members who do not have the requisite expertise themselves. Details are found in TIL024 'BMAA Technical Team' available on the BMAA website.
4.15 INSPECTION OF REPAIRS

4.15.1 SUSPENSION OF THE CERTIFICATE OF VALIDITY

The Technical Office usually hears of damage to aircraft via an AAIB Initial Accident Notification or sometimes directly from the pilot in command. Occasionally a news report or anonymous caller alerts us to an unreported accident. This triggers a process whereby a decision is made as to whether to suspend the permit or not, based on the description of the damage contained in the AAIB Initial Accident Notification, or from other sources such as photographs of the damaged aircraft published on the internet! If a Certificate of Validity is just about to run out a suspension may be deemed to be unnecessary.

A reportable accident to the AAIB is one where the aircraft has incurred significant damage beyond that of the engine, its cowling or accessories, propellers, wing tips, antennae, tyres, brakes, fairings and small dents or punctured holes in the aircraft skin. On receipt of AAIB Initial Accident Notification BMAA will automatically suspend the of the Certificate of Validity for Permits to Fly or Certificate of Clearance for Flight for Test Purposes using the form AW/026.

Ground occurrences incurring significant damage as above, whilst non-reportable to the AAIB, should be reported directly to the BMAA Chief Inspector or one of his staff who will similarly issue the AW/026.

Any subsequent Check Flight under B-conditions is thereby legal.

The AW/026 form is used again to lift the suspension and doubles as the Certificate of Clearance for the damaged aircraft. It will need to be signed by an Inspector and Check Pilot upon successful completion of the repair and must be returned to the BMAA. This is then forwarded to the CAA so their records maybe updated. Note that if the Certificate of Validity has expired a full Permit Revalidation inspection will also be required on Form AW/001 and appropriate Inspection schedule (AW005/006/007).

4.15.2 THE DAMAGE ASSESSMENT

In addition to this a Damage Report Form AW/071 will be sent to the Owner. This is to establish the extent of damage prior to repairs being undertaken which should be documented and photographed or sketched so as to assist the inspector later for its return to service.

The damage report seeks to record the consequence of the accident, not determine the cause of it.

If invited by the Owner to assess a damaged aircraft, it most important that the Inspector makes it quite clear to the Owner that no repair work may commence without the approval of the BMAA Technical Office.

While repair by replacement with manufacturer specified parts is an owner certifiable maintenance activity, it only applies for assembly and disassembly of components using threaded fasteners. Minor ‘fettling’ activity like fitting, filing, reaming, de-burring etc. is also permitted.

Many repairs involve a fabrication process such as cutting, drilling, riveting, swaging, welding, stitching, gluing, heat treating, surface coating/plating/anodising, curing of resins, deformable bending or the use of alternative materials to that of the original specification, are likely to be classified as major repairs and require approval by the BMAA Technical Office and possibly a letter of no technical objection from the appropriate Type Approval Holder i.e. the Aircraft Manufacturer.
Exceptions to the above rule are minor repairs involving fabrication processes like exhaust welds, non-structural pop-riveting as documented, by a manufacturer supplying approved replacement assemblies, and stitching/patching of sails in accordance with TIL015 ‘Guidelines for Sail Repairs’.

Note that approval for a repair cannot be sought after it has been implemented because the BMAA will have had no formal oversight of the implementation of the work. Most major repairs cannot be satisfactorily inspected after the fact.

4.15.3 THE REPAIR APPLICATION

Always ensure the owner uses the derivative Form BMAA/AW/002b ‘Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Repair’.

PHASE 1: ADVISING OWNER’S ON REPAIRS

1. Establish whether it is a Modification or Repair.
2. If it is an intentional change to the design standard it is a modification. Either it is covered by a Standard Minor Modification or requires approval by the Technical Office and classification as to whether it is Major or Minor.
3. If it is a deviation from the approved design that arises unintentionally during service, it is a repair and will require approval by the Tech Office and classification as to whether it is a Major or Minor repair. This will depend on whether a fabrication process, such as cutting, drilling, riveting, swaging, welding, stitching, gluing, heat treating, surface coating/plating/anodising, curing of resins, deformable bending or the use of alternative materials to that of the original specification, is required.
4. If it is an exact restoration to the approved design that arises unintentionally during service due to damage, or naturally during service due to wear, corrosion or deterioration, then it is Repair by Replacement, and is a normal maintenance activity.
5. Do not advise the Owner to proceed with a Modification or Repair unless it is covered by a standard or specific approval from the BMAA Technical Office. If in doubt refer him to the Chief Technical Officer for advice.

PHASE 2: INSPECTING COMPLETED REPAIRS

1. Ask the Owner to show you the approval document. If none STOP the inspection.
2. Check the validity of the approval. If invalid, STOP the inspection.
3. If the modification or repair is approved, inspect the structure and parts in accordance with the approved inspection protocol.
4. Ensure that prepared structure and parts are inspected for absence of damage, conformity to design standard, prior to assembly & processing, before signing off any preparatory stage. If pre-existing defects are evident, STOP the inspection.
5. The Owner, or a Qualified Person selected by him/herself, may carry out the work.
6. Inspect completed modification or repair. If unairworthy, STOP the inspection.
7. If everything is satisfactory, sign off work in the logbook and compete Form AW/002b.

4.15.4 INSPECTION OF MAJOR REPAIRS

Use Form BMAA/AW/002b ‘Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Repair’.

Major repairs nearly always involve some sort of irreversible process, so if it has been determined that repairs to damaged aircraft involving a fabrication process (see also Section 9: Terminology for full definition) such as cutting, drilling, riveting, swaging, welding, stitching, gluing, heat treating, surface coating/plating/anodising, curing of resins, deformable bending or the use of alternative materials to that of the original specification will generally be classified as Major Repairs and require prior approval by the BMAA Technical Office and a letter of no technical objection from the appropriate holder of the A1 approval, a.k.a. the Type Approval Holder or Aircraft Manufacturer, and be supported by documentary evidence of approval by the appropriate authority (e.g. BMAA AAN or CAA AAN). For this reason major repairs are often carried out by the manufacturer.
The guiding principle that the Owner must be taught is “paperwork before handiwork”.

Rivet removal and replacement, while it is still considered to be a fabrication process, does not normally require prior approval by the Tech Office provided that no damage is caused during the removal phase and no drilling is required on the replacement part or existing mating parts, other than that required for the precise fitting and alignment of panels and parts which are supplied undrilled or pilot drilled.

All Major Repairs will require a second inspection by a BMAA Inspector and must be signed off in the airframe logbook.

Major Repair inspections for the lifting of a suspension of the Certificate of Validity for Permits to Fly or Certificate of Clearance for Flight for Test Purposes under CAA B-conditions, may only be carried out by a BMAA Inspector following an approved repair as a result of an earlier accident or non-compliance.

So, if as a result of reported damage, a Suspension of Certificate of Validity for a Permit To Fly (Form BMAA/AW/026) is in force, the Inspector will need to sign the Inspector’s Declaration, certifying that he has inspected the aircraft and found it to be airworthy and compliant with the requirements of the repair scheme approved by the BMAA / Type Approval Holder.

If required, the aircraft will then have to be check flown to confirm it is airworthy and handles appropriately for the type.

The Certificate of Validity/Clearance ceases to be suspended only after the form has been signed and the inspection and check flight recorded in the airframe/engine logbook. It should then be sent promptly to the BMAA.

If the aircraft fails its inspection then the suspension remains in force and the BMAA Inspector must make a certified entry in the airframe/engine logbook to the effect that he has inspected the aircraft and found it to be un-airworthy, giving reasons for the failed inspection, in order to communicate this decision to any inspector or check pilot who might be approached to re-inspect the repair.

The Owner may fly his aircraft immediately after a BMAA Inspector (and BMAA Check Pilot if required) has released it back to service by signing the BMAA/AW/026 - Suspension of Certificate of Validity for the Permits to Fly, and recording the decision in the aircraft logbook.

4.15.5 INSPECTION OF MINOR REPAIRS

Use Form BMAA/AW/002b ‘Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Repair’.

For repairs classified as minor the owner, or their nominee, may carry out the repair himself. The entry in the Airframe or Engine Logbook must then be countersigned by a BMAA Inspector at next Permit renewal.

Examples of minor repairs are mild steel exhaust welds, non-structural pop-riveting as documented by a manufacturer supplying approved replacement assemblies, and to sails with tears below the thresholds outlined in TIL015 ‘Guidelines for Sail Repairs’.

The Owner may fly his aircraft immediately after the appropriate first and second signatures are entered against the repair entry in the aircraft logbook.

4.15.6 INSPECTION OF REPAIRS BY REPLACEMENT

Specific approval is not necessarily the case with all repairs, as the Owner is free to replace parts on his aircraft using parts known to have been approved by the BMAA Technical Office or with the appropriate Type Approval Holder. Life limited or
primary structural parts removed or salvaged from other examples of the type should be supported by Form BMAA/AW/046 “Details of Removed Aircraft Part”.

However, if primary structure or flight control systems have been replaced, then a second independent inspection is required by a Qualified Person resulting in two signatures in the Airframe Logbook. See inspection matrix paragraph 4.6 for a quick reference.

The Owner may fly his aircraft immediately after the appropriate first and second signatures are entered against the repair entry in the aircraft logbook.

Filling Form BMAA/AW/002b ‘Assessment of Proposed Repair’

All fields in the ‘Initial Application for Assessment by BMAA of Proposed Microlight Aircraft Repair’ (Form BMAA/AW/002b), including the Owner’s details and signature, must be completed.

Payment is not required for repairs.

1. AIRCRAFT DETAILS
Enter Registration letters, Aircraft Type and Serial Number and the Owner’s Details. On many aircraft the variant is defined by powerplant configuration. If this is the case state the engine make / type, the reduction drive ratio and the propeller make / type, number of blades and pitch setting. State if the engine is inverted.

State whether or not the repair is implemented on the aircraft already. If yes, please note that approval is not guaranteed and that some repairs require stage inspections during implementation which may be impossible if already implemented.

2. APPLICANT
The applicant, who need not be a BMAA member, should furnish his contact details here. Most correspondence must be in writing. Email is most convenient for the BMAA.

3. INSPECTOR
A suitably qualified BMAA Inspector is proposed on the form, ensure they are contacted beforehand.

4. NO TECHNICAL OBJECTION (NTO)
Repairs to supported, type-approved (factory built) aircraft that may have a significant effect on airworthiness require the type-approval holder to declare that they have No Technical Objection (NTO) to the repair. When NTO is not required it is nonetheless good practice to approach the designer for his comments or advice.

5. WEIGHT CHANGE
State the estimated weight change, and change in the centre of gravity for 3-axis aircraft.

6. PROPOSED REPAIR
Attach document(s) describing the repair in detail.

The applicant is encouraged to consult the BMAA Technical Team, consisting of suitably qualified and experienced BMAA members who have indicated that they may be available to assist members who do not have the requisite expertise themselves. Details are found in TIL024 ‘BMAA Technical Team’ available on the BMAA website.

On receipt of this application the BMAA will advise the applicant of any additional information required.

7. DECLARATION
The Owner agrees to abide by any conditions pertaining to the repair once it has been approved.
The Applicant confirms that the information in the application is correct and that he will inform the BMAA of any changes to the design of the repair prior to approval.

8. CHECKLIST
This checklist is for the applicant’s convenience to assist in making as full an application as possible. On receipt of this application the BMAA will advise the applicant of what additional information is required.

Repair approvals do not normally incur a fee. The BMAA reserve the right to charge for assessing a proposed repair that could alternatively be economically repaired by replacement.

4.16 FUEL FLOW REQUIREMENTS

The purpose of the test is to confirm that fuel flow at full throttle is adequate for both gravity fed and pumped fuel systems. This is generally only required for new amateur built aircraft, or when modifications are made to the powerplant or fuel system.

This is a requirement in CAP 482 ‘British Civil Airworthiness Requirements for Section S - Small Light Aeroplanes’ which states in Section S 955:

- **Gravity systems**: The fuel flow rate for gravity systems (main and reserve supply) must be 150% of the take-off fuel consumption of the engine.

- **Pumped systems**: The fuel flow rate for each pump system (main and reserve supply) must be at least 125% of the take-off fuel consumption of the engine at the maximum power established for take-off.

The Inspector will satisfy himself by testing that fuel flow is adequate at maximum demand before any new amateur built aircraft is flown. The record of this inspection will consist of a letter addressed to the BMAA Chief Technical Officer and signed by the Inspector or as part of the completed powerplant checklist for an amateur built aircraft.

Technical Information leaflet TIL007 – ‘Drip trays, fuel lines and ignition switch wiring’ should also be consulted.

**Recommended reading:**

The LAA also publish a very informative Technical Leaflet

TL 2.20 Issue 2 - 21 February 2010 – Carrying Out a Fuel Flow Check to a Pumped Fuel System
4.17 INSPECTION OF MAINTENANCE RECORDS OF HIRED BMAA AIRCRAFT

4.17.1 INTRODUCTION

Hire of certain BMAA administered aircraft is allowed subject to guidance explained in TIL032 ‘BMAA Code of Practice for Aircraft Hire’.

Carrying a passenger in a hired Microlight has only been permitted since 2008. An aircraft that has been used for hiring prior to this time will need to apply for a new exemption to take advantage of this change. If the aircraft is still operating with the original single seat exemption, it must carry an endorsement on the cover of the operator’s manual, and a placard in the cockpit, stating that when hired, the aircraft may only be flown as a single seater. An aircraft holding the new two seat exemption requires no endorsement or placard.

As with all operations the aircraft must have a current Permit to Fly and not carry any unapproved modifications (including modifications pending approval or being flight tested).

4.17.2 MAINTENANCE REVIEW

All scheduled maintenance checks – of interval 50 hours / 6 months or greater – performed on aircraft exempted for hiring must be certified by a BMAA Inspector by means of a Maintenance Review statement entered into the aircraft logbook.

It is the responsibility of the ‘Maintainer’ to carry out and record this maintenance in the appropriate logbooks in accordance with the schedule in the Aircraft’s Operating Handbook/ Maintenance Manual (and, if separate, the Engine Maintenance Manual); if none exists the maintenance schedule MMS-1 in TIL 020 may be used.

It is the responsibility of the ‘BMAA Inspector’ employed for the task to certify the latest 50 hour / 6 month checks (or greater interval checks, if that was the case). If the Owner or Hirer is an appropriately qualified BMAA Inspector it is permissible for them to also certify this check.

The previous Permit to Fly revalidation must have been carried out by a BMAA Inspector and Check Pilot, who are not the Owner or Hirer. There is no exception permitted to this rule.

It is the responsibility of the ‘Pilot’ hiring the aircraft from the ‘Hirer’, before an aircraft is hired, to examine copies or originals of the following documents: the hiring exemption letter, permit to fly, certificate of validity, registration document, authority from the flying club, operator’s manual including the engine manual, all modification approvals applying to the aircraft, weight and balance report, insurance certificate(s), statement of the charging scheme, any hire conditions and, if such applies, the insurance excess and the airfield briefing sheet. He must ensure the airframe and engine logbook(s) are up to date to the end of the last flight or maintenance action, that they are properly certified, and that a summary of the aircraft’s approved modification state is in the front of the current logbook.

Before his/her first flight on any day in the aircraft, the Pilot must make a signed entry in the aircraft logbook (or elsewhere) stating that their daily inspection (DI) was satisfactory.
4.17.3 ACTIONS REQUIRED

The Maintainer should submit the airframe/engine logbooks and evidence of his work to the Inspector in the form of a worksheet (e.g. on Form BMAA/AW/068) or as a marked-up copy of the inspection schedule taken from the aircraft’s maintenance manual or, if none exists, the maintenance schedule taken from TIL 020 MMS-1, with other supporting evidence as necessary e.g. receipts for parts or consumables.

The Inspector then forms a judgement as to whether the correct work has been carried out by reading the maintenance manual and logbooks, checking the worksheet or marked up schedule against them, questioning the maintainer and, if he considers it necessary, examining the condition of the aircraft.

In signing the maintenance review statement below, the BMAA Inspector is confirming that he has satisfied himself that the correct schedule has been used at the relevant maintenance interval and that the inspection items and any maintenance actions specified have been recorded as having been carried out.

<table>
<thead>
<tr>
<th>Maintenance Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have inspected the record of work against the required maintenance schedule and I am satisfied the correct checks and actions have been recorded.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inspector Signature:</th>
<th>Inspector No.</th>
<th>Date:</th>
</tr>
</thead>
</table>
CHAPTER ALPHA

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5 LEGAL AND LIABILITY ISSUES WITH INSPECTIONS

5.1 INTRODUCTION

Over the years, aviation law has developed into a rather complex set of rules, regulations and procedures. Whether you are an owner, pilot, check pilot, instructor, inspector or maintainer, you have an obligation to ensure that your activities and your actions are not negligent or contrary to the regulations, standards or procedures.

When an accident happens, questions will be asked during the course of an investigation. The specific line of enquiry will be by asking “the hard questions” concerning acts or omissions by those involved, the nature of the duty to the public that existed, if there was a breach of duty by you, and whether someone suffered a loss that was foreseeable.

In law, this is known as “duty of care”.

This is akin to “foreseeability”. A Safety Management System [16] sets out a clear safety policy and implements a system for identifying safety hazards and managing risks. Having this system in place demonstrates that the BMAA has attempted to foresee situations that can or will lead to an incident or accident, which could result or end up in claims worth many thousands, if not millions, of pounds. In law, it all comes down to your duties, your obligations and your responsibilities to members of the aviation community, the naïve participant and the public.

The concept of negligence, duty of care, both by regulation and contract, standard of care, foreseeability, insurance considerations, risk assessment and the advantages of a full, complete and proper safety management system is explored next.
5.2 DUTIES AND OBLIGATIONS OF OWNER, MAINTAINER AND INSPECTOR

Aircraft operators are responsible for their own safety, that of their passenger and for not endangering the safety of an aircraft. They are also responsible to ensure that the crew members and other aviation personnel are able to operate safely. This is enshrined in the ANO, viz:

ANO Article 73: Endangering safety of an aircraft
A person shall not recklessly or negligently act in a manner likely to endanger an aircraft, or any person therein.

ANO Article 74: Endangering safety of any person or property
A person shall not recklessly or negligently cause or permit an aircraft to endanger any person or property.

In addition to the passengers and others, aircraft operators are also liable to third parties as a result of accidents or incidents.

Responsibility can also be shared by others and is sometimes referred to as concurrent responsibility. This is typically shared by pilots, engineers, maintenance organisations, local airport authorities, air traffic controllers, the aircraft manufacturer or component manufacturers or overhaulers, the Government, service companies and various aviation personnel who provide aviation services.

We have now seen to whom we are responsible and who shares in that responsibility. This acts as a good “check and balance” for the purposes of ensuring that your operation has assessed and considered the appropriate “risk” and that steps have been taken to minimise those risks as much as possible.

5.2.1 OWNER’S RESPONSIBILITIES

It is the registered owner’s and operator’s direct responsibility, not that of the inspector, to maintain the aircraft as per the conditions stated on the Permit to Fly. The owner must inform their inspector of any maintenance, repair or modification when the aircraft is being examined for the annual validation of a Permit to Fly. The inspection represents an annual audit of the owner’s care of their machine.

5.2.2 INSPECTOR’S RESPONSIBILITIES

The Inspector has an obligation to ensure that his activities and actions are not negligent or contrary to law, regulations, standards or procedures. He is responsible to the BMAA for inspecting the aircraft according to the standard guidelines laid down herein and, after carrying out the inspection, shares accountability with the owner for the safety of the general public, because in law, anyone who is closely or directly affected by any act or omission is owed a “duty of care”.

5.2.3 BMAA INDEMNITY INSURANCE

AVIATION PRODUCTS LIABILITY

The insurers have confirmed that they will include “BMAA authorised inspectors” within the definition of insured under this policy. The definition of insured will therefore be amended to read as follows:

"British Microlight Aircraft Association (BMAA) and/or Subsidiary and/or Associated Companies and/or their respective officers, directors, employees (full/part-time/free-lance/volunteers/BMAA authorised inspectors) each for their respective rights and interests as they may appear."
This means that inspectors are only covered under this policy for accidental bodily injury or property damage as a result of the inspections that they are authorised to undertake on behalf of the BMAA.

*For example:*

*During a revalidation inspection the inspector fails to recognise a critical fracture in a component that later fails in flight causing a fatal accident and aircraft loss, then the inspector’s liability for the failure to spot the fault is covered. As long as said inspector has not been negligent.*

**PROFESSIONAL INDEMNITY**

The definition of employee has been amended to include "inspectors employed by, engaged by or acting on behalf of and under the control of the BMAA".

This means that inspectors are specifically covered for their legal liability to third parties due a negligent act, error or omission during the course of their work where they act on behalf of the BMAA in accordance with SIGMA guidelines. *This cover specifically excludes* bodily injury and property damage (this would be covered under the Aviation Products Liability policy above) and would only cover a financial loss suffered by a third party.

**WHAT IS NOT COVERED**

Note that the policy does not cover the inspector for damage caused by the inspector during an inspection, or at any other time.

Our advice to inspectors is to either ask the aircraft owner to add you to their own insurance policy, so that in the event of any damage being caused you are covered. Note that this is sometimes standard on some policies, or can be added usually at no extra cost. Alternatively, you could take out a personal policy that covers you for accidental damage.

**INSPECT NOT MAINTAIN**

Remember the role of the inspector is to inspect and not maintain. You find the defects and the owner makes arrangements for them to be rectified.

*For example:*

*If you spot corroded cables on an aircraft, it is not the responsibility of the inspector to replace them. Make the owner aware and the owner arranges replacement, which you subsequently re-inspect.*

The same goes for running engines or operating parts of the aircraft, it is up to the owner to comply with your requests and requirements as an inspector. If the engine must be run, get the owner to operate the aircraft. This can be useful to gain insight as to the techniques being used.

It is not the inspector’s responsibility to run the engine, just to be present to be satisfied that the fault had been rectified. By taking on the task directly you also take on the responsibility and potential liability in the event of a problem.

Such liability is not covered by any BMAA insurance and is not necessary to carry out the function of inspection.

*Section 2 of SIGMA covers this topic in detail.*
5.3 STANDARD OF CONDUCT

The Court must consider, and in fact decide, the applicable duty of care. The duty of care is the legal “standard of conduct” that a Court will consider in determining whether a specific individual or entity was negligent or whether there was a breach of that duty to passenger or student or naïve participant or general public. The test that the Court will consider is whether the standard of conduct was “reasonable” in the circumstances.

This standard applies to all phases of operation including pre-flight planning, pre-flight inspections, aircraft maintenance, in-flight operations and procedures and post-flight responsibilities.
5.4 INSPECTION AND THE LAW

5.4.1 CRIMINAL LAW

UK aviation safety legislation (including EASA Regulations) is part of criminal law. Any breach is a criminal offence. The CAA is given responsibility by DfT to enforce the law and have a team of investigation officers who will prosecute where appropriate. However, the Police/CPS are responsible for other and more serious offences such as manslaughter.

Manslaughter involves gross negligence or recklessness, where the conduct was so bad in all the circumstances as to amount to a criminal act or omission.

Recklessness means indifference to an obvious risk of injury, or actually to have foreseen the risk but to have determined nevertheless to run it.

5.4.2 NEGLIGENCE AND THE ANO

The most serious offence in the ANO, Article 73: Endangering safety of an aircraft and ANO Article 74: Endangering safety of any person or property, is reckless or negligent endangering, and also requires the prosecutor to prove recklessness or negligence.

5.4.3 CIVIL LAW

Civil liability largely depends on whether there has been negligence.

5.4.4 INGREDIENTS OF NEGLIGENCE

Four ingredients of a negligence claim are:

- a person is negligent
- loss or injury is suffered by some other person;
- the negligent person owed a duty of care to the person who has suffered loss or injury; and
- that loss or injury was reasonably foreseeable

5.4.5 NEGLIGENCE

A person is negligent if they fail to exercise such care, skill or foresight as a reasonable person (of that profession) in their situation, would exercise.

5.4.6 DUTY OF CARE

A duty of care is owed to “persons who are so closely and directly affected by my act that I ought reasonably to have them in contemplation as being so affected when I am directing my mind to the act or omissions which are called into question”.

If it is proved that there was no negligence, then there is no liability, regardless of duty of care.

5.4.7 MINIMISING RISK WITH SIGMA

It is very easy to be wise after the event and to condemn as negligence that which was only misadventure, and that a mere error of judgement is not negligence.
But where negligence is proved it almost always turns out that either no proper procedures have been developed at all or there are perfectly adequate procedures but they have not been complied with.

To minimise the risk to the BMAA Inspectorate appropriate procedures have been laid down in these Standard Inspection Guidelines for Microlight Aircraft.

The BMAA in turn ensures that the procedures are appropriate and up to date, and that an adequate number of inspectors are recruited, managed and supported, as well as monitoring and enforcing compliance to the Guidelines.

The Inspector undertakes to work within the framework laid down by the Guidelines and should report any shortfalls in the procedures and defects in the documentation when they are found to the Chief Inspector.
5.5 JUST CULTURE

There are about 10 countries in the world who offer a no-blame system of accident and incident reporting. The USA pioneered it, followed by Canada, Australia and New Zealand. Lately Korea, Singapore and South Africa have joined the list - interestingly some of the most liberated democracies in the world. Within the European Union, the most progressive States are Denmark and Sweden. Switzerland is another.

Blame-free, or no-blame cultures are extremely rare. However real progress will come as we move beyond a 'blame' culture. Criminalisation of error is a key contributor to adversarial relationships we sometimes see in the aviation industry, and as long as there is the potential for it to play a role in an incident or accident, the 'real' truth may never surface. Various versions of the truth will emerge, perhaps following particular agendas such as avoiding litigation or limiting liability. Learning becomes severely restricted, if not impossible.

Aviation traditionally was an environment in which no, or at least very few, errors were made. The public tended to believe that individuals working in the aviation industry belonged to a special breed of super-humans who performed error-free throughout their careers. Microlight accidents are sensationalised and capture the headlines out all proportion to their actual probability of occurrence. Microlights are regularly touted as 'dangerous' when in fact the statistics prove they are one of the safest aircraft types to fly in the non-public transport sector.

Over the years the authorities and we ourselves have realized that pilots are not superhumans, but normal everyday people, each as prone to committing errors as any other. Attention is shifting from determining who made the error to identifying the circumstances under which the error was made.

The purpose of voluntary hazard reporting systems is two-fold. First, by understanding the circumstances, it might become possible to introduce changes that could make it less likely that similar errors would be made again - Error Prevention, and second, understanding the circumstances might make it possible to develop strategies to minimise the negative effect of the error - Error Recovery. Safety Occurrence Reporting Programs like CHIRP or the BMAA Occurrence and Accident Reports are a cornerstone for finding these circumstances.

But note that non-punitive and confidential environment cannot be equated with total immunity. There always is, and always will be, a threshold beyond which a safety occurrence will be subject to punitive treatment. A crucial first step in clarifying the matter is to recognise the fact that the confidentiality of these reporting systems will be based on 'honest mistakes' and it must be understood that any behaviour beyond the notion of 'honest mistake' cannot be protected by confidentiality and immunity.

The dividing line between errors which are 'culpable' and those which are 'blameless' is clear. Sabotage, substance abuse and reckless violations are still punishable. System induced violations, negligent errors, organisational failures and honest errors of judgement are forgivable.
CHAPTER ALPHA

6. Human Factors within Inspection
   6.1 Human Error
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   6.3 The “Dirty Dozen”
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      6.3.2 Complacency
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6. HUMAN FACTORS WITHIN INSPECTION

6.1 HUMAN ERROR

Human error is said to be a major causative factor in 60 per cent of aircraft accidents. Errors can manifest themselves as acts of commission (Type I) or acts of omission (Type II).

There are two popular views on human error causation.

The Old View

Human error is the cause of accidents. To explain failure, you must find out who made the inaccurate assessments, wrong decisions, bad judgements and faulty actions, and then punish them. This is also known as the ‘moralistic’ view of error. [7]

The New View

Human error is a symptom of system and organisational problems. To explain failure, you don’t just focus on who made the errors, rather you find out how those inaccurate assessments, wrong decisions, bad judgements and faulty actions were made at the time, given the set of circumstances that surrounded them. This is known as the ‘systemic’ view of error. [8]

This approach was applied successfully by the Honourable Virgil P. Moshansky, a Justice of the Queen’s Bench of Alberta, in his Commission of Inquiry into the Fokker F28-1000 Fellowship crash at Dryden, Ontario on March 10, 1989, that resulted in 191 aviation safety recommendations. [23]

6.2 TYPES OF FAILURE

Modern accident thinking groups failures into two broad categories, depending on the immediacy of their consequences.

An active failure is an error or a violation which has an immediate adverse effect. These errors are usually made by the person operating the aircraft at the time. A pilot pulling instead of pushing the bar on landing exemplifies this failure type.

A latent failure is a result of an action or decision made well before an accident, the consequences of which may remain dormant for a long time. Such failures typically might originate at the regulator, approver, controller, designer, manufacturer or maintainer levels; that is, with people far removed in time and space from the event.

A decision to merge two organisations without providing training to standardize aircraft inspection and flight testing procedures illustrates the latent failure type.

These failures can also be introduced at any level of the system by the human condition, for example, through poor motivation or fatigue.

Latent failures, which originate from questionable decisions or incorrect actions, although not harmful if they occur individually, can interact to create “a window of opportunity” for a pilot, air traffic controller or mechanic to commit an active failure which breaches all the safe guards of the system and results in an accident. In such cases, the operator becomes the inheritor of a system's safe guards because they are the ones dealing with a situation in which their actions, technical problems or adverse conditions will reveal the latent failures long embedded in the system. In a well-guarded system, latent and active failures will interact, but they will not often breach the safe guards.

When the safe guards work, the result is an incident; when they do not, it is an accident.
6.2.1 FREQUENCY OF ERRORS

The United Kingdom Civil Aviation Authority (UK CAA) recently published a listing of frequently recurring maintenance discrepancies.

According to this listing, the leading maintenance problems in order of occurrence are:

1. incorrect installation of components
2. fitting of wrong parts
3. electrical wiring discrepancies (including cross-connections)
4. loose objects (tools, etc.) left in aircraft
5. inadequate lubrication
6. cowlings, access panels and fairings not secured
7. landing gear ground lock pins not removed before departure.

An analysis of 122 documented occurrences involving Human Factors errors with likely engineering relevance revealed that the main categories of maintenance error were:

<table>
<thead>
<tr>
<th>Maintenance error categories</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>omissions</td>
<td>56%</td>
</tr>
<tr>
<td>incorrect installations</td>
<td>30%</td>
</tr>
<tr>
<td>wrong parts</td>
<td>8%</td>
</tr>
<tr>
<td>other</td>
<td>6%</td>
</tr>
</tbody>
</table>

The majority of items often omitted are fastenings left undone or incomplete.
6.3 THE “DIRTY DOZEN”

Listed below are some major adverse influences on performance. Known as “the dirty dozen” they are adapted from CAP 716 Aviation Maintenance Human Factors (JAA JAR145) Appendix H. As it is useful for inspectors to understand the sources of maintenance error, I have modified the “dirty dozen” for the BMAA to show what you should avoid and how to avoid it.

1. Lack of communication
2. Complacency
3. Lack of knowledge
4. Distraction
5. Lack of teamwork
6. Fatigue
7. Lack of parts
8. Pressure
9. Lack of assertiveness
10. Stress
11. Lack of awareness
12. Norms

6.3.1 LACK OF COMMUNICATION

Lack of communication can be in the form of verbal or written or a combination of the two.

Example:

Leaving an inspection panel open with the assumption the owner will close it.

The safety nets:

a) Use logbooks, worksheets, etc. to communicate and remove doubt.
   b) Discuss work to be done or what has been completed.
   c) Never assume anything.

6.3.2 COMPLACENCY

Complacency is an insidious factor which, with the constant repetition of many inspections, can cause or contribute to an error in judgment.

Example:

Signing the inspection sheet after skipping a component that you have never found to be defective in previous inspections.

The safety nets are:

a) Train yourself to expect to find a fault.
   b) NEVER sign for anything you didn't do.

6.3.3 LACK OF KNOWLEDGE

In this ever-changing world, Lack of Knowledge is not that uncommon a cause of an error in judgment. When coupled with the "Can-Do" attitude of some of us, it becomes even more probable.
6.3.4 DISTRACTION

This cause is thought to be responsible for about 15% of all errors. You leave a task (both physically and/or mentally) for any reason and return thinking that you are further along with the task than you are.

Example:

An inspector being called away from an inspection to answer a phone call from his wife.

The safety nets listed are:

   a) When you return to the job always go back three steps
   b) Use a detailed check sheet
   c) Consider using coloured pens to mark inspected components

6.3.5 LACK OF TEAMWORK

This cause is often tied in with lack of communication but can be responsible for major errors. Although inspection is often a solitary activity, when others are present, you may ask for someone to assist you. So good teamwork becomes essential.

Example: The owner sits in the cockpit and moves the control column at your command for you to measure the control surface deflections.

The safety nets call for:

   a) Discuss what, who and how a job is to be done.
   b) Be sure that everyone understands and agrees.

6.3.6 FATIGUE

Fatigue is a very insidious cause, but, until it becomes extreme, the person is often unaware that he is affected. Symptoms of fatigue are a profound lack of energy, feelings of muscle weakness, and slowed movements or central nervous system reactions. Fatigue can also trigger serious mental exhaustion. Persistent fatigue can cause a lack of mental clarity (or feeling of mental "fuzziness"), difficulty concentrating, and in some cases, memory loss. Medical signals such as headaches, joint pain, mild fever and muscle aches, sore throat and colds should be heeded.

The fatigue safety nets call for:

   a) Be aware of the symptoms and look for them in yourself and others.
   b) Plan to avoid complex tasks at the bottom of your circadian rhythm.
   c) Sleep and exercise regularly.
6.3.7 LACK OF RESOURCES

Many microlight owners operate their aircraft on a shoestring. Look out for any cutting of corners or bogus parts used to maintain or repair.

The safety nets are:

a) Check suspect areas at the beginning of the inspection.
b) Know the difference between bona fide and rogue parts
c) If in doubt fail the inspection

6.3.8 PRESSURE

Few industries have more constant pressure to see a task completed. The secret is the ability to recognize when this pressure becomes excessive or unrealistic. Do not be hurried into completing your inspection.

The safety nets to counteract this are:

a) Be sure the pressure isn't self-induced.
b) Communicate your concerns.
c) Ask for extra help.
d) Just say No.

6.3.9 LACK OF ASSERTIVENESS

The average inspector is not an assertive person and most of the time his job does not require him to be. However, there may come a time when something is not right and he will have to be assertive in order to ensure the problem is not overlooked. Do not be browbeaten by the owner.

The safety nets to counteract this are:

a) Record the commencement of your inspection in the log book.
b) Record any defect in the log book if the owner is disbelieving.
c) Refuse to compromise your standards.

6.3.10 STRESS

Stress is a normal part of everyday life until it becomes excessive. The secret is to be able to recognize when it is becoming excessive.

Stress safety nets call for:

a) Be aware of how stress can affect your work.
b) Stop and look rationally at the problem.
c) Determine a rational course of action and follow it.
d) Take time off or at least have a short break.
e) Discuss it with someone.
f) Ask fellow inspectors to monitor your decisions.
g) Exercise your body.
6.3.11 LACK OF AWARENESS

This often occurs to very experienced inspectors who fail to think fully about the possible consequences of the decisions they are making.

The safety nets are:

a) Think of what may occur in the event of an accident.
   b) Check to see if the work you are inspecting will conflict with an existing modification or repair.
   c) Ask others if they can see any problem with the work done.

6.3.12 NORMS

This last cause is a powerful one. Most people want to be considered one of the crowd and norms develop within such a group which dictates how they behave. Research has shown that group decisions tend to be riskier than those taken alone.

The safety nets offered are:

a) Always work as per the instructions or have the instructions changed.
   b) Be aware that "norms" don't make it right.

