

Audit or assessment of Builder’s premises and processes for newbuild vessels destined to the UK Flag

Contents

1	Objective	3
2	Scope	3
3	References	3
4	Application.....	4
5	Inspections	4
6	Quality Assurance	4
6.1	General procedure and oversight:	4
6.2	Documentation, process.....	5
6.3	Documentation, records	5
6.4	Responsibility for process control	5
7	Vessel production, welded steel and aluminium	6
7.1	Storage and handling of materials	6
7.2	Workshop conditions and environment.....	6
7.3	Construction –	6
8	Aluminium craft specific requirements.	10
8.1	Building environment.....	10
8.2	Storage	10
8.3	Tools	10
8.4	Galvanic action / Corrosion protection.....	10
9	Fibre Reinforced Plastic production (FRP/GRP).....	11
9.1	Storage and handling of materials	11
9.2	Workshop conditions and environment.....	11
9.3	Moulds	12
9.4	Resin processing.....	13
9.5	Laminating – process specific.....	13
9.6	Surface finishing.....	15
10	Wood.....	17
10.1	General	17
10.2	The Workshop.....	17
10.3	Materials.....	17
10.4	Manufacturing	18

10.5	Preventing deterioration	18
10.6	Protective coating.....	18
11	Safety & Environmental Protection	19
11.1	General	19
12	Other materials	19
12.1	General.....	19
Annex 1	Audit / assessment template for smaller / less complex projects.....	20

1 Objective

The objective of this document is to provide a basic structure and guide for surveyors when assessing whether a builder and their build facility are able and suitable to construct a vessel destined for the UK Flag and substantially according to plan and to the required vessel construction standard.

2 Scope

The standards and guidance used for the construction of the particular vessel type will specify that the premises are to be suitable for the construction material proposed, and are to be in accordance with the requirements of those standards, where applicable.

This document may be used for assessing the suitability of builder and premises, when constructing new domestic vessels to be certified by the MCA or Certifying Body (RO's and CA's) on behalf of the MCA. In all situations the relevant Certifying Body is responsible for assessing this suitability, by auditing the builder and yard.

This guide specifies workshop conditions, material storage and handling, and requirements for the manufacture of the craft. The primary construction materials considered in this guide are:

1. Welded steel for larger vessels,
2. Fibre Reinforced Plastic (GRP or FRP),
3. Aluminium Alloy and
4. Wood. Reference is considered for whole vessel construction and subcomponent assemblies where appropriate.

In order to ensure the finished vessel is constructed in a manner that conforms to the approved plans, it is required that the builder will operate in a manner that guarantees this conformity, by means of a Quality Assurance process, which can be verified by audit and or inspection.

3 References

Reference documents are construction standards and guidance documents provided by the MCA for those vessels destined for the UK Flag. These documents are available as standards, Merchant Shipping Notices. Merchant Guidance Notes and Instructions to Surveyors.

Other recognised procedures for manufacture quality assurance, as developed or recognised by marine industry bodies, such as Classification Societies, and appropriate Rules and Regulations may be utilised.

4 Application

This guide is applicable to all yards building vessels destined for the UK Flag.

As indicated above and in the applicable codes, recognition and acceptance of the suitability of builders' workshop premises and procedures is a precondition for certification. This document is intended to give surveyors guidance on assessing premises and working practices. It may be used to give builders guidance on meeting survey and certification expectations for production.

5 Inspections

All vessel builders can be expected to undergo monitoring visits to confirm that the builder is applying a systematic approach to quality. All yards can be expected to be visited at intervals not exceeding 5 years where a series of vessels may be built. For smaller or intermittent build projects yards may be inspected as determined by the nature of the work. These inspections are chargeable, and the yard should be notified when a visit should be expected. The inspections will be recorded using one of the applicable forms (MSF5017 for smaller / less complex facilities; MSF 5071 – Vertical Contract Audit Report for larger / more complex facilities) and a copy provided to the builder.

6 Quality Assurance

Each builder shall operate a Quality Assurance System (QA-system) for manufacturing, final product inspection and testing of equipment. The QA system may follow an approved standard or may be of a self-designed type. The complexity of the system should be determined by the number and complexity of the vessels or projects under construction.

