possible solutions may be appropriate. The system of dehumidification chosen is the best one for maintaining and preserving the ship, but it will nonetheless require careful application and close monitoring.

34. Recommendation 5 Conservation treatment of the hull

34.1. The vessel's topsides should remain exposed to the environment, above the glass plane, in order to present the vessel in a manner that greatly aids visitor comprehension and quality interpretation.

34.2. The dome headed bolts on the hull exterior should be removed and the resultant holes filled with GRP and finished flush with the surface of the plates. This would have the advantages of removing material that could cause galvanic corrosion and make the ship more closely resemble her pre-timber-clad days. Liaison with a conservation engineer would be required to ensure that the structural stability of the ship was not compromised by this change.

34.3. The topsides will need to be thoroughly cleaned to SA2 or SA 2 1/2, and any areas of failing GRP removed. This treatment should continue to a level just below the level of the glass plane.

34.4. Any replacement GRP patches should cover the minimum amount of iron, commensurate with providing an adequate seal and adhering properly. They should be fitted only after the iron has been adequately cleaned and conserved. Large patches will be reinforced. The colour and texture of the patches will be determined in conjunction with the curator, to reflect the interpretative requirements. Where holes are large enough to span frames, it may be prudent to replace GRP with textured steel, if it is possible to achieve this without the loss of original iron.

34.5. The hull both above and below the waterline will need to be cleaned, and areas of loose scale will need consolidation. It is not possible to specify exactly what form of cleaning will be required on each part of the ship. This decision will be taken by the conservator and the curator on an area-by-area basis, as the cleaning takes place.

34.6. Appropriate paint coatings will need to be applied, once the surface is as clean as possible. The paint coatings will need to be sympathetic to the curator's interpretation of the ship's original colour scheme.

35. Recommendation 6 Drainage and moisture control

35.1. The system of drainage pipes installed within the ship in the 1970s needs to be re-designed to mesh with the drainage channel and inlet drains on the steel weather deck.

35.2. The original lead scuppers should be reconnected to the hull to allow full functionality.

35.3. Water draining from the ship to the dry-dock floor should flow through flexible pipes to avoid splash-back

35.4. The outlets from the hull should be reduced to a minimum (preferably one) and piped directly to the dock waste water disposal system.

35.5. On rainy days, a considerable amount of moisture can be brought onto the ship by visitors. Cloakrooms should be provided and people encouraged to use them.

36. Recommendation 7 Improvements to services

36.1. Given the risk of fire and explosion, the general use of gas and heat on the ship should be strictly controlled and avoided where possible. Where there is no alternative, formal risk assessment should be undertaken and hot works permits issued. The permit should include a requirement to finish generating heat at least four hours before ceasing work and that all gas equipment be removed from the ship and its environs at the end of each working period. Gas sensors should be fitted within the ship.

36.2. The galley should be sited on the dockside if the caterers cannot manage without gas-fired equipment. This would confer other advantages as well as reducing the risk of explosion and fire such as reduction in water vapour in the ship. It would also make it easier to allow for a larger space to be left between the galley panelling and the hull. If the galley cannot be re-sited, it should be made all electric. This would also reduce the production of water vapour on the ship, although not by as much as relocating the galley.

36.3. The heating system should be removed from the after tank top hold and sited in a new plant room. Hot and/or conditioned air could be ducted into the ship as required. Should dehumidification of the ship be adopted as the conservation method, the equipment necessary for this task should as far as is possible be located off the ship. The irregular offset to the port side of the dry dock might provide an appropriate place for such equipment. In practice, however, the dehumidification task might require separate machines for dealing with the ship and the dry dock. In that case, ducting requirements might make it more appropriate to have the machine located within the ship.

36.4. The electrical system of the ship and the surrounding buildings should be re-wired to reduce the risk of fire, increase safety and render the system more easily understood. Existing services should be stripped out rather than modified or adapted. New services should be installed appropriate to requirements and modern standards.

36.5. The ship should be fitted with a new, purpose designed automatic fire fighting system. This should be permanently active, fully accessible to all members of staff at all times, and not require coupling before use.

36.6. As an interim measure, the three-inch fire main currently in use should be permanently attached to a water supply.

36.7. In general, the services of the ship should be modernised, rationalised and, where possible, centralised. A new plant room should be created to accommodate main electrical distribution & control equipment, heating equipment, dehumidification equipment, pump controls and fire-fighting controls.

37. Recommendation 8 Structure of the Ship[80]

37.1. A compound armature should be built within the ship which relies on keel, bulkheads, stringers and frames to strengthen the ship's pre 1970s iron.

37.2. The columnar structure of the ship should be reinforced to transmit loads from deck to tank top. Concentrate these loads on to the keel which will serve as the foundation. Pass the concentrated linear load through the keel blocks to a new beam inserted above the dry dock keel stones to ensure as even a distribution as possible to the existing foundation system. The weight of the new system should be kept to an absolute minimum.

37.3. Special concentrations of load, such as those arising from the engine should be catered for by providing individual foundations.

37.4. Attachment of the new armature to the existing system is crucial. It should be unobtrusive and be linked as closely as possible to the curatorial requirement to open up as much of the ship as possible for public access and interpretation and to the conservation requirement to treat and seal various parts of the ship.

37.5. The attachment method must be minimalist in its interference with the ship's original material. However, there may be areas of the ship where the decision to remove, modify or otherwise interfere with original material has to be taken, for the sake of preservation of the ship as a whole. To this end, when installing the armature, a hierarchy of allowable intervention has been agreed:

37.5.1. Alterations and adaptation of post 1970's construction can be freely made;

37.5.2. Existing holes or fake bolts may be used for attachment;

37.5.3. If no alternative exists, existing rivet holes may be used. Where the rivet must be removed, this will be done as sensitively as possible, after full curatorial approval. Experimentation will be required to determine a method of rivet removal that will preserve as much of the rivet as possible

[80] The recommendations for structural support modifications are based largely on suggestions proposed by Julian Harrap Architects

37.5.4. Other interventions with the potential to damage or remove original material must be considered on a case by case basis to ensure there is no alternative, and would only be countenanced in exceptional circumstances. Any alteration to the ship's fabric should include an appropriate archaeological recording element.

37.6. Any modern concrete in the hull that is considered to be harbouring corrosive compounds & moisture holding materials and increasing weight in a manner that is deleterious to the vessel should be removed, unless it is important to the structural stability of the ship. Any removal of concrete should be undertaken in close liaison with a conservation engineer and may require the insertion of additional support steel-work.

38. Recommendation 9 The dry-dock

38.1. There are three factors which dictate appropriate work on the dry dock:

38.2. First, that the conservation needs of the ship must be met by ensuring that the protection afforded to the ship by the dry dock environment is adequate. This will largely consist of measures aimed at improving the drainage into the sumps and ensuring a higher standard of water-tight integrity of the dry dock entrance, walls and floor than at present. It may be necessary to take invasive measures aimed at investigating the under-wall and floor structures, and at ensuring the ship's support structures are adequate.

38.3. Second, that the conservation needs of the dry dock as a listed structure, should be considered. Any treatment designed to preserve the ship must be carefully considered as to how it will affect the dry dock. The conservation needs of the dock itself will need to be met through detailed analysis of the dock structure and condition, including photogrammetric survey and photography, and non-invasive survey. This should include preliminary cleaning to enable a more comprehensive survey, removal of all organic matter & litter, raking out joints, re-pointing using an appropriate mortar and re-setting loose stones & bricks. A regime of maintenance cleaning and repairs will need to be established.

38.4. Third, that full, safe public access to the dock, both to view the ship and to experience the dock must be made. A visit into the dry dock is considered by the ss Great Britain Project as an essential part of the visitor experience to the ship. Further work will be necessary to bring the dock up to an acceptable standard to allow the extension of safe public access beyond the currently restricted area. This will include creating elevator access and ensuring floor and wall surfaces are suitable.

39. Recommendation 10 The Caisson

39.1. The caisson must be inspected and treated in a manner agreed with the curator. It is important that the caisson should continue to perform its function correctly. Any treatment should ensure continued structural integrity and that the sluices open and seal correctly when closed.

39.2. Inspection and treatment can only occur if a temporary dam is constructed between the Floating Harbour and the caisson that will allow the water between the dam and the caisson to be pumped out. The caisson could then be lifted out using a mobile crane.

39.3. This should be done by constructing a sheet piling dam across the entrance to the dock. This would have a number of advantages:

39.3.1. the sheet piling would act as a physical barrier and protect against catastrophic failure of the caisson;

39.3.2. the water between the new barrier and the caisson could be pumped out periodically to allow inspection and maintenance of the caisson. This pumping system could form part of an improved waste water management system;

39.3.3. the caisson could be lifted out of position and taken away for treatment, if necessary;

39.3.4. the caisson, dock seals and surrounding masonry could be more effectively treated;

39.3.5. the dam could form an anchor for a new pontoon allowing pedestrians to pass along the towpath across the dock entrance.

39.3.6. the dam could be removed at a later date if required.

39.4. In the short term, a boom or very strong and firmly anchored chain should be fitted across the entrance to the dry dock.

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Acknowledgements

Considerable help has been offered and gratefully received during the preparation of this report. Thanks are due to:

Maurice Ball	ss Great Britain - Engineering volunteer
Des Barker	Portsmouth University - Lecturer in Corrosion Science
Roger Barnes	ss Great Britain - Engineering Chargehand
Joe Blake	ss Great Britain - Initial Director
Barry Bromley	Quantity surveyor
Stewart Bowler	SGB Major Projects
May Cassar	Museums & Galleries Commission
Shane Casey	ss Great Britain - Curatorial Assistant
Simon Clarke	Sandberg Consulting Engineers
Dr Ewan Corlett	ss Great Britain – Vice President
Dr Jo Cox	Keystone Historic Buildings Consultants
Julian Harrap	Julian Harrap Architects
David Hill	South West Museums Council
Martin Holden	Holden Conservation
Des Jarvis	Leighs Paints
Peter Lawton	Hampshire County Museums Service
Bob Mealings	Royal Naval Submarine Museum
Peter Meehan	Science Museum, Wroughton - Head of Conservation,
Brian Morton	The Morton Partnership Ltd.
Edward Morton	The Morton Partnership Ltd.
Frank Porter	ss Great Britain – Engineering consultant
Steve Proud	Hodge Clemco Ltd.
Simon Raeburn - Ward	Interface Force Measurement Ltd
Nugmais ul-Rasheed	Acrylon – tannate treatment
Claire Smith	University of Cardiff research student
Rebecca Stevens	ss Great Britain - Volunteer
Siobhan Stevenson	University of Cardiff Senior Lecturer
David Stirling	Mowlem Civil Engineering
Matthew Tanner	ss Great Britain - Curator
Robert Thorne	Alan Baxter & Associates
Ann Towers	Julian Harrap Architects
Jonathan Walton	The Severn Partnership
David Watkinson	University of Cardiff
Duncan Wilson	Inskip & Jenkins Ltd.
Chris Young	ss Great Britain - Curatorial Assistant
Jean Young	ss Great Britain - Archivist
Andrew Wood	ss Great Britain - Curatorial Assistant
Lindsay Ward	ss Great Britain - Volunteer

Appendix B

Brief for Conservation Consultants
ss Great Britain Project 1998

ss Great Britain Project
Brief for Preparation of a Condition Report for the ss Great Britain

1. Introduction

1.1. A Condition Report is a document that states what is the current chemical, physical and biological condition of the original fabric of the iron steamship, ss Great Britain.

1.2. This report is integral to the work carried out under the main Conservation Plan, but it may be viewed as a separate project where the skills of another consultant(s) or sub-contractor are seen as necessary. In either case, this report must be dependent upon the findings of the main Conservation Plan.

1.3. Commissioning body

1.3.1. This Condition Report is commissioned by the Executive Committee of ss Great Britain Project Ltd.

1.3.2. ss Great Britain Project Ltd. is a company limited by guarantee for the purposes of preserving and displaying for the public benefit the ship ss Great Britain within her original building site, and is located at the Great Western Dock, Bristol, BS1 6TY.

2. Definition of place or object

2.1. The Condition Report will examine the ship known as the ss Great Britain, which is defined as the ship created by I.K Brunel and his collaborators and launched in 1843, until the end of her working life as a ship, hulk or wreck in 1970.

3. Purpose of report

3.1. The purpose is to provide a report of condition, evaluate the report, and consequently to recommend possible conservation solutions. These solutions must accord with the requirements for the retention of the significance in the ship outlined by the main Conservation Plan for the ship.

3.1.1. The report will describe the current physical, chemical and biological ***state of the original fabric*** of the ship.

3.1.2. The report will provide an ***evaluation of the current state*** of the fabric, and provide a prognosis for the proceeding future condition of the fabric.

3.1.3. The report will provide consequently, in consultation with the curator, a ***statement of options for specifications for possible conservation solutions.***

4. General parameters, time, scale, and remuneration

4.1. This Report is jointly funded with the Heritage Lottery Fund, who have also assisted with the appointment of a professional curator to ss Great Britain Ltd. The consultant(s) will be expected to liase closely with and work in conjunction with the curator at all times, and the curator will be the point of contact between the commissioning body and the consultant(s).

4.2. The Condition Report will commence as soon as mutually agreeable after the approval of this brief by the Heritage Lottery Fund Project Monitors. A timetable for the work will be agreed with the curator based upon the following stages:

- Draft of report on state of original fabric
- Comments upon report
- Draft evaluation and prognosis report
- Comments upon report
- Draft statement of options

- Comments upon statement
- Submission of completed final report

4.2.1. The consultancy fee will be agreed and paid on invoice at the submission of the final report, or at other intervals to be mutually agreed.

4.2.2. All analysis must be based upon evidence, which should be properly referenced.

5. Publication and Copyright

5.1. Copyright will remain with the author(s) of the Condition Report, but the author(s) must agree to the unrestricted use of the material by the commissioning body. The author(s) will be expected to co-operate in the publication of a mutually agreed text of the Condition Report.

5.2. Presentation

5.2.1. The final report should be produced in four copies bound in A4 or A3, and a further copy on computer disk.

5.2.2. All terminology used in the report should be based upon the agreed terminology found in the Burra Charter, and amplified by Kerr (The Conservation Plan, 1996).

5.2.3. All expenses involved in researching, producing and presenting the report should be included in the tender price.

5.2.4. A formal presentation is not envisaged since close liaison with the curator is expected throughout the course of the work.

6. Indemnity

6.1. The consultant(s)s must agree to indemnify ss Great Britain Project Ltd. from and against all liability in respect of personal injury (including death) to persons including the consultant(s)s, or damage to property arising directly or indirectly out of any act or omission of the consultant(s)s in the course of carrying out the services described in this brief.

7. Role of ss Great Britain Project Ltd.

7.1. ss Great Britain Project Ltd. will:

- provide access to its staff and advisers at mutually agreeable times.
- provide access to all relevant documentary material in its possession or collections.
- provide access to the ship and all appropriate spaces at mutually convenient times.
- provide a full briefing on the general outline of possible desired developments and alterations to which the ship may be subject.
- provide any other assistance by mutual agreement.

8. **Condition report on the state of the original fabric of the ship**
   - **8.1.** The consultant(s) is to examine, photograph, and describe in an appropriate manner the evidence which remains within the ship for her current condition
   - **8.2.** Existing work carried out, particularly by Dr Ewan Corlett (The Iron Ship 2nd ed. 1990), will give a strong lead to understanding the history of the fabric of the ship. It is anticipated that Dr Corlett may make himself available to advise the consultant(s) carrying out this work. Investigation of archaeological or physical evidence should not involve intervention in the surveying fabric of the ship, unless a good and pressing argument for such work can be sustained.
9. **Evaluation and prognosis of condition**
   - 9.1. The consultant(s) is to gather and reference all documentary information that can be used to understand the progressive history of the condition ship and her individual parts and other features. ss Great Britain Project Ltd. possesses an incomplete set of plans, photographs, reports and references to the ship.
   - 9.2. Physical condition of the place
     - 9.2.1. The consultant(s) is to provide descriptions of the physical and structural integrity of the ship sufficient to enable policy decisions to be made on appropriate treatment of fabric, and to call attention to areas where more detailed or specialist survey and investigation may be required. These might include survey drawings, architect's inspections, structural inspections, specialist surveys such as condition reports, M & E inspections, and health and safety requirements.

Appendix C

Tabulated results of ss Great Britain acoustic and visual test programme
Eura Conservation 1999

Condition of hull plates

Condition of plate (see below)	Percentage of sites tested found to be within categories 1 - 4				
	Port internal	Port external	Starboard Internal	Starboard external	Total.
4	23	5	25	4	17
3	41	54	40	42	44
2	17	37	21	53	28
1	4	3	3	1	3
Areas examined that were wholly composed of GRP, or covered with timber or concrete	14	1	11	0[1]	8

Condition 4	Very Poor, displaying very severe corrosion with parts missing. Will become lace-like or entirely non-existent during dry abrasive cleaning
Condition 3	Poor Condition, displaying severe corrosion and likely to become perforated during dry abrasive cleaning
Condition 2	Fair Condition, corroded with some probability of a reasonable amount of iron surviving dry abrasive cleaning
Condition 1	Good Condition, with a strong probability of a reasonable amount of iron surviving dry abrasive cleaning

[1] This does not imply that there are no fibre-glassed areas on the exterior, merely that problems of access precluded examination of those areas. A large number of fibre-glassed areas were examined from within the hull.