6.4 A PERSONAL CHECKLIST

<table>
<thead>
<tr>
<th>Before the Inspection</th>
<th>After the Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do I have sufficient knowledge to perform this inspection?</td>
<td>Did I perform this inspection to the best of my abilities?</td>
</tr>
<tr>
<td>Do I have all the technical data, log books and manuals perform this inspection?</td>
<td>Was the decision reached with correct data?</td>
</tr>
<tr>
<td>Have I performed this inspection before?</td>
<td>Did the inspection go according to plan?</td>
</tr>
<tr>
<td>Have I had proper training to do this inspection?</td>
<td>Did I learn anything from this inspection?</td>
</tr>
<tr>
<td>Have I read all the Service Bulletins, Airworthiness Directives, Mandatory permit Directives and Data Sheets to ensure legal compliance?</td>
<td>Do I need to record any observations in my personal diary/daybook or inform the Chief Inspector of any unusual observations?</td>
</tr>
<tr>
<td>Am I mentally prepared to perform this inspection?</td>
<td>Did I perform this inspection without pressure, stress and distraction?</td>
</tr>
<tr>
<td>Am I physically prepared to perform this inspection?</td>
<td>Did I perform all the operational checks to verify compliance?</td>
</tr>
</tbody>
</table>
Have I taken the proper safety precautions to perform this inspection?

Did I use all the methods, techniques and practices in the inspection?

Do I have all the resources required to perform this inspection?

Am I willing to sign for the inspection performed?

### 6.5 HUMAN ERROR CLASSIFICATION

Human error can be broken down and classified in a number of ways. One widely accepted taxonomy was put forward by Reason [8] which divides unsafe acts into two broad categories: activities that are unintentional, and those that are intended.

#### 6.5.1 UNINTENDED ACTIONS

Unintended actions are further broken down into slips and lapses, and intended actions into mistakes and violations. Much of Reason’s analysis is based on studies of everyday errors and case studies of large-scale technological disasters, such as the Chernobyl nuclear powerplant explosion.

#### 6.5.2 INTENDED ACTIONS

In terms of violations the HSE defines these as ‘any deliberate deviation from rules, procedures, instructions and regulations’ [9]. Violations that occur in the workplace have serious implications for safety. The HSE divide violations into three categories: routine, situational and exceptional.

**ROUTE VIOLATIONS**

Occur when workers break the rule to an extent that it becomes the normal way of working. Their motivation is to save time and energy, or purely because they see the rules as too restrictive.

**SITUATION VIOLATIONS**

Occur when resources needed are not available and this forces the worker to improvise.

**EXCEPTIONAL VIOLATIONS**

Are rare, but occur when the worker has good intentions but acts on a risky decision.
6.5.3 SUMMARY OF ERROR TYPES

LATENT FAILURES

Organisational Influences
- Resource Management
  - Personnel
  - Money
  - Equipment
- Organisational Climate
  - Culture
- Organisational Process
  - Technical procedures

Unsafe Supervision
- Inadequate Supervision
  - Failure to provide guidelines
  - Failure to provide training
  - Failure to provide procedures
  - Failure to perform audits
  - Failure to provide oversight
  - Failure to track qualifications
  - Failure to track performance

Planned Inappropriate Operations
- Approval of owner inspections
- Approval of owner check flights
- Approval of ferry flights

Failed to Correct Problem
- Failure to correct documentation errors
- Failure to identify inspector at risk
- Failure to track aircraft at risk
- Failure to initiate corrective action

Supervisory Violations
- Authorisation of invalid signatory

PRE-CONDITIONS FOR UNSAFE ACTS

Sub-standard Conditions of Inspectors
- Adverse Mental States
  - get-it-done-itis
  - life stress
  - task saturation
  - task fixation
  - time pressure
  - distraction
  - mental fatigue due to sleep loss & other stressors
  - personality traits & pernicious attitudes
  - overconfidence
complacency
misplaced motivation
arrogance

Adverse Physiological States
inner ear infection
head ache
eye irritation
fatigue
physical disability
shivering
perspiring

Physical/Mental Limitations
colour blind
visually impaired
muscularly weak
slipped disc
bodily inflexible
lack of dexterity
slow reaction time

Sub-standard Practices of Inspectors

Crew Resource Management
owner/operator/inspector cooperation
failure to use all available resources
failure to enlist second opinion

Personal Readiness
lack of sleep
hangover
self-medicated

ACTIVE FAILURES FOR UNSAFE ACTS

Skill-Based Errors (Unintended Behaviours) of Inspectors

Attention Failures
visual scan pattern disruption
task fixation
inadvertent activation of controls
mis-ordering steps in a procedure
distraction etc.

Memory Failures
omitted items in a checklist
losing the place in the list
forgetting original intentions

Decision Errors (Intentional Behaviour)
misdiagnosis
poor decision
improper execution of procedure
misinterpretation of data
misuse of relevant information
inaction

Perceptual Errors
visual illusion
misjudged distance
aggravated by poor illumination

Violations (Intended Behaviours) of Inspectors
Routine (infractions, willful departures from authorisation, condoned by management)
failed to adhere to procedures
lack of preparation
cutting corners
cursory attitude

Situational (improvisations, unavailable resources)
lack of preparation and planning

Exceptional (isolated departures from authorisation, not condoned by management)
not authorised for inspection category
not current and paid up
ineligible to sign for own work
signing for unseen work

An illustration of the vigilance decrement.
6.6 EXAMPLES OF INSPECTION ERRORS

Human error can be broken down and classified in a number of ways. The classification used by the Maintenance Extension to the Human Factors Analysis and Classification System (HFACS-ME) is adapted in the examples below.

6.6.1 SUPERVISORY CONDITIONS

Supervisory Conditions that lead to an active failure consists of both unforeseen organisational and field level errors:

Examples of unforeseen organisational conditions:

- A MAAN omits to draw attention to a mandatory change in the gearbox specification (Inadequate Documentation)
- Poor component layout prevents direct sight of part for inspection (Inadequate Design)
- A service bulletin calls for a modification beyond that of the owner’s competence (Inadequate Directive)

Examples of field supervisory conditions:

- An inspection is performed outside the hangar in high winds and the aircraft is overturned (Hazardous Operation)
- An inspector does not ensure that onlookers stand clear (Inadequate Supervision)
- An owner uses toxic cleaning fluids without considering risks (Inappropriate Operations)
- An owner neglects to correct short cut on performing a routine check (Uncorrected Problem)
- An owner wilfully orders someone who is untrained to move an aircraft (Supervisory Violation)

6.6.2 INSPECTOR CONDITIONS

Inspector Conditions that lead to an active failure are medical, coordination, and readiness:

Examples of inspector medical conditions:

- An inspector has a marital problem and cannot focus on the inspection (Mental State)
- An inspector works for 20 hours straight and suffers from fatigue prior to the inspection (Physical State)
- A handicapped inspector cannot reach an aircraft component for visual inspection (Physical Limitation)

Examples of inspector - coordination conditions:

- An Inspector leads the Owner into pushing his aircraft into another due to improper hand signals (Communication)
- An inspector signs off an inspection due to perceived pressure (Assertiveness)
- An inspector downplays a discrepancy to meet the check flight schedule (Adaptability)

Examples of inspector readiness conditions:

- An inspector working on an aircraft avoids attending any BMAA Inspector Seminars or Training Sessions (Training)
- An inspector engages in a procedure he has not been shown before (Qualification)
- An inspector is intoxicated on the job (Violation)
6.6.3 WORKING CONDITIONS

Working Conditions that can contribute to an active failure are environment, equipment, and workspace:

Examples of environment working conditions:

- An inspector working at night leaves a tool behind (Light)
- An inspector securing a wing in a driving rain fails to properly tie it down (Weather)
- An inspector working on a slippery floor and falls over (Environmental Hazard)

Examples of equipment working conditions:

- An inspector accepts inadequate illumination due to a broken light bulb (Damaged)
- An inspector examines control surface deflections without a protractor (Unavailable)
- An inspector uses an out of date copy of the TADS (Dated)

Examples of workspace working conditions:

- An inspector working in a hangar cannot properly position his step ladder (Confining)
- An inspector is checking for wing symmetry has his view obscured by another aircraft or object (Obstructed)
- An inspector is unable to perform a corrosion inspection that is beyond his reach (Inaccessible)

6.6.4 INSPECTOR ACTS

Inspector Acts are active failures which directly or indirectly cause mishaps, or lead to a Latent Maintenance Condition that an aircrew would have to respond to during a given phase of flight, they include errors and violations:

Examples of errors in inspector acts include:

- An inspector steps onto the sail by mistake (Attention)
- An inspector uses the wrong value in a Bettsometer test (Rule)
- An inspector incorrectly removes a wing batten causing damage (Skill)

Examples of violations in inspector acts:

- An inspector engages in practices, condoned by management, that bend the rules (Routine)
- An inspector strays from accepted procedures to save time, bending a rule (Infraction)
- An inspector willfully breaks standing rules disregarding the consequences (Exceptional)
- An inspector implements and signs off a safety critical Service Bulletin without reading it (Unacceptable)
# CHAPTER ALPHA

## 7 Where to Find Information

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<th>Description</th>
<th>Page</th>
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<td>7.4.1</td>
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<td>Mandatory Permit Directives</td>
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<td>7.6</td>
<td>BMAA Inspector Zone</td>
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<td>Inspector Seminars</td>
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<tr>
<td>7.8</td>
<td>Technical Reference Documents</td>
<td>4</td>
</tr>
</tbody>
</table>
WHERE TO FIND INFORMATION

This is an example of the types of documentation an Inspector can access on the internet as and when he needs it, to ensure the latest issue is used.

7.1 AIRCRAFT DATA SHEETS

Type Approval Data sheets for Type Approved aircraft (inc. MPDs)

Type Acceptance Data sheets for Type Accepted aircraft

Homebuilt Aircraft Data sheets for Amateur Built aircraft (inc. MPDs)

7.2 TECHNICAL INFORMATION LEAFLETS

Technical Information Leaflets (TILs) are written to give specific information on a variety of topics.

7.3 FORMS

Forms for Technical Applications and Recording.

7.4 SERVICE BULLETINS

The UK Rotax Supplier is CFS Aeros

The official Rotax website for bulletins, manuals, distributor list etc. can be found http://www.flyrotax.com or http://www.rotax-owner.com the American website where you can register and automatically receive an email to inform you that a Rotax bulletin has been issued.

Some aircraft manufacturer and importer websites publishing service bulletins are listed below:

Airborne Australia

P&M Aviation

Ascent Industries

The Light Aircraft Company

Light Sport Aviation

Pipistrel

7.4.1 BMAA SERVICE BULLETINS

Applicable to BMAA amateur built and orphan types:

BMAA Service Bulletins
7.5 MANDATORY PERMIT DIRECTIVES

**CAP 661: Mandatory Permit Directives** - contains all issued MPDs up until 31 January 2012, when the publication ceased to be amended. The MPDs in CAP 661 remain valid and are not ‘withdrawn’

All MPDs realised after 31st January 2012 are available directly on the CAA website:

http://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=list&type=sercat&id=55&filter=2&reorder=dateOrder

Mandatory Permit Directives (MPDs) are published by the Civil Aviation Authority in accordance with British Civil Airworthiness Requirements (BCAR) Chapter A5-8. They summarise the mandatory actions that are required to be complied with by UK Owners and Operators of Permit to Fly aircraft.

For quick reference the following are useful for BMAA types:

- **Miscellaneous MPDs** for all BMAA types.
- **Powerplant MPDs** for all BMAA types.

For all airframe applicable MPDs please refer to the appropriate Aircraft Datasheet.

7.6 BMAA INSPECTOR ZONE

Homepage for the BMAA Inspector Zone

Other direct links:

- **Inspector Notices**
- **Aircraft Defect Alerts**
- **BMAA Service Bulletins**

7.7 INSPECTOR SEMINARS

- **Mainair Inspection Guide 2009**
- **Pegasus & Quik Wings 2009**
- **Quik & Quantum Trikes 2009**
- **BMAA Amateur-built Kits 2012**
- **Flylight SkyRanger & Air Creation 2012**
- **EuroFOX 2016**
- **LSA Eurostar 2016**
ULPower 2018

Fly About Aviation - Pipistrel Aircraft Alpha & Virus Workshop 2018

7.8 TECHNICAL REFERENCE DOCUMENTS

FAA-H-8083-5 Weight-Shift Control Aircraft Flying Handbook 2008 (64Mb)

AC 43.13-1B Aircraft Inspection and Repair (16Mb)

AC 43.13-2B Aircraft Alterations (6Mb)


AC 65-12A A&P Mechanics Powerplant Handbook (28Mb)

AC 65-15A A&P Mechanics Airframe Handbook (30Mb)

Peter Lovegrove - Guidelines for Inspectors 1986 (4Mb)

Peter Lovegrove - Defect Warnings 1985-1989 (14Mb)

Peter Lovegrove - Fault Spotlight by Type 1985 (5Mb)

Peter Lovegrove - Summary of Reported Defects 1992 (21Mb)

Peter Lovegrove - Various SBs 1987-1988 (6Mb)

CAP 562: Civil Aircraft Airworthiness Information and Procedures (CAAIPS)

Aviation Mechanics Handbook – Dale Crane
CHAPTER BRAVO

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The following information is provided to give the Inspector some background as to how and why inspection decisions are reached.

A very good starting point for all Inspectors is to read the paper [21] by Dr Bill Brooks which he presented at the "Design your own Aeroplane" conference held at Bath University called “Structures, Materials and Costs for Light Aircraft”. It is published in the Proceedings of the 2000 Royal Aeronautical Society Conference on Light Aircraft Design.

Further information can be gleaned from AC43.13-1B: Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair and from the old Civil Aircraft Inspection Procedures (CAIPs), some of which is retained in CAP 562: CAAIPS - Civil Aircraft Airworthiness Information and Procedures.

Many popular books are published though one should be cautious in accepting all aviation “lore” at face value, particularly from internet chat groups. Check vital information from at least two independent sources before acting upon it, or better still, run your plans across the Chief Technical Officer at the BMAA.

A good data book to own is the [22] Aviation Mechanic Handbook by Dale Crane, the 5th edition of which is now out, with additional material on aircraft batteries.

Much of the material in this chapter is derived from the old Guidelines for the Inspection and Maintenance of Microlight Aircraft (GIMMA) written by the former BMAA Chief Inspector, Peter Lovegrove. While some of the advice dates back to 1993, it is still a highly relevant contribution to the inspector’s art.
8.1 FORCES OF ATTRITION

Attrition, for the purpose of these guidelines, is defined as the general wear and tear of an aircraft during its service life. The five basic sources of attrition are: weather, friction, overloads, heat, and vibration. These forces exert themselves in many ways on the entire structure of the aircraft during its life span. Persons making inspections should be familiar with the visible, measurable, or otherwise detectable effects on these forces.

8.1.1 WEATHER

Much depends on local conditions such as heat, humidity, rain, wind, and snow. Each element, or combination of elements, has its own peculiar effect upon different parts of the aircraft. These effects are discussed briefly in the following paragraphs.

ATMOSPHERIC MOISTURE - The moisture content of the atmosphere is directly related to the severity of oxidation found on an aircraft. Aircraft based near large bodies of water or in areas receiving heavy rainfall are more susceptible to oxidation (rusting and corrosion) than those based in arid areas.

OXIDATION - This condition is caused by the chemical combination of metal and oxygen. Oxidation is called rusting when talking about ferrous materials; i.e., steel or iron. The oxidation of copper, aluminium, and other nonferrous materials is usually known as corrosion.

RUSTING - Rust usually begins as a reddish discoloration on the surface and, if permitted to progress, will result in a reddish-brown crustiness on the metal surface. Removal of the crust will probably reveal pitting. If pitted, the part should be carefully evaluated to determine the extent of the damage sustained and a decision reached to either scrap or implement corrective action.

CORROSION - Aluminium and other nonferrous metals are susceptible to corrosion whenever the protective coating deteriorates. Deterioration is accelerated whenever the coating is in contact with an eroding chemical such as battery acid, insecticide, fertilizer or defoliants. Contact between two unprotected dissimilar metals sets the stage for galvanic action and corrosion, the rate of which increases greatly in the presence of moisture, especially saltwater.

Ordinary corrosion of aluminium alloy parts can be detected by watching for signs of surface flaking, pitting, or a white or greyish-white powdering. If pitting is apparent after removing the flakes or powder film, an experienced mechanic should be contacted to evaluate the damage. On aluminium alloys surfaces that have been painted, watch for paint bubbles or blisters. These indicate corrosion under the paint. The suspected part should be cleaned to the bare metal and examined carefully.

FABRIC DEGRADATION - Ultraviolet light readily attacks both thread and fabric. Look carefully for severe discolouration or other indications of deterioration of the Dacron, especially if the machine has spent any significant period of time tied down out in the open, with or without covers on the flying surfaces. Polyester fabric, such as Poly-Fiber or Ceconite, does not rot but it does rapidly lose its strength if left outside unprotected in sunlight. Spraying the fabric with a coating of vinyl filled with aluminium powder is the simplest way to block this damaging ultraviolet radiation.

Since re-covering a surface is usually an expensive process, economics dictates the practice of good preventive maintenance. Washing fabric-covered surfaces with mild soap and water, at reasonable intervals, will do much to prolong the life of dope and fabric. Protection from sunlight also prolongs fabric life, since ultraviolet light is a prime factor in fabric deterioration.
Bacteriological or fungal contamination such as mildew is also a factor in the degradation process, as are bird droppings and other animal waste.

### 8.1.2 FRICTION AND WEAR

**Friction** - Described as the resistance to relative motion between two bodies in contact. Like any machine, the aircraft develops friction in hundreds of moving parts. The effect of friction on the aircraft and its components is known as wear. Wear cannot be prevented, but steps can be taken to deter its ultimate effect on the aircraft's airworthiness by proper lubrication, alignment of moving parts, and cleanliness. To better understand inspection techniques, the terms used to describe the various conditions of wear, due to friction, must be understood. They are as follows:

**Abrasion** - Form of wear caused by the presence of an abrasive substance between two moving parts. In the flight control system, the possibility of abrasion can be detected by a gritty, grinding sensation noticeable during operation. Landing gear joints subjected to abrasion may exhibit an uneven jerky action when in motion. Usually a black gritty substance will be noticed at any joint subjected to abrasion.

**Adhesive Wear** — Also known as scoring, galling, scuffing or seizing. It occurs when two solid surfaces slide over one another under pressure. Surface projections, or asperities, are plastically deformed and eventually welded together by the high local pressure. As sliding continues, these bonds are broken, producing cavities on the surface, projections on the second surface, and frequently tiny, abrasive particles, all of which contribute to future wear of surfaces.

**Burnishing** - The polishing of a surface by sliding contact with another smooth, harder metallic surface. Usually there is no displacement or removal of metal. Burnishing is probably the least serious of friction-caused problems; however, it should be very closely monitored. It can be considered a warning of an impending more serious condition, galling, which is discussed later.

**Chafing** - Wear between two parts caused by the rubbing, sliding, or bumping of one on the other. The term is normally used to describe wear between parts not normally in contact. Chafed fabric, wood, or metal can be detected easily since chafing usually marks one or both parts involved. Metal parts, when chafed, show a bright area where contact has been made. Aluminium parts normally display a black or dark grey residue around the point of chafing. The simplest method of inspecting for chafing is to carefully inspect cables, wires, tubes, etc., wherever they are in close proximity to another part or when they are mounted to permit motion.

**Cutting** - Results in cuts or grooves in the worn part. The cause of cutting is similar to chafing except that a sharp edge is in contact, instead of a smooth surface.

**Dent** - Term used to describe an indentation in a surface produced by an object striking with force. The areas surrounding the indentation will usually be slightly upset. Areas especially susceptible to dent damage are the propeller, spinner, nose contour of engine cowling, nose cone of fuselage, and the leading edges of wings, horizontal and vertical stabilizers.

**Elongation** - Term used to describe the egg-shaped wear of a bearing surface around a bolt, hinge pin, clevis pin, etc. It results in looseness in one plane of motion greater than that of the other planes. Flight control surface hinges, engine control rod ends, flight control push-pull rod ends, bellcrank ends, cable clevis ends, and similar parts are particularly susceptible to this type of wear.
For example, an elevator may have the control cable rigged so taut that a positive pressure is applied on one side of the hinge. During normal operation, the hinge bearing will wear egg-shaped due to the hinge pin rotating under a thrust load imposed by the cable.

**EROSION** - Loss of metal from the surface by mechanical action of foreign materials, such as fine sand or water. The eroded area will be rough and may be lined in the direction in which the foreign material moved relative to the surface. Aircraft operated from unimproved airports are particularly susceptible to erosion, primarily on propellers, landing gear, cowling, and leading edges of wings and stabilizers.

**FRETTING** - Refers to corrosion damage at the asperities of contact surfaces. This damage is induced under load and in the presence of repeated relative surface motion, as induced for example by vibration. The ASM Handbook on Fatigue and Fracture defines fretting as: "A special wear process that occurs at the contact area between two materials under load and subject to minute relative motion by vibration or some other force." Fretting damage is identified by the presence of rouge (iron oxide powder) and the rough, torn appearance of the pitted surface.

**GALLING** - The breakdown (or build up) of metal surface due to excessive friction between two parts having relative motion. Particles of the softer metal are torn loose and "welded" to the harder metal. Galling quite often begins as burnishing.

**GOUGING** - Usually involves material loss but may be largely the displacement of material and results from contact with foreign material under heavy pressure.

**SCRATCHING** - Thin shallow cuts or marks in the material surface from light momentary contact with foreign material or object.

**SCUFFING** - A severe adhesive failure situation associated with high speed, high load lubricated contacts. It is particularly prevalent with cams, tappets, cylinder bores and gears.

It is characterised by the following sequence of events. Intermittent surface contact through the lubricating oil film, either due to poor entrainment, localised surface roughness or debris entrapment, followed by a consequent increase in the friction and, due to the high loads and speeds, an increase in the frictional heating, decreasing the oil viscosity, with a corresponding decrease in the oil film thickness and, inevitably, a higher frequency of surface contact events. As a result of the increased contact, even greater friction, more heating, lower viscosity and decreased separation occur leading to yet more increase in the contacts and, finally, a runaway situation where the two surfaces suffer sudden, massive adhesive contact and seizure. The event is sufficiently dramatic to produce characteristic heat transformation layers at the surface.

**SCORING** - Deeper than scratching; a notch or incision in a metal surface from contact under pressure. It may show discoloration from the temperature produced by friction. The term is normally used to describe conditions on parts designed to run together; i.e., a worn bearing might score the shaft.

**SPALLING** - Not to be confused with galling, is the flaking off of material from a larger solid body as a result of projectile impact, corrosion, weathering, cavitation, or excessive rolling pressure (as in a ball bearing).

**TEARING** - A discontinuity which has progressed through the full thickness of the material, a ripping or rending action, pulling a component apart or into pieces by force.
8.1.3 OVERLOAD AND FRACTURE

Aircraft structures and not only designed to be strong and stiff, but also to be tough. Toughness is the resistance to the propagation of cracks that occur when strain energy explosively converts into fracture energy. Objects made of brittle material may be strong (withstand high tensile stress) but may not be as tough, as they require less energy to break them than if made of more ductile materials.

When a crack appears in a strained component it will open up a little so that the two faces of the crack are separated. This implies that the material immediately next to the crack is relaxed and the strain energy in that part has been released. In fact, the strain energy release is proportional to the square of the crack length. As the crack grows it reaches a point where it is releasing more energy than it is taking to pull it apart and, suddenly, it runs away with itself. This critical crack length is known as the Griffith length after the great English engineer A.A. Griffith (1893-1963).

Aircraft are designed to absorb the loads imposed during normal operation and accept a certain amount of overload. Excessive loads, however, result in failure or deformation of the structure. This deformation may be slight or prominent, but it is usually visible. In any case, it can be detected and classified by certain appearances peculiar to the type of overload applied.

In the majority of cases, loads which result in deformed parts also overload the adjacent structure. Due to the possibility of hidden damage, a qualified mechanic, maintenance organisation or the aircraft manufacturer should be called upon to make a detailed inspection when deformation is noted. This is especially true when an aircraft has been in an accident or subjected to suspected overloads on the structure.

8.1.4 TYPES OF FORCES

**TENSION** - When a load is applied at either or both ends of an item, tending to pull it apart, it is loaded in tension. Overloads due to tension usually occur after a hard landing, taxiing on a rough field, or during flight in very turbulent air.

After a hard landing, all attachment fittings should be examined for tension failures or deformation. Failure is indicated by attachment fittings which show signs of pulling away from fuselage structure or failure on a welded area, and bolt holes which are elongated or torn. Welds are particularly subject to failure under tension loads and should be closely inspected.

In aircraft of all metal construction, overloads are usually evidenced by wrinkling of the metal skin, around wing, stabilizer and landing gear attachment points, and deformed or cracked fittings.

Wing struts are in tension during normal flight conditions and when severe vertical currents or gusts are encountered, they may be subjected to heavy loading. The strut attachment points, at the wings and fuselage, should be carefully examined for the indications of failure described for landing gears.

**COMPRESSION** - A part subject to compression loads tends to fail (bulge) at the weakest point in overall length or span, at right angles to the application of the overload.

Compression failures are usually found after a hard landing, flight through turbulent air or an accident, and affects the same areas referenced under tension in the previous paragraphs. A bulge is indicative of compression failure; however, it is not always noticeable. In this event, a break in protective paint coating may be present. Sheet metal and extruded members will
show some form of distortion when damaged by compression. In long members such as wing struts, compression may be first evidenced by what appears to be a bow or bend in the member.

A compression overload of a wood member can usually be detected by a slight ridge across the face of the member at right angles to the direction of the grain.

**TORSION** - A twisting force that tends to turn one end of a part about a longitudinal axis while the other end is held fast or turned in an opposite direction. Wheels caught in frozen ruts during a landing will tend to twist the landing gear members. Severe air loads imposed during abnormal flight manoeuvres or flight through turbulent air may twist the control surfaces or other components. Improper rigging adjustments to wings and tail surfaces may also cause twisting of these components.

The inspection, in these cases, is similar to that described for tension and compression overloads.

Certain landing gears employ a torsional member referred to as a "scissor," "nut cracker," or "torque link." Careful inspection should be made of this assembly for loose bolts and cracks, especially after landing in a rough or rutted field.

**SHEAR** - An action or stress resulting from forces applied so as to cause a portion of a part to move relatively to another portion in a direction parallel to the direction of the force. This action is normally found in tools such as bolt cutters or sheet metal shears which apply the force and shear the material being worked.

When an overload is applied, the part having the least resistance to the force will be the first to fail.

For this reason, bolts, rivets, and clevis pins should be examined for signs of failure. This is especially important when it is found that the overload members do not show the usual indications of failure. Failed bolts, clevis pins, and rivets may shear or partially shear and yet appear perfectly normal to the casual observer. To check for this condition, the following hints may prove useful:

1. **Bolts and Clevis Pins**: Removal and inspection is a positive check for condition. Removal of bolts, clevis pins, etc., is especially difficult if deformed or otherwise damaged by excessive shear loads.

2. **Rivets**: Loose or sheared aluminium rivets may be identified by the presence of black oxide which is caused to form rapidly by working of the rivet in its hole. This oxide will seep out from under the rivet head to stain the surrounding surface. Pressure applied to the skin adjacent to the rivet head will help verify the loosened condition of a rivet.

**BENDING** - A force or combination of forces that will cause a rigid member to curve or bow away from a straight line. Overloads which cause bending are usually the result of abnormal landing and flight loads, or improper ground handling of the aircraft.
Bent components will result from the following practices: stepping or pushing on lift or other struts; lifting the aircraft by the stabilizer; jacking or placing supports under longerons; overloading cabin or baggage compartments; or exceeding turn limitations of the nose steering mechanism.

On fabric-covered airplanes, a bent member can often be detected by looseness or wrinkling of the fabric. Wood or metal skin may become wrinkled, cracked, or distorted.

### 8.1.5 HEAT

The principal source of heat affecting the aircraft is the powerplant. From the standpoint of inspection, we are interested in two heating methods, direct and indirect, both normally the result of engine operation. Direct heat normally originates from leaking exhaust gases. Indirect heat is that radiated from any hot system or component.

**DIRECT HEAT** - Leaks in components of the exhaust system may permit carbon monoxide to enter the cabin heating system. More severe leaks or failures of exhaust system components may allow the escape of flames into surrounding areas with disastrous results.

To forestall serious hazards, the exhaust pipes, clamps, bolts, braces, and welds should be examined at frequent intervals. Exhaust gaskets must be in good condition. The nuts holding the exhaust pipe or manifold to the cylinder must be properly torqued and safetyed. Loose exhaust pipe bracing allows the pipe to vibrate, causes failure at the welds, and leaks from the flange surfaces. Heater muffs or shrouds should be removed to allow inspection of the exhaust system components.

**INDIRECT HEAT** - Indirect heat radiated or conducted from the engine is carried off by the action of the air stream passing through the cowling. If the air stream is unable to carry the heat away, the resulting high temperatures are harmful to the engine and may cause failure of accessories or other parts of the powerplant assembly. Excessive indirect heat may be indicated by one or more of the following:

- High oil temperature.
- High cylinder head temperature.
- Blistering of the paint covering adjacent parts within the engine compartment.
- Odour of burned oil or hot rubber during or after engine operation.
- Auto-ignition upon shut down of the engine (engine tries to continue functioning).

If any of the above indications are observed, immediate steps should be taken to trace the trouble to its source, which is usually loose or leaking engine baffles, improperly fitted cowling, improper rigging of carburettor heat door control, dirty oil coolers and screens, improper grade of oil, or oil leaks. In any case, once indications of excessive heat are found, a detailed inspection should be made by the Owner and corrective action taken immediately.

### 8.1.6 VIBRATION

Vibration is the source of many malfunctions and defects that occur throughout the life of the aircraft. Not only will vibration affect parts that are loose or poorly installed, but it will also accelerate wear and cause the ultimate failure of others. There are two types of vibration in aircraft operation; low frequency and high frequency.

**LOW FREQUENCY** (usually noticeable vibration) - Low frequency vibration is usually caused by a malfunctioning powerplant or propeller, worn engine mounting pads, looseness of the aircraft structure, or improper rigging. The problem causing vibration should be corrected as soon as discovered since it will cause abnormal wear between moving parts of the aircraft and may induce failure in any number of other aircraft parts.
HIGH FREQUENCY (less noticeable vibration) - High frequency vibration is caused by inherent vibration characteristics of the rotating masses in the engine and propeller. It can also be caused by aerodynamic forces acting through the propeller or by engine firing impulses. When harmful vibration frequencies are encountered, the pilot should avoid operating the engine in those rpm ranges that excite it.

FACTORS OF VIBRATION DAMAGE - The factors of vibration damage can be grouped into three categories: fatigue, excessive clearance, and poor installation. These points should be considered when inspecting for the effects of vibration.

FATIGUE - The weakening and/or eventual failure of a member due to the cumulative effects of repetitive loads that results in the ultimate failure of the part. The process starts with a microscopic crack, called the initiation site, which then widens with each subsequent movement. Fatigue cracks are difficult to detect or measure while taking place. The number of cycles required for failure varies and time to failure is difficult to predict and is the reason for life limiting certain components. The greater the applied stress, the shorter the life. Damage is cumulative and materials do not recover when rested.

The first mention in popular literature of a fatigue cracks was by Rudyard Kipling (1865-1936) in his stories ‘The Light That Failed’ and ‘Bread Upon the Waters’ [29]:

> “Then we used to stop and let the bearings cool down, and wonder whether the crack in the shaft was spreading.”
> “It’s the tail-shaft. Ony rollin’ is better than pitchin’ wi’ superfecial cracks in the tail-shaft.’
> She’d a great clumsy iron twelve-foot Thresher propeller - Aitcheson designed the Kites’ - and just on the tail o’ the shaft, behind the boss, was a red weepin’ crack ye could ha’ put a penknife to. Man, it was an awful crack!
> "A seven-inch crack just behind the boss. There’s no power on earth will fend it just jarrin’ off.’

Whenever a crack is detected, characterise it with respect to its nature, tightness, location and direction of propagation. Then select the appropriate NDT inspection technique available to you. Fluorescent penetrant inspection methods have a 50% probability of detection (POD) for a ½ inch crack size and are very sensitive to the condition of the metal surface. Contamination or residual/applied stresses can affect crack detectability. When using dye penetrant NDI beware of falling into the trap of “expectancy of detection”. The number of “false calls” goes up remarkably with these types of techniques.

The best prevention against fatigue damage is to maintain a smoothly running powerplant. In addition, control excessive or abnormal looseness in other components of the aircraft by good maintenance practices, particularly engine mounting pads that are designed to isolate and absorb vibration. With the above in mind, it is easily understood why the various components must be properly mounted and secured to resist the damaging effects of vibration. Copper lines are especially susceptible to fatigue and become hard and brittle when subjected to vibration. The lines should be periodically replaced or removed and annealed to restore the original softness.

EXCESSIVE CLEARANCE - Excessive clearances accelerate the wear rates of all components in which they exist and can contribute to the initiation of flutter. Flutter is an aerodynamic function, wherein oscillating high loads are imposed on the affected movable surfaces and can result in rapid fatigue failure of critical areas, such as control surface hinge fittings and

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1 Lewis W.H. et al. “Reliability of Non-Destructive Inspections” USAF Contract to Lockheed-Georgia Company SA-ALC/MME 76-6-38-1

2 Hollamby D.C. “A perspective on the Use of N.D.T. in the Inspection of Aging Aircraft” Australian Civil Aviation Authority.
attachments. Wear rates are extremely high during flutter. It is very important to maintain clearance within the limit established by the manufacturer.

**POOR INSTALLATION** - Installation, as it is used here, is the proper arrangement of the various parts in relation to each other. A fuel line, for example, may have sufficient clearance relative to another part while at rest, yet under vibration, it may move and make contact with the other part and become chafed or cut.

Ignition or electrical cables in contact with each other may appear perfectly rigid during normal operation, but during periods of vibration they may rub together and wear through the protective casings. Every part of the aircraft should be carefully examined for signs of chafing or cutting. If vibration has gone uncorrected for a time, all nuts, bolts, clamps, etc., should be checked for proper security.

**PROPELLER VIBRATION** - Propellers have inherent vibration characteristics which are not usually harmful but can induce fatigue and in time cause failure of parts essential to the airworthiness of the aircraft. This is one reason why periodic inspection of the aircraft is essential.

A special word about propellers. Quite often a propeller blade becomes nicked, especially at the leading edges. These nicks become points of stress concentration. **IT IS IMPORTANT THAT NICKS BE REMOVED AS SOON AS POSSIBLE AND IN A PROPER MANNER.** Since the removal of nicks requires special skills and tools and a thorough knowledge of the procedure, such work should be accomplished by experienced people only. The importance of correct removal of even small nicks AS SOON AS POSSIBLE after incurring them, cannot be overstressed.
8.2 CONDITION OF COMPONENTS

The following guidance notes were taken from the BMAA "On Condition Schedule" OCI-No:001. Firstly, it should be noted that ‘on-condition’ inspections cannot adequately or acceptably be carried out ‘in the field’. A well-lit, sheltered environment is necessary.

8.2.1 GENERAL SIGNS TO LOOK FOR IN “ON CONDITION” INSPECTION

You are searching for signs of enlarged bolt-holes, cracks, marked thinning, hammering of edges, corrosion, etc.

- Bolt-holes which are enlarged slightly may be acceptable in some locations but unsatisfactory in others. Engine-mounting points, for example, must show no evidence of hole enlargement. Monopole hinge-points are very likely always to be found to be slightly enlarged, with no direct hazard.
- The Southdown International aircraft were commonly found to have bolts of the incorrect plain-shank-length installed, with the result that threads were bearing on tube-walls and brackets. This led to excessive wear of both the tube and the bolt-thread. Inspectors should be especially vigilant for this problem.
- Cracks at virtually any point in primary structure mean that the component must be scrapped. A crack is a longitudinal discontinuity produced by fracture.
- Very localised thinning or fretting may sometimes be acceptable. The Inspector may be forced to make a considered judgement. But the loss of more than 10% of the thickness of the component is normally unacceptable.
- Hammering of edges of components, or of holes in them, must again be judged on the importance of its effect.
- If a component shows any corrosion, it must be dealt with by the Owner.