6.1 General procedure and oversight:

Construction work is only to be carried out by personnel with the necessary skills for the materials and techniques employed – trainees are to be fully supervised and their work inspected by those appropriately qualified / experienced. Construction in differing materials will call for appropriately qualified / experienced supervisory personnel, with defined responsibilities and authority to carry out necessary measures (corrective and or preventive), and specific Quality Assurance documentation.

A single person or departmental head should be named as the responsible supervisor for production, and to sign the records as indicated below.

6.2 Documentation, process

Builders should establish a systematic Quality Assurance (QA) procedure which includes or references:

- Policies;
- Quality objectives;
- Instructions;
- Construction plans;
- Materials used;
- The complexity of the vessel;
- The manufacturing Process;
- Inspection regime;
- The conditions of the manufacturing premises;

which allows for consistent interpretation and application.

For more complex vessels and projects the extent of process compliance shall be increased.

6.3 Documentation, records

For each vessel or series, a record is to be kept containing:

- Data sheets for materials and consumables, including manufacturers' requirements and test reports;
- Records of environmental conditions in manufacture;
- Records of faults and corrective measures carried out;
- Records of final inspection and testing.

For more complex vessels and projects the extent of compliance shall be increased.

6.4 Responsibility for process control

Inspections are to be carried out as determined by 6.2 above with each stage signed off by the person responsible for process control. A final inspection is to be carried out to verify compliance with initial works specification and report produced confirming the same, by the person specified above.

For more complex vessels and projects the extent of compliance shall be increased.

7 Vessel production, welded steel and aluminium

7.1 Storage and handling of materials

7.1.1 Suitability

Materials are to be of a standard in accordance with the relevant sections of the applicable codes – and suitable for marine use. They should be supplied with certificates of origin confirming they are of the required standard.

7.1.2 Identification of materials and consumables

Materials to be identifiable throughout storage and production process, with each delivery accompanied by relevant documentation, and marked accordingly. Purchase orders to be adequately descriptive of material and appropriately archived to be cross-referenced when necessary (with both incoming stock and for audit). Defective materials to be disposed of in accordance with builders' QA procedure.

A process to ensure materials and consumables are identified (by marking or other means, as appropriate) from arrival at the yard through to fabrication, so that all types and grades can be readily recognised, to be established.

7.1.3 Storage facilities and method

Materials are to be stored in accordance with manufacturers' requirements, in order to prevent deterioration through poor handling or climatic conditions.

7.2 Workshop conditions and environment

Whilst under construction, the vessel should be protected to reduce the adverse effects of weather and climate on quality of construction.

Adequate protection, such as screening or shielding are likely to be required if welding is to be carried out in wet, windy or cold weather. In cold or humid conditions, or for larger components, preheating may be required. This should be specified in the construction arrangements and also in the Weld Procedure Specification.

7.3 Construction –

7.3.1 General QA process specific to welded sheet metal

The vessel construction standards may provide more detail but as a minimum it would be expected that the following should be provided:

7.3.1.1 Documentation, process (welding)

- production plan
- welding procedure specification qualification and management
- welders and welding-operators qualification and management
- welding repair
- preheating
- forming.

7.3.1.2 Documentation, records

- welding-procedure specifications (WPS)
- welding-procedure qualification records (WPQR)
- heat-treatment procedure specification and records
- dimensional reports
- records of repairs and non-conformance reports
- other documents, as required

7.3.2 *Welding equipment*

Plant and equipment must be suitable, appropriately maintained, and certificated where required. Welding workshops are expected have documented plans for regular maintenance of welding and testing equipment, particularly specifying maintenance tasks ensuring correct control and reading of parameters listed in the relevant procedure specifications, e.g. welding parameters like speed, voltage, ampere, gas flow, etc.

7.3.3 *Welder and welding qualifications*

The builder is to ensure that welders are qualified for the type of work undertaken, with necessary restrictions on areas of construction, where not qualified. Selecting, training and testing of welders is the responsibility of the builder – who is to qualify them according to suitable standards or practice. The welding workshop is expected to apply properly qualified welding procedure specifications (WPS), applicable for the intended welding. Welding on important materials, components and structures is to be non-destructive tested, according to Class Society or construction area norms.

Adherence to WPS and using qualified personnel will minimise the number of defects in a weld.