Acoustic and visual examination of hull plates - Port, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																					
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
-5																					
-4																					
-3	s4g	g	s4g																		
-2	s3	g	s4g																		
-1	s2	s4g	i4g																		
0	s3	s4g	i4g																		
1	s4g	s4g	s4g																		
2	s4g	g	g																		
3	s4g	s4g	i4g																		
4	s4g	s4g	g																		
5	s3	s4g	g																		
6	s3	s4g	i3g									nv	s2	s1	i4g	nv	nv				
7	s4g	s4g	s4g									nv	s3	s2	i4	nv	nv				
8	s3	s4g	i3									nv	s3	s3	i4	nv	nv				
9	s3	s3	s3									s2	i3	i3	i4g	i4g	i4				
10	s4	s3	s3		i3	i2	i4g	i4g	i4g	i3		i4g	i3g	i3g	i3g	i4	i3				
11	s3	s3	s4g		s2	s2	i4g	i4g	ig	i3	inv	i3g?	i3g	i4g	i4g	i3g	i3g				
12	i3	s2	s4g		s4	s3	i4	i3	i4	i3		s3g	i3	i3	i4	i3g	i3g				
13	s4	s4	g		s2	s4	i2	i3g	ig	i3		s3g	i3g	i3	i3	i4g	i4				
14	s4g	s3	s4g		s3	s2	i2	i3g	i2	i2	inv	i3	i3g	i3	i4g	i4g	i4g				
15	s2	s3	s4g		i4g	s2h	i2h	i3g	i2	i2		i3g	i4g	i3	i4	i2	i2				
16	s3	s3	i4g	Lower Aft Entrance							nv	i3	i4	i4g	air duct		i3				
17	s2	s3g	s4g	Lower Aft Entrance							nv	i3	i3	i3	i3	i2g	i3				
18	s2	s4g	is?4g		s3	s3	i3g	i3g	i4g	i3	nv	i4	i4	i4	i3	i3	i3				
19	s2	s4g	i4g		s3	s2	ig	i3g	i3g	i	nv	i3	i2	i2	i3	i3g	i3				
20	s2	s2	?g								l	s2	i2	i2	i2	i2	i3				
21											s?	i2	i2	i2	i2	i2	i2				
22											nv	l	i4	i3	i3	i3	nv				
23											nv	nv	i4g	i4	i4	i4	nv				
24											i4g	i4g	i3	i3	i3	i4g	nv				
25											i3	i3	i3g	i3	i3g	i3g	nv				
26											nv	i4	i4g	i4g	i4g	i4g	nv				
27											nv	i3g	g	i4g	i4g	i4g	nv				
28											i4g	i3	i4	i4	i4	i4	nv				
29											i3	i3	i3	i3	i4	i4	nv				
30											i3	i3	i3	i4	i4	i4	nv				
31											i3	i3	i4g	i4g	i3	i3	nv				
32											i3	i4	i4g	i4g	i3	i3	nv				
33											i3g	i3	i3	i3	i4g	nv	nv				
34											i3	i3	i3	i3	i4	i3	nv				
35											nv	i2	i2	i2	i3	i4	nv				
36											i3	i3	i4g	i4g	i3	i3	nv				
37										i3	i3	i4	i3	i4	i3	i3	nv				
38										i3	i3	i3	i3	i3	i3	i3	nv				
39										i3	i4	i4	i3	i3	i4	i3	nv				
40										i3	i4	i4	i3	i3	i3	i4	nv				
41										i4	i3	i3	i3	i4	i3	nv	nv				
42										i4	i4	i4	i4g	i4g	i3	nv	nv				
43										i4	i3?	i4	i4	i4	nv	nv	nv				
44										i3	i3	i3	i4	i3	nv	nv	nv				
45										i3	i3	i4	i4	i3	nv	nv	nv				
46										i4g	i3	hole	i3	i4	nv	nv	nv				
47										i3	i3	hole	i4h	i3	nv	nv	nv				
48										i3	i3	i3	i4g	i3g	nv	nv	nv				
49										i3	i3	i4g	i4g	nv	nv	nv	nv				
50										i3h	i4	i4g	i3	nv	nv	nv	nv				
51										i3	i4	i3	i3	nv	nv	nv	nv				
52										i3	i3	nv	nv	nv	nv	nv	nv				
53										i3	i3	i3	nv	nv	nv	nv	nv				
54										i3	i4g	i3	nv	nv	nv	nv	nv				
55										i3	i3	i4	i3	nv	nv	nv	nv				
56	s1	s1	s1						i3	i3	i3	i3	i2	i3							
57	s1	s1	s1						i2	i2	i2	s2	i2	s2							
58	s3	s1	s1						i3	i3	i3	s1i	i2	s2							
59	s3	s1	s1						i4g	h	s3	i2	i2	s3							
60	s2	s1	s1						i3	i2	i2	i2	i2	i2							
61	s4g	s1	s1						i2	i2	i2	i2	i2	i2							
62	s4g	s1	s1						i3g	i3	i3	i2	i2	i2							

Acoustic and visual examination of hull plates - Port, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																					
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
63	s4g	s2h	s1i4g							i3	i3	i2	i2	i2	i3						
64	g	i4g	i4g							i3	i2	i3	i3	i3g	i3						
65	i4g	i4g	i4g							i2	i2	i2	s3	i3	i2						
66	i4g	s3	s4g							i4g	i3	i2	i2	i2	c						
67	i3	s2	s4g							i3	i3	i3	i4	i3	c						
68	s4	s3	s3							i2	i2	i2	s2	s2	c						
69	s3	s3	s4g							s3	s3	s3	i2	s2	i3						
70	nv	s3	nv							i3g	i3	i3	i3	i3	i3						
71	i4g	s3	nv							i3g	i2	s3	i3	i3	i3						
72	i3	s3	s4g							i2	i2	i2	i4	i2	c						
73	s4g	s1	i4							i2g	i2g	i2g	i4g	i3	c						
74	s4	s1	i4g							s3	i2	i2	s4	i4	i3						
75	s3	s2	i3							i3	i2	i2	i3g	i3g	c						
76	s3	s2	i4g							i3	i2	i2	i4g	i3	c						
77	s4g	s2h	i4g							i3	i3	i3	i3	i3	i4g						
78	s4	s2	i3							s3	s3	i2	i3	i3	c						
79	s4	s1	i4g		i3	i3	i3	i2	i2	i3	i3	i3	i3	i3	c						
80	s4	s2	i4g		i2	i2	i3	i2	i2	s3	s3	i2	i2	i3	c						
81	s3	s1	i4g		i2	i2	i3	i2	i3	i3	i3	i3	s3	s3	c						
82	s3	s1	i4g		i2	i2	i3	i2	i2												
83	s3	s1	i4g		i3g	i3	i2	i4g	i2h												
84	s3	s1	nv		i3	i3	i3	i3	i2h												
85	s3	s1	nv		i3	i3	i3	i4g	i3												
86	s3	s1	nv		i2	i2	i2	i3	i4												
87	s3	s2	s3		i3g	i3	i3	i3	i2												
88	s3	s3	s4g		i3	i3	i3	i3	i4gh												
89	nv	s3	s4g		i2	i2	i2	i4	i3												
90	s3	s3	s3		i2	i2	i3	i3	i3												
91	i3	s4g	s4g		i2	i3	i3	i4	i3												
92	s3	s1	i4g		i2	i2	i2	i3	i3												
93	s3	s1	i3		i2	i2	i2	i3	i3												
94	s3	s1	i3s1		i2	i2	i2	i4	i4												
95	s3	s1	nv		i2	i2	i3	i3	i3												
96	s3	s1	s1	s1	i2	i2	i2	i3	i3												
97	s3	s1	s1	s1	i2	i2	i2	i2	i3												
98	s3	s1	s1	s1	i2	i2	i2	i4g	i4g												
99	s2	s1h	s1	nv	i3	i3	i3	i3	i4g												
100	s2	s1	s1	s1	i3	i3	i3	i3	i4g												
101	s2	s1	s1	s1	i4	i3	i3	i3	i4g												
102	s2	s1	s1	s1	i2	i2	i3	i4	i4												
103	s2	s1	s1	s1	i2	i2	i2	i3	i4												
104	s2	s1	nv	nv	i3	i3	i3	i4	i4												
105	s2	s1	nv		i3	i2	i2	i4	i4h												
106	s2	is?3	s1	nv	i2	i3	i3	i4	i3h												
107	i4g	s1	s1		i3	i3	i3	i4	i3h												
108	s2	s1	s1	i3	i3	i3	i4	i4	i3												
109	s3	s2	s2i4g	i3	i3	i3	i4	i4	i4												
110	i3	s1	i4g	i3	i3	i3	i3	i4	i4												
111	s2	s2	i4g	i3	i3	i2	i4	i3	i4												
112	i4g	s2	i4g	i3	i3	i2	i3	i3	i3												
113	s2	s2	i4g	i3	i3	i3	i3	i3	i3												
114	s2	s2	i4g	i3	i3	i3	i3	i3	i3												
115	s2	s1	i4g	i4	i3	i3	i3	i3	i3												
116	s2	s4	s3	i4	i3	i3	i3	i3	i3	i2	i3g										
117	s2	s2	g	i3	i3	i3	i4	i3	i3	i3	i2h										
118	s2	s2	i4g	i4	i3	i3	i3	i3	i3	i4	i3										
119	s3	s3	i4g	i3	i3	i2	i3	i3	i3	i3	i3										
120	s2	s4g	i4g	i3	i3	i3	i2	i3	i3	i3	i3	i3	c								
121	s2	s2	i4g		i3	i2	i2	i3	i3	i3	i2	i2	c								
122	s2	s3	s3		i3	i2	i2	i3	i4	i2	i2	i2	c	c							
123	s2	s4	s4		i3	i2	i2	i3	i3	i2	i3	i2	ic								
124	s4g	s4g	s4g		i3	i2	i2	i3	i3	i4g	i3	i3	i2c								
125	s2	s4g	s4		i3	i2	i2	i3	i3	i3	i3	i3	c								
126	s3	s4g	i4g		i4g	i3	i2	i3	i3	i4	i3	i3	c								
127	s2	s4	s3		i3	i2	i2	i4	i3	i4	i4g	i2	c								
128	s3	s3g	i4s		i3	i3	i2	i4	i3h	i2	i2	nv	nv								
129	s2	s3	s3		i3	i2	i2	i4	i3	i3	i3g	i3									
130	s2	s3	s3		i3	i2	i1	i3g	i2	i3	i3	ic									
131	s3	s3	s3			i3	i2	i4	i3	i3	i4	i2									
132	s3	s4	s4			i2	i2	i2	i3	i3	i4	i4									

Acoustic and visual examination of hull plates - Port, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																			
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20 keel
133	s4g	s4g	s4			i2	i2	i3c	i3	i3g	i3	i3								
134	s2	s2h	s2			i3	i3	i4g	i3g	i3	i4	i3	i?							
135	s2	s4g	s4			i3	i3	i4g	i4	i4g	i2	i2	nv							
136	s4g	i4g	i3			i3	i3	i4g	i4g	i3	i4g	i4	i2							
137	s3	i4g	i4g			i4g	i3	i3c	g	i4g	i3	i3	i2							
138	i4g	i4g	i3			i3g	i3	i3c	i4g	i3	i2	i3	i2							
139	s3	s3	g				i4g	i4g	i4g	i4g	g	i4	i3	i3						
140	nv	s3	g				i3g	i3g	i4gc	i4	i4	i4	i4	i3h						
141	s2	s2	s2				i4	i3	i3	i3g	i4	i3	i3	i4						
142	s2	s3	i4g				i3	i4	i3	i3	i3	i3	i3	i4	i3					
143	s2	s3	i4g				i3	i4g	i4g	i2	i4	i3	i3	i4g	i3					
144	s2	i4g	i4g				i3g	i3g	i3g	i3	i4	i3	i3	i3	i3					
145	s2h	i4g	g				i3	i3	i4g	c	i3	i3	i3	i3	i3h					
146	s2	s3	s3				i4	i3	g	i4	i4	i3	i3	i3	i3					
147	s2	i4g	i4g				i3	i3	g	i4	i4	i3	i3	i3h	i3					
148	g	*	i4g			i3g	i3g	i3g	g											
149	i3	i4g	i4g			g	g	i4g	i4g											
150	i4g	i4g	i4g			g	i3g	i3g	g	i4g	g	g	g	g	g	g	g			
151	i4g	i3	i3		nv	g	i3g	i3g	g	i4g	g	g	g	g	g	g	g			
152	s3	i3	i4g		i3g	i4g	i4g	i3g	g	i4g	g	g	g	g	g	g	g			
153	s3	i3	i4		i3g	i3g	g	i3g	g	i4g	g	g	g	g	g	g	g			
154	s4g	s3	i4		i3g	i3g	i4g		i4g	i4g	g	g	g	i3	i3	i3	i3			
155	i3	i4g	i3		i3g	i3g	i4g		i4g	g	g	g	g	i3	i3	i3	i3	i3		
156	s3	s4g	i4		g	g	g		i4g	g	g	g	g	i3	i3	i3	i3	i3		
157	s4g	s3	i4		g	i3g	g		g	gh	g	g	g	g	i3	i3	i3	i3		
158	i4g	i4g	i4g	i4g	i3g	i3g	g		g	nv	g	g	i3	i3	i3	i3	i3	i3		
159	i4g	i4g	g	i4g	i3g	i4g	g		i3g	i3	g	g	g	g	i4g	i3	i4g	i3		
160	i4g	i4g	t	t						i3	g	g	g	g	i3	i3	i3	i3		
161	i4g	i4g	t	t							g	g	g	g	i3	i3	i3	i4g		
162	i4g	i4g	t	t							g	g	g	g	i3	i3	i3	i3		
163	t	t	t	t							g	g	g	g	i3	i3	i3			
164												g	g	g	i3	i3	i3			
												g	g	g						
												g	i3							

Acoustic and visual examination of hull plates - Port, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
-5																					
-4																					
-3																					
-2																					
-1																					
0																					
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																	i3	i3	i2		
11																	i3	i2	i2		
12																	i4	i3	i2		
13																	i4g	i3g	i2		
14																	i4g	i3	i3		
15																	i4g	i3	i3		
16																	i3	i3	i3h		
17																	i2	i2	i3		
18																	i3	i2	i2		
19																	i3	i3	i2		
20																	i3	i2	i2		
21																	i2	i2	i2		
22																	i3	i3	i2		
23																	i3	i2	i2		
24																	i3	i2	i3		
25																	i2	i2	i3		
26																	i3	i3	i3		
27																	i3	i3	i2		
28																	i3	i3	i2		
29																	i2	i3	i2		
30																	i2	i3	i3		
31																	i2	i2	i3		
32																	i2	i3	i3		
33																	i2	i2	i2		
34																	i2	i3	i2		
35																	i2	i2	i2		
36																	i2	i3	i3		
37																	i2	i3	i4h		
38																	i2	i2	i2		
39																	i2	i2	i3		
40																i3	i3	i2	i2		
41																i3	i2	i2	i3		
42																i2	i2	i3	i4		
43															i3	i2	i2	i3	i4		
44															i2	i2	i2	i3h	i3		
45															i3	i2	i3	i3g?	i2		
46															i3	i2	i3	i2	i2		
47		s1	s2	s1	s1	i3g	i2	i3g	i3g	i3g					i3	i3	i3	i3	i2h		
48		s1	s1	s1	s1	i3g	i2	i3	i2	i3g				i2	i2	i3	i2	i2	i3		
49		s1	s1	s1	s1	i3g	i3g	i3g	i3gh	i3g				i3	i3	i2	i3	i3	i2		
50		s1	s1	s1	s1	i3	g	i3g	i2h	i3g				i2	i2	i2	i3	i2	i2		
51		s1	s1	s1	s1	i3g	i3g	i3gh	i3g	i3g				i3	i2	i2	i2	i3	i2		
52		s1	s1	s1	s1	i3g	i4g	i3	i3g	i2g	i2	i3	i3h	i3	i3	i2	i2	i3	i2		
53		s1	s1	s1	s1	i3g	i3g	i3	s3g	s2	i2	i3	i3	i2	i2	i2	i2	i3	i3		
54		s1	s1	s1	s1	i4g	i3	i2	i3g	i4g	i2	i3	i2	i3	i2	i2	i2	i3	i2	i3	
55											i2	i3	i3	i3	i2	i2	i3	i2	i2	i3	
56														i3	i2	i3	i3	i2	i3	i2	
57														i3	i3	i4g	i2	i2	i3	i2	
58														i3	i3	i3	i3	i2	i3h	i3	
59														i3	i3	i2	i2	i3	i2	i2h	
60														i3	i2	i2	i2	i2	i3	i3	
61														i3	i2	i3	i2	i2	i2	i3	
62														i3	i2	i2	i2	i2	i2	i3	