The steps of the “on condition” inspections are as follows.

8.2.2 DETAILED STAGES OF “ON CONDITION” INSPECTION

TUBULAR COMPONENTS AND PLATES

(i) Firstly, all areas of attachment of the components, and of the other components related to them, must be very carefully examined for signs of abrasion, fretting, cracking, corrosion, looseness, etc., before they are dismantled.

(ii) If evidence of any of these problems is found, it should be noted for reference. If the damage or wear is serious, the components must be scrapped and new ones fitted.

(iii) The listed components must now be completely dismantled from the aircraft.

If indications of problems were noted in stage (i), those zones should receive special attention, to determine if the concern was founded. The decision as to whether or not to scrap the component may be taken at this stage, if the evidence is adequately clear-cut.

(iv) If, at this stage, the component still appears to be serviceable, it should be thoroughly cleaned in accordance with good engineering practice.

(v) Repeat the detailed examination on the cleaned component.
(vi) Only if you are totally sure that the component is fully airworthy should you sign it off as such, and allow its reassembly into the aircraft.

If you are undecided about a possible crack, you must ensure that an accepted crack-testing procedure (such as dye-penetrant testing) is applied.

If you have the slightest doubt, you must consult the Chief Inspector for advice. If necessary, he will nominate another Inspector to advise or consult with you.

If you have the slightest doubts about the airworthiness of a component, you must err on the side of safety and insist that it is replaced.

(vii) When you are satisfied with the parts dismantled from the machine, or with appropriate replacement parts, you must examine the whole aircraft after reassembly using those parts. Only then can you sign the Airframe and Engine Logbook and recommend a Permit Renewal if all is acceptable.

**CABLES**

These are considerably easier to examine in detail:

(i) Dismantle the cable from the aircraft and lay it on a flat surface.

(ii) Examine it for any tendency to coil in an abnormal manner, any signs of marked kinks or any point at which there is discoloration due to rust – either outside or beneath sheathing – or projecting, broken strands.

(iii) Is the length of the cable correct? Does it give any indication at all of serious stretching?

(iv) Examine the condition of the ferrules. Are they secure or is there any hint of slippage? Is there any sign whatsoever of corrosion between the cable and the ferrule; if close scrutiny of the two end-faces of the ferrule reveals any indication of white or black material which may assumed to be corrosion products, then the cable must be scrapped and replaced.

(v) Examine the condition of the thimbles. Are they bent out of shape at all? Is there any ‘corner’ developing at the point where maximum pressure is borne? Has the thimble become at all loose in the ‘eye’ of the cable in which it sits? If it has, the cable must have stretched, or slipped through the ferrule(s), or the thimble has deformed.

(vi) Examine the condition of any coupling-plates. Are the holes enlarged or burred? Are the plates bent?

(vii) What is the condition of the monopole back-up cable? IT IS VITAL THAT THIS REMAINS ALWAYS IN PERFECT CONDITION. Does it show any indication that it has been sharply bent, by being wrongly located within the monopole during folding? If appropriate, does it have the protective sleeve round it to ensure that such damage cannot occur during folding? Was it correctly fitted to the monopole top and base, so as to be totally capable of fulfilling its function if and when required?

Again, if a cable is considered to be less than totally satisfactory in all of the above respects, it must be scrapped.
FASTENERS

When each bolt, clevis-pin, washer, nut and spring-clip is removed from a component, examine it carefully.

The following must be scrapped and replaced with new items:

(i) Bent bolts.
(ii) Bolts with damaged threads or those which have been ‘thread-bound’.
(iii) Corroded bolts, washers, clevis-pins, nuts or spring-rings.
(iv) Spring-rings which have opened up, either out of circular or between turns.
(v) Nylon-locked nuts.
(vi) Clevis-pins in which the holes for the spring-rings have enlarged or not been well-placed at original manufacture.
(vii) All used split-pins.

8.3 THE DETECTION AND ASSESSMENT OF CORROSION

8.3.1 CORROSION AND ITS IMPACT ON THE OWNER

Corrosion is a very common and potentially destructive agent, as far as airframes are concerned. Therefore, the Inspector must give scrupulous attention to its detection. The removal and the prevention of its re-occurrence is the responsibility of the Owner.

This is doubly important in the ‘On-condition’ inspection of life-limited components for which approval for extended use is being sought, beyond that recommended by the manufacturer of the aircraft in question.

Normally corrosion cannot be properly detected unless the component under scrutiny is removed from the aeroplane and divested of all subsidiary components which are normally attached to it. Ask the Owner to remove the part so it can be properly examined if you are concerned that a part may be dangerously corroded, or condemn it there and then.

The Owner should be aware of the importance for the removal of corrosion. If corrosion is found on any part of an aircraft, it is vital that it is totally removed, for two important reasons, viz:

(i) to reveal the extent of the loss of material thickness, etc., and to allow the damage to be properly assessed and a correct course of action decided upon,

(ii) because the presence of corrosion products is itself a stimulant to the further propagation of corrosion.

8.3.2 FORMS OF CORROSION

There are many forms of aircraft corrosion. The most commonly known occurs when aluminium interacts with water, creating aluminium oxide. It is not just the exterior skin of all-metal aircraft that is vulnerable; any metallic airframe expanding and contracting in response to sunlight, heat, and cold, water can penetrate into bolt holes and rivet holes and thus deeper into the structure.
Since microlights aircraft make much use of aluminium, they are particularly vulnerable to this form of corrosion. Aluminium oxide has none of the strength and structural properties of uncorroded aluminium. This is why early detection and, where necessary, replacement of overly oxidized aluminium parts is a must.

A less obvious but equally deadly form of decay is galvanic corrosion. This occurs on the atomic level, when ions flow between two adjacent, chemically different materials. Galvanic corrosion doesn’t just occur between metals; a composite/metal pairing can also result in ions being transferred.

### 8.3.3 Levels of Corrosion

Corrosion can be classified as uniform corrosion or localised corrosion [18].

Uniform corrosion, as the name suggests, occurs over the majority of the surface of a metal at a steady and often predictable rate. Although it is unsightly its predictability facilitates easy control, the most basic method being to make the material thick enough to function for the lifetime of the component.

The consequences of localised corrosion can be a great deal more severe than uniform corrosion generally because the failure occurs without warning and after a surprisingly short period of use or exposure.

There are many forms of localised corrosion, such as galvanic corrosion, pitting corrosion, selective attack, stray current corrosion, microbial corrosion, intergranular corrosion, concentration cell corrosion (crevice), thermogalvanic corrosion, corrosion caused by combined action, corrosion fatigue, fretting corrosion, stress corrosion cracking and hydrogen damage.

Stress corrosion cracking is intergranular by nature and tends to propagate at a comparatively shallow angle to the surface. When the fatigue mechanism takes over the crack turns to propagate across the thickness of the skin. Fatigue cracks causing multiple site damage (MSD) are often initiated by corrosion pitting started by small cracks in the metal surface layer.

### 8.3.4 Detecting Corrosion

Generally, corrosion is detected visually. Go over every accessible inch of an airframe during the permit inspection, having removed all access panels to maximise access and light.

The best strategy is to look in the places where water, salt and acids can seep into and collect. This means all the nooks and crannies in the fuselage, wing pockets, and within the ailerons, flaps, and elevators. Airframe corrosion doesn’t happen overnight. It can take a year or more for corrosion to seriously weaken a structure, which is why early detection is so important. For those aircraft flying in corrosion-prone areas, such as seaside coastal regions, the Owner should be advised to be on the lookout for corrosion more often.

### 8.3.5 Corrosion of Cables

Stranded steel cables of the type used for flying and landing wires, etc., have a lubricant worked into them during, and for, the manufacture process. It is therefore most important not to degrease them with any solvent.

If corrosion – typically as reddish-brown or blackened areas – is found anywhere on a cable, it will have to be scrapped and replaced.

If cables appear to be satisfactory but there is concern that future corrosion is very likely because of the known use, storage or tying-down of the aircraft, the Owner should be advised to take steps to guard against it.
The most common point at which cables exhibit corrosion, is at the ferrules. Moisture is actually ‘sucked’ into the capillary channels between the small strands of the cable and the clamping ferrule. This water then promotes corrosion.

If a close scrutiny of the centres of the two end-faces of the ferrule reveals any identification of (typically) white or black material which may be assumed to be corrosion products, the cable must be scrapped and replaced. There is no acceptable repair or reclamation procedure available to us.

8.3.6 CORROSION OF CABLE END-FITTINGS, FERRULES, TURNBUCKLES, ETC.

Thimbles are normally made from stainless steel and their failure is usually mechanical; corrosion is not generally a problem. The same is normally true of coupling plates.

Turnbuckles can suffer corrosion in the threaded portions which interact inside the ‘bottle’ part of the assembly. They also receive high point-loads inside the ‘eye’ ends. Both areas should therefore receive detailed scrutiny.

If any corrosion is found, the turnbuckle should be scrapped, even though this will normally mean that the cable, onto the thimbles of which the turnbuckle’s ‘eyes’ are normally directly attached, must also be replaced.

Clevis-pins, bolts and the like, are subjected to abrasive wear and compressive wear from the loads applied to them by thimbles or coupling-plates. They should therefore be carefully examined in the areas in which corrosion of exposed metal can reasonably be expected. If any is found, they should be judged as for other bolts and fasteners. The most common procedure to be expected is direct replacement with new parts. Especially with trivial items like clevis-pins, there is little justification for re-using doubtful parts.

8.3.7 CORROSION OF LOCKING WIRE

This seemingly trivial item is sometimes regarded too casually. Almost all locking wire sold now is made of softened stainless steel in grade 321, although 302/304 and 316 are also supplied. Locking wire in Monel 400, Inconel 600 and tinned Copper can also be purchased.

Sizes available are typically SWG 20, 21, 22, 23, 24 and 26 (0.91mm, 0.81mm, 0.71mm, 0.61mm, 0.56mm, 0.45mm).

It is important always to ensure that the correct locking wire is used because an ill-chosen material may, for example, actually set up the electrolytic corrosion process in combination with the part being locked. Brass and aluminium are typical combinations that, in the presence of water, will corrode very rapidly.

8.3.8 CORROSION OF FASTENERS

The general basis on which bolts should be scrapped has been discussed earlier. Enlarging on this, it must be recognised that – even with aircraft-quality bolts and nuts – where they are screwed together, the plating will normally be removed by the abrasive friction of the load applied via the thread. Therefore, both the nuts and the bolts should be examined for corrosion of their threads.

The small number of bolts employed in any part of a microlight structure is such that there is little argument for the retention of any fastener which is significantly corroded. It is not reasonable to consider cleaning, examination and re-plating of fasteners in our context. It is very difficult, in the absence of laboratory or professional inspection facilities, to establish to what extent the strength of a fastener has degraded. Therefore, any rusted items should be scrapped.
Where the corrosion is most definitely only superficial it may be possible to re-use the bolt, provided that it is carefully cleaned only at the affected areas with “Scotchbrite” or similar material and zinc-chromate paste is applied to it and its adjacent components during reassembly. The latter step should also take place very soon after the corrosion has been removed from the bolt.

8.3.9 CORROSION OF PLATES AND TUBES

These are undoubtedly the items which are of most concern. It was the known fallibility of the specific types of monopole materials used on early Puma Sprints which promoted the extreme procedure which ultimately appeared in the relevant Aircraft Operators’ Manuals, and which gave rise to this “On condition” schedule. The care with which the relevant plates and tubes must be examined, judged and – where appropriate – treated and re-used, must reflect this concern.

8.3.10 CORROSION OF BOLT-HOLES

Bolt-holes might be deemed to be trivial items to examine. Nothing could be more untrue.

Dirt and corrosion products get forced into minute cracks round bolt-holes, especially as bolts are withdrawn, and are not easily removed.

Reaming the holes gently is not a direct answer, because the reamer tends to draw metal over the cracks and occlude the corrosion or dirt in them.

The holes should therefore be cleaned with a round bristle brush wetted with solvent (as used in cleaning; described above). Only then can they be properly examined.

If any doubt exists as to whether a crack is present or not, a standard crack-detection method – such as the dye-penetrant technique – must be applied.

8.3.11 GALVANIC SERIES

The following galvanic table lists metals in the order of their relative activity in seawater environment. The list begins with the more active (anodic) metal and proceeds down to the least active (cathodic) metal of the galvanic series.

In general, the further apart the materials are in the galvanic series, the higher the risk of galvanic corrosion, which should be prevented by design. So, the farther one metal is from another, the greater the corrosion will be. However, the series does not provide any information on the rate of galvanic corrosion and thus serves as a basic qualitative guide only.

A "galvanic series" applies to a particular electrolyte solution, hence for each specific solution which is expected to be encountered for actual use, a different order or series will ensue. In a galvanic couple, the metal higher in the series (or the smaller) represents the anode, and will corrode preferentially in the environment. The corrosion rate of the more active metal will be accelerated, while that of the more noble metal is retarded. A greater cathode to anode area ratio will result in a greater accelerating factor in the rate of galvanic corrosion. Passivation (surface cleaning and sealing) lowers a metal’s electrical potential and improves its corrosion behaviour.

Listed below is the latest galvanic table from MIL-STD-889 where the materials have been numbered for discussion of characteristics. However, for any combination of dissimilar metals, the metal with the lower number will act as an anode and will corrode preferentially. The table is the galvanic series of metals in sea water from Army Missile Command Report RS-TR-67-11 "Practical Galvanic Series" [15]
Active (Anodic)

1. Magnesium
2. Magnesium alloy AZ-31B
3. Magnesium alloy HK-31A
4. Zinc (hot-dip, die cast, or plated)
5. Beryllium (hot pressed)
6. Aluminium alloy 7072 clad on 7075
7. Aluminium alloy 2014-T3
8. Aluminium alloy 1160-H14
9. Aluminium alloy 7079-T6
10. Cadmium (plated)
11. Uranium
12. Aluminium alloy 218 (die cast)
13. Aluminium alloy 5052-0
14. Aluminium alloy 5052-H12
15. Aluminium alloy 5456-0, H353
16. Aluminium alloy 5052-H32
17. Aluminium alloy 1100-0
18. Aluminium alloy 3003-H25
19. Aluminium alloy 6061-T6
20. Aluminium alloy A360 (die cast)
21. Aluminium alloy 7075-T6
22. Aluminium alloy 6061-0
23. Indium
24. Aluminium alloy 2014-0
25. Aluminium alloy 2024-T4
26. Aluminium alloy 5052-H16
27. Tin (plated)
28. Stainless steel 430 (active)
29. Lead
30. Steel 1010
31. Iron (cast)
32. Stainless steel 410 (active)
33. Copper (plated, cast, or wrought)
34. Nickel (plated)
35. Chromium (Plated)
36. Tantalum
37. AM350 (active) stainless steel chromium-nickel alloy
38. Stainless steel 310 (active)
39. Stainless steel 301 (active)
40. Stainless steel 304 (active)
41. Stainless steel 430 (active)
42. Stainless steel 410 (active)
43. Stainless steel 17-7PH (active)
44. Tungsten
45. Niobium (columbium) 1% Zr
46. Brass, Yellow, 268
47. Uranium 8% Mo
48. Brass, Naval, 464
49. Yellow Brass
50. Muntz Metal 280
51. Brass (plated)
52. Nickel-silver (18% Ni)
53. Stainless steel 316L (active)
54. Bronze 220
55. Copper 110
56. Red Brass
57. Stainless steel 347 (active)
58. Molybdenum, commercial pure
59. Copper-nickel 715
60. Admiralty brass
61. Stainless steel 202 (active)
62. Bronze, Phosphor 534 (B-1)
63. Monel 400
64. Stainless steel 201 (active)
65. Carpenter 20 (active)
66. Stainless steel 321 (active)
67. Stainless steel 316 (active)
68. Stainless steel 309 (active)
69. Stainless steel 17-7PH (passive)
70. Silicon Bronze 655
71. Stainless steel 304 (passive)
72. Stainless steel 301 (passive)
73. Stainless steel 321 (passive)
74. Stainless steel 201 (passive)
75. Stainless steel 286 (passive)
76. Stainless steel 316L (passive)
77. AM355 (active) stainless steel chromium-nickel-molybdenum
78. Stainless steel 202 (passive)
79. Carpenter 20 (passive)
80. AM355 (passive) stainless steel chromium-nickel-molybdenum
81. A286 (passive) iron-base nickel-chromium austenitic superalloy
82. Titanium 5Al, 2.5 Sn
83. Titanium 13V, 11Cr, 3Al (annealed)
84. Titanium 6Al, 4V (solution treated and aged)
85. Titanium 6Al, 4V (anneal)
86. Titanium 8Mn
87. Titanium 13V, 11Cr 3Al (solution heat treated and aged)
88. Titanium 75A
89. AM350 (passive) Stainless Steel Chromium-Nickel Alloy
90. Silver
91. Gold
92. Graphite

Noble (Less Active, Cathodic)
8.4 SCREW FASTENERS (NUTS, BOLTS, WASHERS, PIP-PINS ETC.)

8.4.1 BACKGROUND

Inspectors must assume, and they will often be disappointed, that given what they regard as an adequately urgent need, some Owners will re-use a badly worn nut or bolt, or install any old commercial bolt that appears to fit their purpose! There has been considerable evidence of this in all spheres of amateur aviation; BMAA members are definitely not the only ones sometimes to exhibit such foolishness. But it remains the Inspector’s job to try to root out this, or any other kind or dangerous practice. It is part of the educational aspect of the Inspector’s role.

On the older (orphan) machines, a complete miscellany of fasteners was sometimes used and, with these cherished aeronautical geriatrics continuing to emerge as the TADS standards are sorted out. Some unacceptable ones will still be found and must be dealt with.

Probably the commonest piece of bad practice was the installation of M6 bolts in holes drilled 1/4” diameter. On the basis of (wear begets wear) this was a bad start for any installation.

Another poor feature which, quite wrongly, also found its way into some Section S permit aircraft, was the use of commercial, high-tensile bolts, with long threaded portions. The strength of the bolts was acceptable but it usually meant that the threads were bearing on tubular members and fittings. If one stops to consider that it is the tips of the thread-form which rests on the tubes, transferring the load via a minute bearing area, it is easy to see why wear is so fast under such conditions.

Bolts should always be selected to be of such a length that smooth shank bears against the members being joined. If one needs to use up to 3 washers, or even an alloy collar, to achieve this happy state, so be it.

A typical example of a failure sequence caused by loads being carried on the threads of bolts is the following:

1. The axle of the nosewheel on a flexwing as secured to the flat-plate forks with a set-screw threaded into each of its ends.
2. The screw which held the right side of the axle sheared across its thread, exactly in the plane where the side-plate butted against the end of the axle.
3. The left bolt then failed because it had been left with the impossible task of supporting the whole assembly and the front-wheel ground-loads.
All that was needed was to counter drill the axle slightly from each end, to a fairly close fit on the bolts, which should have had a short plain length. The shear forces would then have fallen on to smooth shank, and not thread-form.

8.4.2 FASTENER STRENGTH

The strength of mating threads depends upon the depth and length of the thread engagement as well as the material it is made from. The depth of the engagement is based upon the overlap of the threads determined by the major diameter of the bolt thread and the minor diameter of the nut thread. The length of engagement depends upon the thread length which supports the load.

Bolt stress and the transfer of loading through the threads into another component is a complex engineering problem which takes into consideration things such as the elasticity and plasticity of materials. As materials become less plastic due to heat treating and other processes, the need for quality and adherence to dimensions and specifications becomes increasingly critical.

8.4.3 THREAD CATEGORIES

Threads generally fall into “fit” categories such as Class 1, Class 2, and Class 3. Class 1 is a sloppy fit and is hardly ever used on aircraft. Class 2 is sometimes used on aircraft, but is mostly used in automotive applications. Class 3 is mostly aircraft and, more than any other, approaches a "perfect fit" condition. There is very little tolerance between the high limit of the bolt and the low limit of the nut. They fit together, or should fit together, without any "play."

8.4.4 PRELOAD

Fasteners work through a condition termed preload. For a joint to do the job for which it was intended it must be torqued to a proper value. This preloads the assembly and transfers the load to the tightened assembly. Obviously, if the nut comes loose from the bolt, the load must be transferred elsewhere and will cause failure. Incorrect preloading can cause static failure of the fastener, static failure of the joint, vibration loosening of the nut, fatigue failure of the bolt, joint separation, joint slip, etc.

The basic quality of the parts is a vital factor. Correct preloading cannot be achieved unless the parts are the right size, are hardened properly and are in good condition. If bolts are soft then they cannot be preloaded to the correct torque, and relaxation of the joint will be even worse.

Out-of-tolerance bolts can have catastrophic effects. While it is easy to inspect for imperfections in the surrounding structure, it is much harder to assess the quality of the threads.

8.4.5 THREAD GEOMETRY

All aircraft threads are "unified" in that they have a 60-degree "included angle." The outside of the external thread is called the "major diameter" as is the unseen large diameter of the internal thread. The "minor diameter" is the root diameter at the base of the external thread while it is the visible hole in the internal thread. Again, the "pitch diameter" is that distance measured equally between the major and minor diameters. (The pitch diameter indicates the "minimum material" condition of the thread.)

8.4.6 ISO METRIC STANDARD

The metric ISO screw threads are the most commonly used type of general-purpose screw thread worldwide. They were one of the first international standards agreed when the International Organization for Standardization was set up in 1947.
The ISO metric screw thread preferred series, based on round millimeter dimensions, is the standard that has been adopted worldwide and has displaced all former standards, including the Unified Thread Standard (UTS). In the USA, where UTS is still prevalent, over 40% of products contain ISO metric screw threads. The UK, in contrast, has completely abandoned its commitment to UTS in favour of the ISO metric threads, and Canada is in between.

In November 1948 the Unified Thread was agreed upon by the UK, the US and Canada to be used as the single standard for all countries using inch units.

In 1965 the British Standards Institution issued a policy statement requesting that organisations should regard the BSW, BSF and BA threads as obsolescent. The first choice replacement for future designs was to be the ISO metric thread with the ISO inch (Unified) thread being the second choice. Metric threads are designated by the letter M followed by the nominal major diameter of the thread and the pitch in millimeters. For example M10 x 1.0 indicates that the major diameter of the thread is 10mm and the pitch is 1.0mm. The absence of a pitch value indicates that a coarse thread is specified. For example stating that a thread is M10 indicates a coarse thread series is specified of diameter 10mm (giving the thread a pitch of 1.5mm).

Each metric thread is characterized by its major diameter D and its pitch P. ISO metric threads consist of a symmetric V-shaped thread. In the plane of the thread axis, the flanks of the V have an angle of 60° to each other. The outermost 1/8 and the innermost 1/4 of the height H of the V-shape are cut off from the profile.

The thread form for Unified and Metric threads are identical.

If

\[ p = \text{pitch of the thread} \]
\[ d = \text{depth of the thread} \]
\[ r = \text{radius at the top and bottom of the threads} \]

then:

\[ d = 0.54127 \, p \]
\[ r = 0.14434 \, p \]
8.4.7 UNIFIED THREAD STANDARD

The Unified Thread Standard (UTS) defines a standard thread form and series — along with allowances, tolerances, and designations — for screw threads commonly used in the United States and Canada. It has the same 60° profile as the ISO metric screw thread used in the rest of the world, but the characteristic dimensions of each UTS thread (outer diameter and pitch) were chosen as an inch fraction rather than a round millimeter value. The UTS is currently controlled by ASME/ANSI in the United States. UTS consists of Unified Coarse (UNC), Unified Fine (UNF), Unified Extra Fine (UNEF) and Unified Special (UNS).

8.4.8 CLASS OF THREAD

A classification system exists for ease of manufacture and interchangeability of fabricated threaded items for both ISO Screw Threads and the Unified Screw Threads. This system is analogous to the fits and tolerances used with assembled parts.

It is useful for the Inspector to know that a number of things can produce a thread oversize condition. This happens if the 60-degree angle varies, or as a result of an oversize pitch diameter, a warped thread or an imperfect "lead". On the other hand, an undersize pitch will produce an undersize thread condition. Either is bad because an undersize thread will not preload properly and an oversize thread will not mate with the internal thread flanks properly and therefore will not transfer loads as needed.

For threads to be correct they must meet two criteria: minimum material condition (pitch diameter) and functional size. Functional size is defined as the size which includes the cumulative effect of variations in lead, uniformity of helix, flank angle, taper, straightness and roundness. Pitch diameter is defined as the diameter of the cylinder that passes through the thread profile of either an internal thread product or external screw thread in such a manner as to make the widths of thread ridge and thread groove equal on both sides of the thread and parallel to the axis. The pitch diameter is the measured value of the minimum material limit of size of either an internal or external thread.

8.4.9 CLASSIFICATION OF ISO SCREW THREADS

The ISO Screw Threads Tolerance Positions and Grades classification system gives a full designation for a metric thread includes information not only on the thread diameter and pitch but also a designation for the thread tolerance class.

A tolerance class is made up of two parts, a tolerance grade and a tolerance position, or fundamental deviation, which is given to an internal or external thread. A tolerance class for an internal thread when combined with the tolerance class for an external thread gives the class of fit for the mating threads.

For example, a thread designated as M12 x 1 - 5g6g indicates that the thread has a nominal diameter of 12mm and a pitch of 1mm. The 5g indicates the tolerance class for the pitch diameter and 6g is the tolerance class for the major diameter.

A fit between threaded parts is indicated by the nut thread tolerance designation followed by the bolt thread tolerance designation separated by a slash. For example: M12 x 1 - 6H/5g6g indicates a tolerance class of 6H for the nut (female) thread and a 5g tolerance class for the pitch diameter with a 6g tolerance class for the major diameter.

8.4.10 CLASSIFICATION OF UNIFIED SCREW THREADS

The Unified Screw Thread Standard Series Classification System class refers to the acceptable range of pitch diameter for any given thread.
**Class 1 thread**: Loosely fitting threads intended for ease of assembly or use in a dirty environment.

**Class 2 thread**: Most common, they are designed to maximize strength considering typical machine shop capability and machine practice.

**Class 3 thread**: Used for closer tolerances.

There are several methods that are used to measure the pitch diameter. The most common method used in production is by way of a Go-NoGo gauge.

### 8.4.11 BOLT HEAD MARKINGS

The markings used on bolt heads indicate their grade & strength.

<table>
<thead>
<tr>
<th>ISO Property Class</th>
<th>Nominal Size</th>
<th>Material and Treatment</th>
<th>Head Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.6</td>
<td>M5-M100</td>
<td>low or medium carbon steel</td>
<td>4.6</td>
</tr>
<tr>
<td>4.8</td>
<td>M1.6-M16</td>
<td>low or medium carbon steel, fully or partially annealed</td>
<td>4.8</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>-----------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>5.8</td>
<td>M5-M24</td>
<td>low or medium carbon steel, cold worked</td>
<td>5.8</td>
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<tr>
<td>8.8</td>
<td>M16-M72</td>
<td>medium carbon steel, quenched and tempered</td>
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</tr>
<tr>
<td>M16-M36</td>
<td></td>
<td></td>
<td>A325M 8S</td>
</tr>
<tr>
<td>8.8</td>
<td>M16-M36</td>
<td>low carbon boron steel, quenched and tempered</td>
<td>8.8</td>
</tr>
<tr>
<td>M16-M36</td>
<td></td>
<td></td>
<td>A325M 8S</td>
</tr>
<tr>
<td></td>
<td>M16-M36</td>
<td>atmospheric corrosion resistant steel, quenched and tempered</td>
<td>A325M 8S3</td>
</tr>
<tr>
<td>9.8</td>
<td>M1.6-M16</td>
<td>medium carbon steel, quenched and tempered</td>
<td>9.8</td>
</tr>
<tr>
<td>9.8</td>
<td>M1.6-M16</td>
<td>low carbon boron steel, quenched and tempered</td>
<td>9.8</td>
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<td>M12-M36</td>
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<td>A490M 10S</td>
</tr>
<tr>
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<td>M5-M36</td>
<td>low carbon boron steel, quenched and tempered</td>
<td>10.9</td>
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<td>A490M Type 2</td>
<td>M12-M36</td>
<td></td>
<td>A490M 10S</td>
</tr>
<tr>
<td>A490M Type 3</td>
<td>M12-M36</td>
<td>atmospheric corrosion resistant steel, quenched and tempered</td>
<td>A490M 10S3</td>
</tr>
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<td>12.9</td>
<td>M1.6-M100</td>
<td>alloy steel, quenched and tempered</td>
<td>12.9</td>
</tr>
<tr>
<td>SAE Grade No.</td>
<td>Size Range</td>
<td>Material</td>
<td>Head Marking</td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>----------</td>
<td>--------------</td>
</tr>
<tr>
<td>1</td>
<td>1/4 thru 1-1/2&lt;br&gt;1/4 thru 3/4&lt;br&gt;7/8 thru 1-1/2</td>
<td>Low or medium carbon steel</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1/4 thru 1&lt;br&gt;1-1/8 thru 1-1/2</td>
<td>Medium carbon steel,&lt;br&gt;quenched &amp; tempered</td>
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<tr>
<td>5</td>
<td>1/4 thru 1&lt;br&gt;1-1/8 thru 1-1/2</td>
<td>Low carbon martensite steel,&lt;br&gt;quenched &amp; tempered</td>
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</tr>
<tr>
<td>5.2</td>
<td>1/4 thru 1</td>
<td>Low carbon martensite steel,&lt;br&gt;quenched &amp; tempered</td>
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</tr>
<tr>
<td>7</td>
<td>1/4 thru 1-1/2</td>
<td>Medium carbon alloy steel,&lt;br&gt;quenched &amp; tempered</td>
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<tr>
<td>8</td>
<td>1/4 thru 1-1/2</td>
<td>Medium carbon alloy steel,&lt;br&gt;quenched &amp; tempered</td>
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</tr>
<tr>
<td>8.2</td>
<td>1/4 thru 1</td>
<td>Low carbon martensite steel,&lt;br&gt;quenched &amp; tempered</td>
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</tr>
<tr>
<td>ASTM Standard</td>
<td>Size Range</td>
<td>Material</td>
<td>Head marking</td>
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<td>------------</td>
<td>----------</td>
<td>--------------</td>
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<tr>
<td>A307</td>
<td>1/4 thru 4</td>
<td>Low carbon steel</td>
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</tr>
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<td>A325 Type 1</td>
<td>1/2 thru 1</td>
<td>Medium carbon steel, quenched &amp; tempered</td>
<td>A325</td>
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<tr>
<td></td>
<td>1-1/8 thru 1-1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A325 Type 2</td>
<td>1/2 thru 1</td>
<td>Low carbon martensite steel, quenched &amp; tempered</td>
<td>A325</td>
</tr>
<tr>
<td></td>
<td>1-1/8 thru 1-1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A325 Type 3</td>
<td>1/2 thru 1</td>
<td>Weathering steel, quenched &amp; tempered</td>
<td>A325</td>
</tr>
<tr>
<td></td>
<td>1-1/8 thru 1-1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A449</td>
<td>1/4 thru 1</td>
<td>Medium carbon steel, quenched &amp; tempered</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-1/8 thru 1-1/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-3/4 thru 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A490 Type 1</td>
<td>1/4 thru 1-1/2</td>
<td>Alloy steel, quenched &amp; tempered</td>
<td>A490</td>
</tr>
<tr>
<td>A490 Type 3</td>
<td>1/4 thru 1-1/2</td>
<td>Weathering steel, quenched &amp; tempered</td>
<td>A490</td>
</tr>
</tbody>
</table>
8.4.12 ROTATING COMPONENTS

Bolts which support components which intentionally rotate, such as those which form the hinge-pins of rudders and elevators, or the bearings for control horns, or pulleys, etc. MUST BE SECURED WITH A CASTELLATED NUT AND SPLIT-PIN or, at the very least, a spring-clip of the safety-pin type.

The split-pin is the more preferable, especially if the joint is not to be dismantled frequently. In the United States it is known as a cotter pin.

A split pin is a metal fastener with two tines that are bent during installation, similar to a staple or rivet. Typically made of wire with a half-circular cross section, split pins come in multiple sizes and types.

Split pins are typically made of soft metal, making them easy to install and remove, but also making it inadvisable to use them to resist strong shear forces. It is advisable to always replace the split pin rather than to reuse it, lest metal fatigue cause it to fail in use.

There are two preferred ways to install a split-pin, depending on the exact application.

![Figure: Castellated nut and both methods of installing split pin](image)

Note that:

“IN GENERAL NYLOC AND SIMMONDS-TYPE NUTS ARE NOT ACCEPTABLE FOR COMPONENTS WHICH ARE DESIGNED TO ROTATE IN NORMAL USE”.

These have a plastic or fibre collar set into the nut which is an interference fit on the male thread. On assembly the male thread forces its way through the collar and the resultant friction restricts the tendency to unscrew. These nuts are not as effective for locking if used more than once.
However, for items such as wing leading-edges or trailing-edges, for examples, which have to be rotated very slightly whilst being swung out into position during assembly, and which can be thoroughly ground-checked afterwards, a Nyloc or Simmonds-style nut is acceptable.

REMEMBER THAT NUTS WHICH DO THEIR LOCKING BY FRICTION SHOULD, AS A GENERAL RULE NOT BE USED MORE THAN ONCE IF, ON ASSEMBLY, THEY CAN BE TURNED ON THEIR BOLTS, EITHER WITH THE VERY GENTLE USE OF A SPANNER OR WITH STRONG FINGERS.

Where they are used to secure the propeller to its flanges, THEY MUST NEVER BE USED MORE THAN ONCE.

8.4.13  LOCK-WIRING

The angle of approach of the wire should not be less than 45° to the rotational axis of the component to be locked (see Figure 5), whilst the line of approach should be tangential to the parts being locked (Figure 6). The lay of the wire must always be such as to resist any tendency of the locked part or parts to become loose, and for this reason it is essential to ascertain whether the parts have left or right-hand threads before fitting the wire.

Examples of correct lock wiring (CAP 562 Civil Aircraft Airworthiness Information and Procedures Part 2 Leaflet 2-5 Page 7):

Also look at Section 7 on Safetying in AC 43.13-1B Chapter 7. Aircraft Hardware, Control Cables, And Turnbuckles.
8.4.14 PIP-PINS

“Pip-pins” continue to be popular for use in some applications on microlights, and rightly so, because of their suitability for dismantling and reassembly tasks.

Described as a single acting quick-release pin it works by holding two or more tiny balls, captured in bores drilled radially to the axis of the pin and held in their outward position by an internal plunger which is concentric to the pin. This plunger is provided with detents so that, when it is displaced in either direction from its normal position the balls can retract. The plunger is spring loaded to the locked position and its end provided with either a push button or a pull ring. There should be a minimum possible amount of both radial and axial play.

However, on the older, ‘orphan’ microlights, Inspectors should be careful to check whether the particular application is adequately catered for by using a pip-pin. If a joint shows indication of needing some measure of clamping applied to it, as would be afforded by a nut and bolt, it is not acceptable to use a pip-pin, which can only operate as a simple shear device. But, before insisting that the Owner make the change, consult the Technical office to determine if the problem has been noted before and whether there is already an agreed solution to it.

Where pip-pins are considered to be acceptable on Orphan microlights, or are specified on permit aircraft, it is still important to check carefully that the components are safely joined by such a device. Look, for example, to see if grooves have been ‘tracked’ through them where the pin has been accidentally dragged out without the ‘pips’ properly released. Such grooves could allow clearance for the pips to slide through, permitting the pin to drop out completely.

Alternatively, it can happen that the holes become so enlarged that the pin is quite rattly and could again be expected ultimately to work its way out. Because tubes and fittings were sometimes so large on older machines, in terms of cross-section, for the job they are required to do, they were also made from rather soft material, which could aid the rapid enlargement of the holes for pip-pins.

The use of disc-spring to provide a hard seat for the pips to bear against, as applied to one type of Permit aircraft, could also lead to yet another problem if it was fitted the wrong way round. This has been described in the section on General Airframe Structures.

Pip-pins must, of course, be of aircraft quality, wherever they are used on an aircraft.