7.3.4 *Preparation and cleanliness*

Steel to be cleaned of mill scale and rust prior to use. Preparation (eg forming) not to adversely affect mechanical properties.

Plate edges to be accurately profiled and joints properly fitted, aligned without excessive force or substantial gaps, before welding. Plates to be set up and welded in a sequence such that contraction stresses and distortion are kept to a minimum. Surfaces to be welded should be free from contaminants that may adversely affect weld quality (primers should be compatible with the process and have no detrimental effect).

Ambient temperatures should be considered especially where WPS state pre-heat and interpass temperatures required to be maintained. Post weld requirements (e.g.: shielding) if stated should be observed as being maintained.

Adherence to standard preparation and cleanliness norms will minimise the number of defects in a weld.

7.3.5 *Acceptance criteria*

A non-destructive testing regime should be specified by the builder as part of the Quality Assurance System. It should be appropriate to the material involved, reviewed and agreed with the MCA/FVCA. NDT would expect to include (on a scale as appropriate):

1. Close visual examination;
2. MPI;
3. Dye Penetration;
4. Vacuum Box testing;
5. Fluorescent Dye Penetration;
6. Radiography.

Finished welds need to be sound, free from cracks and substantially free from other harmful defects. Non-destructive testing will include visual examination of all welds, before sampling of proportions of non-critical component welds, and 100% of critical component welds.

Complex and critical components may receive additional attention depending on the end use.

7.3.6 *Steel/aluminium transitions or joints*

These are to be explosion bonded composite transition joints, or by bolting as detailed in paragraph 4.1.18 of <15m construction standard, and Paragraph 4.1.21 of 15 – 24m construction standard.. Bimetallic joints to be suitably protected from harmful effects of seawater or ambient moisture exposure.

7.3.7 Steel/wood aluminium/wood connections

To minimise corrosion, surfaces in contact with wood in a damp marine environment must be protected in accordance with good practice. Contact surfaces to be primed and painted, and or coated with a suitable thickness of sealant.

7.3.8 Protection after fabrication

Metals to be protected after fabrication by appropriate surface treatment or coatings.

8 Aluminium craft specific requirements.

8.1 Building environment

To avoid hydrogen inclusion, aluminium should not be welded in damp or wet conditions

8.2 Storage

Aluminium to be stored under cover in dry areas, clear of the ground

8.3 Tools

When builders are working with both aluminium and steel, tools in contact with the metals used are to be marked for exclusive use for aluminium

8.4 Galvanic action / Corrosion protection

Appropriate corrosion inhibition measures are to be employed for both jointed components and wet/immersed components by coatings or cathodic protection.

9 Fibre Reinforced Plastic production (FRP/GRP)

9.1 Storage and handling of materials

9.1.1 Suitability

General requirements are as above, for welded fabrication

9.1.2 Identification of materials and consumables

General requirements are as above, for welded fabrication

9.1.3 Storage facilities and method

Materials are to be stored remotely from the workshop, in accordance with manufacturers' requirements, in order to prevent deterioration through poor handling or climatic conditions, to ensure no contamination or degradation, and so that constituents and expiry dates are clearly visible. Materials should be used in order of receipt and all structural components are to be made from materials that have not passed the manufacturer's date of expiry.

Unused materials exposed to the workshop are not to be returned to storage and mixed with remaining stock.

9.1.4 Resins, catalysts and accelerants

These items are to be stored in controlled conditions, to manufacturers' recommendations. Where settling out of component ingredients can occur over time, manufacturers' instructions for mixing and conditioning should be followed to ensure consistency of material quality.

9.1.5 Fillers, powder additives, thixotropic constituents etc

To be stored in closed containers to avoid contamination

9.1.6 Reinforcement fabric / fibre cloths and core materials

To be stored in clean and dry conditions, per manufacturer's recommendations

9.2 Workshop conditions and environment

To minimise contamination in both the built vessel laminate and the storage area, construction and manufacturing processes should be carried out in separate areas, and by section divisions if necessary, to reduce cross-contamination. The workshop and equipment associated with

production should be maintained in good condition without surplus build-up of excess materials equipment or waste from other processes.