Acoustic and visual examination of hull plates - Port, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
63																					
64													i3	i2	i2	i2h	i2	i2	i3		
65													i3	i2	i3	i2	i3	i3	i3		
66													i3	i3g	i3	i3	i3	i3	i4		
67													i3	i3g	i3	i2h	i3	i3	i3		
68													i3	i3	i3	i2h	i3	i2	i2		
69													i3	i3	i2	i3	i3	i3	i3		
70													i3	i2	i3	i3	i3	i3	i3		
71													i3	i2	i2	i2	i3	i3	i3		
72													i3	i3	i3	i2h	i3	i3	i3		
73													i2	i3	i3	i2	i3	i3	i4		
74													i3	i3	i3	i2h	i3	i3	i4		
75													i2	i2	i2	i3h	i3	i3	i3		
76													i2	i2	i2	i3h	i3	i3	i3		
77													i2	i2	i2	i2	i3	i3	i2		
78													i2	i2	i2	i3	i3	i2	i2		
79													i2	i2	i2	i3h	i3	i2	i2		
80													i2	i2	i2	i3h	i3	i2	i3		
81													i2	i2	i2	i3	i3	i2	i2		
82													i2	i2	i2	i2	i3	i2	i3		
83													i2	i2	i3	i2	i3	i2	i3		
84													i2	i3	i3	i3	i4	i3	i3		
85													i2	i2	i3	i2	i3	i3	i3h		
86													i2	i2	i2	i2	i3	i3h	i3		
87													i3	i2	i2	i2	i3	i3	i3		
88													i2	i2	i3	i3	i3	i3	i3		
89													i2	i2	i3	i2	i3	i3	i3		
90													i2	i2	i3	i3	i3	i4	i3		
91												i4g	i2	i2	i2	i2	i3	i3	i3		
92												i3	i3	i3	i2	i3	i3	i3	i3		
93												i3	i3g	i2	i2	i2	i3	i3	i2		
94												i3h	i3	i2	i2	i3	i3	i3	i3		
95												i3	i3	i2	i2	i3	i3	i3	i3		
96												i3g	i3	i2	i2	i2	i3	i3	i3		
97												i3g	i3g	i2	i2	i3	i3	i3	i3		
98												i3g	i3	i3	i2	i3	i3	i3	i3		
99												i4g	i3g	i2	i3	i3h	i3	i3h	i3		
100												i4g	i3g	i2	i3h	i3	i3	i3	i3		
101												i4g	i3	i2	i3	i3h	i3	i3	i3		
102												i4	i3	i3	i3	i3	i3	i3	i3		
103												i4	i3	i3	i3	i3	i3	i3	i3		
104												i4	i3	i2	i3	i2	i4	i3h	i3		
105												ih	i3h	i3h	i3	i2	i3	ih	i3h		
106												ih	i3	i3	i2	i2	i3	i3	i2		
107												ih	i2	i2	i3	i3	i3	i3	i3		
108												i3h	i3	i3h	i3h	i3	i3	i3	i3		
109												i4g	i3	i3	i3	i3	i3	i3	i4		
110												i3	i3	i3h	i3	i3	i3	i3h	i3		
111												i3	i3	i2	i3	i3	i3	i3	i3h		
112												i3	i3	i3	i2	i2	i3	i3h	i3h		
113												i3	i3	i3	i3	i3	i3	i3	i4		
114												i3	i3	i2	i2	i3	i3	i3	i4		
115												i3	i3	i2	i2	i2	i3	i3	i3		
116												i3	i2	i2	i2	i2	i3	i2	i2		
117												i3	i3	i3	i2h	i2	i3	i2	i2		
118												i3	i3	i4g	i3	i2	i3	i2	i2		
119												i2	i3	i3	i2	i3	i3	i2	i2		
120												i2	i3h	i3	i3	i3	i3	i2h	i2		
121												i2	i3	i2	i3	i3	i3	i2h	i3		
122												i2	i3	i3h	i2	i2h	i2	i2	i2		
123												i2	i3g	i2	i2	i2	i2	i2	i2		
124												i2	i3	i3g	i2	i2h	i2	i2	i2		
125												i2	i3	i3	i3	i3h	i2	i2	i2h		
126		i2	s2	s3g	s3g	i3g	i4g	i3g	g	i3	i2	i3	i3	i4g	i2	i3	i2	i2	i2		
127		i2	g	s3g	s3g	i3	i3g	i3g	i3g	i2	i2	i2	i3	i3	i4	i4g	i3	i2	i2	i2h	
128		i3g	g	s3g	s3g	s3	i2	i2	i2	i2	i2	i2	i3	i4g	i3	i3	i3	i2	i2	i2	
129		i2	g	s2	s3	s3g	i2	i2	i3	i2	i2	i2	i3	i3g	i3	i4g	i2	i2	i2	i2h	
130		i2	g	i3g	s3g	s3g	i2g	i3	i3	i2	i2	i2	i2	i4g	i3	i3g	i3g	i2	i2	i3	
131		i2g	g	s2	s3g	s3	i2	i2	i2	i3	i2	i2	i3	g	i3g	i4g	i3h	i2	i2	i2	

Acoustic and visual examination of hull plates - Port, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
132		i3g	g	s2	s3g	s3g	i3	i3	i3g	i3	i2	i2	i3	i4g	i4g	i3	i3h	i2	i2	i2h	
133		i3g	g	s2	s2	s3g	i3	i3	i4g	i4h		i2	i2	i3g	i3	i3	i3	i2	i2	i3	
134		i3g	g	s2	s3	s3g	i2	i3	i3	i2				g	i4g	i3	i3	i2	i2	i2	
135		i3g	g	s3g	s3g	s3g	i2	i3g	i2	i2				g	i4g	i3g	i3	i2	i2	i2h	
136		i3g	g	s2	s3g	s2	i2	i3	i2	i2				i4g	i4g	i3	i3	i2	i2	i3	
137		i3g	g	s3	i3	i2	i2	i3	i2	i2						i3	i3	i3	i3	i3	
138		i3	g	s3g	s4h	s4g	i2	i2	i2	i2						i4g	i4g	i3	i3	i2	
139		i3	g	s2g	i3g	i4g	i3		i3	i2						i4g	i4	i3	i3h	i2	
140																	i4g	i3	i3	i2	
141																	i3	i3	i2h	i2	
142																	i3	i3	i3h	i2	
143																	i3h	i3	i3	i3	
144																	i3h	i3	i3	i3h	
145																	i3	i3	i3	i3	
146																		i4	i3h	i3	
147																		i3	i3	i2	
148																		i3	i3	i3h	
149																		i3	i3	i2	
150																		i3	i3	i2	
151																		i3	i2	i2	
152																		i3	i3	i2	
153																		i3	i3	i3	
154																		i3	i3	i3	
155																			i3	i3	
156																			i3	i3	
157																			i3	i3	
158																			i3	i3	
159																			i3	i3	
160																			i4	i3	
161																					

Acoustic and visual examination of hull plates - Starboard, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
-5																					
-4	s2																				
-3	s2	s4g	g	g																	
-2	s4g	s4g	g																		
-1	s4g	g	i4g																		
0	s4g	g	g																		
1	s4g	s4g	i4g																		
2	s4g	s4g	g																		
3	s4g	s4g	si?4g																		
4	s4g	s4g	s4g																		
5	s2	s4g	g																		
6	s3	s3g	s3																		
7	s3	g	s3g																		
8				s4g	g							s1	s1	2s	s4g						
9				s3	i3							i3	s1	s2	i4g	i3	4i				
10				s2	i3	i4g	i3	i3				i4g	i4g	i3	i4	i3	3i				
11				s2	i3	i3g	i3	i3				i2	i3	i3	i2	i2	i3g				
12				s4g	s4g	i4g	i4g	i3				i2	i2g	i3	i3	i2	i4g				
13				s3	i2	i2	i2	i3				nv	i2	i3	i3	i2	i4g				
14				s2	i2	i3	i3g	i3				i2	i2	i2	i2	i3	i1				
15				s3g	i3g	i3g	i4g	ig			i4g	s2	i2	i2	i3	i3	i4g				
16				s3	i2	i3g	g	i2			i3	i4g	i4g	i4	i3	i2	i2				
17				s4	i2	i3g	g	i3			i3g	i3g	i4g	i4	i4	i2	i2				
18				s3	i3	i3	g	i			nv	nv	i3	i4g	i3g	i4g	i3				
19											nv	i2g	i2	i3g	i4g	i4	i3				
20											nv	i2	i1	i2	i3	i3g	i4g				
21											nv	s2	i2	i2	i3	i3	i3				
22											nv	i2	i2	i2	i2	i2	i2				
23											nv	nv	i4	i4g	i2	i2	i3				
24											nv	s?2	i2	i4	i4	i2	i3				
25											nv	i3	i3	i2	i2	i2	i3				
26										i2	s	s2	i2	i2	i4	i2	nv				
27										nv	nv	s2	i3	i4g	i4g	is	nv				
28										nv	nv	i3	i4	i2	i2	i3g	nv				
29										nv	nv	i2	i2	i2	i2	i2	nv				
30										nv	nv	i2	i2	i2	i3	i2	nv				
31										o	nv	i2	i2	i3	i3	i3	nv				
32										nv	i2	i3	i2	i2	i2	i3	nv				
33										nv	i3	i3g	i3g	i2	i3g	i3g	nv				
34										nv	i2	i2	i2	i3	i4	i3	nv				
35										i3	i2	i2	i3g	i3	i3	i?3c	nv				
36				s4	s3	i3	i4g	g	ig	i3	i3	i2	i3	i3g	i3	i4c	nv				
37				s3	s3	s2	i3g	i3g	i3	i2	i2	i3	i3	i3	i3	nv	nv				
38				s3	s2	i3	i3g	ig	ig	i3	i3	i	i3g	i3g	i4	i3	nv				
39				s3	s2	s2	i2	i3g	i	nv	i4g	i4g	i2	i2	i3	nv	nv				
40				s3	s3	i3	i3	i3	i3	i3g	i3	i4g	i4	i3g	nv	nv	nv				
41				s3	s2	i2	i2	i3g	i	nv	i4	i4g	i4g	i4g	i3	nv	nv				
42				s3	i2	i2	i3	i3g	i3	nv	i3	i3g	i3	i3	i4	nv	nv				
43				s2	s2	i3	i3g	i3		nv	i3	i3	i3	i3	i3	i4g	nv				
44				s3	s2	s2	i2	g	i2	i4	i4g	i3	i3	i4g	i3	nv	nv				
45				s3	s2	i2	i3	i3		i3	i3	i3	i3	i4	i4g	nv	nv				
46				s3	s3	i3	i4g	i4g		nv	i3	i3	i3	i4g	i3	nv	nv				
47				s3	s3	i2	nv	nv													
48	s3	s1	s2	s4g	s3	i4g	nv	nv													
49	s2	s1	s1	s4g	s4g	i3g	nv	nv													
50	s2	s1	s1	s2	s4	s3	i3	nv	nv												
51	s3	s2	s3	i3	s4	s3	nv	nv	nv												
52	s3	s3	s3	i3	s3	i2	i3g	i3													
53	s2	s1	s2	i4	s4g	i2	i3	i2													
54	s4g	s1	s2	i3	s3	i2	i3	i3													
55	s4g	s1	s2	nv	s2	i3	i2	i2													
56	s3	s1	s1	s1	s1	i4g	i4g	i3g													
57	s3	s1	s2	s1	s1	i4g	g	i4g	i4c	i3c	i3c	c	c								
58	s3	g	s2	s2	s1	i4g	i3g	i3	i3	i2	i2	i2	i3								
59	s4g	s4g	s4g	nv	s2	i2	i3	i3	i3g	i3	i3	i3	i4								
60	s3	i4g	i4g	s2	s3	i3	i3	nv	i4g	i3	i4g	i3	i4								
61	s3	i4g	i4g	s2	s2	i4g	i4g	i3	i3	i2	i3	i3	i3								
62	s3	i4g	i4g	s2	s2	i4g	i4g	i4g	i2	i3	i3	i3	i3								
							i3	i4	i4	i3	i4g	i3	i4g								

Acoustic and visual examination of hull plates - Starboard, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
63	s3	s4g	s3	s2	s2	i4g	nv	nv	i3	i2	i3	i3	i4g								
64	s3	s2	s2	nv	s2i4g	i4g	i3	nv	i2	i2	i3	i4	i3	i3	i3	i4g	i3	i4g			
65	s3	s3g	s2	nv	i4g	i4g	i4g	i4g	i2	i2	i3	i3	i3	i3g	i3	i3	g	nv			
66	s2	s3g	s4g	nv	i4g	i4g	i3	i3	i2	i2	i2	i3	i3	i3	i3	i3	i4	g			
67	s4g	s2	s2	i3	i4g	i4g	i3	nv	i2	i2	i2	i3	i2	i3	i2	i3	i4	g			
68	s4g	is?4g	s1	s2	i2	i2	i4		i3h	i2	i2	i2	i3	i3g	i4	i3	i4g	g			
69	s3	s4g	s1	s3	i4g	i4g	i4g	i4	i2	i2	i3	i3	i3	i3	i2	i3	i3	gh			
70	nv	s3g	s2	nv	s1	i3	i3	i4	s3g	s2	s2	i3h	s2	i3	i3	i3	i3	i4g			
71	s4g	s4g	s1	s1	s1	i4g	i3	i3	i3	i3	i3	i3	i3	i2	i2	i3	i3g	i3			
72	s4g	s4g	s2	s1	s1	i3	i2	i2	i4	i3	i3	i3	i3	i2	i3	i3	i3	i3			
73	s3	s4g	s2	s1	s1	i3	i3	i3	i2	i3	i2	nv	nv	g	c	c	c	c			
74	s4g	s4g	s1	s1	s1	i4g	i3	i3	i3	s3	s3	i3	s3	i3	c	c	c	c			
75	s3	s4g	s1	s1	s1	i4g	i4g	i3h	i3	i3	i2	i3	i3	i3	i3	c	c	c			
76	s3	s4g	s1	s1	s1	i4g	i4g	i4	i3	i2	i3	i3	i3	i2	i3	i3g	i3	g			
77	s3	g	g	s1	s1	i3	i3	i2	i2	i2	i3	i4	nv	i2	i2	i3	i3	i3			
78	s3	s4g	s4g	s1	s1	i4g	nv	i3	i2	i2	i2	i3	i3h	i2	i2	i3	i3	i3			
79	nv	s3	s4g	nv	s2	i3	nv	i3	s2	s2	s2	s3	s4g	i2	i2	i3	i3	i3			
80	s3g	s4g	g	nv	s3	i3	nv	i3	s2	s2	i3	i3	i3	i2	i3	i3	i3g	i2			
81	s2	s4g	g	nv	s3	i3	nv	i3	s2	s2	s2	i3g	i3	i3	i3	i3	i3	i3			
82	s3	g	g	nv	s4g	i2	i2	i3						i2	i2	i3	i3	i3			
83	nv	s4g	g	nv	s4g	i3	nv	nv						i3	i2	i3	i3	i3			
84	s2	s3g	g	nv	nv	nv	nv	nv						i3	i3	i3	i2	i3			
85	nv	s2g	s2g	nv		i3	nv	nv						i2	i3	i3	i3	i3			
86	nv	s3g	s3g	nv	s4g	i3	i4	i4g						i3	i3	i3	i2	i3			
87	nv	s3g	s3g	nv	s4g	i2	i3	i3						i2	i2	i2	i2	i2			
88	s3	i3	i4g	nv	i4	i3	i4g	i4g						i3	i3	i3	i4	i3			
89	s2	s2	s3g	nv	i4g	i4g	i3	i3													
90	s2	i4g	g	nv	i4g	i3g	i4g	i4g													
91					g	g	g	g													
92	Gangway entrance				i4g	i4g	i3g	g													
93					i4s1	i3g	i4g	i3													
94					s2	i3g	i4g	i4g													
95	s2	s3	s4g	nv	s1	i4g	i3	i4g													
96	s2	s4g	s4g	nv	s1	i2	i2	i3g													
97	s3	s3g	s3g	nv	s1	i3	i3	i3													
98	s3	s4g	s4g	nv	s1	i3g	i2	i3													
99	nv	i4g	i4g	nv																	
100	nv	i4g	i4g	nv																	
101	nv	s4g	s4g	nv																	
102	nv	s4g	s4g	nv																	
103	nv	s4g	s2	nv																	
104	nv	s4g	s4g	nv																	
105	nv	s3g	s4g	nv																	
106	nv	s4g	s4g	nv																	
107	i4g	i4g	s1	s3	i4g	i4g	i4g	i4	i3	i4	i3	i3	i2	i2h	nv	nv					
108	i4g	s2	s1	s3	s4g	i4g	i4g	i3	i2	i3	i3	i2	i2	i2	inv	c					
109	i3	s2	s2	s3	s2	i4g	i3	i3	i3	i3	i3	i3	i3	i2	i3c	c	c	c			
110	i3	s1	s1	s2	s3	i4g	i3	i3	i3	i3	i3	i2	i2	i2c	i2c	c	c				
111	s2	s1	s1				s3	i2	i3	i3	i4	i3	i2	i2	c	c	c	c			
112	i4g	g	s1				i3	i3	i3	i3	i3	i2	i3	i2	i2c	i2c	i2c	c			
113	s2	g	s1				i3	i3	i3	i3	i2	i2	i2	i2	i2c	i2c	i2c	c			
114	i3	i4g	s1				i3	i3	i3	i3	i4	i2	i3	i2	i2c	i2c	i2c	c			
115	s2	s1	s1					i3	s3	i3	i3	i3	i3	i2	i2c	i2c	i2c	c			
116	s2	s2	s1					i3	i3	i3	i2	i2	i3	i2	i2c	i2c	i2c	c			
117	s2	s2	s2					i4	i3	i3	i2	i2	i2	i2	i2	i2	i2	c			
118	s3	s2g	s1					i3	s3	i3	s2	i2	i3	i3	i2c	i2c	i2c	c			
119	s2	s2gh	s2	s3	i4g	i4g	i3	i3	s3	i2	i2	i2	i3	i3	i2	i3c	i3c	i3c	c		
120	s3	i4g	s3	i4g	i4g	i4g	i3	i3	i3	i2	i3	i3	i3	i3	i2	c	c	c	c		
121	s3	s3h	s3	i4g	i4g	i4g	i4g	i4g	i3	i3	i3	i2	i3h	i3h	i2	i2c	i2c	c			
122	s3	s2h	s3	i4	i4g	i4g	i4g	i3	s2	i3	i2	i3	i3	i2	i2	i2	i2	i2	c		
123	s3	s3g	i4	i4g	i4g	i4g	i4g	i3	i3	s2	i3	i2	i2h	i2	i2	i2	c	c	c	c	
124	s3g	s2	s3	i3	i4g	i4g	gh	i4g	s4	s2	i3	s2	i3	i3	i2	c	c	c	c		
125	s4g	s4g	s4	s3	i4g	i4g	i3	i4g	i4	i3	i3	i4	i4	i3	i3	c	c	c			
126	s3	s3	s3	i3	i4g	i4g	i4g	is?4	i3	s3	i4	i2	i3	i3	i2	i2	i2	c	c	c	
127	s2	s2	s3	s3	i4g	i4g	i4g	h	i4g	i3	i4	i2	i3	i3	i3t	c	c	c	c	c	
128	s3	s3	s3	s3	i4g	i4g	i4g	i4g	i4g	s3	i4g	i3	i4	i4	i3	i2	c	c	c	c?	
129	s2	s2	s3	s4g	i4g	s4	i4	i4g	i3	i3	i3	i3	i2	i4	i3c	i3c	i3c	i3c	c		
130	s2	s3	s4g	i4g	i4g	i4g	i4g	i4g	i3	i3	i3	s3	i3	i3	i3c	i3c	i3c	c			
131	s2	s2	s3	s4g	i4g	i3	i3	i4g	i3	i3	i4	i3	i3	i4g	i3	inv	nv	nv	nv		
132	s2	s3gh	i4g	s3	i3	s3	i4	i3	i4	i3	i3	s3	i2	i3	i3	nv	nv	nv	nv		