**DO NOT ALLOW THE USE OF BOAT-TYPE PIP-PINS: THEY ARE Seldom FULLY SATISFACTORY.**
8.4.15 WOODEN PLUGS

Of probably historical interest now, in many of the old “Orphan” microlights, it was standard practice to use wooden plugs, (ideally at least hardwood but all too often just any kind of timber), in the ends of structural tubular members. These plugs were intended to resist the crushing loads where cross-bolts passed through the tubes for the attachment of fittings, etc.

If made of softwood, as they so often were, such plugs were notorious for their ability to crush anyway, under the load of overtightened bolts. They also tended to dry out and shrink, thus failing to do their job at all and, lastly, to rust onto any bolts left too long without removal from the joint. Even the plating used on good-quality bolt did not withstand such corrosion and the bolt could sometimes become totally locked into the plugs. This happened because the wood usually contained quite a large percentage of moisture, which causes the corrosion.

If the aircraft is known, or seen, to have such plugs the Inspector would be wise to ask for each of the joints to be dismantled, to establish the condition of (a) the plug, (b) the tube which it was supposed to protect and, most of all, (c) the bolts. Any one of these found to be unsatisfactory, particularly a corroded bolt, must be scrapped. Obviously discretion must be applied but do give adequate thought to the possible results of a failure in the region under scrutiny.

Overall, wooden end-plugs are generally not acceptable unless specific measures are taken to ensure that they are doing exactly what is required of them. Bolts must not be able to become corroded without the Owner or pilot knowing about it, as can happen if the bolt is submerged – undisturbed – in a wooden plug.

8.4.16 TAB WASHER

If it is necessary to lock a bolt or set-screw into place and a locking-wire is the only obvious way to achieve this, because the bolt-head is all that is accessible, designers are very adept at finding ways to achieve this without cross-drilling the head of the bolt.

For example, various forms of tab-washer can be employed, or they can be combined with a locking wire.
8.4.17 NYLOCS, WINGNUTS AND PLASTIC WASHERS

The reason why nuts with Nylon inserts present the poorest option for securing a propeller is that any vibration or looseness of the latter, in its hub plates, will manifest itself as heat when the engine is at speed. This heat can readily soften the Nylon which forms the grip in the nuts and hence that is lost and so, probably, would be the propeller.

“BUTTERFLY-NUTS OR WING-NUTS” WERE USED TO SECURE THE PROPELLERS ON SOME EARLY MICROLIGHTS, ALONG WITH SPRING-RINGS THROUGH THE BOLTS.

THIS IS NOT NOW AN ACCEPTABLE PRACTICE UNLESS THERE IS ABSOLUTELY NO USABLE ALTERNATIVE. EVEN THEN, IT COULD ONLY BE ENCOUNTERED ON AN EARLY ORPHAN MACHINE LIKE THE EAGLE.

The use of special Nylon moulded washers under propeller-nuts (sometimes employed in the past to secure the ‘pop-over’ type of domed nut-cover) is extremely dangerous and must never be accepted. The material flows (‘creeps’) as pressure is applied to it, when the bolts are torqued. This effectively removes the pressure which should be applied via the hub-plates against the propeller-hub. Owners who have such plastic washers on their aircraft must be asked to remove them before the machine can be signed off.

8.4.18 CLEVIS PINS

The clevis pin is an unthreaded pin with an upset head on one end and a chamfer at the other. The chamfered end is provided with either a split pin hole or a retaining ring groove. They act as intermittent duty fulcrums and because of their positive locking cannot loosen.

On some early machines, the clevis pins which formed parts of turn buckles had the holes for the securing pins drilled so close to their ends that they could readily break out, under wear and vibration.

It was usually the case that such pins and the turnbuckles of which they were part, are sub-standard, often cheap boat components. Only the best should ever be used for our purposes and genuine aircraft-quality parts are often not much more expensive than stainless-steel items sold at excessive prices in the prestige yachting market.

As a rough guide, any hole for a securing pin or clip, should firstly never exceed 1/3 of the diameter of the main shank. (A 1/4" (6.4mm) diameter pin should thus never have a hole larger than 0.085” (2mm) diameter. Even this is an absolute maximum). Secondly, the hole should not be less than about 1/3 of the pin diameter from its end, again, as a minimum, measured from the tangent nearest to the end. Thirdly, the hole must pass directly through the centre-line (axis) of the clevis-pin.
8.4.19 BOLT TORQUES

Bolts normally have a specified torque applied to the nuts. There may be situations where the exact torque is not over-important and it is specified simply to ensure that the bolts are sensibly tightened, not over- or under-torqued. But, in other locations on the aircraft, such as on items which mount the engine or the wing assembly, or any part of the primary structure, etc., it is vital that definite and correct torque values are applied.

On Type-Approved aircraft, these will be set by the manufacturer but on pre 01/01/1984 aircraft, no data may be directly available. In the latter case, the following values may be taken as a reasonable guide:

<table>
<thead>
<tr>
<th>SIZE</th>
<th>TORQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16 inch diameter bolts:</td>
<td>0.9 to 1.6 foot-pounds 1.22 to 2.17 Newton-metres</td>
</tr>
<tr>
<td>1/4 inch diameter bolts:</td>
<td>2.5 to 4.0 foot-pounds 3.39 to 5.40 Newton-metres</td>
</tr>
<tr>
<td>5/16 inch diameter bolts:</td>
<td>5.0 to 6.5 foot-pounds 6.78 to 8.82 Newton-metres</td>
</tr>
<tr>
<td>3/8 inch diameter bolts:</td>
<td>13 to 16 foot-pounds 17.6 to 21.7 Newton-metres</td>
</tr>
<tr>
<td>1/2 inch diameter bolts:</td>
<td>40 to 55 foot-pounds 54.2 to 74.6 Newton-metres</td>
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</tbody>
</table>

8.4.20 ORIENTATION OF BOLTS

It is very sound practice always to locate bolts, screws and pins so that their heads are all at the top, if they have to be installed vertically. There is then a much better chance that they will remain in place, should the nuts or spring-clips go missing. However, there are situations where the bolt has to be installed counter to normal engineering practice, and so the manufacturer’s assembly scheme must be adhered to at all times. For example, one condition which might alter this rule is when there is a high level of vibration present; this can sometimes make bolts and pins ‘climb’ out of their holes.

If they have to be angled, it is common practice to place the bolt heads so that the force of the slipstream pushes them back into their holes, rather than assisting them in withdrawing, in the event that nuts or spring-clips fall away.

It is also good practice for all horizontal or angled bolts and pins to always have their heads aligned along one side of the airframe. Whether port or starboard is chosen will usually depend on one or more bolts which cannot arbitrarily be located at will. All other bolts should then be matched to these.

This has the advantage of making it a simple matter to check that all bolts and pins have their fixing nuts or clips properly in place, when pre-flight inspections are carried out.

8.4.21 OVER-TORQUING

It is vital to note that it must not be possible for the shank end of the thread of a bolt to be made to enter the nut, by clumsy or brute-force assembly or over-torquing. This produces an effect called 'Thread-binding'; the nut seizes on the
bolt-thread and both bolt and nut become damaged, often dangerously. And, possibly even more importantly, it gives the impression that the bolt is correctly torqued up, even with a torque-spanner in use.

In the extreme - and not uncommonly - it is possible for the damage to be so severe that a ring of material is roughly stripped off the bolt (and/or the nut). This weakens it by reducing the overall cross-sectional area and also provides a sharp-edged location' (when compared with the smooth-formed rolled thread) from which fatigue failure can more readily propagate.

There is such an infinite choice of bolt-lengths available that there is no excuse for using one which gets into this dangerous range. However, if there is some reason why the bolt chosen is slightly over-length, there are two alternative methods to make it acceptable to the inspector, so long as the bolt is in shear.

8.4.22 BOLT SIZE

If the bolt is in tension, there may be different constraints, depending on its overall length-to-diameter ratio. It is normally safe to assume that, once the bolt has been torqued to a precise value (as bolts under tension most assuredly must be) the designer would not have wished it to have extra and avoidable 'stretch' in it. So, the original size of bolt should always be retained in that location; there is little room for alternatives here. Nevertheless, if you are at all in doubt, seek advice from the Technical Office or the Chief Inspector.

Fortunately, most bolts on microlight aircraft are in shear, simply because it is the simplest way to make assemblies of the kind we need. This therefore allows us to resort to some special measures to accommodate over-length bolts, should we need to do so.

8.4.23 OVERLENGTH BOLTS

First of all, it is a basic prerequisite that all bolts present smooth shank against which the components being joined will bear. Components must never bear against the bolt's thread (a basic concept seemingly not known to many early manufacturers of microlights and, some would argue, not always remembered today).

It is never very difficult to meet this requirement. A bolt can always be obtained which will allow the components to be held together, whilst letting its thread start just (and only just, say, 0.5 -1 mm) within the material of the outermost component, or just beyond, say, within the thickness of a washer.

Nevertheless, due to haste, or because they happen to own a batch of expensive bolts, or because a fitting has been deleted from a joint, owners will sometimes have over-length ones on their machines. Provided that these bolts are in shear and one of the measures described below is employed, Inspectors can readily accept them:

Firstly, up to three washers may be put on, instead of one, to take up excess length.

Secondly, and this is a slightly better measure, providing modification approval has been obtained from the Technical Office, a turned spacer can be installed on the bolt. Its bore should ideally be reamed to fit the bolt-shank, the closer the better. Experience has shown that the material used for the spacer must be of reasonable quality. Various good-quality aluminium-alloys, cadmium-plated or primed steel, etc., are quite acceptable.
Bolt Grip Length JUST RIGHT, in safety with sufficient thread start

Bolt Grip Length TOO SHORT, threads bearing on structure

Bolt Grip Length TOO LONG, joint is loose.
For one application on an early production machine, however, pure aluminium spacers were used and they rapidly hammered themselves into doughnut rings and allowed the fixing to become loose. Soft aluminium-alloy spacers between the bearings on a propeller reduction-gear allowed the whole assembly to become loose. The list is quite long so do remember that a trivial component can become a serious hazard.

**AN OVER-LENGTH BOLT MUST NOT BE FITTED, WITH SPACERS OR EXTRA WASHERS, IN A SITUATION WHERE TENSION IS THE PRIME FORM OF LOADING ON THE BOLT.**

### 8.4.24 THREAD PROTRUSION

Until about 1988, BMAA Inspectors would have been instructed never to accept any microlight aircraft as airworthy, unless every bolt had about 1 to 1½ turns of thread protruding through its nut.

But, at that time, CAA surveyors began accepting specimen aircraft submitted by manufacturers for their scrutiny for Type-approval under Section S, on which many of the bolts were of such a length that they ended flush with the nuts. On a strictly personal basis, the author has no hesitation in condemning this as a rash action! Requiring bolts to protrude through nuts had been accepted as sound, airworthy practice for seventy years or so and had grown - like so many good practices - out of the observed cure for recognised problems, which often cost early aviators their lives.

One hears arguments about ‘modern’ Nylon-insert nuts not needing the bolt to pass beyond the insert. This is not true. Nuts are mass-produced and plastic can misfire in the moulding process. Along with that, bolts can, and do, often have the first one or two threads malformed in the rolling operation, or damaged in subsequent handling. So, if one puts a bolt with poor end-threads flush into a nut with plastic only in the outer, visible region, one has a combination that cannot lock, or will do so only weakly and temporarily.

When one considers the millions of nuts and bolts that are made and used daily, and if one accepts that even aircraft fasteners are able to be shoddy sometimes (remember the McHaffie episode or the earlier ANS-bolt fiasco each involving millions of them!) this sort of dangerous combination must occur very much more often than one might imagine.

So, whilst BMAA Inspectors can certainly accept bolts that end flush with their locking nuts, they are still strongly advised to try to indoctrinate owners to stick to the old rule. The cost is insignificant if the change is made when the bolts are routinely being replaced.

### 8.4.25 THREAD INTERFERENCE

If you feel you cannot subscribe to that line of argument, consider this one: Good quality bolts, especially aircraft bolts, have a defined thread-length in relation to the length of their plain shank. Therefore, if the end of the bolt is flush with the face of the locking nut, there must almost certainly be threads bearing against fittings, tubes, etc., behind that nut. That is contrary to any accepted standards of good engineering design.

Under conditions of engine-vibration, ground taxiing, and so on, those threads will 'mill' their way into the components and seriously enlarge the holes. Really, the start of the thread - at the end of the plain portion of the bolt - should lie about one to two millimetres behind the nut, with washers taking up most of the intermediate length.

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3 McHaffie Inc. did not test bolts used on such aircraft as the F-16 fighter and B-1B bomber and then submitted falsified certificates saying the tests were conducted. In 1990 Mr McHaffie got a three year sentence in prison and a $750,000 fine.
8.4.26 PLASTIC CAPS

On some machines, one finds plastic caps fitted on to nuts, to prettify them or to make Dacron slide smoothly over them. Whatever the reason, remove them and examine the nuts carefully. Do not sign off what you cannot see.

8.4.27 CHROMIUM PLATED BOLTS

On some Hornet microlights, Chromium-plated bolts were used to secure the propeller assembly. Although purchased in perfectly good faith by Hornet, the supplier had not effectively heat treated these bolts to prevent embrittlement. As a consequence, the unsuspecting microlight-aircraft manufacturer - who had sought to add extra quality and safety, not less - was suddenly faced with owners complaining about broken propeller-bolts. The solution was a simple one; the chromium-plated bolts were all replaced with ordinary zinc- or cadmium-plated bolts. So, if a BMAA Inspector comes across chromium-plated bolts on any item of primary structure or on the power-plant, he or she should require them to be removed and replaced with suitable alternatives.

In case of doubt, contact the manufacturer of the aircraft or, for an "Orphan" aircraft, the BMAA Chief Technical Officer or the Chief Inspector.
### 8.5 CONTROL SURFACES, MECHANISMS AND HINGES

#### 8.5.1 FLIGHT CONTROLS

Flight controls are an essential part of the primary structure of any microlight aircraft. On a flexwing, this concerns only the main hang-point in most instances. But trimming mechanism, such as the adjustable reflex bridle or electric trimmer found on the newer Quik models may need to be treated as a primary control. Never assume that innovation in flexwing design has come to an end. Manufacturers and designers are still striving to try out new ideas and progress further. This is what keeps microlighting alive and vital.

On virtually any microlight aircraft, loss of control can occur for any of several reasons, viz:

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>TYPICAL CAUSES</th>
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| (i) The controls become jammed. | Inadequate clearances. Foreign objects becoming trapped in control runs, linkages or hinges.  
Cables jumping out of pulleys or guides and becoming trapped.  
Levers moving over ‘top dead centre’ and locking into that position, etc..  
Safety-straps sliding out of position and fouling moving members.  
Push-rods being bent by being leaned or stepped on. |
| (ii) The control circuit becomes too sloppy. | Inadequate maintenance.  
Excessive wear.  
Poor design  
Components under-strength.  
Geometry of control-cable versus control-horns not correctly designed, etc.. |
| (iii) The control breaks in flight. | All of the above, plus:  
Corrosion.  
Kinks developed by careless storage and de-rigging.  
Incorrect or careless manufacture.  
Cables not correctly routed when rigging aircraft, etc. |

It is a vital part of the Inspector’s role to try to highlight any area where any of these events might occur.
Loss of control can sometimes occur due to indirect causes. In one instance, a pilot suddenly found that the wing of his flexwing machine had locked solidly in pitch, whilst remaining free in roll. Obviously, the pilot had no choice but to prepare to land but in the ensuing moments after the throttle had been closed, control was restored, again for no obvious reason. After landing successfully, he found that the 5mm back-up cable – sheathed in rubber – had jammed in the king-post bracket. Since it was known to be a non-standard system, the normal version was rapidly installed before any further flight was attempted!

Inspectors may often find it difficult to spot such non-standard features on a microlight, especially if they have been engineered superbly. It is only natural for one to notice an outstandingly bad piece of workmanship which may even be a poor representation of a standard feature, yet miss a nicely built modification.

There used to be a wicked doctrine which said, if you wanted the CAA Surveyor not to notice an illicit modification to your aircraft, for which you had no paperwork, you simply half-concealed a spanner or screwdriver close to it! He was then so busy giving you a long lecture about the dangers of leaving tools in an aircraft, that he failed to spot your naughty alteration. Actually, it was surprising how often one heard that it worked!

But, now that they have been forewarned, BMAA Inspectors will not be led astray by such devious approaches; they will instantly start seeking the source of the need for concealment!

### 8.5.2 Play

The controls for rudders, elevators, ailerons and spoilers on two- and three-axis machines are usually so simple that they can be considered to be covered by the ground-rules for scrutinizing tubes, fittings, cables and fasteners.

But Inspectors should remember that quite small amounts of play can present serious problems in a close-coupled control-column, such as those side-mounted on some designs. During the pushing or pulling on equally short horns on the control-surfaces, this play can give plenty of scope for rattle, which may either mean some loss of control or give the opportunity for flutter to occur, should a pilot allow speeds to get too high.

The risk is admittedly small but the design of control surfaces on many early two- and three-axis microlights left little margin to cope with vibration of any kind nor, sometimes, the effects of wear in the holes in control-horns.

### 8.5.3 Friction

Exceptions to the concept of controls always being tubes, fittings and fasteners are the push-pull cables – such as Teleflexes (see below) – used to operate the tail control-surfaces on some machines; also the somewhat complicated mixer-controls associated with Vee-tails. However, besides being comparative rarities, the latter are really rather simple and can again be regarded as assemblies of trivial parts. The only special consideration is that small amounts of wear in any unbushed bearing-holes may again introduce a disproportionate degree of ‘slop’ in the control-surface action, so giving the chance for oscillations to commence, or even locking to occur.

Sheathed cables can present a significant amount of friction in the control runs if lubrication is lacking. If the cable has been installed unwisely, with an excessive number of bends or if the bends are of too small a radius, this friction becomes even worse.

To determine whether the problem is in the cable, when a control feels excessively stiff, disconnect the control surface and, whilst holding the rear end of the sheath in its normal position, operate the control column or actuating arm. If the control still feels too stiff, the cable must be lubricated.
8.5.4 LUBRICATION

Very thin lubricating oil may be used to lubricate the cable in the sheath. For throttle cables oil thicker than ‘3 in 1’ should not be used. Bowden cables can also be lubricated by means of solvent-carried graphite.

8.5.5 WEAR

Where cables can be dismantled, it is wise to take advantage of this ability and establish whether any excessive wear or fraying of the cable has occurred.

Look also for any damage to the sheaths of the cables, either to the fabric protection or to the coiled sheath itself. If damage is found, determine the cause and – whether or not a replacement cable is deemed necessary – try to remove the source of the problem by re-routing, etc. If the plastic sheathing has been cut and abraded from the spiral casing, it is not unusual to find that moisture has entered the assembly at that point. It will make the cable stiff to move initially and, finally, it will fail completely at the corroded point.

But replace the cable completely. Most definitely DO NOT simply wrap the casing with any type of contact-adhesive tape. It will soon separate from the casing, leaving an ideal entry point for capillary moisture.

8.5.6 BUCKLING

Irrespective of the degree of lubrication, it may be possible for the protruding cable of a Teleflex system to buckle when a push is applied to it, if too long a length is unsupported between the control column and the actual sheath, or between the latter and a control horn. After all, it is only a cable, even if it is used as a push-rod, so its unsupported length should be minimised.

When such a buckling has occurred once, it will happen more easily on subsequent occasions. Unsupported lengths of these cables must therefore be removed from the design by relocation of the sheath or, possibly, by replacement of the entire cable and sheath. (Consult the Technical Office on such a problem as this, which has to be considered as a Major Modification).

8.5.7 HINGES

The hinges for the control surfaces on many older microlights were crude, to say the least, albeit they were totally effective. The Inspector must not be surprised to find simple bolts through alloy tubes, or bits of 3mm plate, or scraps of channel, often without any trace of lubrication. These might just be deemed to be acceptable on a particular aircraft and in a given location. It often happened that the aircraft was so slow and lacking in ‘dramatic’ performance that the forces on these primitive hinges were as light as they needed to be!

But, as always, if an Inspector has any doubts about what is acceptable, he should contact the Chief Inspector or the Technical Office.

8.5.8 CASTELLATED NUTS

What is certainly OBLIGATORY is that the bolts which are used as hinges for any rotating surface such as the rudder, ailerons or elevators, and on the control-column itself, MUST be fitted with castellated nuts and split-pins (known as cotter pins in the USA). Bolts which can or must rotate in their normal operation, MUST NOT be fitted with Nyloc or Simmonds-type nuts. No Inspector may accept any secured in that way.
CAP 482 BACR Section S 607 Locking of connections: An approved means of locking must be provided on all connecting elements in the primary structure and in control of other mechanical systems which are essential to safe operation of the aircraft. In particular, self-locking nuts may not be used on any bolt subject to rotation in operation, unless a non-friction locking device is used in addition to the self-locking device.

8.5.9 FORBIDDEN FITTINGS

The following types of detail fitting are totally forbidden on primary flight controls:

(a) Holes tapped directly into the ends of aluminium-alloy tubes to receive the screwed shanks of rod-ends. Inserts such as “Helicoils” are usually totally forbidden for use in such circumstances.

(b) Bolts used as pivots, without some means of preventing them from rotating within their supporting structure. The simple way to achieve this is by fitting a sleeve over the bolt, clamped between the ears and lugs, etc. of the supporting structure. The member being moved, e.g. a control horn, then rubs against this stationary (and replaceable) sleeve.

8.5.10 BENDS

Tight bends in cables (‘tight’ means small in relation to the diameter of the cable in question) involve severe bending in the cable strands, which may ultimately fail because of that.

8.5.11 DEFLECTIONS

Inspectors need to make sure that a 2- or 3-axis fixed wing aircraft has the specified amount of movement on the rudder, elevator, ailerons, spoilers and/or flaps, as appropriate. This information is normally available from the Type Approval Data Sheet or Type Acceptance Data Sheet (TADS).

If the Inspector does find difficulty in identifying the required control-movements for an ‘Orphan’ aircraft, the Technical Office should be consulted. They will either advise directly or may be able to provide the name of the Type-Specialist, who should be able to help.

Once such data have been determined and proven correct by subsequent use of the aircraft, it should be recorded in the aircraft’s log-book for easy future reference.

Be aware that you cannot reasonably depend upon Owners to provide reliable data about control deflections. This does not mean they are stupid or uncooperative; it may be that either they do not know, or that they think they do but they have their facts wrong.

But one does still occasionally encounter the foolish person who sets out to convince you that what their machine does is correct, just so that they do not have the tedium of doing something about it. Even Check Pilots get misled sometimes by such misinformed persuasiveness!

So, if the movements are well out from those quoted above, try to get help from, or through, the Technical Office.

Obviously, if you accept a machine as satisfactory for flight, when the control deflections are awry you could be presenting the Check Pilot with some irritating or dangerous problems. Always err on the side of safety (particularly if you happen to be the Check Pilot).
8.5.12 ROD ENDS

Where rod-ends are employed in any control mechanism, check that they are limited in the extent to which they can be subjected to misalignment. Most rod-ends have a specified maximum misalignment of around 9 to 10 degrees; some have as little as 5 degrees. If in doubt, disconnect the rod-end, and see what the bolt and/or spaces permit. Remember that, once a rod-end has reached its maximum misalignment, any further offset must result in bending and may lead to fatigue or simple bending failure.

Check that the rod-end is properly screwed onto its shaft or bolt. Many rod-ends have small ‘witness’ holes in their shanks, through which a wire should be unable to pass if the thread is correctly engaged within.

Rod-ends must be correctly secured against accidental unscrewing. Locknuts are the most common method for achieving this.

Check that, where rod-ends have been used at both ends of a shaft or push-rod, they are NOT left – and right – handed. (If both loosen, the shaft can fall out completely, as has happened in commercial and light aviation). They must both be left handed or both be right handed, even though a paired left and right hand arrangement may seem a brilliant way to achieve adjustment, working like a turnbuckle.

8.5.13 CLEARANCES

Be certain that there is adequate clearance for controls to move.

For example on Goldwings the slots ahead of the spoilers are very commonly found to need enlarging slightly to permit full and free movement of the spoilers.
8.6 CABLES, FERRULES AND THIMBLES

8.6.1 CABLES

Wire rope and cables are considered to be “machines”. The configuration and method of manufacture combined with the proper selection of material when designed for a specific purpose enables a wire rope or cable to transmit forces, motion and energy in some predetermined manner and to some desired end. [27]

The term cable is often used interchangeably with wire rope. However, in general, wire rope refers to diameters larger than 3/8”. Sizes smaller than this are designated as cable or cords.

Two or more wires concentrically laid around a centre wire is called a strand. It may consist of one or more layers. Typically, the number of wires in a strand is 7, 19 or 37. A group of strands laid around a core would be called a cable or wire rope. In terms of product designation, 7 strands with 19 wires in each strand would be a 7x19 cable: 7 strands with 7 wires in each strand would be a 7x7 cable.

These flexible cables are made from preformed carbon steel wires coated with pure tin or zinc or from uncoated stainless steel wires.

The 7x7 cable consists of six strands, of seven wires each, laid around a centre strand of seven wires. The wires are laid so as to develop a cable which has the greatest bending and wearing properties. The 7x7 cable should have a lay length of between 6 and 8 times the cable diameter.
The 7x19 cable consists of six strands laid around a centre strand in a clockwise direction by convention. The wires composing the seven individual strands are laid around a centre wire in two layers.

The centre core strand consists of a lay of six wires laid around the central wire in a clockwise direction and a layer of 12 wires laid around this in a clockwise direction. The six outer strands of the cable consist of a layer of six wires laid around the centre wire in a counterclockwise direction and a layer of 12 wires laid around this in a counterclockwise direction.

Cables of less than 2mm (3/32”) diameter are not acceptable for use in primary control systems.

Use of sub 2mm cable on microlights is permitted for other applications, provided they have been shown to be durable by the track record for the type of aircraft in question and for a reasonable number of hours operation.

One obvious example of this is where they form the inner part of a Bowden-cable assembly. Another is where they are installed to actuate some item of minor equipment, which requires only small operating forces and whose total loss could never impair the safety of the aircraft. A third use would be as a lanyard preventing the loss of a retaining pin or safety clip or detachable instrument.

But even where Bowden cables find their most obvious application, that is, for throttle and choke operation, every care must be taken to ensure that the complete installation is free and smooth.

If there is any stiffness in the sheathed cable or in the device ultimately actuated by the cable, it may simply kink and cause problems.

<table>
<thead>
<tr>
<th>CONSTRUCTION</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>1 X 7</td>
<td>Basic strand for all concentric cable, relatively stiff in larger diameters, offers the least stretch. Stiffest construction in small diameters.</td>
</tr>
<tr>
<td><strong>Strand (1x19)</strong></td>
<td>Smooth outside, fairly flexible, resists compressive forces, strongest construction in sizes above 3/32-inch diameter.</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Cable (7x7)</strong></td>
<td>Durable, higher flexibility and abrasion resistance. Good general purpose construction for strength and flexibility. Can be used over pulleys.</td>
</tr>
<tr>
<td><strong>Cable (7x19)</strong></td>
<td>The strongest and most flexible of cables with greatest stretch. Recommended for use over pulleys.</td>
</tr>
</tbody>
</table>

**Terminology of Construction and Components of Strand and Cable (Wire Rope) [26]**

**Strand** - Is two or more wires wound concentrically in a helix. They are usually wound around a center wire. Strand is normally referred to as 1 by the total number of wires in the given strand. Such as 1x7 (one group of seven wires) or 1x19 (one group of nineteen wires).

**Cable** - The generic term that refers to constructions of wire rope that fall into the category of aircraft cable. These constructions include 7x7 (seven groups of 1x7 strand) and 7x19 (seven groups of 1x19 strand) respectively.

**Wire Rope** - Technically the correct term for groups of strand wrapped in a uniform helix around a core. The constructions included in wire rope are numerous, but the most common are 6x19 and 6x37 class wire ropes. These descriptions of the construction fail to include the core as a part of the primary number. Part of the reason for this is that the composition and the construction of the cores in these wire ropes is so numerous, that it is necessary to call out the outer construction of the wire rope and then describe the core. Such as 6x19 fibre core, or 6x37 IWRC (Independent Wire Rope Core). The terms Cable and Wire Rope are synonymous for all intents and purposes.
CORE - Can be a variety of things, including: Strand in many constructions or even a cable or wire rope. The core can also be a composition other than metal, such as polypropylene rope, but note that the Nicopress swaging tool was not designed for fibre-cored cables and will therefore not produce a correctly swaged joint. Whatever the construction or the composition of the core, it is the center member of the cable or wire rope.

CONSTRUCTION - Strand, wire rope or cable is the nomenclature for describing the number of wires contained in, and their relationships to each other in the particular product being described. 1x19 describes one group of nineteen wires; 7x19 describes seven groups of nineteen wires. (or seven groups of 1x19); 6x37 IWRC describes six groups of thirty-seven wires wound around a core that might actually be 7x7 construction itself. Thus, the term Independent Wire Rope Core, since the core of 7x7 is actually a piece of wire rope. The construction of the core is partially determined by the diameter of the wire rope being described.

COMPOSITION - Wire rope or strand refers to the material used to manufacture the product being described. Strand, wire rope and cable are made from various grades of both stainless steel and carbon steel.

STAINLESS STEEL - Grades that are the most common are Type 302/304, Type 303 (nonmagnetic), and Type 316.

TYPE 302/304 - 18-8 (18 parts chromium and 8 parts nickel) stainless steel and is most commonly used in the manufacture of wire rope. This type of stainless steel is commonly used in applications that require more corrosion protection than is available from galvanized cable. Contrary to popular belief, stainless steel is not stronger than galvanized cable. The fact is it usually has a lower breaking strength than galvanized cable of the same diameter and construction.

TYPE 305 S/S - Cable (nonmagnetic) is also commonly available in smaller sizes. This type of S/S is generally used in applications where sensitive instrumentation or other systems might be affected by magnetism.

TYPE 316 S/S - Increasingly popular in many outdoor salt air environments. It has excellent corrosion protection and is the preferred choice of the marine industry. The increase in popularity of Type 316 S/S has spurred the availability of many wire rope terminals also becoming available in Type 316 S/S.

MONEL - Really a stainless nickel alloy, primarily composed of nickel (67%) and copper (28%), with some iron (5%) and other trace elements like manganese and is used in applications where added resistance to corrosive substances and liquids are required. The main drawbacks to Monel are that its minimum breaking strength is about 30% less than that of Type 302/304 S/S, and that it is not readily available.

CARBON STEEL WIRE - Available in different grades, sometimes referred to as Plow Steel, Improved Plow Steel, or even Extra Improved Plow Steel. Wire rope manufactured from uncoated wire is commonly referred to as “Bright.” Bright wire rope is available in sizes 1/4” and over.

GALVANIZED - Carbon steel wire is frequently used to manufacture wire rope. Galvanized wire rope provides good corrosion protection in mild environments. In smaller sizes (less than 1/4”) it is almost automatically used when stainless steel is not specified.

LAY - Of the strand, wire rope or cable, is the direction in which the helix of the wires orbit the core. An easy way to determine the lay is to hold the specimen vertically in front of you and observe whether the strands or wires travel up and to the right or up and to the left, just as you might visually determine the direction of a thread on a bolt. There are other types of lay or wire rope, such as Lang and Herringbone. These types of lays in wire rope are for special purposes, but it is nevertheless useful to be aware of the distinction.
Regular lay, as opposed to Lang lay, denotes the direction of wire twist in the strands. In regular lay rope the wires in each strand lie in the opposite direction from the strands.

**FIGURE:** In Lang lay rope the wires in each strand lie in the same direction as the strands.

**PREFORMING** - Of wires refers to the forming in a helix of each group of strands so as to enable them to all be “closed” into a uniform helix capable of retaining its shape when cut. Miniature diameters (smaller than 3/64”) usually must also be ordered as stress relieved in order to be capable of not “brooming” after cutting. Under most circumstances, specifying “preformed” strand, wire rope or cable is not necessary since almost all modern stranded product is preformed.

**COATING** - Of a cable is optional, but can serve many useful purposes. The most common types of coatings are PVC Polyvinylchloride, various Nylon compounds, and Teflon. These materials are referred to as compounds. These compounds are applied to the cable via the use of a plastics extrusion machine fitted with a crosshead. The bare cable passes through the crosshead as it is introduced to the heated, molten plastic under pressure and exits the crosshead on its way to a cooling trough where it congeals.
8.6.2 CORED CABLE

Wire-rope cores are made of fibre, cotton, asbestos, polyvinyl plastic or wire.

Fibre cored cables are not acceptable to the BMAA, unless specified by the manufacturer, so the presence of a fibre, cotton, asbestos or polyvinyl plastic core would generally indicate the use of an unapproved part. This is underlined by the AAIB Safety Recommendation below:

Safety Recommendation 2006-126

The British Microlight Aircraft Association should promulgate the information that fibre-cored cables should not be used on aircraft, unless specified by the manufacturer, and that the Nicopress swaging tool was not designed for fibre-cored cables and will therefore not produce a correctly swaged joint.

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Wire cores are made in two different forms. The one used most extensively is a wire rope of suitable size to serve as a core and is referred to as independent wire rope core (IWRC). The other type of wire core is a wire strand structure (WSC or SC). This consists of a multiple-wire strand, and may be the same construction as the main rope strands. The IWRC type has about the same flexibility as the fibre core rope.

Manila or sisal fibre (fibre composite) is the type of core often used when loads are not too great. It supports strands in their relative positions and cushions the wires to prevent their nicking each other. Cotton fibre is used for small ropes such as sash cord and aircraft cord. Asbestos cores can be furnished for certain operations where the rope is used in oven operations.

Plastic cores include the following general types:

- Polypropylene cores, made up of a multiplicity of synthetic filaments extruded from a petrochemical resin. These are similar in physical construction to fibre cores.
- Plastic impregnated fibre cores are sisal fibre cores impregnated with polyvinyl chloride (PVC).
- Solid plastic cores are rods of PVC plastic.
- Plastic covered fibre cores have PVC extruded to a specific thickness around the core.

8.6.3 KINKING OF CABLE

Kinking of wire cable can be avoided if properly handled and installed. Kinking is caused when the cable takes a spiral shape after it has been unnaturally twisted. One of the most common causes for this twist is improper unreeling and uncoiling. In a kinked cable, strands and wires are out of position, which creates unequal tension and brings excessive wear at this part of the cable. Even though the kink may be straightened so that the damage appears to be slight, the relative adjustment between the strands has been disturbed so that the cable cannot give maximum service and should be replaced. Inspect cables for a popped core or loose strands. Replace any cable that has a popped core or loose strands regardless of wear or broken wires.

In one instance, the pilot was unable to close the throttle on his aircraft because of such kinking. Inspectors should always check all controls very carefully for full and correct movement. (For the pilot, of course, this is also a normal part of every pre-flight inspection and check before takeoff).
8.6.4 CEMENTING

One leading manufacturer of flexwing microlights once used the technique of locking the casings of Bowden cables into their ferrules with cyanoacrylate cement ("Superglue). They argued that this method was more positive than wire locking. It is not a good technique at all. Cyanoacrylate cement deteriorates with exposure to water and we know that all aircraft get wet, sooner than later.

8.6.5 MATCHING FERRULES TO CABLES

With normal multi-strand and multi-core cables, it is most important that the cables and ferrules are correctly matched. Imperial ferrules must only be used on imperial cable and metric cable must be fitted only with metric ferrules.

This is not always as easy as it sounds, since some sizes are very similar in appearance. In several of the available sizes, it is possible to make the ferrules fit an inappropriate cable by over-crimping, but that is most unacceptable.

Another mistake that can occur is the selection of ferrule by outside diameter alone, neglecting to measure the wall thickness of the material. This will result in a weakly formed swaged joint, whose outside crimped dimension is gauged correctly, but had internally failed to grip the cable strands sufficiently.

A recent accident from which the pilot and passenger escaped with their lives after their flexwing crashed into the roof of a barn close to the landing threshold of the airstrip occurred for this very reason. Ferrules had failed in all four of the fore and aft pitch control wires causing loss of control. The cables failed as a result of the wire rope pulling through the ferrules. The lower wall thickness of the ferrules reduced grip on the wire rope. The cable assemblies were privately made and unapproved.