9.2.1 Temperature / humidity

Moulding areas need to be kept within minimum and maximum temperature and humidity values, as specified by the materials' manufacturers to ensure full and proper cure. These values are to be recorded and ensured brought within the limit values before commencing work, during work, and in the curing period - for both workshop and materials brought in for processing. Should the workshop be outside the limit values at any time during this critical period, the builder is to establish with the resin manufacturer that resulting laminate will meet the requirements expected of the scantling design.

Temperature and humidity records are to be included in the Builder's Quality Assurance records.

9.2.3 Ventilation

Adequate ventilation should be provided tailored to the workshop size, divisions and workpiece size. It should not adversely affect the moulding environment by reducing the temperature in the curing process. Proper design of the ventilation should reduce the accumulation of fumes in the mould though without excessive evaporation of the resin monomers from excessive draughts.

9.2.4 Dust

Accumulations of dust on moulds and laminates are to be avoided by proper cleaning and removal, including through ventilation extractors. Workers tracking dust into moulds between laminate layers/processes and reinforcement additions is to be avoided by both clean transition areas and protective films. Accidental accumulations are to be removed before subsequent layers/additions.

9.2.5 Lighting

Harmful effects of unfiltered direct sunlight on mould and moulding should be avoided. Adequate lighting for the working area is to be provided.

9.3 Moulds

9.3.1 Construction

Hull moulds should be a true representation of the designed hull shape. Dimensional control of the mould is expected to show it closely matches the expected hull shape. Moulds should be suitably stiffened to maintain the shape and fairness of the workpiece and of suitable materials to not adversely affect cure.

9.3.2 Preparation

Moulds should be cleaned, dry and stabilized over time in their workshop placement before final preparation. Release agent should be matched to and compatible with both the mould and the resin system to be employed – noting certain generic release agents may interfere with adhesion at primary or secondary lamination.

9.4 Resin processing

Mixing, blending and preparation for lamination is to follow resin manufacturers' approved procedures, carefully matching accelerant and catalyst/hardener quantities, noting also that different resin systems require different handling and processing procedures. Familiarity should be gained with new systems before use. Test specimens matching the critical areas of laminate are to be made up that allow post production testing of cure and mechanical properties.

Where resins are to be modified outside the approved design specification or manufacturers' requirements, approval is to be obtained first from the FVCA.

9.5 Laminating – process specific

9.5.1 General

Vessel standards gives more detail on the following:

9.5.1.1 Documentation, process

- Production plan
- Laminate sequence
- Cure and post cure
- Design details as per the construction standards

9.5.1.2 Documentation, records

- Temperature and humidity controls
- Weights on and off if required
- Cure process records
- Barcol hardness maps
- Dimensional reports
- Records of repairs and non-conformance reports
- Other documents, as required

9.5.2 Manual hand wet lay-up

It is assumed that most new-builds will use the female mould process.

Gelcoat or similar – which may be the laminating resin if designed for this - should be used to offer protection from UV radiation, hydrolytic attack and abrasion, particularly above the waterline. Under the waterline, a clear outer gelcoat or resin finish is recommended for better inspection of the final laminate integrity, but must still offer similar protection.

The outer reinforcement layer should be compatible with ensuring adequate wet-out to avoid hydrolytic attack and applied to the gelcoat as soon as it has adequately cured.

The stack sequence and degree of cure between must be in accordance with the resin manufacturer's requirements to ensure primary adhesion. Where limits are exceeded, surfaces are to be properly treated and or re-prepared for secondary bonding.

9.5.3 Spray lamination

Spray should be limited to applications where an even thickness can be obtained. Excessive build up of wet laminate thickness should be avoided to limit exothermic heat build up; to limit sagging of bulk laminate; and to aid deaeration. The amount added will depend on the complexity of the mould but should not normally exceed 1100GSM or thereabouts, unless shown that thicker and heavier sprayed laminates perform satisfactorily.

Uniformity of the laminate should be checked throughout the spray lay-up procedure. Where the first back-up layer after gelcoat is also sprayed, fibre control should be ensured to prevent wicking effect.

Spray equipment should be monitored and a calibration check carried out at least at the beginning of each day.