Acoustic and visual examination of hull plates - Starboard, internal

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
133	s4g	s3g	s3	s4	s4g	s3	i4	i3	i3	i4g	i3g	i3	i3	i3	i3c	nv	nv	nv	nv		
134	s3	s2	s3	s3	i4g	i4g	i3	i4	s3	i3g	i3	i4	i2	i2	i3	nv	nv	nv	nv		
135	s3	s2	i3	i4g	i4g	i4g	i4g	i4g	i4g	i3	s3	i4	i3	i3	i3h	nv	nv	nv	nv		
136	s3	s4	s4	s4g	i4g	i4g	i4	i4	i3	i3	i4	i4	i3	i3	i3c	nv	nv	nv	nv		
137	s3	i4gh	i4	s4g	i4g	i4g	i4g	i3	i4g	i3	i3	i2	i3	i3	i2	i3c	nv	nv	nv	nv	
138	s3	i3	i3	s4	i4g	i4g	i4g	i3	i3	i3	i3g	i3	i3	i4	i3	i2	i2	standing water			
139	i4g	i4g	nv	i4g	i4g	i4g	g	i4g	i4g	s3	s4g	s3	i2	i3	i3	i3	i2	i2			
140	i4g	i4g	i4g	i4g	i4g	i4g	g	i4	i4g	i4g	i4g	i4c	i4g	i4	i3	i3	i3	nv	nv	nv	
141	s3	s2h	s2	nv	i4g	i4g	i4g	i4g	i4g	i3	i4g	i4g	i3g	i3g	i3	i2	i2	nv	nv	nv	
142	s1	s2	s2	nv	i4g	i4g	i4g	i4g	i4g	i4g	i4g	i4g	i3	i3	i3g	i3h	i3	nv	nv	nv	
143	s1	s2	s3	nv	i4g	g	i4g	i4g	i4g	i3	i3	i4g	i3	i3	i4	i3	i3	nv	nv	nv	
144	s3	fm	fm	nv	i4g	i4g	g	g	i4g	i3	i3	g	i3	i3	i4	i3	i3	nv	nv	nv	
145	s3	s3g	g		i4g	i4g	i4g	i4g	i4g	i4	i4	g	i3	i3	i3	i3	i3h	nv	nv	nv	
146	s3	i4g	i3		g	i4g	i4g	i4	i4	i3	g	g	i3	i4g	i4g	i3	i3h	i3c	i3	nv	
147	g	nv	i4g	i4g	i3g	g	g	g	g	g	g	g	ig	ig	i2	i3	i3				
148	g	nv	i4	i4	i3	g	g	g	g	g	g	g	g	i4g	i4	i3	i3				
149	i3	i3	i2	i3	i4g	g	g	g	g	g	g	g	i4g	g	i2	i3	i3				
150	i4g	i3	i4	i4	i4g	g	g	g	i4	i4	i3	i3	i4g	ig	i3	i2	i2	i3			
151		s3	i4	i3	nv	i4g	g	g	i3	i3	i3	i3	i4g	g	i2	g	i3g	i3			
152		s3	i3	i3		g	g	g	i4g	i4g	i4g	i3	i4g	g	i3	i3	i3g	i3			
153		s3	g	i4		g	g	g	g	i4g	i3g	g	g	g	i2	i4g	i3	i4g			
154		i3	i2	i3		i4g	g	g	g	g	g	g	g	g	i2	g	i3	i4g			
155		g	i2	i3		g	g	g	g	i3g	i4g	i3g	i3g	g	i2	g	i3	i4g			
156		g	i3	i3		g	g	g	g	i3g	i3g	i3g	i3g	g	i2	g	i3	i3g			
157		g	g	g		g	g	i3g	g	i4g	i4g	i4g	i4g	g	i3	g	g	g			
158		g	i4g	i4g	i4g	i4g	g	i3g	g	g	i3g	i3g	i3g	g	i2	g	i4g	i4g			
159		i4g	i4g	i4	i4g		g	g	g	g	i?g	i4g	i3g	c		c	c	c			
160		i4g	i4g	t	t		g	g	g	g	i3g	i3g	i3g			c	c	c			
161		i4g	i4g	t	t		g	g	g	g	i3				i2						
162		i4g	i4g	t	t		i4g	i4g	i4g												
163		t	t	t	t		i4g	i4g	i4g												
164																					

Acoustic and visual examination of hull plates - Starboard, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
-5																					
-4																					
-3																					
-2																					
-1																					
0																					
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																	i3	i2	i2		
11																	i3	i2	i2		
12																	i3	i2	i2		
13																	i3	i2	i2		
14																	i3	i2	i2h		
15																	i3	i2	i2h		
16																	i2	i2	i2		
17																	i2	i2	i2		
18																	i3	i2	i2		
19																	i2	i2	i2		
20																	i2	i2	i2		
21																	i2	i2	i3		
22																	i3	i3	i2h		
23																	i2	i2	i2		
24																	i2	i2	i3		
25																	i3	i3	i2		
26																	i2	i2	i2		
27																	i3	i2	i2		
28																	i2	i2	i2		
29																	i2	i3	i2		
30																	i2	i2	i3h		
31																	i2	i2	i3		
32																	i2	i2	i2		
33																	i2	i2	i2		
34																	i2	i2	i2		
35																	i2	i2	i2		
36																i2	i2	i2	i2		
37																i2	i2	i2	i3h		
38																i2	i2	i2	i2h		
39																i3	i2	i2	i2		
40																i3	i2	i2	i2		
41															i2	i2	i2	i2	i2		
42															i2	i3	i3	i3	i2h		
43															i3	i3	i3	i2	i2		
44															i3	i2	i3	i2	i3		
45															i2	i2	i2	i2	i2		
46														i2	i2	i2	i2	i3	i3		
47														i2	i2	i2	i2	i4h	i2h		
48														i2	i2	i2	i3	i3	i3		
49														i2	i2	i2	i2	i3	i3		
50														i2	i2	i2	i3	i2	i3		
51														i2	i2	i3	i3	i2	i3		
52														i2	i2	i2	i3	i2	i3		
53														i2	i2	i2	i2	i3	i3		
54													i2	i2	i2	i3	i3	i2	i3		
55													i3	i2	i2	i2	i2	i2	i2		
56													i2h	i2	i2	i3	i3	i2	i2		
57													i3	i3	i2	i3	i2	i2	i2		
58													i3	i2	i2	i3h	i2	i2	i2		
59													i2	i2	i3	i3h	i2	i2	i3		
60													i2	i3	i3	i3h	i2	i2	i3h		
61													i2	i3	i3	i3h	i2h	i2	i3		
62													i2	i2	i3	i3h	i2	i2	i3		

Acoustic and visual examination of hull plates - Starboard, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
63													i3	i2	i2	i2h	i2	s2	i2		
64													i3	i2	i3	i3h	i2	i3	i3		
65													i3	i2	i2	i2	i2	i2	i3h		
66													i2	i2	i3	i3h	i2	i2	i2		
67													i2	i2	i3	i3h	i2	i2	i2		
68													i2	i2	i3	i3h	i2	i3	i2		
69													i2	i2	i3	i3h	i2	i3	i2		
70													i2	i2	i3	i2	i2	i3	i2		
71													i2	i2	i3	i2	i3	i3	i2		
72													i2	i2	i3h	i3	i3	i3	i3		
73													i2	i2	i3	i3h	i3	i3	i2		
74													i2	i2	i3	i2	i3	i3	i2		
75													i2	i2	i3	i3h	i2	i2	i2		
76													i2	i3	i3	i2	i2	i3	i3		
77													i2	i3	i3	i3	i2	i2	i3		
78													i2	i2	i3	i2	i2	i2	i3		
79													i3	i2	i3	i3	i2	i2	i2		
80													i2	i2	i3	i3	i2	i2	i3		
81													i2	i2	i3	i3	i2	i3	i2		
82													i3	i2	i3	i2	i2	i3	i3		
83													i2	i2	i3	i2	i2	i2	i3		
84													i2	i2	i3	i3	i2	i2	i2		
85													i2	i2	i2	i3	i2	i2	i3h		
86													i3	i2	i3	i3	i2	i2	i3h		
87													i3	i2	i2	i2	i2	i2	i3		
88													i3	i2	i2	i2	i2	i2	i3h		
89													i3	i3	i2	i3	i3	i3h	i3h		
90													i2	i2	i2	i3	i3	i4h	i4h		
91													i2	i2	i3	i3	i3	i4h	i3		
92													i4	i4	i4	i4	h	i3	i3		
93													i4	i4	i4	i4h	i2	i3	i3		
94													i4	i4	i4	i4	i2	i2	i2		
95													i2	i3	i2	i2	i3	i2	i2		
96													i2	i2	i2	i3	i3	i2	i2		
97													i2	i2	i3	i3	i2	i3	i3		
98													i2	i2	i3h	i3	i2	i2	i3		
99													i3	i2	i2	i2	i2	i2	i2		
100													i3	i2	i3	i2	i3	i2	i2		
101													i2	i3	i3	i2	i2	i3h	i2		
102													i2	i2	i2	i3	i3	i2	i2		
103													i2	i3	i2	i3	i2	i3h	i3		
104													i3	i2	i2	i3	i2	i3	i3h		
105													i3	i2	i3	i3	i2	i2	i2		
106													i3	i2	i3	i3h	i2	i3	i2		
107													i3	i3	i3	i3	i2	i2	i3		
108													i3	i2	i4h	i3	i2	i3h	i3		
109													i3	i2	i3	i3	i2	i2	i3		
110													i2	i3	i3	i3	i2	i3	i3		
111													i3	i3	i2	i3	i3	i3h	i3h		
112													i3	i2	i3	i2	i2	i3	i3		
113													i3h	i3	i2	i2	i3	i2	i3h		
114													i3	i3	i3	i2	i2	i2	i3h		
115													i3	i2	i2	i3	i2	i2h	i3h		
116													i3	i2	i3	i2	i3	i3h	i3		
117													i2	i3	i3	i2	i3	i3h	i3h		
118	s3	s3g	s4g	s1	i3	i3g	i3g	i2	i2	i2	i3	i3L	i3	i2	i3	i2	i3	i3h	i3		
119	s3	s3g	s4g	s1	i3	i3g	i3g	i2	i2	i3	i2L	i3L	i3	i2	i3	i2	i2	i3h	i3		
120	i3c	s3g	s3g	s1	i3	i3g	g	i3	i3	i2	i2	i2L	i2	i2	i2	i2	i3	i3	i3		
121	i3g	s2	s3g	s1	i3h	i3g	i3g	i3	i3	i3	i2	i2L	i3	i2	i2	i2	i2	i3	i3		
122	i3	s3g	s3g	s1	i3g	i3g	i3g	i3	i3	i3	i2	i2L	i3	i3h	i3h	i2	i3	i2	i3		
123	i3g	s3g	s3	s1	i3g	g	i4g	i4g	i3	i3	i2	i3L	i2	i3g	i2	i2	i2	i2	i3		
124	i3g	s3g	s3g	s1	i2	i4g	i4g	i4h	i3	i3	i2	i2L	i3	i4g	i3	i3g	i2	i2	i2		
125	i3g	s3g	s3	s1	i3	i3g	i4g	i4h	i4h	i3	i2	i4L	i4h	i3h	i2	i2	i2	i2h	i2		
126													i3	i3	i3	i3	i3	i3	i2h		
127													i4h	i3	i3	i3	i3	i2	i2		
128													i4	i4h	i4h	i2	i2	i2	i2h		
129														i3	i4h	i2	i2	i2	i2h		
130														i3	i3	i2	i2	i2	i3h		
131														i3	i3g	i3	i2	i2	i2h		

Acoustic and visual examination of hull plates - Starboard, external

Frame Number from Aft perpendicular	Strake (numbered from the weather deck down)																				
	Weather deck	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	keel
132															i3	i3	i4h	i2	i2	i3	
133															i3	i3	i3	i2	i2	i2	
134																i3	i3h	i2	i2	i2h	
135																i3	i3h	i3	i3	i2h	
136																i3	i3	i2	i3	i2	
137																i3	i3	i2	i2	i2	
138																	i3g	i2	i2	i2	
139																	i3g	i3	i2	i2	
140																	i3g	i2	i2	i2	
141																	i3	i2	i2g	i2	
142																	i3g	i3g	i2g	i2h	
143																	i3g	i3	i3	i2h	
144																		i2	i2	i3	
145																		i2	i3g	i3h	
146																		i3	i2h	i3	
147																		i2	i3	i2	
148																		i2	i2	i2h	
149																		i2	i2	i2h	
150																		i2	i2	i2	
151																			i2	i2	
152																			i2	i2	
153																			i2	i2	
154																			i2	i2	
155																			i2	i2h	
156																			i2	i2	
157																			i2	i2	
158																			i2g	i2	
159																			i3g	i2	
160																			i3g		

Appendix D

Preliminary Survey of the Great Western Dry Dock and other masonry. Ref 418
Holden Conservation, 26 November 1998

In the following text references to the "dock" should be taken to include the historic walls including the brick wall currently bounding the stern of the ship and the stone walls forming part of the area used by the wood yard. When reference is made to the "dry dock" this refers to the area which floods to allow the ship to float.

For convenience at this stage no distinction is drawn in the importance of the different areas although later on within the project distinctions in the manner of treatment may be necessary to allow development in the complex. For instance the boundary walls may require more restoration to ensure public safety or to provide security.

SURVEY AND BRIEF.

A visit was made in May 1998 to visually survey the dry dock and surrounding dock area of the SS Great Britain.

The purpose of the survey and the following report is to provide some general comments on the issues involved in the conservation of the stone and brick fabric with in the site.

The intention at this stage is to provide an overview and make suggestions for work that should be included within the main conservation project.

CONTENTS

DISCUSSION OF THE CONTEXT

The dock is the environment for the ship. Consideration of the dock can not occur without account of the requirements of the ship.

The dry dock and the surrounding dock land provides the context for the ship. It will be crucial to preserve the context.

Any intervention on conservation grounds must be carefully considered with in the overall context.