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Inspectors should be on the alert for this type of corner cutting to save money and time. It is all too easy for the wrong ferrules to be obtained, sometimes due to nothing more than genuine errors on the part of stock-holders, for example if an Owner should buy ferrules from, say, a boat chandler where standards can be lower.

The photograph opposite shows undersize and unplated copper ferrules being used on a stainless steel cable similar to the one that failed in flight.

CAAIPS Leaflet 2-12 Section 6.2 states that copper ferrules are used with corrosion resisting steel cable, though this is not a hard and fast rule.

### 8.6.6 CABLE/FERRULE ELECTROLYTIC PAIRS

Almost all cables must be fitted with thimbles and ferrules at their ends. Carbon-steel cables should have aluminium or unplated copper ferrules, whilst stainless-steel cables must be fitted with zinc-plated copper ferrules. This is to avoid the fairly rapid corrosion which can occur with ‘electrolytic pairs’, should there be a mismatch.

Worst of all, because the corrosion will occur where the different metals are in closest juxtaposition – which is certainly the case inside a crimped ferrule – there will be metal eaten away inside the ferrule. This slightly enlarged annulus then forms an ideal capillary trap for more moisture, which thus accelerates the corrosion. The end product of this process is that the cable can either fail due to the loss of cross-section, or can literally be provided with sufficient clearance inside the ferrule for it to be able to slip out.

### 8.6.7 THIMBLES

Thimbles must be secure but not too tight in the cable loops. A thimble which is loose may actually fall out, leaving the cable to take highly concentrated bending and bearing loads, for which it is totally unsuited.

Contrary to what some folk advise, the ends of the thimble must not be snipped off to make it fit more closely against the ferrule. The ears are there by design, not cheap or carelessness manufacture. The ends could just as easily have been made ‘squared-off’ during production, if that had been a desirable measure.

Check that the center of the thimble is not cracked or worn through, where the bolt or pin bears against it. Plastic inserts, such as ‘Never-Kinks’ are sometimes useful, since they spread the load over the whole of that curve available inside the thimble.

### 8.6.8 CLAMPS

Devices which grip cables by means of screw-tightened clamps must be regarded as absolutely forbidden from use on aircraft.
They are NOT acceptable, whether or not the plastic sheathing has been stripped away from the cable at the clamping point.

Several hang-gliding accidents (under less loaded conditions than those encountered on microlights) occurred some years ago, because of ill-considered use of these clamps.

8.6.9 CORROSION

The cables should be examined carefully for signs of corrosion. This may appear as reddish rust-spots on carbon steel cables and thereby be easily recognized. Alternatively, it may appear on plastic-coated cables, for example, as dark discolorations under the covering. This may be the result of oil or grease being forced out of the mass of strands as corrosion takes place within them.

Corrosion may also be revealed as white powder forming at the junction of aluminium ferrules and galvanized steel cables. Any aircraft which has been used or stored near the coast is rather more likely to be prone to this problem.

In some aircraft structures (like Goldwings for example), cables can readily rust within the structure and need detailed care and regular scrutiny. Any cables which are hidden from view, whatever the aircraft, are best assumed as prone to corrosion. Then, if it does happen, it will not remain unobserved for long.

8.6.10 TWIST AND TENSION

In some older machines, builders were recommended to adjust the tension of cables by simply varying the amount of twist in them. This is a reasonably acceptable practice, having been ‘proved by usage’, but it must be applied in strict moderation and then only by slightly INCREASING the amount of twist to shorten the cable. Cables should never be forced to unravel.

When checking a cable to determine whether it has been adjusted excessively by twisting, or by careless storage, release it from its end-fixings. If it has been over-twisted, it will tend to lay in a coarse spiral and will probably have to be rejected by the Inspector.

8.6.11 TANG PLATES

It is also easy to make provision for correct cable adjustment by the incorporation of turnbuckles (“bottlescrews”) or by fitting tang-plates at the ends of the cables. (These plates have a multiplicity of holes drilled in them, so that the setting which gives the correct tension can readily be chosen). In any event, it is seldom necessary to adjust any cable on a microlight aircraft to limits closer than 1.5 mm (about 1/16 inch); that is easily achievable.

8.6.12 TURNBUCKLES

Turnbuckles are by far the best way to achieve adjustment of the length of a cable. They should be of aircraft quality, although boat equipment might seem to be a good alternative.

Some of the smaller types of stainless-steel turnbuckles are intended for fairly light-duty on dinghies, etc. They are too crudely fabricated - often with 'rattling good threads' - and quite unsuitable for application on an aircraft. They are identifiable by their miniature threads, small locking-nuts and generally fragile appearance. They are not to be accepted.
Since standard, aircraft quality turnbuckles (typically of the '10 cwt' type) cost little more than some of these DIY boat devices (because the latter happen to be made from stainless steel), it is not unreasonable to expect aircraft builders to use them for our specialised application. Nor can weight be a criticism, since these aircraft devices weigh only a very few ounces.

8.6.13 WITNESS HOLES

Aircraft quality turnbuckles usually have 'witness' holes in their barrel to allow a check that the screws are properly engaged.

But in the absence of these witness-holes, and even when they are present, the simple rule should be applied that no more than three threads of the fork-end or eye-end screws must be visible outside the extremities of the barrel.

8.6.14 DISMANTLING

Before you ask the owner to dismantle any turnbuckle, say, to allow examination of a complete cable, carefully measure its assembled length. It will then be a simple matter to fit it back together in the original settings, if that is required. Do not omit the re-locking, with the correct form of stainless-steel wire for the job.

It may actually be valuable to make a simple sketch in the logbook for the owner to use for future reference. It may also help you too, if you get the owner to do such jobs as this before you arrive to do the inspection. He will learn by the experience; you will be able to save time and expense and, at a later date, he will be helped in his routine maintenance checks.

8.6.15 LOCKING WIRE

A turnbuckle has a right-hand threaded screw at one end, and a left-hand screw at the other. Thus, when the screws (and their cables) are held stationary and the barrel is turned, the overall length of the unit becomes greater or less, depending upon the direction of rotation.

This is excellent from the point of view of adjustment but it does mean that, if the screws are not locked to the barrel, they will eventually fall out if that barrel begins to turn.

Some turnbuckles are provided with locking-nuts on each screw. However, these should be regarded as a useful aid to fitting and adjusting the turnbuckle and not as a total solution to locking it permanently into place.

All turnbuckles should have locking wire - preferably stainless steel - installed on them. It should be fitted in such a way that it is trying to tighten up the screws in the barrel.

Below is an extract taken from the FAA’s Advisory Circular AC 43.13-1B on Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, Chapter 7. Aircraft Hardware, Control Cables, and Turnbuckles, Section 10. Safety Methods For Turnbuckles.
SECTION 10. SAFETY METHODS FOR TURNBUCKLES

7-179. GENERAL. Safety all turnbuckles with safety wire using either the double or single-wrap method, or with any appropriately approved special safetying device complying with the requirements of FAA Technical Standard Order TSO-C21. The swaged and unswaged turnbuckle assemblies are covered by AN standard drawings. Do not reuse safety wire. Adjust the turnbuckle to the correct cable tension so that no more than three cable threads are exposed on either side of the turnbuckle barrel.

A & B: 7-180. DOUBLE-WRAP METHOD. Of the methods using safety wire for safetying turnbuckles, the method described here is preferred, although either of the other methods described is satisfactory. The method of double-wrap safetying is shown in figure 7-26(A).

C & D: 7-181. SINGLE-WRAP METHOD. The single-wrap methods described in the following paragraphs and as illustrated in figure 7-26(C) and (D) are acceptable, but are not the equal of the double-wrap methods.

Whilst the single wrap method is considered acceptable for amateur built aircraft, it is recommended that the locking wire is wound in bi-directional spirals to prevent the turnbuckle from moving in either direction, as recommended in the following illustrations taken from the British Civil Airworthiness Publication CAP 562 - Civil Aircraft Airworthiness Information and Procedures (CAAIPS).
The first method terminates the two ends at the centre, where they are neatly twisted together.

In a second method, the wire is passed through the fork of one screw and then bound round both the screw and the wire.

The free end is then passed through the hole in the barrel, on through the other fork-end and finally bound round that screw.
Yet a third method is similar to the above but brings the free end of the wire back to the starting end, where it is terminated by binding it on as through it were a continuation of the first winding. It must not be wound on over the top of the first winding.

![Diagram of Wire-locking of Turnbuckle with Swaged End-fittings](image)

Note the locking-nuts on each screw used to fit and adjust the turnbuckle and not to lock it.

### 8.6.16 CONTROL HORNS

The use made of turnbuckles should always be considered carefully when inspecting a microlight. They are excellent in applications where they fit into free lengths of cable. If used at the extreme end of a cable, they might not be so appropriate.

A common need on many microlights is the attachment of a cable, complete with some degree of adjustability, to a flat-plate control horn. If one attempted to do this by simply fitting the fork-end of a turnbuckle over the control-horn, and then installing a clevis-pin through the assembly, one might expect trouble. Even if the profile of the control-horn were radiussed around, and close to, the hole in such a way as to allow it to pivot inside the fork-end, there would probably be an inadequate amount of metal remaining to make the installation safe.

On some early Thrusters, a forked-end turnbuckle was used to attach the cable-end directly to the flat-plate control-horn in exactly that way. Because of the limited depth of the fork-end, it fouled on the control-horn at large control inputs.

The result was that the screws bent and, when the turnbuckle was replaced, the same thing occurred again, almost immediately.

### 8.6.17 CLEVIS PINS

On some early machines, the clevis pins which formed parts of turnbuckles had the holes for the securing pins drilled so close to their ends that they could readily break out under wear and vibration. Replacement of the turnbuckles was the best action.

These pins and the turnbuckles of which they are part, were substandard boat-components. Only the best should ever be used for our purposes and genuine aircraft-quality parts are often not much more expensive than these stainless-steel items sold at excessive prices in the prestige yachting market.
8.7 SWAGED CABLES

8.7.1 SECONDARY FERRULES

There has been much debate as to whether a cable needs one or two ferrules at each termination. Let me try to clarify the situation.

Systems like the Nicopress type, or similar, have been designed so that one ferrule - properly applied - will give a termination which more than matches the strength of the cable to which it is attached.

Where a cable is to be frequently handled and fingers can get pricked, or the cable has to be packed and unpacked from transportation/storage bags (which may get torn), it is obviously convenient not to have any sharp ends protruding from the cable. Since there has to be a positively discernible length left protruding from any single-ferrule installation, albeit only a very few millimetres, that will always present a mild hazard.

To deal with this problem, heat-shrink sleeving may be used but, if applied as generously as some manufacturers have used it even on double-ferrule installations - it has the disadvantage of also hiding the exact state of the cable end. At the first major Permit Renewal inspection, it has to be removed and is seldom replaced, so might be seen as rather a pointless exercise.

Perhaps it is viewed as an integral termination of the protective plastic sheathing to be found on many such cables.

But, quite the contrary, it becomes a trap for condensation and the consequent initiation of corrosion. It thus completely destroys the concept behind its installation.

Double ferrules have become something of a vogue in microlight aircraft construction, really quite needlessly, and probably retained only because some early constructors made some sloppy assembly of cables and had a few slippages.

Now that professionally made cable-ends are as they should be, slippage is not a serious risk, so one must assume that the second ferrule is now retained only to provide a tidy niche in which to tuck away the ragged end of the cable.

Of course, if fitted to the same high standard as the main ferrule, the secondary one will still contribute some strength to the cable-end, albeit redundant.

8.7.2 SINGLE FERRULES

A better compromise, perhaps, is simply to install one perfectly crimped ferrule, leaving 3/4" (20 mm) of cable extending beyond it. Then fit a band of heat-shrink sleeving - again about 3/4" long and ideally transparent - over the end of the cable.

That way the cable-end is easily accessible for cutting, its ragged end is properly secured, the ferrule is made off correctly and the cable is adequately exposed for inspection.
So, of course, the little band of heat-shrink sleeving does not need to be removed when conducting a permit renewal inspection.

8.7.3 CRIMPS

Whatever method of cable ending is used, Inspectors should look for precisely correct setting of the crimps on the ferrule, irrespective of whether there is duplication of ferrules. The end of the cable must – on no account - be recessed inside a ferrule if it is the only one fitted. (The crimped ferrules can be checked by slipping the appropriate 'go-nogo' gauge over them, but such a check is not possible if the whole end of the cable, up to the edge of the thimble, has been sleeved in heat-shrink sleeving. Therefore, this has to be removed. Because this sort of check would have been be carried out by the manufacturer it does not have to be redone for the annual permit renewal inspection).

On some machines, for example, on some Mainair aircraft, use is made of fully pre-swaged cable ends. These are the rather robust looking ends into which the cable passes axially and by which it is held by a fully machine-made 'clench'. These terminations are incredibly strong and easily exceed the strength of any cable on which they are installed.

However, failure, when it does come, is usually due to abusive bending of the cable just where it enters the end of the swage-fitting. Such bending is likely to be the outcome of careless handling during rigging and de-rigging, or by overtightening of the holding-bolts, so that the swage is not completely free to swivel on demand.

8.7.4 SLIPPAGE

Inspectors should advise owners to put a dab of paint just where the cable emerges from the swage. Then, if the cable should ever begin to slip out of the swage body - albeit a most unlikely occurrence - it will be seen during pre-flight inspection, before it becomes dangerous.

Similarly, if either an owner or an Inspector has any reason to be concerned that cables may be slipping through their ordinary ferrules, a simple check can be made by putting a small dab of paint on the cables about 10 millimetres from the ferrules.

Note the distance in the logbook. It is all too easy to convince oneself that the distance between the paint and ferrule was originally 5mm, if you are the owner and you are faced with the need to replace cables after a subsequent re-check!

Keep a very careful watch on the location of these marks and take action as necessary.

8.7.5 PULLEYS

Where a pulley is used to guide a cable through a change of direction, the pulley must be of reasonable diameter in relation to the diameter of the cable and its component strands. Section 5 states that the inside diameter of the pulley groove should not be less than 300 times the diameter of each elemental strand, so estimates like "pulley diameter equals 300 times the strand diameter or 20 times the cable diameter" are reasonable guides when making a visual assessment. If smaller sizes have been approved as satisfactory 'by usage' because, for example, the required change of cable-direction is only a few degrees, then they may be less than the above ratio.

All pulleys, with no exceptions, must be fitted with an adequate means of ensuring that the cable cannot jump out of the pulley groove and/or jam down the side of it. In most instances, this means that a suitable plate must be installed over the pulley, following its shape for the necessary arc.
Sometimes, if circumstances permit, the same result may be achieved by the nature of the pulley installation, e.g. it may be fitted very close to adjoining structure which is effective as a guard. But half-measures must never be accepted if that cable can conceivably jump out and jam, Murphy’s Law will ensure that it will do so, one day!

8.7.6 FAIRLEADS

Fairleads are sometimes used to change the direction of cables but this is only permissible up to 3 degrees. Changes of direction greater than this MUST be achieved with pulleys.

Fairleads must be made from materials such as Tufnol, Delrin, Noryl etc., which, whilst not absolutely ideal, are better than metals such as aluminium alloy or composites like glass-fibre, the latter because of its extremely abrasive quality.

On no account should cables be greased to ease their passage through fairleads, because grease picks up grit and dirt and accelerates wear. If lubrication seems necessary, either the fairlead is of the wrong material, the cable is wrong for the application, or the change of direction is too great.

At the very most, one may apply a little dry graphite lubricant in such locations.

8.7.7 FREE ROTATION OF RIGGING WIRES

It is absolutely vital - and this cannot be emphasized too much – to ensure that the terminations or attachments on rigging wires allow the thimbles to rotate freely on the bolts, plugs or bushes that anchor them. If the thimble cannot rotate freely, then any out-of-line loads are going to bend and unbend the cable and cause failure by fatigue between the cable and ferrule or, more likely, where the cable exits from the ferrule. This is the outcome of repeated bending; the latter itself may be due to nothing more than the in-flight flapping of the cable.

This seemingly trivial problem has caused an incredible number of problems with microlights in the past and will probably continue to do so. One must always be vigilant for the cause of the problems.

8.7.8 PRE-TENSIONING

When examining cables, be careful to take into account exactly what they do and the factors which might affect their performance of that duty.

For example, a little excessive tension in flying wires and landing wires might not seem too bad a thing. But if the cables carry avoidable and unnecessary loads before taking on any of those which they were designed to support, remember that they will reach their failure point earlier.

Secondly, the additional load due to pre-tensioning may add to the wear in the airframe. An example of this is that excessive tension, in flying and landing wires, gives added bearing loads on the tubes and bolts at the roots of the wings on 2- and 3-axis Dacron-and-tube machines. Avoidable wear may soon be induced, reaching dangerous proportions, as has happened and caused lethal failures in the past.

8.7.9 RIGGING AND DE-RIGGING INSPECTIONS

In general, although non-engineers tend to look upon cables as a very fragile means of supporting items like wings, for example, they are mostly only loaded very lightly. Consequently, they have wide safety margins. This is excellent because it allows the cable to tolerate the reduction in strength which accrues from broken strands, excessive kinking and so on, giving the operator or pilot plenty of time to notice the problem during his or her pre-flight inspections.
Because of the constant rigging and de-rigging which take place, these are features which are commonly encountered in microlight-aircraft operation.

### 8.7.10 UNDERCARRIAGE BRACING WIRES

In a few instances, cables do get a brutally heavy workload on microlights. Typical of these are the cables, which are installed between the legs of the undercarriage on some designs. Owing to the nature of the geometry of the undercarriage setup, the loads generated are actually increased by leverage before the cable is called upon to support them. Therefore, these particular cables do tend to stretch faster than any others except, possibly, the bracing wires used to stabilise the engine mass on some older machines.

All too often, owners have no idea just how great a proportion of the strength of the undercarriage is invested in the cross-cables. So, Inspectors must not be surprised to find owners tolerating these undercarriage cables in a slack condition.

A direct outcome is that other cables which may be attached between the undercarriage legs and the monopole will be dangerously slack when the machine is standing on the ground. That means that the primary structure is not braced by a set of reasonably taut cables. This applies whether the machine is airborne or grounded.

It is therefore most important that the Inspector ensures that the cross-cable between the undercarriage legs is as taut as the designer intended and any ill-effects its slackness might transmit to other cables or components is thereby avoided.

It is important to note that any visible slackness in these highly loaded cables may not only be due to stretching in the wire. It can be the result of slipped ferrules, stretched bolts and - maybe most important, since it affects primary structure enlarged holes in the undercarriage legs. What happens is that the bolt is bearing only on the wall thickness of the tube and, with the factoring-up of the loads, the compressive stress developed in the aluminium-alloy actually exceeds the maximum level tolerable. So the material yields and the bolts cuts itself an elongated hole, moving upwards towards the pivot of the undercarriage-leg.

If this sort of damage is found, as it often was on older machines, there is probably no alternative to a total replacement of the undercarriage legs.

### 8.7.11 PROPELLER CLEARANCE

Another important point for which Inspectors (and owners) should be vigilant, is the ability for cables to contact the propeller. Typical cables at risk are those on flex-wings from the base of the control-frame up to the rear of the keel.

Obviously, this is not something which any manufacturer would knowingly build into a design. But it can occur as the result of the coincidence at a series of factors. In severe turbulence, in a heavy landing, with a very heavy pilot and/or passenger, or due to rolling on rough or pot-holed terrain, the keel may suddenly flex downwards to some extent. That means the cables develop slackness, however briefly, and can distend downwards.

There is an equal possibility that the engine may move on its resilient mountings. Depending on their "Shore Hardness", the standard test method used for measuring the hardness of rubber and plastic, and their location, the engine may actually move upwards, sometimes by an astonishing amount.

This overall combination of momentary slackness in the cables and an upward-moving engine and propeller mass has actually occurred on several known occasions, resulting in contact between the cable and the propeller and mutual damage to them.
To prevent the propeller from contacting the cables in such circumstances, there must be (as a general guide) at least 60 mm (2.5") between the propeller tips and the cables. For some Rotax 912 mounted propellers, like the Warp Drive, this can be much more and necessitate the addition of a machined propeller hub spacer to ensure that the prop clears the rear of the wing keel. This should be with the control-bar fully forward and the machine totally at rest and unstressed apart from the deliberate pull being exercised to try to force the propeller and cables to their closest approach point. On some designs, like the Quik, an engine mount spacer has been added.

The problem can also occur when old "Orphan" combinations of wings and trikes are married together. Although they may be of a blend which is covered by a TADS, even production versions of these older machines - both wings and trikes - were so often individually 'hand-crafted', so to speak, that they have to be regarded as being unique specimens.

So, on any such combination, always check carefully that there is a generous static clearance between propeller and cables. Then take the tests al stage further and try pushing the engine and pulling the cables. It often happened that the assembly was far less 'taut' that is the case on Section S machines, and a contact could be forced with very little effort.

On good modern microlights, this test takes far more muscle power than one might imagine. But, nevertheless, G-force can sometimes provide the equivalent of that muscle when ground or turbulence forces come into play.

If contact can be made, seek guidance from the manufacturer or the BMAA Technical Office immediately.

8.7.12 PULLEYS AND FAIRLEADS

Whilst pulleys and fairleads are normally acceptable and are a necessary means of changing the direction of cables, wear of the latter can, and will, occur. Look carefully for any evidence of broken strands, permanent kinks in the cables, etc.

If the cables are obviously run around very small diameter pulleys, for example, it is virtually inevitable that they will take a curved 'set' and that strands will break. Seek them out and, if possible and approved by the Technical Office, fit larger diameter pulleys. As mentioned earlier, this problem has been found on Goldwings and was all the more worrying because it occurred inside the fuselage, where inspection was not a trivial matter, nor readily conducted in detail.

Remember, the check for broken strands inside the cable structure is to curve the cable slightly (about 2" (50 mm) radius) and then untwist it very slightly. Do not be brutal about this, or you will spoil what might otherwise be a sound cable. If no broken strands are seen, turn the cable about 90° and repeat the exercise. Do this through two further 90° increments.

It at no position are any broken strands seen, the cable can be re-used so long as it is satisfactory in all other respects.

8.7.13 STRUCTURAL INTERFERENCE

Where cables are installed so as to be terminated within, or to lie very close to structural members, Inspectors should be alert for the possibility of abrasion between the two.

On one type of aircraft, the cables passed through holes in the king-post and were abraded where they rubbed against the tube.

On another, the cables were carried round a bolt inside the kingpost and again were abraded.

Because both of these defects were largely obscured by the adjacent metalwork, they could have been missed but for diligent inspection.
8.7.14 CHANGES OF DIRECTION

If cables have to pass through sudden and marked changes of direction and, even worse, if they have to - or can - move back and forth over the pivot point, damage can easily occur.

This is a problem which seems to be fairly prevalent on the leech-lines of flexwings and in similar locations.

Stainless-steel multi-hole fittings would appear to offer the ideal solution to a tricky constructional problem and have been pressed into service on all sorts of microlight.

Basically, a separate clevis-pin forms the support for each cable but the arrangement has the serious disadvantage that such a small-diameter pin subjects the cable to a bending-radius which is far below the recommended lower limit for that size of cable.

The same rule always applies to cables if they need to slide and/or change direction, either a fairlead or, its equivalent, must be provided (for directional changes up to 3°) or a pulley must be installed. If there is no intention to allow the cable to slide over the clevis-pin but it might actually do so, thimble-ends must be used to ensure that it definitely cannot happen.

Similarly, if a sheathed cable is taken though a thimble, as is again convenient on leech-lines and the like, the high pressure generated at the point of contact, and slight back-and-forth movement between the two, soon destroys any sheathing which might be on the cable. The strands of the cable then begin to be attacked and start to break.

Since such items are an obvious source of trouble, Inspectors should give them close attention.

8.7.15 ENGINE CONTROL CABLES

There have been many problems with the small brass end-ferrules on Bowden cables used for throttles and chokes. These difficulties stem from the fact that owners are sometimes not aware of how such a ferrule is attached to the cable.

The end of the cable, and its brass ferrule, can be lubricated by dipping it into '3-in-l' oil. If the ferrule is of the cylindrical type, as fits into a choke-lever unit, make sure that it fits properly and - if required - can rotate freely. A little grease can be applied but only to the ferrule itself.

The Inspector should determine if the owner has remade any Bowden cables and, if so, whether he had approval to do so. A detailed examination of the cable-ends should form a part of the inspection.

On modern factory-assembled Bowden cables, it is common to find swaged (crimped) aluminium ferrules installed. This 'sort of end-fitting cannot be relocated and is not easily replicated by the average amateur, unless he has access either to a supply of ferrules and a crimping tool or crimping bars, or the workshop equipment with which to make them.

If both ends at a cable are to be made off, a very careful check should always be made to ensure that all requisite sheathing, end-adjusters, nipples, etc., have been put on before the final cable-end is splayed and soldered.

8.7.16 LOOKING FOR BROKEN STRANDS

When needing to inspect cables for internal broken strands, say, where the cable has been running over a pulley, one can use either of two similar techniques.
Firstly, the cable can be twisted open over a 3-4” (80-100mm) length, like a Chinese lantern, so that the internal structure can be seen.

Secondly, the cable can be curved slightly about 3” (80mm) is the very tightest radius you should use - and then again untwisted slightly. It no broken strands are seen. Turn the cable through 90° about its axis and repeat the exercise. Do this through the remaining two 90° increments. But do not be brutal about this check; you could end up ruining what was actually a perfectly good cable.

A light cloth can be drawn down a cable too, to detect protruding strands. This is better than using your fingers, as you may get painfully pricked and that could lead to tetanus it you have not recently had your jabs!

### 8.8 METAL FRAME / FABRIC COVERED STRUCTURES

#### 8.8.1 GENERAL AIRFRAME STRUCTURE

Where aluminium-alloy is used, the primary structure of all microlights built in Britain is normally seamless drawn tubing of HT-30-TF grade or its direct equivalent like Al 6082 aluminium alloy.

On older aircraft this might not be so and the inspector will need to use discretion. Fortunately, it was often the case that those early ‘designs’ used tubes which were very much over-sized anyway, so there was a hefty margin of strength.

Steel components may vary from aircraft-quality steel like British T45 and its equivalent American 4130 chromoly steel, to commercial grade material, especially if the loading is small.

#### 8.8.2 TUBE CONSTRUCTION

In the main, the tubes forming the structure of microlight aircraft are coupled together by alloy or stainless-steel plates, or by brackets or lugs cut from extruded channels, angles or other special sections of alloy. Nowadays, anodising is the norm for alloy parts but this was not always so. And, even today, one still occasionally finds anodising of poor quality, which allows the metal to corrode badly, especially if the machine is tied down outside for long periods, as is the case with so many training machines where they need to be rapidly available.

Early Thrusters were especially prone to mild corrosion of the fuselage-tube, internally and externally.

One sometimes encounters special castings in use, typically at the roots of wings, on engine-mountings and - on trikes - for the monopole-keel joint or for the hang-bracket assembly.

#### 8.8.3 STAINLESS STEEL

It must be remembered that stainless steel whilst good from the point of view of corrosion-resistance, is not the first choice from the aspect of fatigue resistance.

Do not simply do lip-service to inspecting a stainless-steel fitting because it looks pretty and professional.

On early Thrusters, for example, the thin stainless-steel brackets which Join the wings and other structure to the main fuselage-tube have shown themselves prone to cracking with rough-field handling.
8.8.4 WHAT TO LOOK FOR

Usually, there is not too much difficulty in gaining access to do a full inspection of fittings, whatever their type.

Obviously, one looks for cracks, badly enlarged bolt-holes or, more particularly, holes for pip-pins.

If such an enlargement has occurred at a pip-pin hole, there is often no alternative to installing a bolt, washer and Nyloc nut, however inconvenient. Remember to note the change in the Airframe and Engine Log-book.

If a hole does enlarge even slightly in a position coinciding with the 'pip'. or the supporting bracket changes in shape, the pin may be able to rattle out. On some designs of trike, this releases the whole seat-frame. If that seat-frame is used to brace the mast the risk is greatly compounded.

Generally, the assessment which an Inspector has to make is whether the bracket or fitting has worn or bent to an extent which demands its replacement. You are not permitted to grant - as a possible alternative - its continued use for some specified period you conjure up yourself. Do not take a gamble. Consult the Chief Inspector or Chief Technical Officer if you are concerned and always record your decision in the Airframe and Engine Logbook.

In some cases, wear will be the direct result of poor design, e.g. insufficient bearing-area. On older machines, this was often compounded by the fitting of 6mm bolts in 1/4" diameter (6.35mm holes, giving a 'rattling good fit'.

The use of bolts in a rather crude arrangement often led to their being bent in some applications on older machines.

Yet another malpractice, which has certainly continued into the manufacture of some Type-Approved microlights, is the use of bolts that have an insufficient plain shank-length. This results in the thread having to bear against the tube or bracket with very rapid wear being the direct outcome.

For the same reason, avoidable stresses were placed on tubular members, which resulted in their cracking.

Typical of the sort of problem which was encountered is the wear on the hang-bracket on early Hiway machines. The remedy was to ream the main 1/4" diameter hole to 5/16" (8mm), as soon as it had exceeded about 9/32" diameter. The bracket still remained usable so long as the nearest point of any of the holes from the edge of the bracket was not less than 1/4". Once that limit has been passed, the bracket HAD to be replaced. Today this would have to be approved by the Technical Office before any remedial work is done.

However, on all modern Type Approved microlights the remedy would be to simply replace the bracket with one obtained from the manufacturer. In principle, this concept might still be applied to some modern flexwings. But again, approval must be sought via a formal modification application.

8.8.5 ALUMINIUM VERSUS STEEL

Some owners tend to believe that the aluminium-alloy components on their aircraft are vulnerable to failure but steel parts are virtually infallible. Nothing could be further from the truth.

What is true is that a steel component can be bent or slightly compressed and it may still present no direct or immediate life-threatening hazard to the pilot of the machine. But one area where this is certainly not the case is round the engine installation.

Engine-bearers structures are inevitably highly stressed and subject to vibration, so cracks can very easily begin and propagate if there is any flaw, even a minute one like a missing length of weld (not unknown!) or a patch of corrosion.
Such cracks are very hard to find before they reach significant sizes, because there is usually oil and dirt round the region of any engine installation. So, it is important to clean the area thoroughly before attempting to find any problems.

When examining engine mountings, always look for signs of what may be termed 'unintended flexibility'. It is all too easy, because flexible mounts are commonly a part of any engine installation, to ignore a movement which does not result from those mounts, but which stems from, perhaps, a cracked part.

8.8.6 SHOCK LOADS

Parts of the aircraft which are subject to a high shock loads, and which are specifically made from welded steel, such as the nose-snoots on the trikes of flexwings, are all too often found to be bent after very hard landings.

Similarly, brackets which are welded to these snoots may also be cracked. The impact loads from, say, a nose-wheel-first hard landing will easily start cracks in a simple 'ear'-type bracket attached with a single line of welding.

If such an item is hidden inside a pilot-pod or fuselage, it is very hard to detect any such crack. The very least you must do is get as close as you can to any suspect component, with a good strong light and a magnifying glass.

If it is certain that the aircraft has been landed heavily, or the nose-wheel lacks freedom of rotation, or there is stiffness in the steering, there may be no alternative to dismantling the snoot from the keel for a fully detailed examination.

8.8.7 BOLTED LATTICE FRAMES

Bolted lattice frames, as on the Hummer fuselage, can be susceptible to cracking in specific locations where stresses have been concentrated by the conjunction of other supported loads.

The only way to deal with this problem is to examine every joint as though it must have failed. There will often be 'giveaways' such as patches of fretted aluminium dust where components have been moving about in ways for which they were never intended.

8.8.8 DESIGN FAILURE

If poor initial design is the cause of a failure, then usually the manufacturer will have devised a cure for it already.

On older (Orphan) aircraft, you may be the first person to meet the problem, in spite of the intervening years, and you will have to get advice from the Technical Office.

Typical of such problems was the failure of the ribs in the tail assembly of a Pathfinder 1.

8.8.9 NORMAL FLIGHT LOADS

Stresses arising from normal flight-loads or, often much more brutally, from wind forces on a machine tied down outside, can produce very clear-cut cracks or total failures of members.

Wherever the simplicity of microlight-aircraft design and construction yields a form of assembly which might lend itself to cracking, for example, you must assume that it will happen.

Plain holes through tubes, such as hang-bracket attachments to monopoles, or cable-holes through king-post caps, are just the sort of place where cracks can easily start.
8.8.10 MISASSEMBLY AND MURPHY’S LAW

As mentioned, several times before in this handbook, if there is a wrong way to assemble anything, the average person will ultimately find a way to do it! That does not mean the individuals are stupid, simply that we are all human and - given the right situation - we all make mistakes sooner or later.

“ If anything can go wrong it will”

Misassembly may not mean any flagrant disregard of what should be an obvious procedure; it might be nothing more than not pushing quite hard enough on a tube or fitting before inserting a bolt or pip-pin. If one convinces oneself that a bolt has entered a hole as it should, after you have manoeuvered two components into what you consider their correct alignment, you may have no reason even to question the alternative possibility.

This happened on one machine when the owner pushed the front strut into its bracket and inserted the through-bolt, and missed!

If the components in question are not easily accessible, the risk of such inadvertent misassembly is even greater.

If a component is badly assembled or part of it has been made incorrectly, this can lead to secondary problems that have nothing to do with the basic component, whose design is actually quite satisfactory.

Murphy’s Law was named after Capt. Edward A. Murphy, an engineer working on a U.S. Air Force research project at Muroc Field to see how much sudden deceleration a person can stand in a crash. One day, after finding that a transducer was wired wrong, he cursed the technician responsible and said,

“If there is any way to do it wrong, he’ll find it.”

Muroc Field was later renamed Edwards Air Force Base after test pilot Glen Edwards died while testing the Northrop YB-49 prototype jet-powered flying wing.

8.8.11 INCORRECT ASSEMBLY EXAMPLE

The control-frame on a flexwing was found to be badly deformed and the Inspector assumed at first that the machine had been crashed.

Only when the control-frame was dismantled, was it found that the individual members were perfect. The uprights had been installed incorrectly, so that the milled slots in their lower ends were effectively reversed and fouled the milled cross-bar ends.

On another machine, a disc-spring had been used to provide a hard face against which a pip-pin could locate, rather than relying on the softer face of the tube or having to drill a close-tolerance hole through it.

But if this washer were installed backwards, the ‘pips’ on the pin were unable to extend and the pin was certainly insecure.
8.8.12 OMISSION OF FASTENERS

The simple omission of, say, a single fastener can sometimes lead to problems in a component. Aircraft manufacturers never put anything into their designs which can be omitted, because 'simplify and add more lightness' has to be their motto.

So, if even one rivet is missing, that may be bad news and can lead to trouble. The owner or Inspector should therefore be looking for empty holes or minute differences between two machines of apparently identical type.

8.8.13 HINGE PINS

The simple design practices which have to be applied to microlights, if they are to remain in that very lightweight category of aircraft, means that some components do get subjected to an unavoidably high rate of wear.

Simple hinge-pins in nose-wheel suspensions are typical of such areas of high wear, especially if the machine is operated from rough fields.
8.9 OPEN AIR STORAGE AND ITS EFFECTS

8.9.1 OPEN AIR STORAGE

Serious corrosion has been noted on the airframes of modern machines which have spent many months tied down out in the open, (as so many training aircraft are) so do not presume this is a problem only associated with older aircraft. It depends almost entirely on how the machine is treated.

8.9.2 AIRFRAME CORROSION

Check the whole airframe carefully for corrosion. Some early machines were built from mill-finish tubing and severe corrosion could set in, given the right environment.

Owners can sometimes also bring about an equivalent condition by trying to save cash by making repairs with bare tube, albeit it of the HT-30-TF specification, so always be wary.

In one or two early machines, brass and alloy were employed where they came closely into contact, with the brass as a critical bearing material. This can be an extremely corrodible combination, mainly due to electrolysis when wet. Look hard for any sign of this pair of metals together.