9.5.4 Infusion / vacuum consolidation

The system should be designed to both allow full and correct distribution of resin through the laminate, and to ensure proper consolidation pre and under cure. Feed systems and bleed routes should be designed and tested for correct infusion through the laminate, including tailoring quantities and gelation times to the avoid under infusion and early gelation preventing full infusion flow-through. Equipment should be set up to allow modifications to the vacuum and extra draw-off points to be added during the infusion, to limit bridging and under infused areas. Pressure gauges should be used in areas of the moulding, to ensure adequate infusion and consolidation. Gauge pressure checks should be recorded. Checks for full infusion of the laminate should be made to and between the draw off points to ensure no dry areas. A 'dry-run' should be demonstrated to the surveyor to ensure adequate vacuum and bag coverage, and to identify potential problem areas.

9.5.5 Pre-preg / film

Pre-impregnated laminates or dry laminate/resin film systems should be stored and handled according to manufacturers' recommendations, and similarly used. Both techniques are expected to be consolidated under vacuum as manual techniques are inappropriate for either method. See above under infusion. Film consolidation and wet-through processes are specialist applications, to be demonstrated to the surveyor in conformance with the manufacturer's requirements.

9.6 Surface finishing

Gel flow-coat or a similar protective coating of resin system should be applied to protect the final inner layer, particularly in bilges and other areas where water and or oil is likely to pool.

9.7 Manufacturing sandwich

9.7.1 Female moulding

9.7.1.1 When bonding core to wet laminate, care should be taken not to disturb un-gelled structural laminate and to ensure adequate resin to bond and gap fill between core and shell.

9.7.1.2 Scored or block core should be laid with sufficient resin to fill all kerfs (on wet or gelled laminate).

9.7.1.3 Materials to be kept in close contact while curing to avoid springing off, avoid air inclusion and ensure a structural bond obtained.

9.7.1.4 Core surface voids and irregularities should be removed or filled, depending on following skin lay-up

9.7.2 Male moulding

9.7.2.1 Structural properties of the core should not be adversely affected when laying over male formers.

9.7.2.2 Joints, kerfs and irregularities should be filled and fixed before applying subsequent skin laminates

9.7.2.3 Core should be wet-out before applying subsequent skin laminate

9.8 Laminate cure

9.8.1 Open mould

Laminate cure should closely follow manufacturer's recommendations and be documented according to the QA process. Post cure, when required at elevated over ambient temperature may be adversely affected or slowed by the presence of core materials, which should be taken into account. Elevated temperatures are not to adversely affect the laminate, core or gelcoat properties. All post cure activity should be documented

9.8.2 Closed mould

Specialist procedures are to be adopted that take into account the influence of all component and mould materials. These are to be documented and approved.

10 Wood

10.1 General

General requirements are as above, for welded fabrication, as applicable. The build standards give more detail on the following:

10.1.1 Documentation, process

- Production plan
- Design details as per the construction standards

10.1.2 Documentation, records

- Environmental control
- Timber moisture content

10.2 The Workshop

Premises for Wooden Vessel construction and repair are to be of a standard suitable for the process, including for fault free bonding using temperature and humidity sensitive adhesives. Builders should be able to monitor and, if necessary, control temperature for sensitive processes in the construction sequence.

The workshop should also be maintained clean, as appropriate, to avoid contamination.

10.3 Materials

10.3.1 Materials storage

Once seasoned, timber should be stored in a dry and well-ventilated area, protected from sunlight and excessive moisture. Storage normally horizontal, adequately supported to avoid bow and sag, with free air circulation to help avoid spore and mould.

10.3.2 Adhesives

These should be suitable for the material and purpose, whether jointing or laminating. Adhesives should give bond life exceeding that of the timber. They should be stored according to manufacturer's recommendations, and used before expiry date – else disposed of.

10.3.3 Fasteners

All fasteners, whether load bearing or not, should be suitable for use in a marine environment, and made of corrosion resistant alloys specified for marine use, or hot-dip galvanised.

10.3.4 *Suitability*

All material shall be suitable for the end requirement. The material shall be confirmed as being acceptable through its inclusion in the Standard or Build Reference; a RO or CA publication or other noted document – accepted at the discretion of the MCA. Unique or unusual combinations should have been discussed with the MCA prior to inclusion.

10.4 Manufacturing

10.4.1 *General*

This should happen in an environment suitable, as noted for workshop above.