So for example:

> the dry dock would almost certainly always have been damp with water seeping in and rain being accumulated, to set an objective to dry the environment would constitute a change in the historical and current context.
>
> It may eventually be decided that it is necessary but the justification for doing it must be considered against the destruction of part of the context.

This is only an example and may be neither possible nor required but it does illustrate the delicate conservation issues which go beyond technical matters alone.

> To continue using this example the complications in drying the environment may require intervention within the dry dock structure which would destroy historical or archaeological information.
>
> To understand and assess the present state of the archaeology is considered a primary objective which would allow for making informed decisions about any conservation measures that may be required.
>
> To this end the first aspect of the conservation recommendations is to set out the nature of further documentation and analysis.

OUTLINE FOR FURTHER DOCUMENTATION

This should be compatible with documentation systems to be used elsewhere in the overall project.

Detailed analysis of the current structures and condition is required.

For this;

1. All areas of the dock must be photographed in detail on a grid pattern. The exact requirements need consideration but it is suggested that the grid be in approximately metre square sections.

2. photogrammetric survey to be undertaken and a full set of drawings produced for use in documentation. The scale should be relatively large to assist in accurate and detailed documentation.

3. Produce a number of cross sectional surveys through the width and the length of the dry dock.

4. Consider the use of a metal detector scan of all areas to ascertain the presence of buried metal which may possibly be constructional cramps.

To facilitate the photography and the photogrammetry it is recommended that the surfaces are first cleaned to remove organic growths and general soiling.

Analysis.

1. Undertake a preliminary visual survey to identify the different types of stone, mortar and other materials used in the construction.

2. Record the findings on a set of drawings and agree the location and number of samples to be taken for geological and material identification.

3. Take samples for

- geological identification and possible tracking back to quarry
- materials identification
- mortar analysis
- metals analysis
- timber analysis

Analysis would provide the following information;

- If the sources of stone are identified historical information about the quarries may inform the knowledge about the periods of construction.
- The presence of other materials with in the construction may also add to the understanding of the periods of construction.
- The dry dock is from a period in history when hydraulic mortars were developing rapidly and much information of interest may emerge adding to the body of knowledge.
- Plotting the use of the different mortars may identify different periods of building and maintenance more accurately than the types of stone which could easily be reused from earlier construction. There may be links established between the dry dock and other walls on the site.
- If mortars need to be repaired the analysis will be crucial in developing suitable matching repair mortars. Note that the brick wall at the stern of the ship was originally built with a black mortar (photographs 32,33,34,35).
- Identification of the various metal inserts around the dock may help to provide information about the use and date of manufacture.
- The various bulks of timber where they are built into the structure of the dry dock should be identified to assist in preparing their conservation requirements.

Following the analysis:

- Record the results of analysis on sets of drawings and apply the results of the samples to code the different areas with materials, construction methods and possible dates or relative periods of building.
- Compare with other docks, dock walls etc. either in the locality or with other historical docks.
- Document the masonry techniques.

  Identify types of cutting, methods of working stones, tool markings, methods of construction and other information which will help to identify similarities and differences throughout the dock. This may provide information about the sources of material and identify different periods of construction.

OUTLINE FOR FURTHER CONDITION SURVEY.

A full survey of the condition should be undertaken before any decisions are taken about the details of any conservation programme.

A very detailed survey is necessary to establish a conservation management plan.

To enable the survey to be properly undertaken the surfaces should be cleaned to remove organic growths and soiling.

The condition survey of the dock must encompass the visible surface material and the substrate. Consideration should be given to the use of non invasive survey techniques where ever possible. Invasive techniques may be employed where the perceived benefit is deemed to be greater than the damage caused to historical material.

Non invasive survey.

A set of drawings should be annotated with;

the condition of the structure in general including cracks, settlement and alterations to the historic construction.

the condition of each stone, brick, or other components detailing cracks, friability, organic matter, rot, and other items pertaining to their past, current and future conservation.

the presence or absence of mortar, its condition and an assessment of its ability to function appropriately within the construction.

presence of metal inserts (pipes, rings, cramps etc.)

the condition of the timber used in the construction.

Use of non invasive archaeological methods such as ground radar may provide information about buried structures around the dock environment. It may also help to ascertain the sources of water seeping or flowing into the dock.

There may be other methods not known to the author of this report.

Invasive survey.

Consider whether it is necessary to undertake investigation of the substrate by opening up the construction.

for the purpose of adding to the information about the methods of construction and to compliment other knowledge of the archaeology of the dock.

for structural or engineering reasons it may be decided to investigate areas of water seepage.

Where this occurs careful documentation of the removed materials will enable precise reconstruction.

BRIEF SUMMARY OF THE CURRENT CONDITION.

Dry dock

The condition of the stones within the dry dock is generally good but the condition of the pointing gives cause for concern.

There has been a history of repairs which needs further study but in general it is anticipated that patches of recent hard cement pointing and render will need to be removed as it appears to be failing. See photographs numbers 9 and 10 where recent "ribbon" style pointing is shown to be cracking and falling out.

Boundary walls.

The condition of the stone within the boundary walls is also generally good but the pointing is badly in need of maintenance.

Brick wall.

The brick wall at the stern of the ship has been made from quality bricks which remain in good condition. It was originally constructed from a black mortar which has been over pointed with a grey portland cement mortar.

EXAMPLES OF POSSIBLE CONSERVATION.

Preliminary cleaning to enable a clearer survey.

Tests should be carried out to ascertain the most appropriate method.

Options are;

remove plants by hands

brushing to remove loose soil from surfaces and joints

hand cleaning of surfaces to remove algae and soil by bristle brush and water or solutions of detergent in water.

high pressure water;

high pressure steam;

Maintenance cleaning;

The dock will continue to accumulate soil and organic growth. Decisions will need to be made about the approach to this. Frequency of cleaning treatments will have implications on the long term conservation of the structure.

Preventive treatments such as applying biocides will impact upon the wider natural environment and present health and safety risks.

Repairs.

To put the structures back into good order a certain minimum amount of maintenance will be required.

This will include;

inspection by an engineer experienced in historic structures to pass comment on the stability, particularly of the boundary walls

rebuilding of loose areas of stone and brick and reintegration of detached components.

consolidation of areas where mortar is substantially lost or failing,

repairs to structural cracks (for example the end wall in photograph (number 32).

pointing of joints

removal and replacement of non original pointing which may be detrimental to the long term preservation of the structure

consideration of treatment of integral timbers by consolidation or maintenance of the wet environment.

Establishment of a conservation management plan.

This will include recommendations for maintenance and regular inspections of the condition.

Holden Conservation Ref. 418
SS Great Britain Survey.

Budget costs.
Prepared 12th September 1998

	days	cost
1 Cleaning to allow for further detailed surveys and recording.		0
1a Dry dock		0
take out weeds 2 men X 1 day	2	400
gentle pressure wash 2 men X 10 days	20	4000
scaffold access		500
pressure wash hire		500
1b brick wall - no work needed		0
1c boundary walls		0
remove plants 2 X 1 day		0
gentle pressure wash 2 X 5 days		0
	2	400
	10	2000
		0
2 Photographic survey		0
allow for professional photography - complete guess at		0
		0
3 Photogrammetric survey - complete guess at		8,000
		0
		8,000
		0
4 Preliminary visual survey of material types inc. documenting a set of		0
drawings as provided by photogrammetric survey to determine the		0
analysis required, and take samples in association with specialists.		0
allow 1 X 5 days		0
	5	1000
		0
5 Geological analysis		0
say 100 samples @ £ 50 each		0
		5000
6 Mortar analysis		0
say 100 samples @ £50 each		0
		0
		5000
7 metals analysis		0
say 10 samples @ £50 each		0
		0
		500
8 timber analysis		0
say 10 samples @ £50 each		0
		0
		500
9 general materials analysis		0
say 10 samples @ £50 each		0
		0
		500
10 Post analysis documentation and correlation of information obtained		0
from analysis		0
allow 5 days		0
		0
PAGE TOTAL	5.	1000
		0
		37300

Holden Conservation Ref. 418		Budget costs.
SS Great Britain Survey.		Prepared 12th September 1998
11 Non invasive condition survey		0
recording of condition of individual stones		0
assume only record where problem exists that are not documented by		0
the photogrammetric survey and where the photographic records needs		0
to be supplemented with commentary.		0
allow 20 days	20	4000
		0
ground survey costs - no idea what this might be		5000
		0
		0
		0
12 Invasive survey		0
		0
allow to open up certain areas		10,000
		0
		0
		0
13 Repairs		0
structural engineer		1000
		0
13a rebuilding loose and decayed stone and brick		0
dry dock area		0
allow for 20 sq. m. @ £ 400 per metre		8000
boundary walls		0
allow for 100 sq. m @ £400 per metre		40000
		0
		0
13b consolidation where mortar is lost or failing		0
dry dock area		0
allow for 100 sq. m @ £200 per m.		20000
		0
brick wall		0
allow for 100% @ £200 per metre sq.		0
what is the length X both elevations		0
guessed at 120 metres		24000
		0
boundary walls		0
allow 100% @ £200 per metre sq		0
what is the length X both elevations		0
guessed at 3000 m sq.		600000
		0
		0
		0
13c pointing of joints		0
dry dock area only (rest is 100% covered under 13 b)		0
allow for 50% of area @ £100 per m sq.		0
area guessed at total 4000 sq. m. allow 2000 m sq @ £100		200000
		0
		0
13d repairs to structural cracks		0
allow a lump sum		2000
		0
		0
13e Removal of detrimental pointing covered under item 13c		0
		0
PAGE TOTAL		**914000**

Holden Conservation Ref. 418

SS Great Britain Survey.

Budget costs.

Prepared 12th September 1998

13F Conservation of timber elements allow lump sum amount	0
	2000
PAGE TOTAL	**2000**

SUMMARY

PAGE 1	37300
PAGE 2	914000
PAGE 3	2000
BUDGET TOTAL	953300

Appendix E

Testing of structural materials ss Great Britain, Report 17499/M/01
Sandberg Consulting Engineers, 2 October 1998.

SANDBERG
CONSULTING ENGINEERS
TESTING INSPECTION
QUALITY MANAGEMENT

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REPORT 17499/M/01

TESTING OF STRUCTURAL MATERIALS

SS GREAT BRITAIN

Reference: Instruction from Mr R Turner of Naylor Conservation.

1. INTRODUCTION

Site visits were conducted to the SS Great Britain, Bristol Historic Dockyard by our engineers on the 29 and 31 July 1998 in order to remove samples of structural material and assess the load bearing wooden supporting struts. In addition to this inspection and testing was carried out to determine the condition of the coffer dam used to secure the dry dock in which the ship is berthed.

The samples of structural material were tested to determine their mechanical properties and establish a better assessment of the structural performance of the hull including the rivetted joints.

For the purpose of testing the samples were given the following unique reference numbers.

Metallurgy Laboratory Reference	Sample Reference / Description	
ME 479	BR SGB 1998	No 26
ME 480	BR SGB 1998	No 40
ME 481	BR SGB 1998	No 67

Additional samples of corrosion product were received on the 1st September and these were given the following unique reference numbers.

Metallurgy Laboratory Reference	Sample Reference / Description	
ME 594	Corrosion Sample	No 2
ME 595	Corrosion Sample	No 3
ME 576	Corrosion Sample	No 4
ME 597	Corrosion Sample	No 5

2. SAMPLE DESCRIPTION

Sample ME 479 was a large flat plate with a rivetted lap joint along the centre. Both plates were approximately ⅝" original thickness which was determined from sections of less corroded material around the rivetted lap joint, (see Plate No.1).

Sample ME 480 was a large flat plate, approximately 1" original thickness, with a rivetted strip along one edge, (see Plate No.2).

Sample ME 481 was a rivetted compound section incorporating flat plates and angle sections forming a stiffening rib on the inside of the hull, (see Plate No.3).

From three samples received five separate material specimens were selected for the program of mechanical testing and three rivetted sections were selected for macro examination.

3. TEST PROCEDURES & RESULTS

3.1 Laboratory Testing

3.1.1 Tensile Testing

From each of the five material specimens, one tensile test piece was prepared and tested in accordance with BS EN 10002:1:1990. The results are shown on Test Certificate 17499/M/1.

3.1.2 Charpy Impact Testing

A set of three test pieces from each specimen were suitably prepared and tested in accordance with BS EN 10045:1:1990. The results are shown on Test Certificate 17499/M/1.

3.1.3 Hardness Testing

Each sample was suitably prepared and Vickers hardness tested in accordance with BS 427:1990, HV30, the results of which are shown on Test Certificate 17499/M/2.

3.1.4 Metallographic Examination

A section from each specimen was mounted in bakelite and then suitably prepared to a 1μm finish. These were then etched in 2% Nital and examined under the microscope, the results of which are shown on Test Certificate 17499/M/3 to 7.

3.1.5 Macrographic Examination

Three rivetted joints were sectioned, suitably prepared and then etched in 10% Nital for examination. The results are shown on Test Certificate 17499/M/9 to 11.

3.1.6 Tensile and Compression Testing Across Rivets

Three tensile and three compression test pieces were suitably prepared and tested in our universal testing machine. The results are shown on Test Certificate 17499/M/8.

3.1.7 Determination of Chloride Content

The four corrosion samples were submitted to our Chemistry Laboratory and analysed for chloride content with reference to BS 1881: Part 124:1988. The results are shown on Test Certificate 17499/M/12.

3.2 Site Testing

3.2.1 Examination of Timber Support Props

Six timber props, three from each side were examined to determine the load in each prop. A secondary support incorporating a hydraulic ram and calibrated load cell was positioned adjacent to each of the props. Jacking of the secondary prop was continued until the load was released in the original prop. These results are shown on Test Certificate 17497/M/13 and by Plate Nos. 18, 19 and 20 in Appendix B of this report.

3.2.2 Ultrasonic Thickness Survey of Coffer Dam

An ultrasonic survey was conducted on the coffer dam to determine remaining wall thicknesses and condition. The results are shown on Test Certificates 17499/14a and 14b.

4. COMMENTS

The tensile test results show a range of 0.2% proof stress values of 206 to 269 N/mm^2 and ultimate tensile stress values of 231 to 365 N/mm^2. Three tests gave elongation results of 6.0, 11.6 and 6.6% the two samples ME 479-1 and ME 479-2 both fractured outside the gauge length marks. These variable results are typical of a low strength poor quality wrought iron.

The Charpy impact results gave a range of results from 9 to 48 Joules when tested at 20 °C. Due to excessive corrosion pitting over most of the samples it was necessary to produce sub-standard sized test specimens. If the sub standard sample results are factored to give the equivalent to the 10 mm samples then the results would be higher. This would increase the average for 479-1 to 22 J, the average for 479-2 to 22 J, the average for 481-1 to 39 J and the average for 481-2 to 20 J. This does still leave the only full size set of results from sample 480-1 at an average of 12 J.

Hardness testing on the five samples gave results ranging from 109 to 141 VPN. This is a wide spread of hardness values and be considered typical of those expected from variable, coarse grained material such as wrought iron. This is particularly so for poor quality wrought iron, such as these samples, where the inclusion size and content can influence the results significantly.

Metallographic examination of the five samples showed microstructures consisting of large non-uniform slag/oxide inclusions in a course ferritic matrix. The structures were highly variable and some of the inclusions were very large which makes these materials typical of a poor quality wrought iron.

Examination of the macro sections through the rivets showed elongated slag inclusions in both the plate and rivet material. This would be considered typical for this type of material. In general the rivets were found to be highly deformed conforming fully to the holes in the plates.

In general the corrosion to these samples had occurred on the exposed faces causing massive wasting of the section. This proved to cause problems in selection and machining of samples for the tension and compression shear testing across the rivet samples. Corrosion products were however visible inside the samples between the rivets and the plates as well as between the plates themselves.

The heads form of the rivets varied, samples 479-1 and 480-1 were counter sunk to provide a flush finish. The sample in 479-1 was only countersunk on one side and the other side which had been subjected to higher levels of corrosion and originally a dome head was severely corroded away. The corrosion had also penetrated along the flow lines into the body of t he rivet from both sides. At present the cross sectional area of the rivet has not been significantly compromised but the reduction of the dome head would reduce the mechanical strength of the joint.

The sample in 480-1 was countersunk on both sides and the penetration of corrosion into the ends of the rivet was not as severe as on sample 479-1. However there was a build up of corrosion product around the head of the rivet on one side. Due to the expansion of the oxide as it forms it will hold the joint tight. However the oxide is also friable in nature and as it becomes thicker may be prone to releasing the joint with out much plastic movement. This effect will be enhanced by the build up of oxide between the plates that will put further stress on the rivetted joint.

The samples in 481-1 were both typical dome head rivets which had been inserted into poorly aligned plates with punched holes. The degree of fill due to the deformation of the rivet was lower than the other samples. This may be due to the complexity of the joint or because they were but in a difficult position. There is considerable build up of oxide in this joint, the expansion of which will add to the load on the rivets. The head of the rivets are severely corroded with only small overlap at the edges to retain the plates. These rivets had not suffered penetration of oxide into the shank along the flow lines from working.