Exactly the same problem can occur with stainless-steel and aluminium-alloy components. So always expect to see evidence of, say, zinc-chromate paste between, say, stainless-steel brackets and alloy tubes, even if the latter are anodised. Once water gets drawn into such a joint by capillary action, corrosion is almost a foregone conclusion.

If some form of plastic isolator is installed between such 'electrolytic pairs', the problem is greatly reduced.

8.9.3 CORROSION TO TUBE JOINTS AND FITTING ATTACHMENT POINTS

Pay attention to the tube joints and fitting-attachment points. Wax finish or WD40 affords some protection but etch-priming and painting properly is by far the best course for alloy structures, unless the correct use of good-quality anodising has been made.

(Do not forget that zinc chromate compounds are suspected of being carcinogenic - cancer-forming - so use gloves and extremely good ventilation when handling them for any task).

As an aside, paint helps fabric to slide on to tubes more easily, too.

8.9.4 ABRASION DAMAGE

On some early Thrusters, plastic bushes which were intended to prevent abrasion damage during road transit, were quite wrongly located and others omitted.

As a direct consequence, each wing structure was highly stressed in one region whilst folded, and severely abrasion occurred in those areas which ought to have been protected by the plastic buffers.

8.9.5 HANG-GLIDER WINGS

Many early flexwings used basically conventional hang-glider wings, albeit high-performance ones. In those cases, now getting very much rarer, where the wings are still actually being used for hang-gliding, unfasten the sail at the keel and look
inside the envelope. The cross-tubes should not be bowed due to some prior heavy landing giving a nose-impact. These, and the centre assembly which joins them, might be prone to critical damage of a type which is known to have caused one wing to fold in flight.

A heavy landing on a hang-glider may also distort the keel of the wing, bend the hang-bracket bolts or enlarge the holes which take the bolts attaching the hang-bracket or A-frame to the keel. Such asymmetrical damage would often lead to bias in flight at the very least.

8.9.6 ATTENTION TO DETAIL
Small detail items can often be a source of problems. The little clips which secure the ends of the tip-struts on one flexwing were very prone to crack and needed to be replaced with some better system.

A plastic anchor-block proved to be a far better alternative. (Note that such a change would now constitute a Minor Modification, albeit readily approved for installation and subsequent inspection)

8.9.7 CABLE BRACES
Poor design and fabrication of the cable system which braces the wing structure on Dragon aircraft led to a dangerous degree of wear and wing malformation.

Because the cables failed to hold the compression struts in their intended manner, they moved past their 'top dead centre' location and were supporting the loads in a mode for which they were not designed.

Since this would appear to be a 'series' type of fault which could readily occur on all Dragons, Inspectors should always examine the uncovered structure of the wings and establish the precise character of the folding process on any such machine which they examine.

Another minor flaw revealed in this wing was that the bolts which secured the halves of the, compression-struts were installed upside down. Had the nuts been lost, the bolts could have dropped out of the assembly, with structural failure being the inevitable outcome.

8.9.8 SEAT SUPPORTS
On the 250-Robin Hiway trikes, the top seat-supports tended to bend and had to be replaced. Experience showed that a tube and sleeve gave the best result, not the original arrangement of a tube with an internal steel rod.

8.9.9 TAPING UP WIRES
Some owners apply tape to the keel-ends of the pairs of cables from the A-frame, pulling them together. This is unwise as it can easily bow the keel. Owners must be told to remove such strapping. Consult the Technical Office or Chief Inspector.
8.10  TUBOLOGY

8.10.1  ALUMINIUM-ALLOY TUBES
Aluminium-alloy tubes, which are subject to high stresses, must always be examined carefully for signs of cracks. The parts of fuselage-booms where engines, reduction-gears, propellers, etc., form high point-loads are prime sources of such cracks.

8.10.2  TIP TUBES
Again, because of the need for designers to be most ingenious in achieving what they seek to do, with the minimum of weight and complexity, it is possible for abuse to damage components which may not be wholly easy to examine. Tip-tube mechanisms have sometimes been found to be damaged by a combination of misuse and corrosion due to rain penetration.

8.10.3  WING STRUCTURE
Where tubes are concealed by sail-fabric, it is often difficult to check for unwanted bends. In such instances, a reasonable substitute is sometimes a tape measure, so long as it is knowledgeably and competently used. With it, check the symmetry of the port and starboard halves of the rigged aircraft.

Structural members in compression merit extra scrutiny when looking for bends. For example, if the side-tubes of the control frame on a flex-wing are bowed, they may need replacement at the very least and, possibly, sleeving as well. But remember that quite a number of modern flexwings have their leading edges bowed by design, so that cannot always be regarded as a problem.

8.10.4  INNER SLEEVES
On some early Demon wings, it needs to be confirmed that the inner sleeves, mandated to be fitted to the inboard leading edges, actually extend at least 3” (76mm) outboard of the holes.

8.10.5  DENTS IN TUBES
Small dents in tubes, although common, are normally rarely large enough to cause problems. If they are, the associated tube is usually bent as well and needs scrapping on that account. Dents with sharp edges or profiles, or where the wall thickness has been reduced, are unacceptable.

Where fabric covers a tube, any dents of a magnitude which might threaten buckling can be found by carefully feeling along the length of it, with the cloth pulled taut.

So long as a dent is small, with no evidence of a local cut in the tube wall, it need not necessarily be regarded as a serious matter. As a rule of thumb, a tube that has suffered impact damage in the form of a smooth shallow dent may be satisfactory if the dent is not deeper than the wall thickness of the tube, and not immediately next to a structural fitting. But, as always, if in doubt ask the Chief Inspector or Technical Officer for guidance: do not guess.

Dents even of, say, 3-4mm maximum depth in a 50mm diameter tube may, in some extreme instances, still be considered as ‘small’. But this certainly not true if they are grooves, which could so easily be the propagation source from which the tube could buckle.
8.10.6 BENT TUBES
In general, any tube should not be permanently bent more than 1 unit in 300 out of true. In the case of primary airframe tubes this can be as restrictive as 1 in 600, though in one type the outer leading-edge tube is permitted to have a maximum straightness tolerance of Length/500.

8.10.7 CRUSHED TUBES
Tubes should not be crushed any more than one wall thickness out-of-round, and if the tube is prone to crushing, it should be plugged to resist the repetition of this type of damage. This would require modification approval.

8.10.8 LOOSE CONTACT ABRASION
Wear can occur between two aluminium alloy tubes in loose contact - especially during transport of a machine - but may not always be easy to spot without dismantling. Be alert for traces of aluminium dust (sometimes black) round an interface. Watch out for tubes appearing to butt together far more snugly than the designer ever intended! Whenever you are seeking to establish if abrasion has occurred between tubes or fittings, always try to remove all static loads. If they are free to rattle, they are more likely to shed the odd spot of dust or show up the excessive play accompanying such wear.

8.10.9 TORSIONAL OR LINEAR PLAY
If it is important that any particular components fit closely, with no torsional or lateral play, it must be properly checked that this condition is met.

8.10.10 REAMING FOR BOLT FIT
Where components are bolted to tubes, the acceptable repair guidelines would be as follows:

A "drill, ream and bolt through" technique is permissible but, ideally, only when the tube wall-thickness, including sleeves, is not less than one-sixteenth of the tube outside diameter. Also, as a general guide, the centre distance of any drilled hole should never be less than two hole diameters from the end of the tube. Approval must be sought if more that 0.010” of material is being removed or if bushes are to be inserted. Metric to Imperial bolt conversions should also be run by the Type Approval Holder.

On modern Permit aircraft, which match the 'Type-Approved’ specimen aircraft, you can safely assume that this issue has been properly addressed.

8.10.11 TUBE REPLACEMENT
If a tubular member of an airframe has been damaged and replaced between inspections, the machine must not be flown before having a second inspection. Also, if the machine is an ex-Exemption type, the Inspector will insist on seeing the invoice, receipt, or other evidence that the tube is seamless drawn material (HT-30-TF or equivalent, if aluminium alloy; steel will usually be stainless, carbon T45 or 4130-style chromoly).

If the machine is a Type-Approved one, its primary structure can only be repaired with factory-supplied and certificated parts. And, if the primary structure is involved, a second inspection is required before aircraft can be flown again. If either party is unsatisfied about the total airworthiness of the machine, it must not be signed off as such, pending clearance of any outstanding questions.
8.11 BLIND RIVETS

8.11.1 BLIND RIVETS (POP-RIVETS)

Pop-rivets are break stem fasteners, which are installed by gripping and pulling the end of the mandrel/stem. They are self-plugging. As installation is completed, the end of the stem fractures at the groove and is discarded, leaving the head of the stem in the fastener body.

If pop-rivets are used on microlight structures, it is not uncommon for them to loosen and, sometimes, even drop out.

Aluminium rivets are the worst in this respect. Check for any which are defective or missing and warn the owner that he or she may need to have them replaced at regular intervals, if the signs of loosening are there.

Blind rivets can also be made from stronger Monel and Stainless Steel.

Again, if it is possible, and necessary in order to carry out a thorough examination of the components, try to get them into a situation where there is no static force jamming them together, which could tend to make the rivets look secure when they are not.

On old flexiform wings, for example, the tip battens were pop rivetted to the leading edges and they worked loose on their location pegs. The aluminium rivets had to be replaced with steel or stainless-steel ones.

8.11.2 RIVET REMOVAL

When inspecting structures that have had their rivets removed ensure that the rivet holes have not been damaged and can be used again. Look for burring, enlargement or undercutting. Ideally, to avoid the risk of fatigue crack initiation, smooth edged holes are essential.

A method widely used for removing rivets is to centre-punch the middle of the preformed rivet head and then, using a drill equal to the diameter of the rivet, drill only to the depth of the rivet head.
The area surrounding the rivet should then be supported on the reverse side and the rivet driven out with a parallel pin punch slightly smaller than the rivet.

**8.11.3 WELDED FITTINGS**

All welds on steel and alloy fittings should be examined carefully.

Welded fittings on many early machines were commonly plastic dipped and this masked a host of bad welds. Such plastic coating is not acceptable and must be removed and the components grit- or vapour-blasted. If the parts are found to be satisfactory, normal priming and finish-painting can be applied. But plating is better, since it leaves the component able to be easily re-examined.

Plastic coatings which adhere badly to fittings not only hide poor welding but can promote corrosion by trapping water.

**8.11.4 CRACK INITIATORS**

You will often find that if cracks do appear, they are initiated from, or pass through, drilled holes.

But do not assume that this is invariably the case. Sometimes if, for example, a plate is bolted up so as to be bent slightly 'out of plane', there will be considerable stresses built up in, the plate at that point, even if it appears to resist the bending and be flat. The same is true if the plate carries a significant static load (such as an engine) and is thus being subjected to bending forces.

Then, if it has the tiniest of surface scratches, that will form the point from which cracking will begin. This type of failure is fairly common on microlights.

Scribe lines are another well known crack initiator.

**8.11.5 VIBRATION INDUCED CRACKS**

Seemingly robust plates and channels can often develop cracks, especially if - as is often the case - they form a part of an engine-mounting system, where vibration levels are high.

**8.11.6 WELD CRACKING**

Examine all welds visually for cracking at the toe of the weld, that is, the boundary between a weld face and the parent metal or between weld faces, and for evidence of fatigue damage.
With steel components, one often finds that welds are the starting-point for cracks or complete fractures. This is due to several reasons.

1. Firstly, the welding process produces stresses which ought to be removed by heat-treatment but this may not have been done.
2. Secondly, there may be tiny ‘occlusions’, as they are termed, of dirt or just air in the weld and these will happily act as a stress centre.
3. Thirdly, the welding process produces metallurgical changes which, indirectly, can lead to the start of cracking.

There are other effects but these are the main fallibilities.

On components formed from thin sheet and then welded, the problem of crack initiation can be an even greater problem.

8.11.7 BEND RADII CRACKS

Even on Permit aircraft, it is still possible to encounter bending radii which are smaller than they should be for the material on which they have been used. This leads very readily to the generation of cracks.

If the component is folded (‘cold-worked’) from thinnish sheet and the loads are such that an end of the fold can be subjected to high stresses, as in a hang-bracket, trouble is almost sure to ensue.

8.11.8 FLIGHT PROBLEMS

If the pilot has reported any form of bias in the aircraft’s flight pattern or ground-handling, careful thought should be given to potential causes of this, before any unnecessary or fruitless dismantling is undertaken. If disassembly is carried out which is not needed, it may well be that some vital examination is omitted, even out of simple embarrassment! So, think twice, act once!

Possible causes of such bias can be the enlargement of critical fixing holes (caused by welting the wing-tip against the hangar door, for example) mis-shaped wing-battens, deformed fittings, bent bolts, low-quality unrecorded repairs, and so on.

8.11.9 HIGH STRESS POINTS

On monopole trikes, now much the commonest form of structure, always look very closely at high-stress points, such as seat frame attachment points, engine-bearer attachment locations, cable end-anchorages, undercarriage-leg fittings, etc. as previously highlighted.

8.11.10 WEAR AT BASE OF PYLON

Always fold down the vertical frame or monopole of a trike, to relax the static loads on it and show up wear at the pylon base and top joint.

8.11.11 PUMA SPRINTS, RAVENS AND RAVENS X

When examining the structure of Puma Sprints, Ravens and Ravens X manufactured by either Southdown International (not Southdown Sailwings) or Medway Microlights, note the following:
If the machine has logged over 500 hours of operation or is over five years old, specified parts of its airframe are either subject to direct replacement by Medway Microlights Ltd, or to the BMAA’s “On Condition Schedule” OCI-No:001 with replacement of the given components where appropriate. One or other procedure must be applied.

8.12 FABRIC STRUCTURE

The standard of fabric work to be found on modern microlights and on those built before 1 January 1984 (the so-called “Orphan” microlights), is widely different. On the current products, it is usually superlative but on the old aircraft, it often lacked finesse. Clearance holes for struts, cables, etc. were sometimes simply cut out with a hot knife and left ragged at their edges.

This might be unimportant except for the fact that there are still a number of these veteran aircraft flying and even now being pulled from the back of attics and lofts with a view to their being put back into use. (The author has a 1983 model which has two virtually ‘as-new” sail-sets with it!)

If you own, or have to inspect an Orphan machine and hot-knife cutting has been used around holes, then look for tears emanating from these holes. This sort of rough-and-ready hole-cutting does tend to leave a thick, brittle rim of plastic just waiting to crack and give the ideal start for a rip.

Stitching was not always duplicated where needed and abrasion-resistant pads were omitted. Nevertheless, although this sort of workmanship looked poor, it was actually airworthy and was never known to have failed dangerously. So be cautious but do not reject it on grounds of aesthetics!

Many of these old sets of fabric have now ended their safe useful lives anyway and have been, or need to be, replaced. If new sails have to be made for an old machine, Inspectors should obviously expect modern standards of workmanship and not tolerate a simple copy of the original set-up, except on a general dimensional basis.

It should be remembered that with the Technical Office having already cleared the way for many pre-1984 machines to be put back into service, and still currently working on them – one is still likely to see such old fabric. But do bear in mind the comments above and remember that many old machines have been carefully stored in lofts and garages, with the fabric in darkness. Sunlight has thus not been able to do its damage, so the fabric may still be in mint condition.

And even with new machines and high-quality sails, the Owners are often extremely careless about how they handle the fabric! One still sees idiots who trample about on their sails when rigging their aircraft! Boot-nails harm fabric faster than UV!

There have been cases where fabric has been ripped badly when flexwings have been unfolded before a careful check has been made to ensure that nothing is snagged anywhere. The forces generated near the front (inboard ends) of leading edges, for example, as wings are unfolded, are enormous and fabric damage can happen without the Owner even being aware that it has happened.

8.12.1 STITCHING

Inspect the stitching for any signs that it may have started to unravel or fail due to degradation. It is helpful to run one’s nail down the line of stitching (and alarming to find how often the stitches disintegrate!)

It is sometimes useful to decide where you think doubled stitching ought to have been used and has not. If you are right, those are the areas where failures may have begun. Also, if ribs or wing structure are so placed that intense local pressure or abrasion is brought to bear on specific areas of the sail, it is reasonable to expect to find holes or rips starting there.
Although, with the Bettsometer, we now have a first-class test for the acceptability or otherwise of Dacron, we have no such guaranteed test for stitching. This is because there is a wide variety of choice open to the sailmaker as to what grade of filament he uses. Even allowing for the various pitches of stitching used – often shorter in length for weaker, cheaper thread – one can still not easily determine an acceptable ‘pass’ strength for stitching in general. For example, tests on new stitching has shown it to fail at tension forces on a single loop, as different as 500 grams and 3000 grams.

8.12.2 WEAR

The chafing wear by cross-tubes on the nose-rib pocket on the very early SX 130 wings, was an example of abrasion. The outer surface needed rectification by a properly sewn fabric patch, backed up by an additional high-strength reinforcement of heavy-duty material. If you own or have to inspect such a machine, it would be wise to contact the present manufacturers of Chasers, who will be the nearest source of good advice, for guidance as to the best course of action, if any is required. Doubtless, they could carry out any necessary minor work.

8.12.3 DETERIORATION

On a Thruster, left tethered outside for months with the elevators hanging down, the Inspector found that simply running his thumb down the rib lines caused the fabric to disintegrate on either side of the rib. This was the outcome of direct abrasion and a less obvious form of interaction between Dacron, water and alloy tubing.

Trapped or condensed water, in particular, forms a grayish mould inside the Dacron cover, frequently on the lower surface which holds the moisture most readily. This mould seems to be almost as damaging to Dacron as ultraviolet light, to the extent that tests on some lower surfaces have commonly shown them to be at least as deteriorated as the UV-exposed top surface and, in one recorded instance, more so. So, do not assume that, if the Dacron top-covering of a component passes its Bettsometer test and is able to be accepted, the lower surfaces do not merit examination to the same standard. They always will.

8.12.4 ULTRAVIOLET

Ultraviolet light readily attacks both the thread and fabric. Look carefully for severe discoloration or other indications of deterioration of the Dacron, especially if the machine has spent any significant period tied down out in the open, with or without covers on the flying surfaces. Even if the sun has been screened off the fabric, dampness (possibly acid dampness, in Britain!) will probably have been trapped under the covers and could have harmed the fabric. Under covers, it is inevitably slow to dry when the breezes come up. Mould growth is unsightly, but whether it is damaging to Dacron is not known scientifically.

8.12.5 FABRIC TESTING

The general test for the condition of fabric used to be to press the center of the panel with your thumb. If an impression was left, or if your thumb actually penetrated the fabric, then replacement was probably necessitated. But this appallingly crude test – which could not be considered as sensibly qualitative and was certainly not even verging on the quantitative – could never be regarded as an even remotely satisfactory test, nor one that was definitive. (At least one individual is known to be able to push his thumb straight through brand-new Dacron, which makes a nonsense of the method!)

The Mawle fabric-test used on doped fabric by the light aircraft industry, is only fractionally better.
8.12.6 BETTSOMETER & BROOKSMETER

After years of searching, the BMAA eventually chose a first-rate fabric-deterioration test method, employing a simple, robust device which is easily carried around and equally trivial to recalibrate.

This simple device, the ‘Bettsometer’ measures the force applied to the fabric by a sailmaker’s needle pushed through it and then pulled parallel to its flat surface in both the ‘weft’ and the ‘warp’ directions of the weave.

One of our Inspectors has professionally conducted many dozens of laboratory tensile tests on Dacron fabric. (Tests by the former Chief Inspector, Peter Lovegrove, on the same fabric samples have entirely confirmed his findings). These have reproducibly demonstrated the manner in which the strength of Dacron alters after various degrees of exposure to sun and rain, etc.

The graph of deterioration in strength is typically exponential in nature. We are now at last in a position reliably to interpolate a direct force at which the Dacron tears under the needle – in terms of a percentage of ‘strength when new’.
All BMAA Inspectors have, from 1 January 1993, used the Bettsometer to test Dacron fabric on member’s microlights presented for permit renewal inspections, with no exceptions. The results from the tests can be recorded on the Fabric Test Report forms AW/062 and AW/063 as ‘pass’ ticks. As the fabric gets older and decays, it will be possible to get a clear indication of why it has done so, by relating it to the storage conditions, etc., applied to the machine. We shall certainly learn just how cruelly damaging it is to leave Dacron covered machines tied down in the sun and rain for prolonged periods.

If the Inspector finds that parts of the Dacron begin to tear at the ‘pass’ level, or below it, then repairs or replacement must be carried out before the aircraft is flown again. The ‘pass’ figure on the TADS is NOT arbitrary.

The 'Brooksmeter', produced by P&M Aviation, is in essence a Bettsometer with a larger hook and greater range of operation. It has been introduced to test reinforcing bands found on more modern flexwing designs.

For more information on the Brooksmeter and testing procedures please refer to the following:

http://www.pmaviation.co.uk/admin/upload_pdf/SB133Iss2%20Wing%20Testing_All%20Wi.PDF
8.13  ALL METAL STRUCTURES

Detailed methods of inspection can be found in Chapter 4: Metal Structure, Welding, and Brazing of AC43.13-1B Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair and in the old BL/6 Series of Engineering Practices and Processes of the Civil Aircraft Inspection Procedures (CAIPs). Below is a general summary of some of the principles of inspecting All-Metal aircraft.

8.13.1  IDENTIFICATION OF METALS

Proper identification of the aircraft structural material is the first step in ensuring that the continuing airworthiness of the aircraft will not be degraded by an improper repair using the wrong materials.

If the material type is known, a hardness test is a simple way to verify that the part has been properly heat-treated.

Hardness tests are useful for testing aluminium alloy chiefly as a means of distinguishing between annealed, cold-worked, heat-treated, and heat treated and aged material. It is of little value in indicating the strength or quality of heat treatment.

Magnetic testing consists of determining whether the specimen is attracted by a magnet to distinguish whether the metal is ferrous or otherwise.

8.13.2  FLUTTER AND VIBRATION PRECAUTIONS

To prevent the occurrence of severe vibration or flutter of flight control surfaces during flight, precautions must be taken to ensure it stays within the design balance limitations when inspecting a maintenance or repair.

BALANCE CHANGES: The importance of retaining the proper balance and rigidity of aircraft control surfaces cannot be overemphasized. The effect of repair or weight change on the balance and centre of gravity is proportionately greater on lighter surfaces. As a general rule, a repair of a control surface must be done in such a manner that the weight distribution is not affected in any way, in order to preclude the occurrence of flutter of the control surface in flight.

PAINTING & REFINISHING: Be aware of the effect of too many extra coats of paint on balanced control surfaces.

TRAPPED WATER OR ICE: Instances of flutter have occurred from unbalanced conditions caused by the collection of water or ice within the surface.

TRIM TAB MAINTENANCE: Loose or vibrating trim tabs will increase wear of actuating mechanisms and hinge points which may develop into serious flutter conditions.

8.13.3  TRANSFER OF STRESSES WITHIN A STRUCTURE

Six types of major stresses are known and should be considered when making repairs. These are tension, compression, bending, torsion, shear, and bearing stress.

An aircraft structure is designed in such a way that it will accept all of the stresses imposed upon it by the flight and ground loads without any permanent deformation. Any repair must accept the stresses, carry them across the repair, and then transfer them back into the original structure. These stresses are considered as flowing through the structure, so there must be a continuous path for them, with no abrupt changes in cross-sectional areas along the way. Abrupt changes in cross-sectional areas of aircraft structure that are subject to cycle loading/stresses will result in stress concentration that
may induce fatigue cracking and eventual failure. A scratch or gouge in the surface of a highly-stressed piece of metal will cause a stress concentration at the point of damage.

8.13.4 LOAD CARRYING MEMBERS IN METAL STRUCTURES

The airframe of a fixed wing aircraft is generally considered to consist of five principal units; the fuselage, wings, empennage, flight control system and landing gear.

Aircraft principal structural elements (PSE) and joints are designed to carry loads by distributing them as stresses. The elements and joints as originally fabricated are strong enough to resist these stresses, and must remain so after any repairs.

Long, thin elements are called members. Some examples of members are the metal tubes that form engine mount and fuselage trusses and frames, beams used as wing spars, and longerons and stringers of metal-skinned fuselages and wings.

- **LONGERONS & STRINGERS** - Designed to carry principally axial loads, but are sometimes required to carry side loads and bending moments, as when they frame cutouts in metal-skinned structures.
- **TRUSS MEMBERS** - Designed to carry axial (tension and compression) loads applied to their ends only.
- **FRAME MEMBERS** - Designed to carry side loads and bending moments in addition to axial loads.
- **BEAM MEMBERS** - Designed to carry side loads and bending moments that are usually large compared to their axial loads. Beams that must resist large axial loads, particularly compression loads, in combination with side loads and bending moments are called beam-columns.
- **OTHER STRUCTURAL** - Elements such as metal skins, plates, shells, wing ribs, bulkheads, ring frames, intercostal members, gussets, and other reinforcements, and fittings are designed to resist complex stresses, sometimes in three dimensions.

Any repair made on an aircraft structure must allow all of the stresses to enter, sustain these stresses, and then allow them to return into the structure. The repair must be equal to the original structure, but not stronger or stiffer, which will cause stress concentrations or alter the resonant frequency of the structure.

All-metal aircraft are made of very thin sheet metal, and it is possible to restore the strength of the skin without restoring its rigidity. All repairs should be made using the same type and thickness of material that was used in the original structure. If the original skin had corrugations or flanges for rigidity, these must be preserved and strengthened. If a flange or corrugation is dented or cracked, the material loses much of its rigidity; and it must be repaired in such a way that will restore its rigidity, stiffness, and strength.

8.13.5 ALUMINUM ALLOY STRUCTURES

Extensive repairs to damaged stressed skin on monocoque-types of aluminum alloy structures must be made in accordance with a repair scheme approved by the BMAA and the Manufacturer.

8.13.6 SELECTION OF ALUMINUM

For replacement parts, all aluminum replacement sheet metal must be identical to the original or properly altered skin. If another alloy is being considered, approval must be obtained from the BMAA Technical Office.
8.13.7 BENDING METAL

When describing a bend in aviation, the term “bend radii” is used to refer to the inside radius. Requirements for bending the metal to various shapes are frequently encountered. When a metal is bent, it is subjected to changes in its grain structure, causing an increase in its hardness.

8.13.8 SETBACK

Setback is a measurement used in sheet metal layout. It is the distance the jaws of a brake must be setback from the mold line to form a bend. For a 90 degree bend, the point is back from the mold line to a distance equal to the bend radius plus the metal thickness.

8.13.9 RIVETING

Rivet holes are slightly larger than the diameter of the rivet. When driven, solid rivets expand to fill the hole. The strength of a riveted joint is based upon the expanded diameter of the rivet. Therefore, it is important that the proper drill size be used for each rivet diameter.

Rivets should be replaced with those of the same size and strength. If the rivet hole becomes enlarged, deformed, or otherwise damaged; BMAA approval must be sought before the hole can be drilled or reamed for the next larger size rivet, to ensure that the edge distance and spacing is not less than minimum allowed. Rivets may not be replaced by a type having lower strength properties, without BMAA approval, who will ensure that the lower strength is adequately compensated by an increase in size or a greater number of rivets.

8.13.10 REPAIRING CRACKED MEMBERS

There are ways of repairing such defects according to standard aviation practice, such as drilling small holes at the extreme ends of the cracks to minimize the possibility of their spreading further, or adding reinforcement to carry the stresses across the damaged portion and to stiffen the joints. All repairs using these techniques must be approved by the BMAA beforehand.

Generally, with microlights it is often cheaper to simply replace the part.

8.13.11 STEEL AND ALUMINUM FITTINGS

STEEL FITTINGS.

Inspect for the following defects.

(1) Fittings are to be free from scratches, vice and other marks, and sharp bends or edges. A careful examination of the fitting with a medium power (at least 10 power) magnifying glass is acceptable as an inspection.

(2) When assessing damage after an accident inspect all highly-stressed main fittings.

(3) Torn, kinked, or cracked fittings will need to be replaced.

(4) Elongated or worn bolt holes in fittings, which were designed without bushings, are not to be reamed oversize. Replace such fittings, unless a method of repair is approved by the BMAA. Do not accept elongated or worn bolt holes that have been filled with welding rod.
ALUMINUM AND ALUMINUM ALLOY FITTINGS

(1) Damaged fittings should be replaced with new parts that have the same material specifications.

(2) Repairs may be made in accordance with data furnished by the aircraft manufacturer, or data substantiating the method of repair may be submitted to the BMAA for approval.

8.13.12 SELECTIVE PLATING IN AIRCRAFT MAINTENANCE

Selective plating is a method of depositing metal from an electrolyte to the selected area. The electrolyte is held in an absorbent material attached to an inert anode. This process requires prior approval by the BMAA or Manufacturer.

8.13.13 WELDING

Welding is one of the three commonly used methods of joining metals without the use of fasteners. Welding is done by melting the edges of two pieces of metal to be joined and allowing the molten material to flow together so the two pieces will become one.

When repairs of any of these flight-critical parts are to be performed, it is extremely important that the weld repair is equal to the original weld. Identifying the kind of metal to be welded, identifying the kind of welding process used in building the part originally, and determining the best way to make welded repairs are of utmost importance.

8.13.14 MICROFISSURES

Cracks in parts and materials can vary from tiny microfissures, that are visible only with magnification, to those easily identified by unaided eyes. Microfissures are the worst type of defect for two reasons; they are often hard to detect, and they produce the worst form of notch effect/stress concentration. Once they form, they propagate with repeated applications of stress and lead to early failures. Every possible means should be used to detect the presence of cracks, and ensure their complete removal before welding operations proceed.

Nondestructive testing methods such as magnetic particle, liquid penetrant, radiography, ultrasonic, eddy current, and acoustic emission can be used; however, they require trained and qualified people to apply them.

8.13.15 INSPECTION TUBULAR MEMBERS BEFORE REPAIR

Prior to an approved repair of a tubular member, carefully examine the structure surrounding any visible damage to ensure that no secondary damage remains undetected. Secondary damage may be produced in some structure, remote from the location of the primary damage, by the transmission of the damaging load along the tube. Damage of this nature usually occurs where the most abrupt change in direction of load travel is experienced. If this damage remains undetected, subsequent normal loads may cause failure of the part.

8.13.16 REPAIRS TO WELDED ASSEMBLIES

For appropriate repair techniques and methods refer to CAP 553, BCAR Section A, Supplement 1 to Chapter A8-10 Approval of Welders.
8.13.17 STAINLESS STEEL STRUCTURE

Repairs to structural components made from stainless steel, particularly the “18-8” variety (18 percent chromium, 8 percent nickel), joined by spot welding, must be in accordance with the instructions furnished by the manufacturer or BMAA.
8.14 ALL COMPOSITE STRUCTURES

8.14.1 SOURCES OF DAMAGE IN COMPOSITE STRUCTURES
- Normal & abnormal flight loads
- Fluid ingress into honeycomb cores
- Paint strippers, hydraulic fluid, etc.
- Impact (in-flight, ground handling equipment)
- Heat & UV exposure

8.14.2 INSPECTION CHALLENGES
- Hidden damage
- Small amounts of moisture
- Heat damage that affects resin matrix
- Weak bonds (manufacturer or environment induced)

8.14.3 FLAW TYPES
- Interply delaminations
- Skin-to-core air gap disbonds
- Skin-to-core “kissing” disbonds
- Impact damage

8.14.4 TAP TESTING
Tap testing is widely used for a quick evaluation of any accessible aircraft surface to detect the presence of delamination or debonding for internal voids and porosity.

The tap testing procedure consists of lightly tapping the surface of the part with a coin or light special hammer with a maximum weight of 2 ounces, or any other suitable object. The acoustic response is compared with that of a known good area.

A “flat” or “dead” response is considered unacceptable. The acoustic response of a good part can vary dramatically with changes in geometry, in which case a standard of some sort is required. The entire area of interest must be tapped. The surface should be dry and free of oil, grease, and dirt. Tap testing is limited to finding relatively shallow defects in skins with a thickness less than .080 inch. In a honeycomb structure, for example, the far side bondline cannot be evaluated, requiring two-side access for a complete inspection. This method is portable, but no records are produced. The accuracy of this test depends on the Inspector’s subjective interpretation of the test response and therefore, only experienced Inspectors should perform this test.

8.14.5 INSPECTION OF DAMAGE
Research on the resistance and tolerance of flat and curved sandwich panels to impact damage have shown that visual inspection methods are misleading and the residual indentation cannot be used as a reliable damage metric for static ultimate strength and damage tolerance criteria for sandwich structures.
Experiments suggest that the impact damage in honeycomb core sandwich panels is better detected by a technique that measures the local stiffness of the sandwich, while the damage in foam core panels can be best assessed with a technique relying on the measurement of acoustic impedance (tap tests) [28].

An illustration of a sandwich panel with honeycomb core (like Ultralam).
8.15 FUEL SYSTEMS

To have been certified under BCAR Section 'S' the fuel system will have been constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any normal operating condition.

The design will have ensured that vapour locks cannot occur and, if the fuel pump can draw fuel from more than one tank at a time, a means will have been provided to prevent introduction of air in quantities that could cause fuel starvation.

8.15.1 FUEL SYSTEM LINES AND FITTINGS

The guidelines in BCAR Section S 993 ‘Fuel system lines and fittings’:

- Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure* and accelerated flight conditions (* consider low suction as well as high delivery pressure).

- Each fuel line connected to components between which relative motion could exist must have provisions for flexibility.

- Each flexible hose must be shown to be suitable for the particular application.

- Each fuel line and fitting in any area subject to engine fire conditions must be at least fire-resistant* (* defined in Section ‘S’ as having the capability to withstand the application of heat by a flame for a period of 5 minutes without any failure that would create a hazard to the aircraft).

- Leakage from any fuel line or connection must not impinge on hot surfaces or equipment which could cause a fire, nor fall directly onto any occupant.

8.15.2 ROUTING OF FUEL LINES

The guidelines in TIL107 ‘Drip Trays, Fuel Lines & Ignition Switch Wiring’:

- Where fuel-tubes are routed along the fuselage members adequate steps must be taken to ensure that abrasion cannot occur against the edges of fittings, struts, etc.

- All safety measures must apply when the aircraft is in-flight or on the ground (rigging / de-rigging, in storage and during transportation). Aircraft have been lost to fires on the ground; this may not be life threatening, but is certainly embarrassing!

- Avoid all possible contact with moving parts at any time (such as engine starting cord) and tight bends in the fuel tubes/hoses. These can lead to blockages and/or fuel line failures, especially near fittings or attachment points.

- Ensure the fixtures/fittings are air/fluid-tight and secure, such that they may not be easily loosened accidentally or through prolonged vibration (or by fuel/oil spillage -where appropriate).

8.15.3 CONDITION OF HOSE AND HOSE ASSEMBLIES

The guidelines in Leaflet 5-5 ‘Hose and Hose Assemblies’ of CAP 562 Civil Aircraft Airworthiness Information and Procedures (CAAIPs):
GENERAL CONDITION - General deterioration of a hose may be recognised by discoloration, flaking, hardening, circumferential cracking or crazing of the outer cover (see figure below). These defects do not render the hose unserviceable unless the cracks penetrate to the braid.

INSTALLATION - The installation of a hose assembly should be checked to ensure that it is not twisted, stressed, or bent through too sharp an angle and that any clips or supports are correctly fitted and not chafing or imposing stress on the hose.

CHAFING & CUTS - Light chafing and cuts in the outer cover are generally acceptable if the braiding is not exposed, but the reasons for the damage should be ascertained and corrected. In the case of hose assemblies which have no outer covering over the braid, any damage to the braid will normally entail rejection, but some manufacturers permit the acceptance of isolated broken strands. Chafing which occurs under clips may entail changing both the hose and the clips.

KINKS - This defect is usually caused by incorrect installation or by mishandling. It shows up as a sharp increase in radius at one point in a bent hose and is usually easy to detect visually unless the hose has a protective cover; finger pressure should be used to check this type of hose. Any kinked hose must be considered to be permanently damaged and must be scrapped.

CORROSION - Hose assemblies with corroded wire braid, or end fittings which are corroded (other than very lightly and locally) must be scrapped.