10.4.2 *Glued joints and laminations*

Wood which has a moisture content over the specified maximum for the adhesive system employed, should not be used. Any contamination or defect to mating surfaces in the area of the joint shall be removed, or alternative timber, free of defect, used.

10.5 Preventing deterioration

Construction of the craft should ensure water pooling does not happen in areas that cannot be drained, and so that natural ventilation is free to all areas of the vessel.

10.6 Protective coating

A protective coating or finish should be applied to areas of finished exposed timber to protect against weather and UV exposure. Timber with natural resilience, such as teak, may be excepted.

11 Safety & Environmental Protection

11.1 General

It is expected that the builder will provide the necessary care, attention and protection to the safety of the work force, visitors and sub-contractors and the environment. Local and national legislation shall apply.

12 Other materials

12.1 General

When using other materials to those specified above, similar processes are to be followed, especially:

Material manufacturer's requirements

Suitability

Traceability

Manufacturing or workshop conditions

Procedures

Qualification and acceptance criteria

All novel materials should be approved by the surveyor and MCA/FVCA before commencing construction.

Annex 1 Audit / assessment template for smaller / less complex projects

Yard Name:	Details of vessel type being built / last vessel built / relevant project:
Last visit:	Number of vessels built since last visit
Name of Contact:	Quality Standard Operated: <i>(formal / audited / self)</i> :
Attending Surveyor:	Last audit report available <i>(if applicable)</i>
Construction Standards most frequently used:	

ref	Item	Comments/criteria met (how)
6	QA Procedure and methodology	
	General / oversight	
	- Supervisor	
	- Sign-off	
	Documentation, process	
	- Plans	
	- Materials	
	- Process	
	- manufacturing conditions	
	Documentation, records	
	- Data /COSHH	
	- Environment	
	- Faults/corrections record	
	- Final inspection and testing (include NDE)	
	Deviations / change schedule recorded	
7	For Welded steel/alloy	
	- Mill certificates	
	- Materials ID and tracking	
	- Storage suitability	
	- Disposal of reject stock	

	Workshop facility suitability – conditions and environment	
	- Preparation and cleanliness	
	- Protection/screening	
	Process	
	- Weld procedure specifications qualification	
	- Welder qualification management	
	- Weld Repair Procedure	
	- preheating/forming	
	Records	
	- WPS	
	- WPQR	
	- Heat treatment records	
	- Dimensional reports	
	- Repairs/non-conformance	
	- Other	
	Welders qualification	
	Material preparation	
	Acceptance criteria	
	Steel/aluminium jointing	
	Joining structure to wood or other dissimilar materials	
	Post fabrication protection	
	Calibration of welding equipment	
	NDT evidence	
8	For Aluminium specific items	<i>In addition to the relevant items above</i>
	- Environment	
	- Storage	
	- tool segregation	
	- corrosion protection	
9	For FRP production	
	- Certificates of origin	
	- Materials ID and tracking	
	- Storage suitability	
	- Storage environment control	
	- Disposal of reject stock	
	Workshop	
	- Temperature/humidity control and record	
	- Ventilation	

	- Dust control	
	- Lighting	
	Mould construction	
	Mould preparation	
	Resin preparation	
	- Segregated area	
	- Cleanliness	
	- Measurement	
	- Specimen	
	Lamination. Method approved Accurately repeatable?	
	Process / records	
	- Plan & sequence	
	- Cure/post cure regime	
	- Details check	
	Records	
	- Weight records of materials and wastage	
	- Temp and humidity	
	- Cure records / post cure/Barcol	
	- Test and samples	
	- Dimensional records	
	- Repairs non-conformance	
	- other	
	Method specific detail	
	- specialist equipment	
	- other record as required	
10	Wood construction	
	Suitability	
	Storage	
	Temperature / humidity control	
	Adhesives	
	Fasteners	
	Process control	
	Surface finish/protection	
11	Safety & Environmental Protection	
12	Other materials Subject to separate approval	

Completion:

Is there a systematic, easily demonstrated QA system in place?	Is there sufficient knowledge of the construction standards?	Is there sufficient knowledge and experience of construction methodologies?
Does the QA system provide for high quality, repeatable projects?	Is there sufficient oversight by the company to maintain standards between site visits?	Are sufficient records maintained?
Recommendations:		
Result of visit:		