During the preparation of the macro samples it was found that the samples deteriorated very quickly after being prepared, even before being etched. The surface corrosion that occurred spread rapidly from the areas of corrosion product exposed on the prepared surface of the sample. This rapid deterioration may be due to the presence of corrodents within the corrosion product which both increase the rate of corrosion and draw water from the atmosphere.

The results of the chloride content testing on the corrosion product samples provided show that there were negligible chloride levels remaining in any of the samples received. This very low level of chloride may be a result of the samples being washed in fresh water prior to their removal from the ship if these areas are subject to regular rain washing. This is however unusual for corrosion products on a structure of this type and in this type of location. Where

the samples have been freshly exposed the effects of the chloride contamination are much more apparent by comparison with areas that would be more readily rinsed.
A series of load tests were conducted across the rivetted joints, three in tension and three in compression. The purpose of these tests was to assess the shear strength of the rivetted joints. Problems were encountered in removing samples from the material submitted due to the severe levels of corrosion that were not always apparent until after attempted machining of the material. Of the six tests conducted only two samples failed by shearing through the rivets.

Two of the tensile test specimens failed by tearing of the plate materials around one of the rivet holes. See Plates No.12 and No.13. This was due to the extensive loss of section from the plate material adjacent to the rivetted lap joint.

The third tensile sample failed by the plate material pulling over the corroded head of the rivet see Plate No.14. This occurred due to the extensive loss of section by corrosion which had completely removed the head of the rivet.

Of the three compression test samples two of them failed by shearing of the rivets and one failed by the collapsing of the plate material due to excessive loss of section from corrosion. See Plates No.15, No.16 and No.17.

The results obtained showed large differences with the samples tending to hold together due to the mechanical locking of the plates where corrosion has occurred between the lapped plates rather than as a direct result of the shear capacity of the rivets. In both tests once the initial friction had been overcome the rivets then sheared through at a steadily decreasing load. In both cases, where the rivets were sheared, the maximum load occurred before there was any significant differential movement of the lapped plates. Once movement occurred and the rivets began to shear the load dropped steadily up to final failure.

Testing of the timber props on site found, in general that the props of the port side of the ship were under less load than a number of those on the starboard side of the ship. Of the three props examined on the port side of the ship the loads were found to range from approximately 15 kN to greater than 25 kN. On the starboard side of the ship a number of props were found to loaded to over 30 kN. A number of other props on this side showed significant signs of bowing due to the load applied.

A number of props on the starboard side were positioned with their bases wedged hard against the wall of the dock and the top end wedged under the angle section stiffener running around the hull of the ship below the water line. The props on this side of the ship appeared to be taking greater loads due to local movement of the hull in this area rather than any significant movement of the ship as a whole.

The starboard side of the ship was the most severely damaged with a large vertical tear approximately amidships which had been crudely repaired by plating. In this area there appears to have been some movement of the hull possibly due to creep of the material or distortion due to the increase in weight on the inside of the hull as parts of the restoration to the inside of the ship are undertaken. Distortion was also apparent in this area where the starboard bilge keel could be seen to distort over one of the supports under the ship. This is shown by Plate 20 in Appendix B of this report.

Inspection of the coffer dam showed no evidence of any significant loss of section from the plates forming the main external skin. The coffer dam was found to be constructed with two

distinct levels inside. Below the line of the first two rows of plates the dam was separated from its base by a complete floor with access to the lower level gained through a small hatchway in the centre of this floor. The lower section of the dam coincided with the bottom three rows of plates visible on the outside of the structure.

The upper floor of the coffer dam was found to be in good condition with the paint coating still present on the internal face of the plates. The lower level of the dam showed no evidence of any recent repainting with the entire internal surface cover with a thin layer of corrosion product under what remained of the paint coating. The upper and lower levels of the structure revealed a difference in plate thickness. The upper half showed a plate thickness of around 7.5 mm and the lower half a plate thickness of around 8.5 mm.

The base of the coffer dam was found to be filled with mass concrete to a depth of approximately 450 mm with additional ballast, in the form of scrap metal principally comprising of rail mounting brackets that was also present on the intermediate floor. During the inspection no evidence was found of any water ingress into the structure, the internal surfaces were dry even in the bottom of the dam.

Examination of the outside of the structure could only be carried out on the inside of the dock due to the water level outside. The area examined showed no evidence of any significant corrosion with the paint coating generally found to be in good condition.

A number of small leaks were apparent around the base and sides of the coffer dam where water was leaking around the outer edge of the structure where it seals with the dock wall.

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TF7 4QT

for Messrs Sandberg

For the attention of Mr Robert Turner

B R Whitney

MET/NAF/BRW/gdt/brw

2 October 1998

Materials, samples and test specimens are retained for a period of 2 months from the issue of the final report. Your attention is drawn to the enclosed sample retention form and we would be grateful if you could complete the form and return it within one month from the date of the report.

Tests reported on sheets not bearing the UKAS logo in this report/certificate are not included in the UKAS accreditation schedule for this laboratory.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

SANDBERG

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TESTING
No. 0957

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Telephone 0171 565 7000
Facsimile 0171 565 7100

17499/M/1

Test Date
16-17.09.98

Samples Received
30.07.98

Order No.
-

MECHANICAL TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Test: Tensile Testing in accordance with BS EN 10002-1:1990

Specimen Identification Met Lab Ref: / Sample Ref:	Area mm²	Proof Load 0.2 % kN	Stress N/mm²	Ultimate Stress Load kN	Stress N/mm²	Elongation %	Area Reduction %	Charpy Test Nominal 300J Impact Energy Impact J	Avg x̄	Temp °C
ME 479-1 5/8" Plate	100	20.7	206	23.2	231	*1		11 11 10*2	11	20
ME 479-2 5/8" Plate	159	34.9	219	47.2	296	*1		11 11 13*2	11	20
ME 480-1 1" Plate	288	71.4	248	90.6	312	6.0		10 13 12*3	12	20
ME 481-1 6" x 3" Angle section	61.1	16.4	269	22.3	365	11.6		48 18 21*4	29	20
ME 481-2 ½" Plate	105	24.1	229	30.9	294	6.6		10 10 9*2	10	20
Specification: N/A										

Comments:
*1 No elongation recorded, samples fractured outside gauge length marks
*2 Substandard Charpy impact specimens 10 x 5mm
*3 Standard Charpy impact specimens 10 x 10mm
*4 Substandard Charpy impact specimens 10 x 7.5mm

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2 October 1998 Report Date

pp B R Whitney Signature

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

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17499/M/2

Test Date
17.09.98

Samples Received
30.07.98

VICKERS HARDNESS TEST CERTIFICATE to BS427:1990

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.

Met Lab Ref:		ME479-1	ME479-2	ME480	ME481-1	ME481-2
Client Ref:		5/8" Plate	5/8" Plate	1" Plate	6" x 3" Angle	1/2" Plate
Load/kg		30	30	30	30	30
Hardness Values	1.	130	123	135	143	127
	2.	115	109	141	140	121
	3.	120	118	141	135	109
Average Hardness Value:		122	117	139	139	119
Correlated Approximate Tensile Strength (N/mm²)						

Comments:

2 October 1998 Report Date

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LAB FORM No. MET/103

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17499/M/3

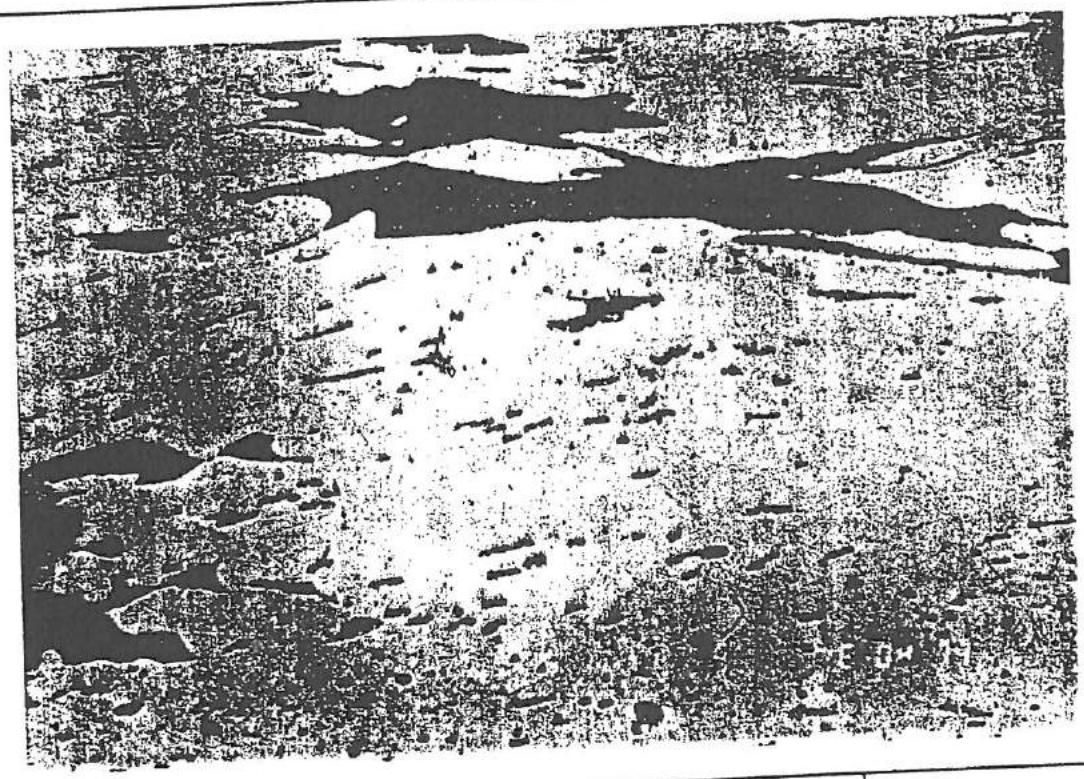
Test Date
16-17.09.98

Samples Received
30.07.98

METALLOGRAPHIC EXAMINATION CERTIFICATE to BS4490:1989

Order No.

Client: Naylor Conservation
Unit H3
Halesfield 19
Talford, Shropshire
TF7 4QT



Met Lab Ref:		M479-1		Client/Ref Description:		5/8" Plate	
Plate No.:	1	Magnification:	X100	Etchant:	2% Nital	Grain Size Index:	III

Comments:
Sampel ME479-1 etched in 2% Nital showing a microstructure consisting of large non-uniform slag inclusions in a coarse ferritic matrix typical of a poor quality wrought iron.

2 October 1998 Report Date

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LAB FORM No. MET/104/B

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17499/M/4

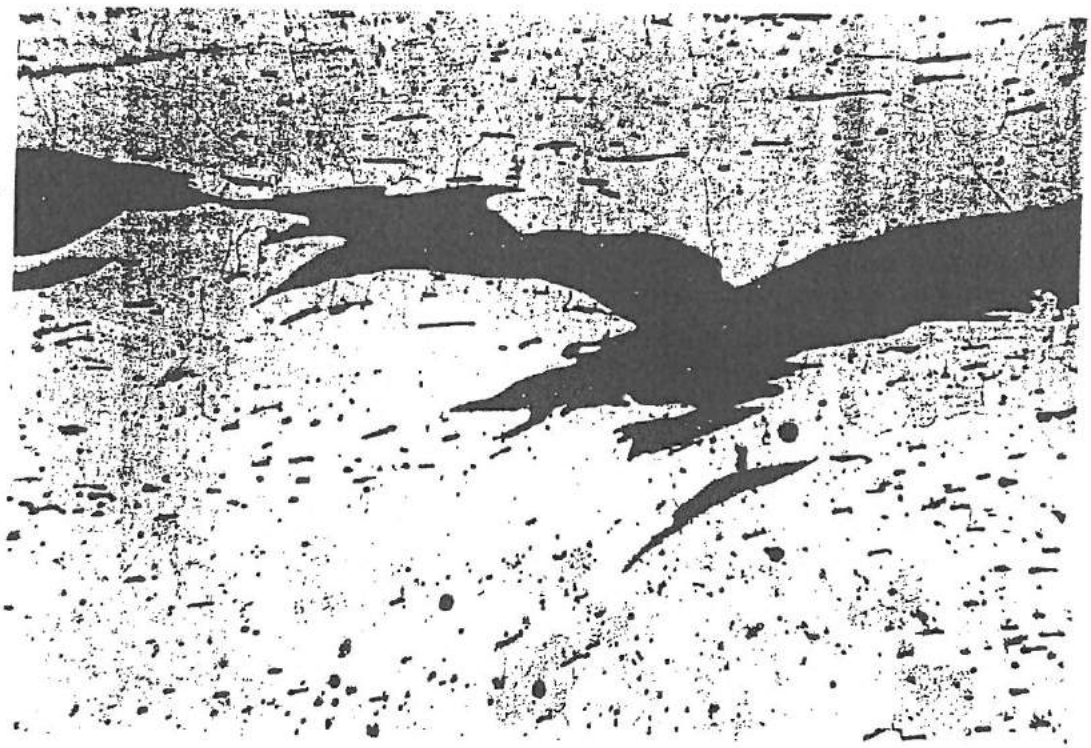
Test Date
16-17.09.98

Samples Received
30.07.98

METALLOGRAPHIC EXAMINATION CERTIFICATE
to BS4490:1989

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.



Met Lab Ref:		ME479-2		Client/Ref Description:		5/8" Plate	
Plate No.:	2	Magnification:	X100	Etchant:	2% Nital	Grain Size Index:	III

Comments: Sample ME479-2 etched in 2% Nital showing a microstructure consisting of large non-uniform slag inclusions in a coarse ferritic matrix typical of a poor quality wrought iron.

2 October 1998 Report Date

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LAB FORM No. MET/104/B

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17499/M/5

Test Date
16-17.09.98

Samples Received
30.07.98

METALLOGRAPHIC EXAMINATION CERTIFICATE to BS4490:1989

Order No.

Client: Naylor Conservation
Unit H3
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Telford, Shropshire
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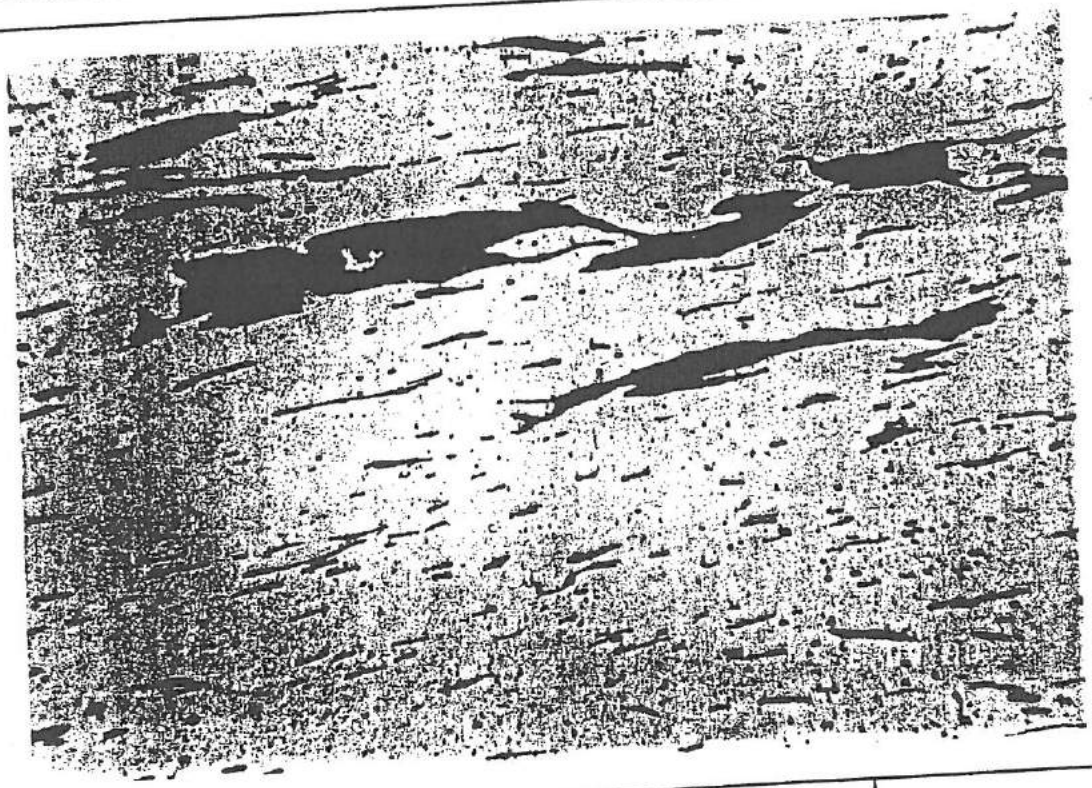

Met Lab Ref:		ME480-1		Client/Ref Description:		1" Plate	
Plate No.:	3	Magnification:	X100	Etchant:	2% Nital	Grain Size Index:	III

Comments: Sample ME480-1 etched in 2% Nital showing a microstructure consisting of large non-uniform slag inclusions in a coarse ferritic matrix typical of a poor quality wrought iron.