CONTAMINATION - Contamination of a hose with an outer rubber cover will show up as swelling, sponginess, hardening or disintegration of the surface and is not acceptable. Hose which is contaminated should be rejected and renewed.

OVERHEATING - The overheating of rubber covered hose is apparent as scaling, crazing, or discoloration of the surface. Hose with an outer wire braid may assume an overall golden brown colour when exposed to normally high temperature and this is acceptable; patches of discoloration caused by overheating are not acceptable.

Blisters - May form on the outer synthetic rubber cover of hoses, but these do not necessarily affect the serviceability of the hoses provided they are able to withstand the applicable test described in a) or b). Certain factors must be taken into consideration, however, e.g. if the hose is exposed to spray from the tyres, puncturing of the outer cover may allow corrosive elements to attack the wire braiding.

LEAKS - Hose assemblies should be checked for leakage with pressure in the associated system. e.g. when the engine is running. Petrol leaks quickly evaporates after an engine is shutdown making it hard to detect. A leak may be detected by the presence of fluid on the hose, end fittings or adjacent structure, or by the appearance of blisters on the hose (When a
protective sleeve is fitted, stains may appear on the sleeve or fluid may emerge from the ends of the sleeve, but if the leak is small and no fluid is visible, the presence of fluid may sometimes be detected by squeezing the sleeve. A leaking hose must be scrapped.

8.15.4 MANDATORY DIRECTIVES – FLEXIBLE FUEL TUBING

MPD: 1998-019-R1 - Light Aircraft Flexible Fuel Tubing – applies to all permit aircraft and calls for immediate replacement of any PVC fuel tubing by tubing of an alternative material (e.g. from polyurethane) which does not harden and shrink with age.

MPD 2010-001 Trelleborg HydroK Hoses – Issued on 9th February 2010 and applying to all UK registered aircraft operating on a CAA Permit to Fly fitted with Trelleborg Hydro K hoses. Visually inspect all Trelleborg Hydro K flexible hoses for signs of cracking. If any cracks are found, before further flight, replace the affected hose(s) with new parts or an alternative approved hose. If no cracks are found under inspect the hoses for cracks at intervals of 30 flight hours or every month, whichever is the shorter. If cracks are found during any of these inspections, the hoses are to be replaced with new parts or an alternative approved hose.
**8.16 ENGINES**

Whatever you happen to be about to do on the power-plant of a microlight, always, but always, follow one golden rule:

**ASSUME THAT THE ENGINE IS ‘LIVE’ AND ABOUT TO BURST INTO LIFE, EVEN WHEN THE THROTTLE IS APPARENTLY FULLY CLOSED AND THE IGNITION SWITCH IS DEFINITELY PUT INTO THE ‘OFF’ POSITION.**

**ONLY IF THE PLUGS ARE WITHDRAWN ARE YOU ABLE TO BE STONE-COLD CERTAIN THAT THE ENGINE WILL NOT FIRE.**

The Rotax 4 Stroke Aircraft Engines have become the de facto standard for light sport aircraft and microlights. They are smooth, quiet, fuel efficient and reliable.

Now that Rotax has become the dominant supplier of engines to the microlight market, the current 447’s, 503’s, 582’s and 912’s all come with dual ignition, dual carburettors, integral gearbox and other features.

**8.16.1 2-STROKE ENGINES**

The Fuji Robin, BMW, Hirth and Solo range of engines are also in use, but Rotax dominates the field.

**8.16.2 BACKGROUND OF ROTAX 2-STROKE ENGINES**

Rotax 2-stroke aircraft engines produce their power at high RPMs. As propellers need to turn much slower, reduction is achieved through a gearbox. The commonest members of the family are the air cooled 377, 447 and 503 and water cooled 462, 532, 582 and 618.

The A type gearbox was fitted to the 377, 447, 462, Bosch ignition 503 and 532. The B type gearbox can be found on the 447, dual ignition 503, 532 and 582.

The B type gearbox is the most economical and lightest model available. It is limited to a propeller mass moment of inertia of 3000Kg/cm².

The C type gearbox is a sturdier model, requires less maintenance and can handle propeller mass moments of inertia up to 6000Kg/cm². The electric starter can be installed on the magneto end (crankcase end opposite of the gearbox).

The E type gearbox is similar in principle to the C type but integrates an electric starter, allowing a recoil starter to be kept as a backup.

You can tell the provisional difference by looking at the power take off end of the crankcase of the 503. The early Rotax UL 503’s were built without provision and with Bosch breaker point ignition. A non-provisioned 503 will have the crankcase flanged out and this will only accommodate a belt reduction.

The provision ‘4’ engines fitted the A gearbox and many early B gearboxes with the 8-spring torsional shock absorber. Provision ‘4’ also always had Bosch breaker points on them.

Provision ‘8’ refers to the 8-bolt pattern for the stronger Rotax B, C, or E gear boxes, which have the 12-spring torsional shock absorber. It has the heavier crank bearings throughout the entire crankshaft along with the large crank seals on both ends and dual electronic ignition. The provision ‘8’ was the beginning of Ducati capacitor discharge ignition either single as on the 377/447 or dual as on the 503. There was not enough room in the cylinder head of the two smaller 377/447 engines to have dual plugs.
8.16.3 4-STROKE ENGINES

8.16.4 BACKGROUND OF HKS 700E 4-STROKE ENGINE

The HKS 700E engine is manufactured by HKS of Shizuoka, Japan, who are a technology development company formed over 20 years ago to create an engine from the ground up for the light aircraft industry.

The HKS 700E is a 60HP, horizontally opposed, 2 cylinder, 4-stroke engine used in Light aircraft, PPC’s and Trikes. It is air-cooled with dry sump forced lubrication, oil cooled cylinder heads and nickel ceramic composite coated cylinders. One central camshaft operates the pushrods and overhead valves. The valve gap is automatically adjusted by hydraulic lifters. electronic dual capacitor discharge ignition (DCDI), electric starter and generator. Reduction gear has integral torsional shock absorption. TBO is 800 hours.

8.16.5 BACKGROUND OF JABIRU 4-STROKE ENGINE

Jabiru produce their own range of lightweight 4 stroke horizontally opposed aircooled engines, specifically designed and engineered for use in aircraft. All engines are direct drive and are fitted with alternators, silencers, vacuum pump drives and dual ignition systems as standard. Over 2000 4 cylinder engines and over 750 of the 6 cylinder engines have been produced. The basic design is now so mature that only minor design changes have been made in the last 1000 engines or so.

The 85 bhp Jabiru 2200 is characterised as a 4 stroke, 4 cylinder horizontally opposed engine with 1 central camshaft with push rods, overhead valves, ram-air cooling, wet sump lubrication, direct propeller drive, dual independent transistorised magneto ignition, integrated ac generator, electric starter, mechanical fuel pump, a naturally aspirated - 1 pressure compensating carburettor on a 6 bearing crankshaft.

8.16.6 BACKGROUND OF ROTAX 4-STROKE ENGINES

The 912UL is a 4 cylinder, 4 stroke liquid/air cooled engine with opposed cylinders, dry sump forced lubrication and separate 3 litre (0.8 US gallon) oil tank, automatic adjustment by hydraulic valve tappet, 2 Bing constant depression (CD) carburettors, mechanical fuel pump, electronic dual capacitor discharge ignition (DCDI), electric starter, integrated reduction gear ratio of 2.273 (optional 2.43). The Rotax 912 UL develops 81 HP at 100% power setting (5800 RPM).

The 912 ULS is a 4 cylinder, 4 stroke liquid/air cooled engine with opposed cylinders, dry sump forced lubrication with separate 3 litre (0.8 US gallon oil tank, automatic adjustment by hydraulic valve tappet, 2 Bing constant depression (CD) carburettors, mechanical fuel pump, electronic dual capacitor discharge ignition (DCDI), electric starter, integrated reduction gear with 2.43:1 ratio. The 100HP 912 ULS aircraft engine is based on the field proven 81 HP Rotax 912 UL design.

The Rotax 912 ULS is not simply a 912 UL with different pistons. Through careful research and development, Rotax has made many design changes and improvements to the crankcase, gearbox, intakes, pistons, cylinders, water pump, exhaust and ignition to increase performance while maintaining the same external dimensions.

8.16.7 CONAIR SOFT START MODULE (SSM)

The ConAir Soft Start Module, designed & manufactured in the UK by ConAir Sports Ltd, alters the timing on one ignition circuit. It has been found to be beneficial on 912ULS engines fitted with a slipper clutch, but there is no real benefit when fitted to engines without a slipper clutch.

The real cause of these problems is inadequate batteries and long starter cables resulting in slow cranking speeds. The Soft Start Module helps overcome the problems caused by these short falls.
It is fully solid state, fully automatic, and triggered by each attempt to start the engine. 4 pin and 6 pin options are available.

It is a Single Magneto ignition circuit installation, leaving the other circuit to operate as normal with twin parallel circuits for added safety backup.

The unit comes with either a 6-way plug or 4-way plug configuration. In order to determine which plug configuration you need to order, you will need to locate the part number on the Rotax Electronic Module fitted to the engine.

<table>
<thead>
<tr>
<th>Engine</th>
<th>E-box part no.</th>
<th>Pin config.</th>
<th>Unit required</th>
</tr>
</thead>
<tbody>
<tr>
<td>912UL (s/n 4400239 - 4406290)</td>
<td>965 358</td>
<td>4 way plug</td>
<td>SSM-002A</td>
</tr>
<tr>
<td>912UL (from s/n 4406291)</td>
<td>966 726 (926726*)</td>
<td>6 way plug</td>
<td>SSM-001A</td>
</tr>
<tr>
<td>912ULS (up to s/n 5643679)</td>
<td>966 721</td>
<td>4 way plug</td>
<td>SSM-002A</td>
</tr>
<tr>
<td>912ULS (from s/n 5643680)</td>
<td>966 726 (926726*)</td>
<td>6 way plug</td>
<td>SSM-001A</td>
</tr>
<tr>
<td>912ULS</td>
<td>966 727</td>
<td>n/a</td>
<td>do not use SSM</td>
</tr>
<tr>
<td>914UL (s/n 4417512 - 4418711)</td>
<td>965 358</td>
<td>4 way plug</td>
<td>SSM-002A</td>
</tr>
<tr>
<td>914UL (from s/n 4418712)</td>
<td>966 726 (926726*)</td>
<td>6 way plug</td>
<td>SSM-001A</td>
</tr>
</tbody>
</table>

The owner will need to seek approval by way of a modification from the BMAA prior to fitting this item to their aircraft. This mod was first approved by the BMAA in MAAN 2090 and quoting this approval number will simplify the mod application.

The unit will function correctly but starting problems may not be cured if the aircraft has a damaged Sprag Clutch or the Gearbox Friction Torque is too low.

**8.16.8 BACKGROUND OF VERNER 4-STROKE ENGINE**

The Verner VM 133MK engine is for microlight and light (experimental) sport aircraft. The engine is a new model developed by Verner Motor Company in the Czech Republic, on the basis of the experience gained from the production of the first model, Verner 1400.

It is a 4 stroke piston engine, 2 cylinder horizontal opposed with chain driven overhead camshaft operating four valves per cylinder, air cooled and fed by 2 Dellorto carburettors. Wet lubrication system is sump type with oil pump and automotive oil filter. An oil cooler is normally installed. Engine case cast in magnesium alloy. Reduction gearbox has teethed steel gears oiled from the motor oil. A torsional vibration absorber (clutch type) is mounted in the reduction gearbox. Electronic capacitor discharge ignition system, breakerless double type (with 2 spark plugs per cylinder). Variable ignition timing driven from an engine control unit, fed from a magneto-alternator with battery charging system 12V/160W. Electric starter
and mechanical driven fuel pump. Crank-shaft and con-rods mounted on sliding bearings. Light dry weight only 61kg (without exhaust pipe and oil cooler). TBO 1000 hours. It has a displacement of 1329cc and power output of 84bhp max @ 5500rpm, 70bhp continuous @ 4200rpm.

8.16.9 BACKGROUND OF UL POWER 4-STROKE ENGINE

The ULPower aero engine has been developed specifically for use in light aircraft, both fixed wing & rotary wing. It is built with a fully electronic ignition and multipoint fuel injection (FADEC) system as standard. The engine is designed with proven technology to be reliable, light weight and high performing with a direct propeller drive.

It is a 4 stroke, air cooled, 4 cylinder opposed engine with multipoint electronic fuel injection (no carburettor icing problems) with automatic altitude and temperature compensation, redundant dual electronic ignition and fuel efficiency on a 5 bearing crankshaft with a thrust ball bearing.
8.17 SEAT HARNESSSES AND WEBBING SYSTEMS

8.17.1 SEAT BELTS

The main purpose of the seat belt is to ensure that the pilot is safely retained in his initial sitting or reclining position under flight and emergency landing accelerations (see Section S AMC S 785d). It will incorporate a seat and belt arrangement that can resist 9g forwards, 4.5g upwards and downwards, and 3g sideways.

8.17.2 SHOULDER HARNESSSES

All occupants must be provided with a lap strap and upper torso restraint, capable of restraining the wearer against the forces resulting from the accelerations prescribed for emergency landing conditions. (see Section S 1307 Miscellaneous equipment).

The exception is that only a lap strap need be provided for front seat occupants of a weight-shift controlled aircraft. It must not be possible for an unsecured safety harness to contact the propeller.

A series of MPDs issued in 2001 (MPD 2001-004, 006, 009 & 010) mandated the upper body restraint to the rear seats of flexwings where forward movement of the passenger could cause injury to the pilot.

It also applied to all 3-axis microlights, though there may be some aircraft where it proved virtually impossible to retro-fit shoulder harness, because of the absence of structure which could provide an appropriately strong anchorage. Strictly speaking, this is a design problem rather than an inspection matter. Seek advice from the Technical Office or Chief Inspector if you have serious doubts about the acceptability of a system presented to you.

8.17.3 SEAT BELT ADJUSTMENT

In order for the wearer to be able to tighten the seat-belt or harness correctly, particularly where pilots of very different stature use the aircraft, it is most important that the loops of the belt are able to slide freely around or along the tubes or bars to which they are attached.

8.17.4 SEAT BELT ABRASION

No feature about any belt, harness or webbing, or its installation, adjustment or locking, should offer the means for cutting into the belt material. Look for signs of distress, wear or biochemical staining. No significant fraying, nicks, or cuts should be accepted.

8.17.5 BELT BUCKLES

On all microlights, the seat-belt buckle must be a fully reliable type, neither easy to open accidentally nor difficult to open readily when required. CAAIPS Leaflet 14-15 says that the buckle release load should not exceed 90N (20lbf) and that the minimum release load should not be less than 22.5N (5lbf).

8.17.6 SEATS

Seats can vary greatly. On earlier machines, they may be rigid, being made by a glass-fibre moulding or a plywood platform, or they may more often be sling seats made by draping a length of Dacron or similar fabric between two suitably placed structural members.
In the case of rigid seats, all the inspector can do is to look for any signs of cracking in the glass fibre, splitting or rotting of the plywood, or imminent failure of any bolts associated with the mounting of the seat.

Sling seats, being fabric, are prone to the same sort of damage as the sails, etc., except that the intensity of the stresses on the attachments of the seat fabric is far higher. Where the seat fabric is looped round the tubes and stitched back, the inspector should look carefully to establish that there is no sign of ripping or failure of the stitching. More modern microlights may have moulded 'bucket' seats, sling-seats, sewn fabric bucket-seats or combinations of both. The inspector should look for indications of failure as for older types.

8.17.7 LEGACY ISSUES

Inspectors must be prepared to find a wide variety of safety harnesses which might surface again on a renovated microlight of early vintage. Unlike the excellent systems installed on modern Section-S aircraft, the belts supplied on early machines or in early kits were often little more than poorly adapted car-seat belts. These were fine in their designed environment but could become quite dangerously unreliable if the end fittings were cut off and the attachment crudely made. Typical of such attachments was wrapping the belt round a tube and sewing it with a length of carpet thread, or by clamping the pieces of belt together with a couple of odd screws from the local DIY store!

Inspectors must never lose sight of the basic requirement that seat harnesses must provide adequate restraint against any undesired movement upwards, forwards and sideways. That means, essentially, that the system must be (at the very least) as good as one would expect to find in a modern car. The webbing should be 45-50mm wide and of a high quality.

Belt-length adjustment devices must move freely when required but lock solidly under all other conditions. As a practical guide for the Inspector this means that the belt-adjuster will not slip if he pulls on it firmly, with his foot braced against the airframe. Typically, this equates to a force of around 350N (70-80lb).

There have been instances where seat belts have been assembled with the 'spare' length up to the adjuster on the inside of the main loop. This is wrong and the belt should be installed so that the adjuster and excess length are on the outside.

For obvious reasons the bolts which anchor the belt or harness to the airframe should be of aircraft quality and the associated details of the fixing design must be sound. If such a fixing is required to swivel in order to align the belt to align without crossways shear on it, as is normally the case for belts, that capability must be properly demonstrated. This is important because it is usually how the loads are evenly distributed across the width of the webbing.

Typical of the sort of attachments one may find used to secure the belt or harness to the airframe, are the following:

(i) One bolt at each attachment, in single shear. In this arrangement, the bolt must be at least 5/16" or 8mm in diameter.
(ii) One bolt in double shear. For such an arrangement, the bolt must be at least 1/4" or 6mm in diameter.
(iii) Two or more bolts sharing the load equally, either in single or double shear.

For all of the above, obviously the Inspector may also accept the use of US 'AF' specification or 8.8 high-tensile plated bolts. If the design calls for the belts to be looped round a tube the Inspector must expect a proper standard of fixing at the belt ends.

For example, this may have been achieved by stitching the end of the belt back to the main length, forming a loop, BEFORE the belt is fitted to the tube.
The stitching should form a rectangular 'lay' (of double cross-stitching) of basically 60mm to 80mm length and about 40mm width (for a 50mm wide belt). Besides following this typical outer rectangular pattern, the stitching should cross the two diagonals. Suitable high-tensile polymer thread should be used.

An alternative which CAA Surveyors accepted in the past for ultralight gyroplanes with tubular seat-frames - a method which therefore found its way into early microlights - was to clamp the end of the belt in a loop back to its main part, with two plates bolted through the belt.

The plates were often made from 16 to 18 s.w.g. (1.2 to 1.5mm) aluminium alloy, well smoothed off around their edges to prevent them chafing the webbing. Suitable bolts for this particular application today would be four M4 aircraft bolts with washers and Nyloc nuts.
8.18 TERMINOLOGY

ADVISORY

This is a note on the Inspection Schedule that advises the Owner of items that have only just passed the inspection, and will need to be replaced or repaired in the near future.

It should list the items that are at the minimum airworthiness requirement, and therefore in need of attention. Failure to attend to these items may result in the Owner, or anyone else operating the aircraft, flying it in an unairworthy condition and thereby be open to prosecution. In addition, it warns the owner that, should he be involved in an accident, it may invalidate his insurance.

AIRCRAFT MANUFACTURER

The ‘Aircraft Manufacturer’ is the Type Approval Holder of the aircraft in question.

AIRWORTHY

The state an aircraft is in when it is fit to fly. To be airworthy an aircraft must be legal by conforming to approved data and all pertinent regulations and must be serviceable by its acceptable condition, known life and origin of parts.

APPROVED DATA

Technical data published by the Civil Aviation Authority Safety Regulation Group, and by the BMAA Technical Office where delegated, constitutes ‘approved data’. These come in the form of Microlight Airworthiness Approval Notes (MAANs) for amateur owners, Airworthiness Approval Notes (AANs) for A1 approval holders, Type Approval Data Sheets (TADS) and Mandatory Permit Directives MPDs.

B CONDITIONS

Allows test flying without Certificate of Validity or a Permit to Fly

CALENDAR MONTH

A period extending from the beginning of a day in one month to the end of the corresponding preceding day in the following month, regardless of how many days there are in that particular month or whether it is a leap year. E.g. 05/06/2007 to 04/07/2007

e.g. If a form is signed on the 11th April 2009 the signature is valid until the end of the working day of 10th May 2009, regardless of the actual time of day the form was signed. In reality the administration office use their discretion in marginal cases, particularly during post office delays due to bad weather or industrial action or over weekends and public holidays.

CERTIFY

To confirm formally as true, accurate or genuine by a dated signature of the Inspector
**COMPOSITE**

A homogeneous material created by the synthetic assembly of two or more materials (a selected filler or reinforcing elements in a compatible matrix binder) to obtain specific characteristics and properties (e.g. strength and weight).

**CONDITION**

A mode or state of being; a state of readiness or physical fitness.

**CONTROL SYSTEM**

A Control System is a system by which the flight path, attitude, or propulsive force of an aircraft is changed.

**DEFECT**

A defect is an imperfection that impairs the structure, composition, or function of an object or system.

The lack of something necessary or desirable for completion or perfection; a deficiency: a visual defect. An imperfection that causes inadequacy or failure; a shortcoming.

**FABRICATION PROCESS**

The process of making a component, assembly or composite part from materials using techniques such as cutting, drilling, riveting, swaging, welding, stitching, gluing, heat treating, surface coating/plating/anodising, curing of resins and deformable bending or the use of alternative materials to that of the original specification.

CAP 482 - BCAR Section S - Small Light Aeroplanes [25] Sub-Section D Design and Construction, Paragraph S 605: Fabrication methods says:

“The methods of fabrication used must produce consistently sound structures which must be reliable with respect to maintaining the original strength under reasonable Service conditions. If a fabrication process (such as gluing, spot welding, heat treating, or processing of plastic materials) requires close control to reach this objective, the process must be performed under a defined process specification. Unconventional methods of fabrication must be substantiated by adequate tests.”

**FIREPROOF**

‘Fireproof’ with respect to materials, components and equipment means the capability to withstand the application of heat by a flame, for a period of 15 minutes without any failure that would create a hazard to the aircraft. Compliance with the criteria for fireproof materials or components should be shown as follows:

1) The flame to which the materials or components are subjected should be 1100°C ± 80°C.

2) Sheet materials approximately 64 cm² should be subjected to the flame from a suitable burner.

3) The flame must be large enough to maintain the required test temperature over an area approximately 13 mm².

For example, materials which are considered fireproof without being subjected to fire tests include:

a) stainless steel sheet 0.4 mm (0.016 in) thick;
b) mild steel sheet protected against corrosion 0.45 mm (0.018 in) thick; and

c) titanium sheet 0.45 mm (0.018 in) thick.

FIRE-RESISTANT

‘Fire-resistant’ with respect to materials, components and equipment means the capability to withstand the application of heat by a flame, as defined for ‘Fireproof’, for a period of 5 minutes without any failure that would create a hazard to the aircraft. For materials this may be considered to be equivalent to the capability of withstanding a fire at least as well as aluminium alloy, in dimensions appropriate for the purposes for which they are used.

LAMINATE

A product made by bonding together two or more layers of material or different materials, such as layers of fibre reinforcement in a resin. E.g. extruded polyester sheet film (Mylar) and para-aramid synthetic fiber (Kevlar) to make a Kevlar scrim/Mylar film laminate (GTS Ultralam or Trilam),

MAINTENANCE

This is the regular, continuous work of keeping something in proper condition and working order. It is a pre-emptive activity and is generally performed on airworthy aircraft. It is unambiguously the responsibility of the Owner to manage and/or perform.

To maintain something is to keep in an existing state, keep up or carry on, continue, preserve or retain, keep in a good condition or efficiency.

The CAA definition extends this to any one or combination of overhaul (a term not recognised in the microlight world – use ‘rebuild’), repair, inspection, replacement, modification or defect rectification of an aircraft or component, with the exception of pre-flight inspection.

MANUFACTURED PARTS

A manufactured part is a complex assembly or compound component that has been processed, such as a tube that has been sawn, cut and assembled, a wire that has been swaged, a sail that has been sewn together, a front fork that has been welded, a sleeve that has been anodised. It is beyond the remit of the owner to make the part himself without approval by the BMAA Technical Office.

MODIFICATION

A modification is a change to part of the aircraft that deviates from the build standard in terms of its fit, form, function and fabrication process. A change in material is also classed as a modification. Because they cause the aircraft to depart from its certified design, all modifications need to go through some sort of approval process before being implemented and inspected.

NON-CONFORMITY

A non-conformity is a deviation from a specification, a standard, or an expectation.
OPERATOR
The operator of an aircraft is the person who at the relevant time has the management of that aircraft. (ANO Article 155 Paragraph 3)

PRIMARY STRUCTURE
Primary structure is structure that carries flight loads or ground loads, and without which the ability of the remaining structure to carry these loads is lost or significantly compromised.

Flight loads are aerodynamic loads generated by lifting surfaces - including horizontal and vertical stabilising surfaces - and reacted by the weight or acceleration of significant masses in the aircraft - including, but not limited to, the engine, occupants, fuel and primary structure.

Ground loads are loads exerted by the ground on the undercarriage and reacted by the weight or acceleration of significant masses in the aircraft.

Primary structure includes lifting surfaces.

PROVENANCE
Place of origin; source; derivation. Proof of authenticity or of past ownership. Formal certificates of conformity are generally required for whole aircraft, homebuild kits and propellers as proof of provenance. Evidence of the origin, service history and the serial number of uncertified engines qualifies as proof of conformance to a known manufacturing and servicing process. In some instances receipts from engine manufacturer’s approved distributors or A1 approved aircraft manufacturers are acceptable to the Technical Office as certificates of conformity, particularly for engine parts and for parts used in primary structure.

QUALIFIED PERSON
Qualified Person is someone the Owner considers to have sufficient knowledge and experience to inspect work done against a published requirement e.g. BMAA Inspector, Licenced Microlight Pilot, Manufacturer, etc.

REPAIR
This means to restore to sound condition after damage is sustained as a result of an unintended event or accident. Synonyms are fix, set right, remedy, renew or revitalize. Major repairs nearly always involve some sort of irreversible fabrication process and so will require prior approval from the BMAA Technical Office.

REPLACEMENT
The replacing of components by ‘form, fit and function’ with fully interchangeable parts approved by the manufacturer.

FORM – if the component is an assembly or a processed part
FIT – all dimensions and tolerances must be the same
FUNCTION – material strength, able to do the same job
For example, Rotax only approve their own genuine Rotax parts for use in their engines, but non-Rotax parts can be used provided they have either been approved for use by the aircraft manufacturer (type approval holder) as part of the original aircraft design or as a modification, or been approved as a modification through a relevant body such as the BMAA or LAA.

SAFETY

Is a measure of organisational resistance to risk.

SAFETY CRITICAL

A safety-critical system is one whose failure may cause injury or death to people. The more accurate definition is one whose failure can contribute to the aircraft getting into a hazardous state.

On microlight aircraft it is difficult to eliminate the risk of all single-point mechanical failures that could lead to a catastrophe because of the economy of the weight driven design, so the focus is on a multi-layered defence by certification of the strength of the design, regulatory control over modifications and repairs, and regular check flights and inspections.

SNAG

A snag is a problem reported by the check pilot or test pilot during flight that is drawn to the attention of the Owner. If it appears to be a defect affecting the airworthiness of the aircraft, the Inspector who released the aircraft for flight must be contacted for it to be investigated and classified.

The Check/Test Pilot cannot sign off the Check/Test Flight until all defects have been properly diagnosed by the Inspector. All snags must be reported to the Owner and recorded in the aircraft logbook. All snags classified as defects must be remedied and the aircraft re-inspected, amending the inspection schedule as necessary. Defects may not be deferred without appropriate liaison with the manufacturer or the BMAA Technical Office.

SUBSTANTIATION

To support a statement or claim with evidence

SUITABLE SUPPLIER

A suitable supplier is one that can supply parts that have either been approved for use by the aircraft manufacturer as part of the original aircraft design or as a modification, or been approved as a modification through a relevant body such as the BMAA.

VITAL POINT

A Vital Point is any point on an aircraft at which single mal-assembly could lead to catastrophe, i.e. the primary aircraft structure or engine or flight control system.
8.19 NAMING OF PARTS

“They call it easing the spring: it is perfectly easy
If you have any strength in your thumb: like the bolt,
And the breech, and the cocking-piece, and the point of balance,
Which in our case we have not got; and the almond-blossom
Silent in all of the gardens and the bees going backwards and forwards,
For today we have naming of parts.”

by Henry Reed from 'Lessons of the War'

This poetic extract, as any cadet or serviceman will recognise, is a contrast between the repetitious boredom of a soldier going through a drill learned by rote and the simple distraction of what is going on around you on a warm summers day.

In the same way we can be easily distracted while inspecting an aircraft.

However, the poem does demonstrate the value of knowing the names of every part of the machine you are inspecting.
**AEROFOIL**
Two dimensional section of a wing (US: airfoil)

**AEROFOIL TUBE**
Aerodynamically shaped extruded tube

**AEROPLANE**
Fixed wing aircraft or aerodyne (see Gyroplane) (US: airplane)

**A-FRAME**
Triangular control frame primary structure comprising base bar and two uprights (a.k.a. trapeze, control frame)

**AFT WIRES**
Run from the ends of the base bar to the rear keel of the wing, locating the base bar whilst also transmitting pitch control forces to the wing. (a.k.a. Backstay)

**AILERON**
hinged surface hinged to the trailing edge of an aircraft wing to provide lateral aerodynamic control, as in a bank or roll [from French, diminutive of ‘aile’ meaning wing]

**AIRCRAFT**
Vehicle or craft which is able to fly through the air

**AIRSHIP**
Aerostats which use their buoyancy to float in the air

**ANHEDRAL**
Downward angle of wings from root to tip

**ASPECT RATIO**
Span divided by the Mean Geometric Chord or \( \frac{\text{Span}^2}{\text{Wing Area}} \)

**AVDEL**
Proprietary breakstem blind stainless steel rivet

**BACKSTAY**
Runs from the ends of the base bar to the rear keel of the wing, locating the base bar whilst also transmitting pitch control forces to the wing.
**BASE BAR**
The lower tube primary structure of the A frame with which the pilot exerts control input forces (a.k.a. Control bar)

**BASE TUBE**
Fore and aft structural component holding the seat frame and nose wheel and connecting to the front strut and pylon (monopole)

**BATTENS**
Formed rods inserted into pockets in the sail and then put under compressive load.

**BETTSOMETER**
Fabric tensometer

**BILLOW**
The amount of fullness exhibited by the sail as a result of sail material movement

**BILLOW SHIFT**
When a bank is initiated by weightshift the rolling moment is augmented by the floating keel and keel pocket which shifts sail fabric to the descending side of the wing so increasing washout decreasing lift, and vice versa on the ascending side which increases lift.

**BOWSPRIT**
Extension to trike keel on which is attached the front strut and nose wheel a.k.a. Gooseneck, snoot

**BRIDLE**
See luff lines

**BRIDLE RING**
Joins compensator cable to reflex bridle

**CAMBER**
Maximum distance from the chord line to the camber line, expressed as a percent of the chord line

**CAMBER LINE**
Line that is midway between the upper surface and lower surface

**CANARD**
Foreplane, an airframe configuration in which the tailplane is positioned ahead of the mainplane

**CATENARY**
The curve theoretically assumed by a perfectly flexible and inextensible cord of uniform density and cross section hanging freely from two fixed points

**CHORD**
Line joining the leading edge and the trailing edge the direction of air flow

**COMPENSATOR CABLE**
Attaches to bridle ring from top of kingpost

**CONTROL BAR**
The lower tube primary structure of the A frame with which the pilot exerts control input forces a.k.a. Base bar
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>CRINGLE</td>
<td>Small ring or grommet of rope or metal fastened to the edge of a sail.</td>
</tr>
<tr>
<td>CROSS BOOM</td>
<td>Braces the two leading edges apart a.k.a cross tube, spreader bar</td>
</tr>
<tr>
<td>CROSS TUBE</td>
<td>Braces the two leading edges apart a.k.a cross boom, spreader bar</td>
</tr>
<tr>
<td>DIHEDRAL</td>
<td>Upward angle of wings from root to tip</td>
</tr>
<tr>
<td>DOWNTUBES</td>
<td>Primary structure, part of the A-frame and in compression during flight. a.k.a. Uprights</td>
</tr>
<tr>
<td>DRAG BRACE</td>
<td>A brace from the axle forwards the main frame of the trike</td>
</tr>
<tr>
<td>ELEVATOR</td>
<td>Control surfaces, usually at the rear of an aircraft, which control the aircraft’s orientation by changing the pitch of the aircraft, and so also the angle of attack of the wing.</td>
</tr>
<tr>
<td>EMPENNAGE</td>
<td>The fin and tailplane assembly of an aircraft, including the horizontal and vertical stabilizers, elevators, and rudder.</td>
</tr>
<tr>
<td>EXTRADOS</td>
<td>The extrados is the external face of a sail, it is the face “hidden from the wind”, and it is generally a convex surface</td>
</tr>
<tr>
<td>FAIRLEAD</td>
<td>A fairlead is a device to guide a line, rope or cable around an object or out of the way, or to stop it from moving laterally. Typically it will be a ring or hooked surface and may be a separate piece of hardware, or it could be a hole in the structure. A fairlead can also be used to stop a straight run of line from vibrating or rubbing on another surface.</td>
</tr>
<tr>
<td>FIN</td>
<td>The vertical tailplane of a three axis aircraft which provides for the lateral stability and attachment of the elevators.</td>
</tr>
<tr>
<td>FLAPS</td>
<td>Articulated or hinged surfaces on the trailing edge of the wings that, when extended, reduce stalling speed of the aircraft by increasing lift, but also increase the drag and decrease the pitching moment</td>
</tr>
</tbody>
</table>
FLEXWING

Derived from the Rogallo concept developed by NASA in the 1960's it consist of a simple sail covered frame with swept back leading edge.

FLOATING CROSS TUBE

Allows the cross tube to move laterally by not being directly attached to the sail.

FLOATING KEEL

Mechanism by which the cross-tubes and keel may move laterally compared to each other.