2 October 1998 Report Date

Signature

pp B R Whitney

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LAB FORM No. MET/104/B

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17499/M/6

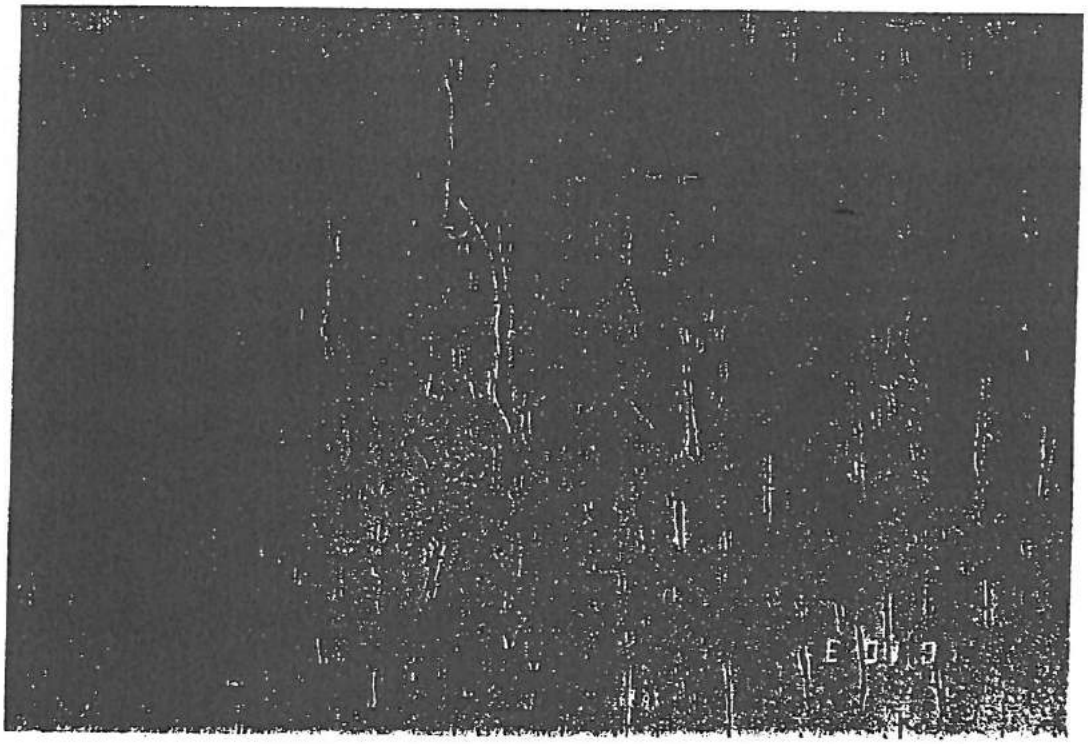
Test Date
16-17.09.98

Samples Received
30.07.98

METALLOGRAPHIC EXAMINATION CERTIFICATE to BS4490:1989

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.



Met Lab Ref:		ME480-1		Client/Ref Description:		6" x 3" Angle	
Plate No.:	4	Magnification:	X100	Etchant:	2% Nital	Grain Size Index:	III

Comments: Sample ME480-1 etched in 2% Nital showing a microstructure consisting of large non-uniform slag inclusions in a coarse ferritic matrix typical of a poor quality wrought iron.

2 October 1998 Report Date

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LAB FORM No. MET/104/B

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17499/M/7

Test Date
16-17.09.98

Samples Received
30.07.98

METALLOGRAPHIC EXAMINATION CERTIFICATE to BS4490:1989

Order No.

Client: Naylor Conservation
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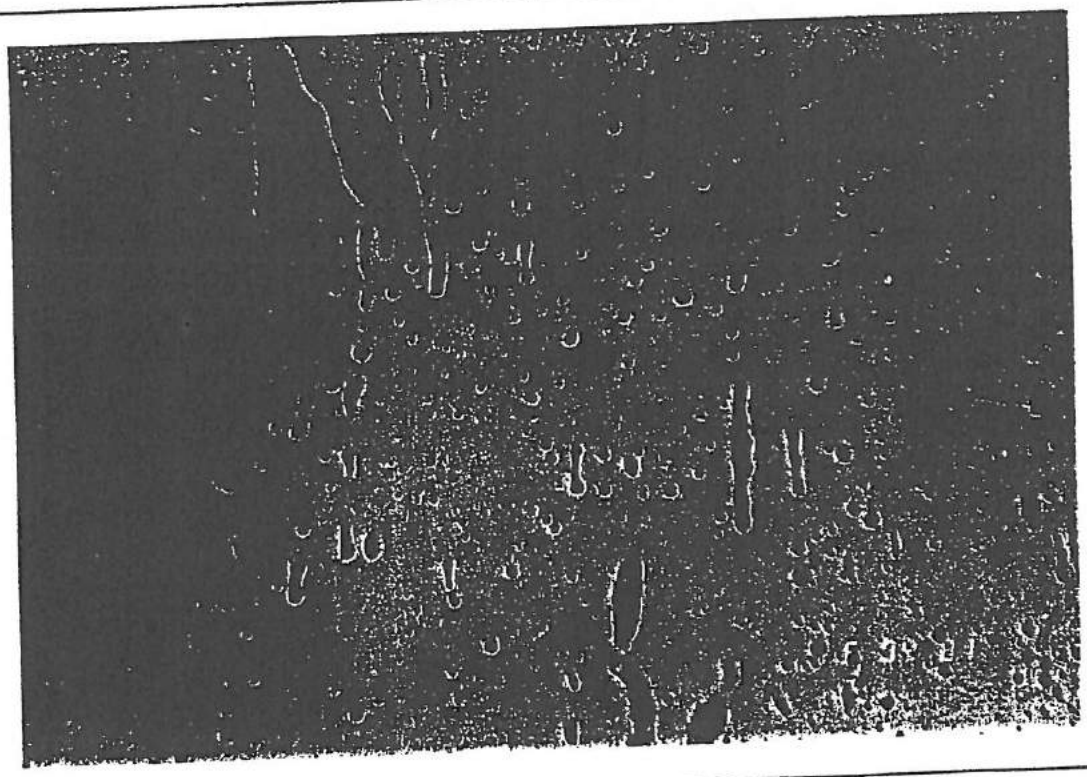

Met Lab Ref:		ME481-2		Client/Ref Description:		½" Plate	
Plate No.:	5	Magnification:	X100	Etchant:	2% Nital	Grain Size Index:	III

Comments: Sample ME480-2 etched in 2% Nital showing a microstructure consisting of large non-uniform slag inclusions in a coarse ferritic matrix typical of a poor quality wrought iron.

2 October 1998 Report Date

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LAB FORM No. MET/104/B

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17499/M/8

Test Date
30.9.98

Samples Received
31.7.98

Order No.

TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire TF7 4QT

Test: Tensile and compression testing of rivetted samples in shear.

Met Lab Ref.	Test Mode	No. of Rivets	Dia. of Rivets	Maximum Load (kN)	Failure mode
ME 479	Tensile	2	1"	110	The riviet did not shear with the parent plate tearing away around one of the rivets.
ME 479	Tensile	2	1"	94.4	The riviet did not shear with the parent plate tearing away around one of the rivets.
ME 479	Tensile	1	1"	73.7	The riviet did not shear with the plates seperating and pulling off the head of the corroded rivet.
ME 479	Compression	2	1"	158	The riviet did not shear with the parent plate buckling either side of the rivetted connection.
ME 479	Compression	1	1"	150	Failure by shearing through the single rivet.
ME480	Compression	2	1"	426	Failure by shearing through the two rivets.

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2 October 1998 Report Date

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LAB FORM No. MET/101/A

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17499/M/9

Test Date
16-17.09.98

Samples Received
30.07.98

MACROGRAPHIC EXAMINATION CERTIFICATE to BS6533:1984

Order No.

Client: Naylor Conservation
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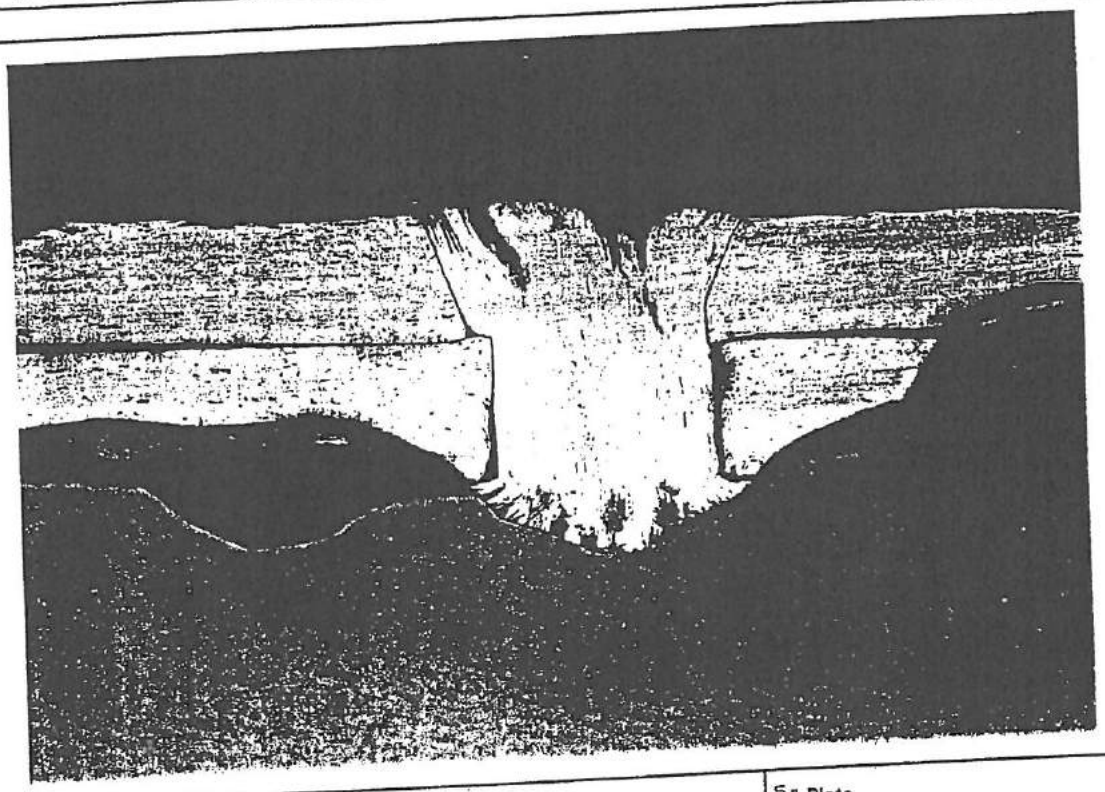
Halesfield 19
Telford, Shropshire
TF7 4QT



Met Lab Ref:	ME479-1	Client Ref/Description:		5/8" Plate	
Plate No.:	6	Magnification:	x 1.25	Etchant:	10% Nital

Comments: Sample ME479-1 showing a typical section through the rivitted connection. This shows the large slag inclusions distributed within the plate and nickel material together with the ingress of corrosion product into the head and point of the rivet.

2 October 1998 Report Date

B R Whitney Signature

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LAB FORM No. MET/129/B

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CONSULTING, INSPECTING
AND TESTING ENGINEERS

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TESTING
No. 0957

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17499/M/10

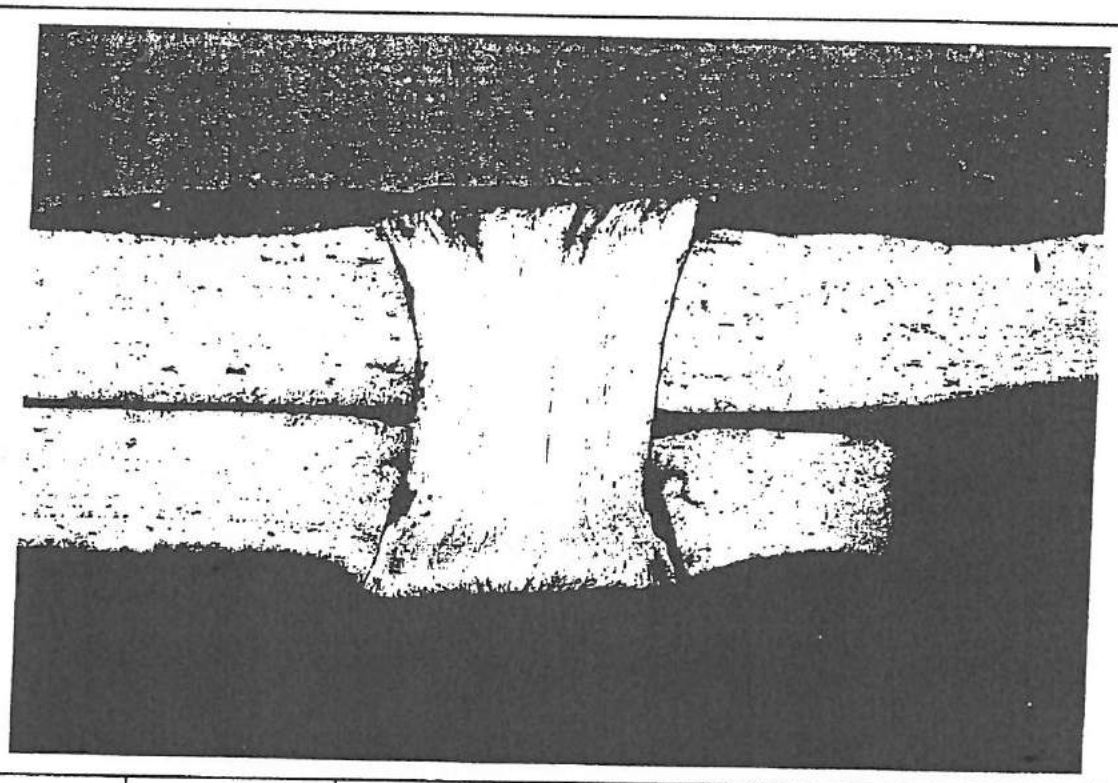
Test Date
16-17.09.98

Samples Received
30.07.98

MACROGRAPHIC EXAMINATION CERTIFICATE to BS6533:1984

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.



Met Lab Ref:	ME480-1	Client Ref/Description:		1" Plate	
Plate No.:	7	Magnification:	x 1.25	Etchant:	10% Nital

Comments: Sample ME480-1 showing a typical section through the rivitted connection. This shows the large slag inclusions distributed within the plate and nickel material together with the ingress of corrosion product into the head and point of the rivet.

2 October 1998 Report Date

Signature

A/B R Whitney

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

123

LAB FORM No. MET/129/B

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CONSULTING, INSPECTING
AND TESTING ENGINEERS

NAMAS
TESTING
No. 0957

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17499/M/11

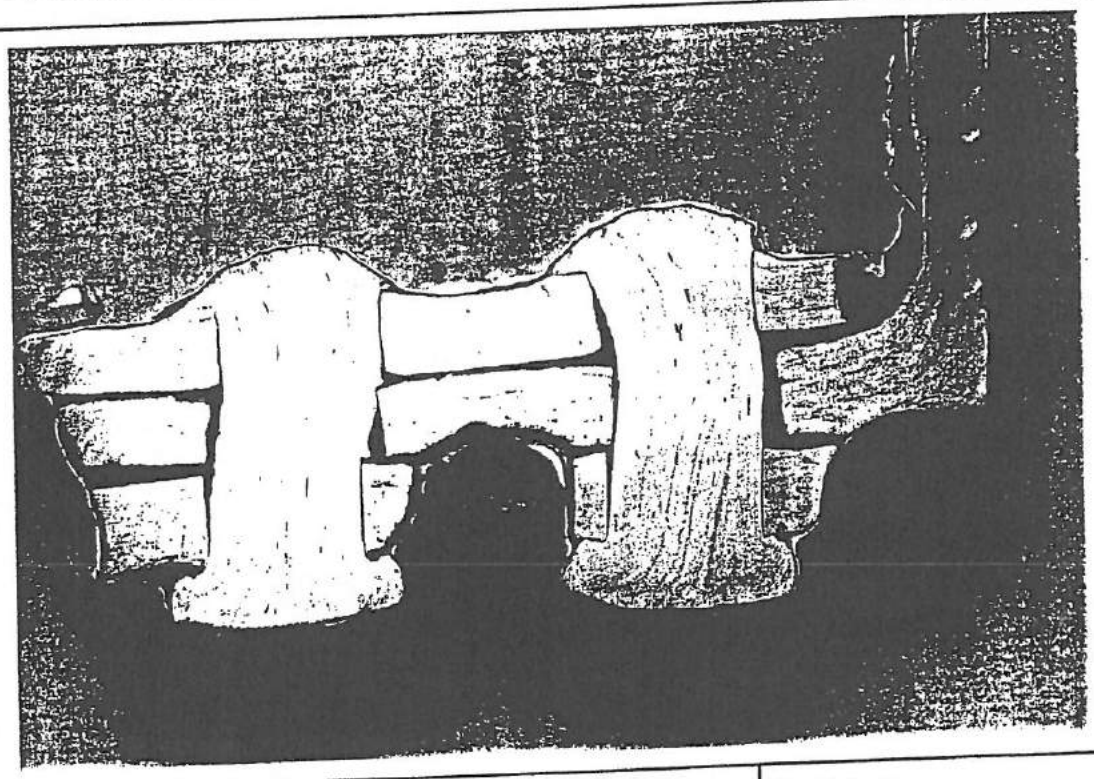
Test Date
16-17.09.98

Samples Received
30.07.98

MACROGRAPHIC EXAMINATION CERTIFICATE to BS6533:1984

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.