FLYING WIRES

Primary structure, carrying in tension much of the wing loads outboard of the cross-boom / leading edge junction.
<p>| <strong>FRONT STRUT</strong> | Has the appearance of primary structure but in most flight modes its primary function is of a control stop – preventing the basebar from travelling so far forward that the propeller may strike the rear part of the wing keel. It does however serve a function in preventing collapse or inadvertent distortion of the trike frame during either heavy landings, or high normal acceleration manoeuvres. The front strut is held in place by a single removable pin at top and bottom; it is essential that it can be easily removed to permit the wing to be removed during derigging. |
| <strong>FORESTAY</strong> | Runs from the ends of the base bar to the nose of the wing, locating the base bar whilst also transmitting pitch control forces to the wing. |
| <strong>FRONT WIRES</strong> | Runs from the ends of the base bar to the nose of the wing, locating the base bar whilst also transmitting pitch control forces to the wing (a.k.a. forestay) |
| <strong>GOOSENECK</strong> | Extension to trike keel on which is attached the front strut and nose wheel a.k.a. Snoot, bowsprit |
| <strong>GROMMET</strong> | An eyelet, usually made of rubber, through which a cable may be passed. |
| <strong>GYROPLANE</strong> | Rotary wing aircraft (see Aeroplane) |
| <strong>HANG BOLT</strong> | Single bolt in quadruple shear at the hang point, sometimes irreverently termed the “Jesus Bolt” |
| <strong>HANG POINT</strong> | A joint connecting the flexwing and the trike which is free to rotate in pitch and roll without hindrance |
| <strong>INBOARD</strong> | Relatively close to the fuselage of an aircraft |
| <strong>INTRADOS</strong> | The intrados is the internal face of a sail, it is the face “seen by the wind”, and it is generally a concave surface. (see Extrados) |
| <strong>KARABINER</strong> | An oblong metal ring with a spring clip; originally used in mountaineering to attach a rope to a piton or to connect two ropes |
| <strong>KEEL</strong> | Horizontal fore and aft structural component. See: wing keel, trike keel |
| <strong>KEEL POCKET</strong> | The attachment of the sail at the wing root to the wing keel by means of a gusset |
| <strong>KINGPOST</strong> | A rod perpendicularly located above the centre of the wing which is used to brace the landing wires |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>LANDING WIRES</td>
<td>Wires running from the top of the kingpost fore and aft, left and right, to support the wing on the ground when unloaded.</td>
</tr>
<tr>
<td>LEADING EDGE</td>
<td>Front edge of the wing</td>
</tr>
<tr>
<td>LOWER WIRES</td>
<td>Run fore and aft from the ends of the base bar to the nose and rear keel of the wing, locating the base bar whilst also transmitting pitch control forces to the wing.</td>
</tr>
<tr>
<td>LUFFING</td>
<td>Flapping of the trailing edge when the angle of attack falls to zero at high airspeeds, usually in a dive</td>
</tr>
<tr>
<td>LUFF LINES</td>
<td>Lines rigged from the top of the kingpost radiating to the trailing edge to maintain a minimum amount of reflex. Sometimes used to provide a pitch trim mechanism.</td>
</tr>
<tr>
<td>LUFFING DIVE</td>
<td>Occurs when the neutral pitch control point, where the pilot is denied any pitch control over the wing and usually resulting in an unrecoverable accelerating dive.</td>
</tr>
<tr>
<td>MAST</td>
<td>“Vertical” mast extending from the main wheels to the hang point on trike a.k.a. Monopole or Pylon</td>
</tr>
<tr>
<td>MOMENT</td>
<td>A fundamental type of force, which turns an object, a torque, the product of a linear force and moment arm</td>
</tr>
<tr>
<td>MONOPOLE</td>
<td>“Vertical” pole extending from the main wheels to the hang point on trike a.k.a. Mast or Pylon</td>
</tr>
<tr>
<td>NOSE</td>
<td>The forward end of an aircraft</td>
</tr>
<tr>
<td>NOSE CONE</td>
<td>A shaped cover attached to the sail of a flexwing at the junction of the leading edges and keel by Velcro to seal the gap and offer minimum aerodynamic resistance.</td>
</tr>
<tr>
<td>OUTBOARD</td>
<td>Relatively far from the fuselage of an aircraft</td>
</tr>
<tr>
<td>P-LEAD</td>
<td>Primary lead, magneto kill switch (Rotax)</td>
</tr>
<tr>
<td>PERMEABILITY</td>
<td>A property of parachute fabric, the mass flow rate or volume flow rate per unit projected area of cloth for a prescribed pressure differential.</td>
</tr>
<tr>
<td>PIP PIN</td>
<td>Quick release double acting two ball pin that locks itself in situ after securing two interfacing parts or joints</td>
</tr>
<tr>
<td>PITOT DYNAMIC HEAD</td>
<td>The dynamic pressure measured at the Pitot Head</td>
</tr>
</tbody>
</table>
PITOT STATIC HEAD
The static pressure measured at the Static Port

PLACARD
A sign or plaque attached to the aircraft for public display

POROSITY
A geometric property of the construction of a parachute, the ratio of void or interstitial area to total area of a cloth defined as a percentage.

PROFILE TUBE
An extruded aluminium tube whose section is aerodynamically profiled for low drag.

PROPELLER
A multi bladed airscrew that rotates to propel air

PUSHER PROPELLER
An propeller mounted at the rear of the aircraft so that ‘pushes’ it along

PYLON
“Vertical” structure extending from the main wheels to the hang point on trike a.k.a. Mast or Monopole

QUAD
The unit hung below the wing, containing crew, undercarriage and powerplant, utilising 4 wheels.

RAM-AIR PARACHUTE
Rectangular, double surface canopy with aerofoil shaped ribs inflated by air flowing into the front openings. Note the non-load-bearing ribs and load-bearing ribs, to which the suspension lines are attached.

REAR WIRES
Runs from the ends of the base bar to the rear keel of the wing, locating the base bar whilst also transmitting pitch control forces to the wing.

REFLEX
Reversed curvature of the aerofoil section at the inboard trailing edge

REFLEX BRIDLE
Lines rigged from the top of the kingpost radiating to the trailing edge to maintain a minimum amount of reflex. Sometimes used to provide a pitch trim mechanism. (See Luff lines)
ROACH  Curved portion of the sail extending behind a straight line drawn between the root and tip of the trailing edge

ROGALLO  Surname of Francis Rogallo, the NACA/NASA scientist who invented the flexwing (b.1912 d.2009)

ROOT CHORD  Chord at the centre or middle of the wing

ROTORCRAFT  Aircraft that uses a spinning rotor with aerofoil section blades (a rotary wing) to provide lift

RUDDER  Operate by re-directing the flow of air past the fuselage, thus imparting a turning or yawing motion to the aircraft. Works in the opposite sense to the trike’s nosewheel steering

SADDLE WASHER  Washer machined to support two crossing tubes at the interface between them

SAIL  High-strength synthetic nonporous fabric such as Polyester Dacron.

SAUMON  Wing tip (Fr)

SIDE WIRES  A.k.a. Flying wires

SNOOT  Extension to trike keel on which is attached the front strut and nose wheel a.k.a. Gooseneck, bowsprit

SPAN  Wing tip to wing tip distance

SPREADER BAR  Braces the two leading edges apart a.k.a cross tube, cross boom

STABILISER  The horizontal tailplane of a three axis aircraft which provides for the pitch stability and attachment of the elevators.

STABILITY  Static, Neutral or Dynamic

SWAN HOOK/CATCH  Latches the front flying wires/forestay to the channel bracket at the nose of the wing keel, secured by a pip pin or pin/clip.

SWEEP ANGLE  Angle between the perpendicular to the centreline and the leading edge of the wing

SWEEPBACK  The backward slant of the leading edge of a wing.
TAILLESS

Refers to a wing consisting of a main plane only, lacking horizontal and vertical stabilizers, elevators, and rudder.

TAILPLANE

Assembly of the horizontal and vertical planes of a three axis aircraft, which provide for the lateral and pitch stability and attachment of the elevators and rudder.

TANG

Flat strap, commonly stainless steel, with holes that allow a fitting to be attached or for it to be bolted to a spar.

TAPER

A gradual decrease in thickness or width of an elongated object

TAPER RATIO

The ratio of thickness or width of the two ends of a tapered object

THRUSTLINE

The three dimensional direction of the force vector produced by the propeller relative to the airframe.

TIP STICKS

Cantilever rods protruding perpendicular to the leading edge of the wing beneath (or occasionally within) the sail. After a catastrophic tumble these rods usually permanently deform slightly in a downwards (negative lift) direction, becoming a significant witness mark of the event.

TOE-IN

A slight inward alignment of the forward edge of a parallel set of wheels to improve steering and minimize tire wear.

TORQUE REACTION

The reverse or opposing moment experienced by an aircraft due to the rotation of the propeller about its axis

TRACTOR PROPELLER

An propeller mounted in front of the aircraft so that ‘pulls’ it along

TRAILING EDGE

Rear edge of the wing

TRAPEZE

Triangular control frame primary structure comprising base bar and two uprights (a.k.a. A-frame)

TRIKE

The unit hung below the wing, containing crew, undercarriage and powerplant, utilising 3 wheels.
**TRIKE KEEL**
Fore and aft structural component holding the seat frame and nose wheel and connecting to the front strut and pylon (monopole)

**TRIM**
Finely adjust the aerodynamic balance of an aircraft

**TWIST**
The spanwise washout of a wing such that the outboard sections have a lower incidence, 3 or 4° or so, and thus lower Angle of Attack, than the inboard sections in flight

**UPRIGHTS**
Primary structure, part of the A-frame and in compression during flight, a.k.a. Downtubes

**WASHOUT**
The spanwise ‘twist’ of a wing such that the outboard sections have a lower incidence, 3 or 4° or so, and thus lower Angle of Attack, than the inboard sections in flight. This gives the wing a greater working angle of attack range.

**WASHOUT BATTENS OR RODS**
Cantilever rods protruding perpendicular to the leading edge of the wing beneath (or occasionally within) the sail. They prevent the washout at the tips reducing below a preset value (usually about 3°) at low or negative angles of attack, and also prevent gross deflections of the trailing edge at the tip in the event of a tuck, so maintaining a restoring moment arm to pitch up the wing. After a catastrophic tumble these rods usually permanently deform slightly in a downwards (negative lift) direction, becoming a significant witness mark of the event.

**WEIGHTSHIFT**
An alternative control system for initiating pitch and roll inputs
WING

A three dimensional aerofoil

WING KEEL

Fore and aft structural component against which the cross boom and sail is pre-tensioned

8.20 LIST OF ACRONYMS

A/C Aircraft
A/G Air to Ground
AAIB Air Accident Investigation Branch
AAL Above Aerodrome Level
AAN Airworthiness Approval Note
AAR Aircraft Accident Report
AARF Aircraft Accident Report Form
AC Alternating Current
AC Advisory Circular
ACAS Airborne Collision Avoidance System
AD Airworthiness Directive
ADS-B Automatic Dependent Surveillance-Broadcast
ADD Acceptable Deferred Defect
AGL Above Ground Level
AIC Aeronautical Information Circular
AIL Airworthiness Information Leaflet
AIM Airman’s Information Manual
AIP Aeronautical Information Publication
AISI American Iron and Steel Institute
AKI Anti Knock Index
ALT Altitude, Altimeter
AMC Acceptable Means of Compliance
AMM Aircraft Maintenance Manual
AMO Aircraft Maintenance Organisation
AMOC Alternative Method Of Compliance
AMSL Above Mean Sea Level
AN Airworthiness Notice
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANO</td>
<td>Air Navigation Order</td>
</tr>
<tr>
<td>A-NPA</td>
<td>Advance – Notice of Proposed Amendment</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AOA</td>
<td>Angle Of Attack, Alpha</td>
</tr>
<tr>
<td>AOC</td>
<td>Air Operator's Certificate</td>
</tr>
<tr>
<td>AOD</td>
<td>Aft Of Datum</td>
</tr>
<tr>
<td>AOG</td>
<td>Aircraft On Ground</td>
</tr>
<tr>
<td>AP</td>
<td>Approved Person</td>
</tr>
<tr>
<td>AP</td>
<td>Automatic Portable emergency beacon</td>
</tr>
<tr>
<td>APC</td>
<td>Aircraft Pilot Coupling</td>
</tr>
<tr>
<td>APS</td>
<td>Aircraft Prepared for Service weight</td>
</tr>
<tr>
<td>APU</td>
<td>Auxiliary Power Unit</td>
</tr>
<tr>
<td>ARC</td>
<td>Abnormal Runway Contact occurrence</td>
</tr>
<tr>
<td>ARO</td>
<td>Aviation Recreation Organisation</td>
</tr>
<tr>
<td>ASD</td>
<td>Allowable Stress Design</td>
</tr>
<tr>
<td>ASI</td>
<td>Air Speed Indicator</td>
</tr>
<tr>
<td>ASIR</td>
<td>Air Speed Indicator Reading</td>
</tr>
<tr>
<td>ASL</td>
<td>Above Sea Level</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>ASR</td>
<td>Altimeter Setting Region</td>
</tr>
<tr>
<td>ASRS</td>
<td>Aviation Safety Reporting System</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing Materials</td>
</tr>
<tr>
<td>ATDC</td>
<td>After Top Dead Centre</td>
</tr>
<tr>
<td>AUW</td>
<td>All Up Weight</td>
</tr>
<tr>
<td>AV</td>
<td>Air Vapour ratio</td>
</tr>
<tr>
<td>AVG</td>
<td>Average</td>
</tr>
<tr>
<td>AW</td>
<td>AirWorthiness form</td>
</tr>
<tr>
<td>BCAR</td>
<td>British Civil Airworthiness Requirements</td>
</tr>
<tr>
<td>BDC</td>
<td>Bottom Dead Centre</td>
</tr>
<tr>
<td>BDP</td>
<td>Bootstrap Data Plate</td>
</tr>
<tr>
<td>BEA</td>
<td>Bureau d’Enquetes et d’Analyse pour la securite de l’aviation civile</td>
</tr>
<tr>
<td>BFI</td>
<td>Basic Flight Instructor</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>BFU</td>
<td>Bundesstelle für Flugunfall Untersuchung – Federal Bureau of Aircraft Accidents Investigation</td>
</tr>
<tr>
<td>BGA</td>
<td>British Gliding Association</td>
</tr>
<tr>
<td>BHGA</td>
<td>British Hang Gliding Association</td>
</tr>
<tr>
<td>BHPA</td>
<td>British Hang gliding and Paragliding Association</td>
</tr>
<tr>
<td>BIT</td>
<td>Built In Test</td>
</tr>
<tr>
<td>BMAA</td>
<td>British Microlight Aircraft Association</td>
</tr>
<tr>
<td>BNC</td>
<td>Bayonet Neill Concelman connector</td>
</tr>
<tr>
<td>BRG</td>
<td>Bearing</td>
</tr>
<tr>
<td>BRP</td>
<td>Ballistic Recovery Parachute</td>
</tr>
<tr>
<td>BRS</td>
<td>Ballistic Recovery System</td>
</tr>
<tr>
<td>BTDC</td>
<td>Before Top Dead Centre</td>
</tr>
<tr>
<td>BV</td>
<td>Bureau Veritas</td>
</tr>
<tr>
<td>BVID</td>
<td>Barely Visible Impact Damage</td>
</tr>
<tr>
<td>C</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td>C of A</td>
<td>Certificate of Airworthiness</td>
</tr>
<tr>
<td>C/B</td>
<td>Circuit Breaker</td>
</tr>
<tr>
<td>C/S</td>
<td>Call Sign</td>
</tr>
<tr>
<td>CAA</td>
<td>Civil Aviation Authority</td>
</tr>
<tr>
<td>CAAIPS</td>
<td>CAP 562 Civil Aircraft Airworthiness Information and Procedures</td>
</tr>
<tr>
<td>CAP</td>
<td>Corrective Action Plan</td>
</tr>
<tr>
<td>CAP</td>
<td>Civil Aviation Publication</td>
</tr>
<tr>
<td>CAR</td>
<td>Civil Aviation Regulations</td>
</tr>
<tr>
<td>CAS</td>
<td>Calibrated Air Speed = RAS</td>
</tr>
<tr>
<td>CAST</td>
<td>Commercial Aviation Safety Team</td>
</tr>
<tr>
<td>CATS</td>
<td>Civil Aviation Technical Standards</td>
</tr>
<tr>
<td>CCBCT</td>
<td>Conrod Bearing Clearance Tester</td>
</tr>
<tr>
<td>CCR</td>
<td>Certification Check Requirement</td>
</tr>
<tr>
<td>CD</td>
<td>Centre of Drag</td>
</tr>
<tr>
<td>CD</td>
<td>Constant Depression carburettor</td>
</tr>
<tr>
<td>Cd</td>
<td>Coefficient of Drag</td>
</tr>
<tr>
<td>CDI</td>
<td>Course Deviation Indicator</td>
</tr>
<tr>
<td>CDI</td>
<td>Capacitive Discharge Ignition</td>
</tr>
</tbody>
</table>
SIGMA – STANDARD INSPECTION GUIDELINES FOR MICROLIGHT AIRCRAFT

CFC  Catastrophic Failure Conditions
CFR  Consolidated/Cooperative Fuel Research Council
CFRP  Carbon Fibre Reinforced Composites
CG  Centre of Gravity
CHIRP  Cockpit Human Factors Incident Report
CHT  Cylinder Head Temperature
CI  Chief Inspector
CI  Compression Ignition
CICTT  CAST/ICAO Common Taxonomy Team
CIMA  Commission for International Microlight Aviation – FAI
CL  Coefficient of Lift
CLR  Command Leadership Resource
CLR  Clear
CLT  Centreline Thrust
Cmo  Zero lift pitching moment coefficient
CMR  Certification Maintenance Requirements
CMR  Certificate of Maintenance Review
CND  Could Not Duplicate
CNRA  Certificat de Navigabilite Restreint d’Aeronef
CoV  Certificate of Validity
CP  Critical Point
CP  Centre of Pressure
CR  Compression Ratio
CRFI  Runway Friction Index
CRM  Cockpit/Crew Resource Management
CRMA  Certificate Relating to Maintenance of Aircraft
CRS  Certificate of Release to Service
CTA  Cognitive Task Analysis
CTO  Chief Technical Officer
CVR  Cockpit Voice Recorder
CWS  Control Wheel Steering
D&D  Distress & Diversion cell
daN  Deca Newton (force of 10 Newtons – roughly 1 kg weight)
DC   Direct Current
DCDI Dual Capacitor Dual Ignition
DCTO Deputy Chief Technical Officer
DD   Deferred Defect
DEG  Degrees
DER  Designated Engineering Representative
DET  Detailed Visual Inspection
DF   Direction Finding
DGAC Direction Generale de l’Aviation Civile
DGPS Differential GPS
DHV  Deutscher Hängegleiter Verband
DI   Direction Indicator
DOA  Design Organisation Approval
DOP  Dilution Of Precision
DP   Dew Point temperature
DV   Direct Vision panels
EAS  Equivalent Air Speed
EASA European Aviation Safety Agency
EDB  Ethylene DiBromide
EDX  Energy Dispersive X-ray
EFATO Engine Failure After Take Off
EFIS Electronic Flight Instrumentation System
EGT  Exhaust Gas Temperature
EL   Electro Luminescent panels
ELT  Emergency Location Transmitter
EM   Engine Manual
EMS  Engine Management System
ENA  Elastic Neutral Axis
EPA  Environmental Protection Agency
EPIRB Emergency Position Indicating Radio Beacon
FAA  Federal Aviation Authority
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FADEC</td>
<td>Full Authority Digital Engine Control</td>
</tr>
<tr>
<td>FAI</td>
<td>Federation Aeronautique Internationale</td>
</tr>
<tr>
<td>FAR</td>
<td>Fatal Accident Rate</td>
</tr>
<tr>
<td>FC</td>
<td>Fixed Cost</td>
</tr>
<tr>
<td>FCMC</td>
<td>Flight Control Mechanical Characteristics</td>
</tr>
<tr>
<td>FDPS</td>
<td>Flight Data Processing System</td>
</tr>
<tr>
<td>FDR</td>
<td>Flight Data Recorder</td>
</tr>
<tr>
<td>FFPLUM</td>
<td>Federation Francaise de Planeur Ultra Leger Motorise</td>
</tr>
<tr>
<td>FFVV</td>
<td>Federation Francaise de Vol a Voile</td>
</tr>
<tr>
<td>FLG</td>
<td>Flashing</td>
</tr>
<tr>
<td>FLPFM</td>
<td>Foot Launched Powered Flying Machine</td>
</tr>
<tr>
<td>FOB</td>
<td>Free On Board</td>
</tr>
<tr>
<td>FOC</td>
<td>Free Of Charge</td>
</tr>
<tr>
<td>FOD</td>
<td>Forward Of Datum</td>
</tr>
<tr>
<td>FOD</td>
<td>Foreign Object Debris</td>
</tr>
<tr>
<td>FOD</td>
<td>Foreign Object Damage</td>
</tr>
<tr>
<td>FOF</td>
<td>Fuel Off/Feather</td>
</tr>
<tr>
<td>FPM</td>
<td>Feet Per Minute</td>
</tr>
<tr>
<td>FSD</td>
<td>Full Scale Deflection</td>
</tr>
<tr>
<td>FT</td>
<td>Feet</td>
</tr>
<tr>
<td>GAMMA</td>
<td>BMAA General Advice on Maintenance for Microlight Aircraft (t.b.d.)</td>
</tr>
<tr>
<td>GIMMA</td>
<td>BMAA Guidelines for the Inspection and Maintenance of Microlight Aircraft</td>
</tr>
<tr>
<td>GASIL</td>
<td>General Aviation Safety Information Leaflet</td>
</tr>
<tr>
<td>GASRWG</td>
<td>General Aviation Safety Review Working Group</td>
</tr>
<tr>
<td>GFA</td>
<td>Gliding Federation of Australia</td>
</tr>
<tr>
<td>GFT</td>
<td>General Failure Types</td>
</tr>
<tr>
<td>GMT</td>
<td>Greenwich Mean Time (Zulu or UTC)</td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GS</td>
<td>Ground Speed</td>
</tr>
<tr>
<td>GSAC</td>
<td>Groupement pour la Securite de l’Aviation Civile</td>
</tr>
</tbody>
</table>
GVI  General Visual Inspection – C Check
GW   Gross Weight
H24  Continuous Day and Night Service
HADS Homebuilt Aircraft Data Sheet
HADS Homebuilt Aircraft Data Sheet
HEP  Human Error Probabilities
HF   High Frequency
HFACS Human Factors Analysis and Classification System
HFACS-ME HFACS – Maintenance Extension
HMI  Hazardously Misleading Information
HOT  Hands Off Trim
HP   Horsepower
HP&L Human Performance & Limitations
hPa  Hecto Pascal (millibar)
HPA  Hecto Pascal (millibar)
HPCCB High Pulse Current Cranking Battery
HQR  Handling Qualities Rating – Cooper Harper
HQRS Handling Qualities Rating System
HSE  Health and Safety Executive
HSI  Horizontal Situation Indicator
HT   High Tension
HTP  Horizontal Tailplane
HUD  Head Up Display
I/C  Intercom
IA   Inspection Authority
IAS  Indicated Air Speed – based on 1.225 kg/m3 air density (ISA conditions)
IBN  Identification Beacon
ICA  Instructions for Continued Airworthiness
ICAO International Civil Aviation Organisation
ID   Ignition Delay
IM   Installation Manual
INCID Incident
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Term Description</th>
</tr>
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<tbody>
<tr>
<td>LOS</td>
<td>Loss Of Signal</td>
</tr>
<tr>
<td>LOSA</td>
<td>Line Operations Safety Audit</td>
</tr>
<tr>
<td>LPO</td>
<td>Long Period Oscillations – dynamic longitudinal stability (see SPO)</td>
</tr>
<tr>
<td>LRFD</td>
<td>Load &amp; Resistance Factor Design</td>
</tr>
<tr>
<td>LSD</td>
<td>Limit State Design</td>
</tr>
<tr>
<td>LSS</td>
<td>Longitudinal Static Stability gradients</td>
</tr>
<tr>
<td>LTO</td>
<td>Letter To Owners</td>
</tr>
<tr>
<td>LWC</td>
<td>Liquid Water Content</td>
</tr>
<tr>
<td>M</td>
<td>Metres</td>
</tr>
<tr>
<td>MM</td>
<td>Maintenance Manual</td>
</tr>
<tr>
<td>MM</td>
<td>Millimetre (mm)</td>
</tr>
<tr>
<td>MAAN</td>
<td>Microlight Airworthiness Approval Notes</td>
</tr>
<tr>
<td>MAC</td>
<td>Mean Aerodynamic Chord – chord weighted average chord length</td>
</tr>
<tr>
<td>MAG</td>
<td>Magneto</td>
</tr>
<tr>
<td>MASPS</td>
<td>Minimum Aircraft System Performance Specification</td>
</tr>
<tr>
<td>MAUW</td>
<td>Maximum All Up Weight</td>
</tr>
<tr>
<td>MAX</td>
<td>Maximum</td>
</tr>
<tr>
<td>MCM</td>
<td>Maintenance Control Manual</td>
</tr>
<tr>
<td>MCM</td>
<td>Maximum Certified Mass</td>
</tr>
<tr>
<td>MCP</td>
<td>Maximum Continuous Power</td>
</tr>
<tr>
<td>MED</td>
<td>Multiple Element Damage</td>
</tr>
<tr>
<td>MEDA</td>
<td>Maintenance Error Decision Aid</td>
</tr>
<tr>
<td>MEK</td>
<td>Methyl Ethyl Ketone</td>
</tr>
<tr>
<td>MEL</td>
<td>Multi Engine Land</td>
</tr>
<tr>
<td>MEL</td>
<td>Minimum Equipment List</td>
</tr>
<tr>
<td>MEMS</td>
<td>Maintenance Error Management System</td>
</tr>
<tr>
<td>MES</td>
<td>Multi Engine Sea</td>
</tr>
<tr>
<td>MF</td>
<td>Microlight Flying magazine</td>
</tr>
<tr>
<td>MFD</td>
<td>Multi Function Display</td>
</tr>
<tr>
<td>MIN</td>
<td>Minimum</td>
</tr>
<tr>
<td>MISASA</td>
<td>Microlight Section of the Aero Club of South Africa</td>
</tr>
<tr>
<td>MLG</td>
<td>Main Landing Gear</td>
</tr>
</tbody>
</table>
MLW    Maximum Landing Weight  
MMEL   Master Minimum Equipment List  
MMS    Microlight Maintenance Schedule  
MOB    Man Overboard  
MODE S Mode Select - co-operative radar surveillance using ground interrogators & airborne transponders  
MOR    Manual Override  
MOR    Mandatory Occurrence Reporting  
MORS   Mandatory Occurrence Reporting System  
MPD    Mandatory Permit Directive  
MPI    Mandatory Periodic Inspections  
MPL    Microlight Pilots Licence  
MPM    Maintenance Policy Manual  
MPS    Metres Per Second  
MRO    Maintenance, Repair and Overhaul  
MSD    Multiple Site Damage  
MSN    Manufacturers Serial Number  
MTOM   Maximum Takeoff Mass  
MTOW   Maximum Take Off Weight  
MTWA   Maximum Takeoff Weight Authorised  
MVD    Median Volume Diameter  
MZFV    Maximum Zero Fuel Weight  
NAS    National Airspace System  
NC     No Change  
NDT    Non Destructive Testing  
NFD    Nil Further Defects  
NIL    None  
NLG    Nose Leg Gear  
NM     Nautical Miles  
NMS    Navigation Management System  
NOM    Normal Operations Monitoring  
NORDO  No Radio  
NOTAM  Notice to Airmen/Notifications for Airmen
NPA  Notice of Proposed Amendment
NRV  Non Return Valve
NTCA Non Type-Certificated Aircraft
NTO  No Technical Objection
NTPD Normal Temperature Pressure Dry (21degC, 760mmHg, no water vapour)
NTSB National Transportation Safety Board
NTT  Normal To Type
NVG  Night Vision Goggles
OAT  Outside Air Temperature
OBD  On Board Diagnosis
OEM  Original Equipment Manufacturer
OFHC Oxygen Free High Conductivity stranded cables
O/H  Overhaul
OM  Operator’s Manual
OPC  Operator Proficiency Check
OR  Octane Rating
OSH  Off Scale High
OSHA  Occupational Safety & Health Act
OSL  Off Scale Low
OSTIV  Organisation Scientific & Technical Internationale du Vol au Voile
OUV  Oskar-Ursinus-Vereinigung German Amateur Builders
P1  Pilot In Command
P1/S PIC is doing his GFT, P1/Student
PBO  Public Benefit Organisation
PBT  Pushback/Towing
PCA  Primary Certification Authority
PEC  Pressure Error Correction
PF  Pilot Flying
PFA  Popular Flying Association (now the LAA)
PFD  Primary Flight Display
PFL  Practice Forced Landing
PFLWOP Precautionary Forced Landing With Out Power
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFRC</td>
<td>Permit Flight Release Certificate</td>
</tr>
<tr>
<td>PI</td>
<td>Professional Indemnity</td>
</tr>
<tr>
<td>PIC</td>
<td>Pilot In Command</td>
</tr>
<tr>
<td>PIM</td>
<td>Post Impact</td>
</tr>
<tr>
<td>PLB</td>
<td>Personal Locator Beacon</td>
</tr>
<tr>
<td>PMR</td>
<td>Permit Maintenance Release</td>
</tr>
<tr>
<td>PN</td>
<td>Performance Number</td>
</tr>
<tr>
<td>P/N</td>
<td>Part Number</td>
</tr>
<tr>
<td>PNF</td>
<td>Pilot Not Flying</td>
</tr>
<tr>
<td>POA</td>
<td>Production Organisation Approval</td>
</tr>
<tr>
<td>POB</td>
<td>Persons/People On Board</td>
</tr>
<tr>
<td>POD</td>
<td>Probability of Detection</td>
</tr>
<tr>
<td>POH</td>
<td>Pilots Operating Handbook</td>
</tr>
<tr>
<td>POL</td>
<td>Permits Online (CAA Online Certificate of Validity Revalidation System)</td>
</tr>
<tr>
<td>PRF</td>
<td>Primary Reference Fuels</td>
</tr>
<tr>
<td>PRV</td>
<td>Pressure Release Valve</td>
</tr>
<tr>
<td>PSE</td>
<td>Principal Structural Element</td>
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<tr>
<td>PT3</td>
<td>Premature Termination of The Tow</td>
</tr>
<tr>
<td>PTF</td>
<td>Permit to Fly</td>
</tr>
<tr>
<td>PTO</td>
<td>Power Take Off</td>
</tr>
<tr>
<td>PTT</td>
<td>Press To Talk</td>
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<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride</td>
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<tr>
<td>QAS</td>
<td>Quality Assurance System</td>
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<tr>
<td>QBAR</td>
<td>Dynamic Air Pressure</td>
</tr>
<tr>
<td>QFE</td>
<td>Airfield pressure with altimeter sub scale set at zero height – station/datum level pressure</td>
</tr>
<tr>
<td>QFF</td>
<td>Sea level pressure</td>
</tr>
<tr>
<td>QNE</td>
<td>Altitude on landing with altimeter sub scale set at 1013.25mb for Flight Levels, pressure altitude</td>
</tr>
<tr>
<td>QNH</td>
<td>Pressure corrected to sea level –altimeter sub scale setting show altitude=elevation of airfield</td>
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<tr>
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<td>Quick Reference Handbook</td>
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<tr>
<td>R/T</td>
<td>Radio Telephone</td>
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<tr>
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<td>RAASA</td>
<td>Recreation Aviation Administration of South Africa</td>
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<tr>
<td>Acronym</td>
<td>Definition</td>
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<td>---------</td>
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<tr>
<td>RADAR</td>
<td>Radio Detection and Ranging</td>
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<td>RAeS</td>
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<td>RAS</td>
<td>Rectified Air Speed = CAS</td>
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<td>Risk Assessment Tool</td>
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<td>RON</td>
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<tr>
<td>ROTAX</td>
<td>Rotating Axle (former name of BRP-Rotax GmbH &amp; Co. KG)</td>
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<tr>
<td>RPL</td>
<td>Recognition of Prior Learning</td>
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<tr>
<td>RPM</td>
<td>Revolutions Per Minute</td>
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<td>RPV</td>
<td>Remotely Piloted Vehicle</td>
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<tr>
<td>RSA</td>
<td>Reseau du Sport de l’Air</td>
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<tr>
<td>RTF</td>
<td>Registered Training Facility</td>
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<tr>
<td>RTOW</td>
<td>Restricted/Regulated Take Off Weight</td>
</tr>
<tr>
<td>SA</td>
<td>Selective Availability</td>
</tr>
<tr>
<td>SARPS</td>
<td>Standards and Recommended Practices</td>
</tr>
<tr>
<td>SASSI</td>
<td>Stay Alive Stupid Stay Informed</td>
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<tr>
<td>SAT</td>
<td>Satisfactory</td>
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<tr>
<td>SB</td>
<td>Service Bulletin</td>
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<tr>
<td>SCF-NP</td>
<td>System Component Failure or Malfunction (Non-Powerplant) occurrence</td>
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<tr>
<td>SCF-PP</td>
<td>System Component Failure or Malfunction (Powerplant) occurrence</td>
</tr>
<tr>
<td>SDET</td>
<td>Special Detailed inspection</td>
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<tr>
<td>SEL</td>
<td>Sound Emission Limit (dBA) A-weighted for the human ear at conversational level</td>
</tr>
<tr>
<td>SEL</td>
<td>Single Engine Land</td>
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<td>SES</td>
<td>Single Engine Sea</td>
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<tr>
<td>SI</td>
<td>Spark Ignition</td>
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<tr>
<td>SIGMA</td>
<td>Standard Inspection Guidelines for Microlight Aircraft</td>
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<tr>
<td>SL</td>
<td>Service Letter</td>
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<tr>
<td>SLA</td>
<td>Small Light Aeroplane, Microlight Aircraft</td>
</tr>
<tr>
<td>SLMG</td>
<td>Self Launching Motor Glider</td>
</tr>
<tr>
<td>SMM</td>
<td>Shift Maintenance Manager</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
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<tr>
<td>SMM</td>
<td>Standard Minor Modification</td>
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<tr>
<td>S/N</td>
<td>Serial Number</td>
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<tr>
<td>SOB</td>
<td>Souls On Board</td>
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<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
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<tr>
<td>SOT</td>
<td>Standard Operating Technique</td>
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<tr>
<td>SPAD</td>
<td>Signal Passed At Danger</td>
</tr>
<tr>
<td>SPD</td>
<td>Signal Passed at Danger</td>
</tr>
<tr>
<td>SPO</td>
<td>Short Period Oscillations – dynamic longitudinal stability</td>
</tr>
<tr>
<td>SRM</td>
<td>Structural Repair Manuals</td>
</tr>
<tr>
<td>SSDR</td>
<td>Single Seat De Regulation</td>
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<tr>
<td>SSI</td>
<td>Structural Significant Item</td>
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<tr>
<td>SSR</td>
<td>Secondary Surveillance Radar</td>
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<tr>
<td>STM</td>
<td>Short Term Memory</td>
</tr>
<tr>
<td>TADS</td>
<td>Type Accepted Data Sheet</td>
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<tr>
<td>TADS</td>
<td>Type Approval Data Sheet</td>
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<tr>
<td>TAS</td>
<td>True Air Speed</td>
</tr>
<tr>
<td>TBO</td>
<td>Top &amp; Bottom Overhaul</td>
</tr>
<tr>
<td>TBO</td>
<td>Time Before Overhaul</td>
</tr>
<tr>
<td>TBO</td>
<td>Time Between Overhaul</td>
</tr>
<tr>
<td>TC</td>
<td>Type Certificate</td>
</tr>
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<td>TC</td>
<td>Transport Canada</td>
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<tr>
<td>TCAS</td>
<td>Traffic Alert and Collision Avoidance System</td>
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<tr>
<td>TCDS</td>
<td>Type Certificate Data Sheet</td>
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<tr>
<td>TCU</td>
<td>Turbo Control Unit</td>
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<tr>
<td>TDC</td>
<td>Top Dead Centre</td>
</tr>
<tr>
<td>TEL</td>
<td>Tetra Ethyl Lead</td>
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<tr>
<td>TEM</td>
<td>Threat &amp; Error Management</td>
</tr>
<tr>
<td>TIL</td>
<td>Technical Information Leaflet</td>
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<tr>
<td>TPM</td>
<td>Technical Procedures Manual</td>
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<tr>
<td>TREM</td>
<td>Threat Recognition &amp; Error Management</td>
</tr>
<tr>
<td>TRI</td>
<td>Training Related Issue</td>
</tr>
<tr>
<td>TSN</td>
<td>Time Since New</td>
</tr>
</tbody>
</table>
TSO  Time Since Overhaul  
U/S  Unserviceable  
UAS  Undesired Aircraft State  
UD  Universal Density prepregnated cotton  
UL  Ultralight  
UNSAT  Unsatisfactory  
UV  Ultraviolet  
VB  Variable Billow  
VG  Variable Geometry  
VCG  Vertical Centre of Gravity  
VLA  Very Light Aircraft  
VOR  Vehicle, Occupant & Restraint  
VTP  Vertical Tailplane  
W/S  Weight Shift  
WFD  Widespread Fatigue Damage  
WOT  Wide Open Throttle  
ZFW  Zero Fuel Weight

V-Speeds

VA  Design Manoeuvre Speed (EAS)  
VC  Design Cruising Speed (EAS)  
VD  Design Diving Speed (EAS)  
VDF  Maximum speed attainable up to Vd that can be demonstrated in flight  
VF  Design Flaps-Extended Speed (EAS)  
VFEXT  Wing Flaps Extended Speed, maximum speed (IAS) with wing flaps in a prescribed extended position.  
VN  Maximum level speed at maximum continuous power  
VLO  Landing Gear Operating Speed, maximum speed (IAS) at which it is safe to extend or retract the landing gear.  
VNE  Never Exceed Speed.  
VSO  Stalling speed (EAS), or if no stalling speed is obtainable, a minimum steady flight speed, with the wing flaps in 
VSL  Stalling speed (EAS), or if no stalling speed is obtainable, a minimum steady flight speed, with the aeroplane in
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