Met Lab Ref:	ME481-1	Client Ref/Description:		6" x 3" Angle	
Plate No.:	B	Magnification:	x 1	Etchant:	10% Nital

Comments: Sample ME481-1 showing a typical section through the rivitted connection. This shows the large slag inclusions distributed within the plate and nickel material together with the ingress of corrosion product into the head and point of the rivet.

2 October 1998 Report Date

pp B R Whitney Signature

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

124

LAB FORM No. MET/129/B

SANDBERG

CONSULTING, INSPECTING
AND TESTING ENGINEERS

NAMAS
TESTING
No. 0957

Metallurgy Laboratory
40 Grosvenor Gardens
London SW1W 0LB
Telephone 0171 565 7000
Facsimile 071 565 7100

17499/M/12

Test Date
14.9.98

Samples Received
31.7.98

TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.

CHEMICAL ANALYSIS
DETERMINATION OF CHLORIDE CONTENT
TO BS 1881:Part 124:1988

Met Lab Ref	Client Ref / Description	% Chloride by weight
ME 594	Corrosion Sample No. 2	0.04
ME 595	Corrosion Sample No. 3	0.03
ME596	Corrosion Sample No. 4	0.01
ME597	Corrosion Sample No. 5	0.01

2 October 1998 Report Date

Signature

pp B R Whitney

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

SANDBERG

CONSULTING, INSPECTING
AND TESTING ENGINEERS

Metallurgy Laboratory
40 Grosvenor Gardens
London SW1W 0LB
Telephone 0171 565 7000
Facsimile 071 565 7100

17499/M/13

Test Date
31.7.98

Samples Received
N/A

TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.

EXAMINATION OF TIMBER TIMBER PROPS

Results:

Prop Location / Number	Approximate Load in Prop (kN)	Comments
2, Port Side	Load just released at 20 kN	Further loading was aborted due to local distortion of the hull
4, Port Side	Initial load released at 11kN, Load off completely at 15 kN.	Damaged prop removed
5, Port Side	Load in prop greater than 25 kN	Further loading was aborted due to local distortion of the hull
2, Starboard Side	Load released at 10 kN	
4, Starboard Side	Initial load released at 25 kN	
5, Starboard Side	Load in prop greater than 30 kN	Further loading was aborted due to local distortion of the hull
7, Starboard Side	Not tested	Buckling in the prop would indicate high loads in this area greater than 30 kN.
8, Starboard Side	Not tested	Buckling in the prop would indicate high loads in this area greater than 30 kN.
9, Starboard Side	Not tested	Buckling in the prop would indicate high loads in this area greater than 30 kN.
11, Starboard Side	Not tested	Buckling in the prop would indicate high loads in this area greater than 30 kN.

Comments: Props numbered from bow to stern of the ship. Six timber props, three from each side were examined to determine the load in each prop. A secondary support prop incorporating a hydraulic ram and calibrated load cell was positioned adjacent to each of the props. Jacking of the secondary prop was continued until the load was released in the original prop or the maximum capacity of the jacking system was achieved.

2 October 1998 Report Date

pp B R Whitney Signature

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

126

SANDBERG
CONSULTING, INSPECTING
AND TESTING ENGINEERS

Metallurgy Laboratory
40 Grosvenor Gardens
London SW1W 0LB
Telephone 0171 565 7000
Facsimile 071 565 7100

17499/M/14a

Test Date
31.7.98

Samples Received
N/A

TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.

INSPECTION OF COFFER DAM

OUTSIDE FACE OF DAM THICKNESS READINGS FOR EACH PANEL (mm)

TOP

Floor	7.5	8.0	7.2	7.7	7.9	7.8	8.0	7.9
	7.5	7.8	7.4	6.8	7.3	7.4	7.9	8.0
	7.0	7.1	8.7	8.7	9.0	9.5	8.5	8.8
	6.7	8.6	8.8	8.7	7.9	8.8	8.8	8.9
	N/A	8.6	8.8	8.7	7.8	8.5	8.7	N/A

BOTTOM

Comments:

The plan of the coffer dam as shown above represents the panels outlined by the framing on the inside of the structure. The plan of the face of the coffer dam is shown as viewed from inside the dock.

Readings on each panel are based on three readings taken using a calibrated ultrasonic thickness probe.

The base of the coffer dam was found to be filled with mass concrete.

4 October 1998 Report Date

pp B R Whitney Signature

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

SANDBERG

CONSULTING, INSPECTING
AND TESTING ENGINEERS

Metallurgy Laboratory
40 Grosvenor Gardens
London SW1W 0LB
Telephone 0171 565 7000
Facsimile 071 565 7100

17499/M/14b

Test Date
31.7.98

Samples Received
N/A

TEST CERTIFICATE

Client: Naylor Conservation
Unit H3
Halesfield 19
Telford, Shropshire
TF7 4QT

Order No.

INSPECTION OF COFFER DAM

INSIDE FACE OF DAM THICKNESS READINGS FOR EACH PANEL (mm)

TOP

	7.1	7.7	7.5	7.8	7.6	7.7	8.0	7.9
	7.4	7.5	7.4	7.1	7.2	7.3	7.6	7.7
Floor	8.8	8.9	8.8	8.8	8.6	8.4	8.9	8.8
	8.6	8.8	8.8	8.7	8.5	8.7	8.8	8.7
	N/A	7.5	8.6	7.9	8.7	8.7	8.7	N/A

BOTTOM

Comments:

The plan of the coffer dam as shown above represents the panels outlined by the framing on the inside of the structure. The plan of the face of the coffer dam is shown as viewed from inside the dock.

Readings on each panel are based on three readings taken using a calibrated ultrasonic thickness probe.

The base of the coffer dam was found to be filled with mass concrete.

4 October 1998 Report Date

Signature

pp B R Whitney

Specimens will be retained for 2 months unless otherwise notified to the Laboratory

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APPENDIX A

PLATE NUMBERS 9 to 17

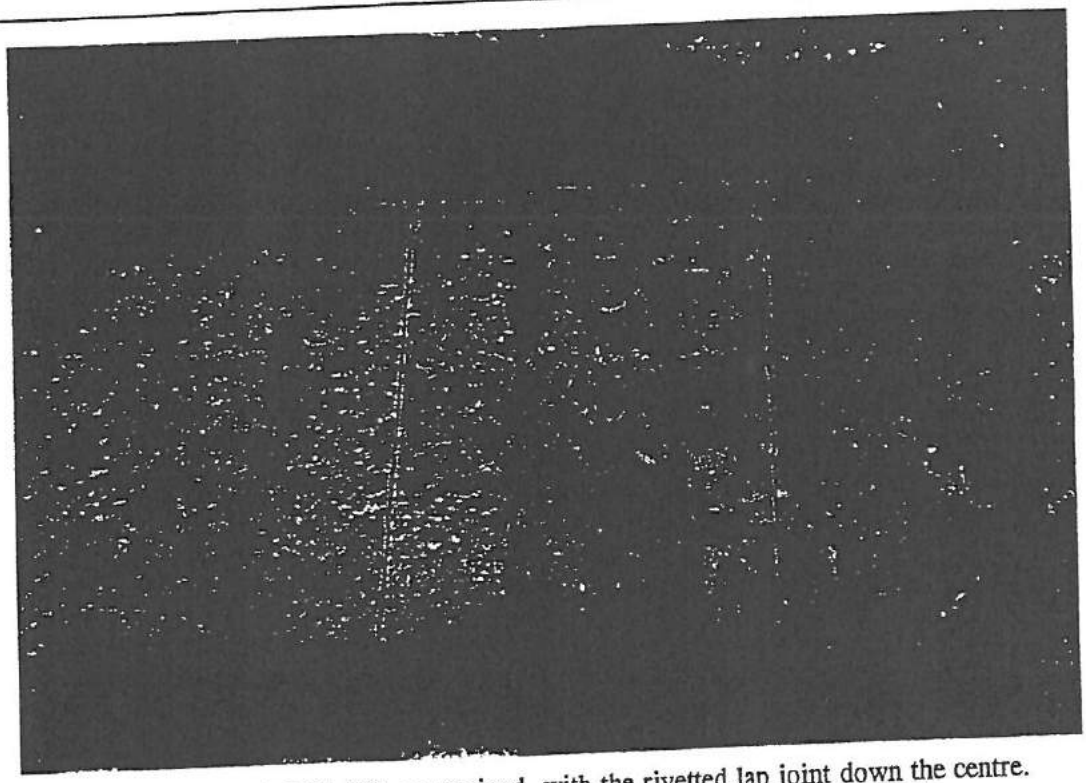

Plate No.9 Showing sample ME 479, as received, with the rivetted lap joint down the centre.

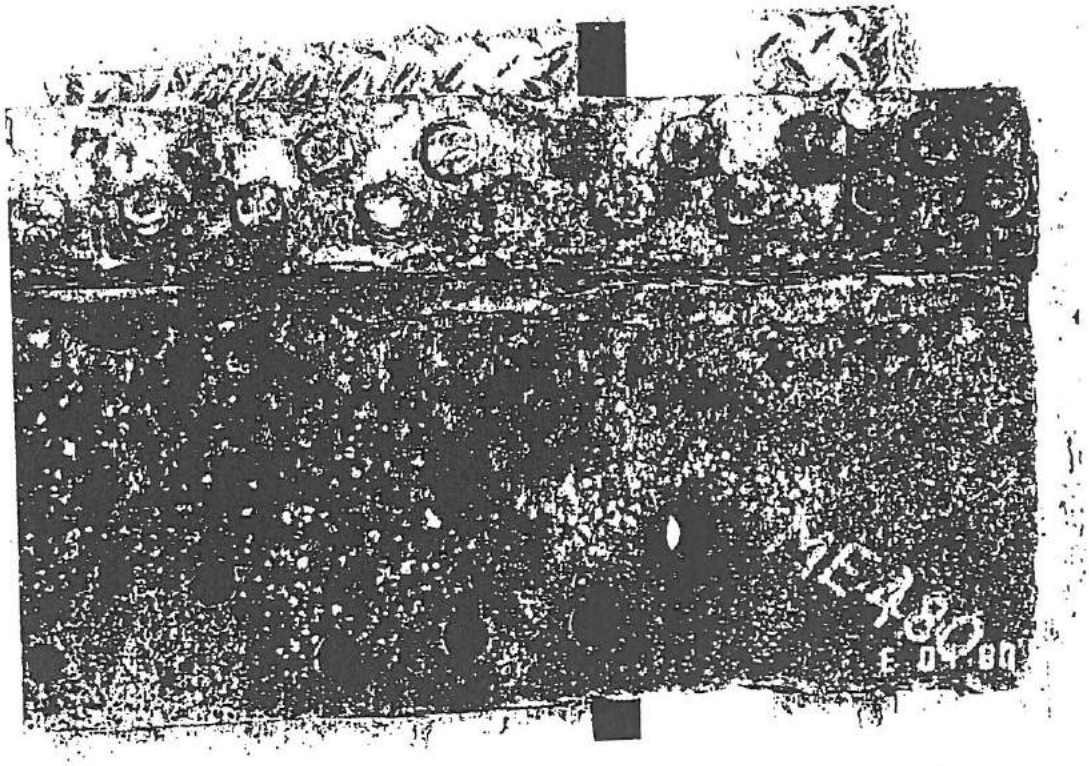

Plate No.10 Showing sample ME 480, as received, with the rivetted strip along one edge.

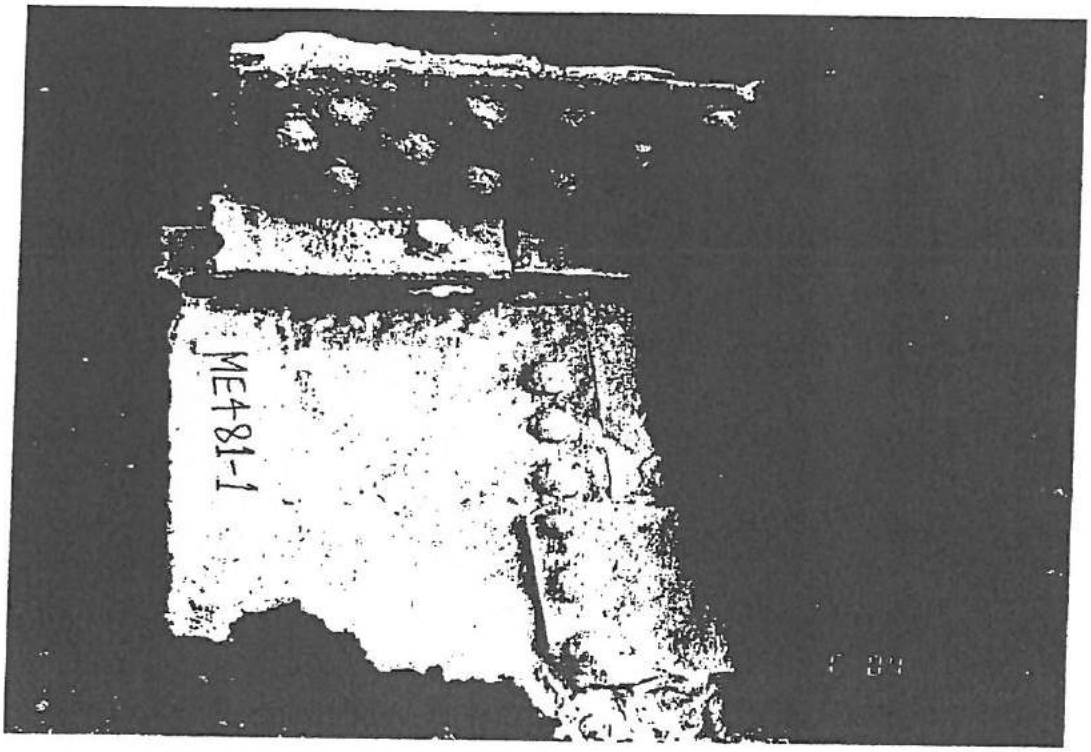

Plate No.11 Showing sample ME 481 a compound rivetted section with plate and angle sections, as received at the Laboratory.

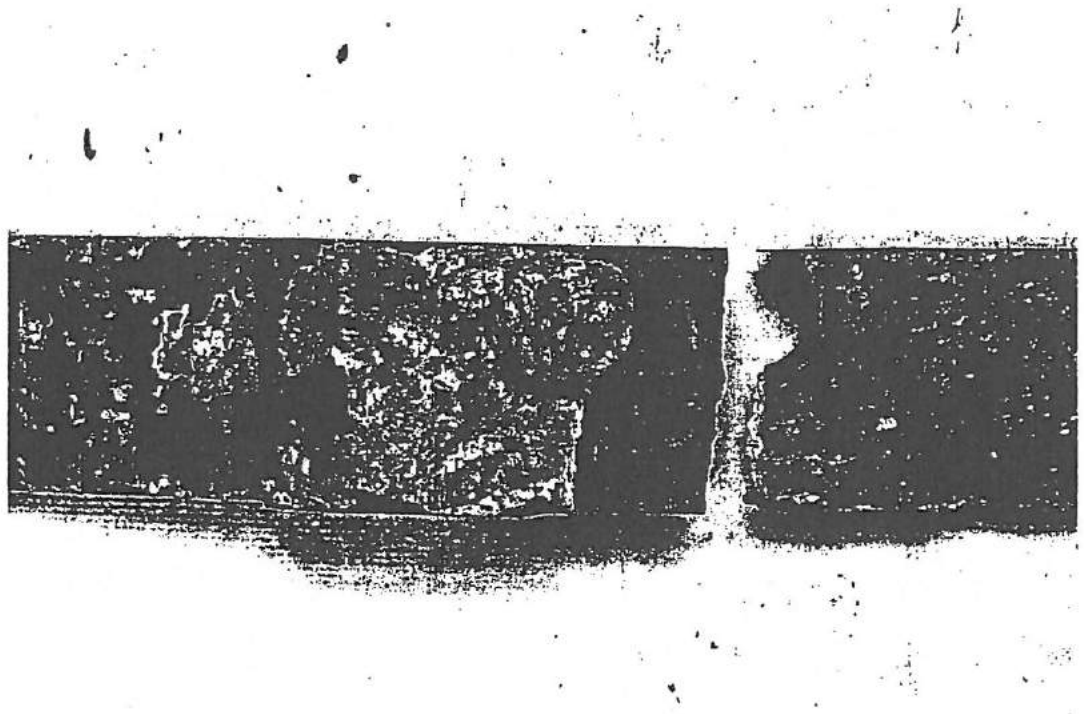

Plate No.12 Showing a tensile test specimen taken across the rivetted joint after testing. This shows the sample failing by tearing of the parent plate around the rivets rather than due to shearing of the rivets.

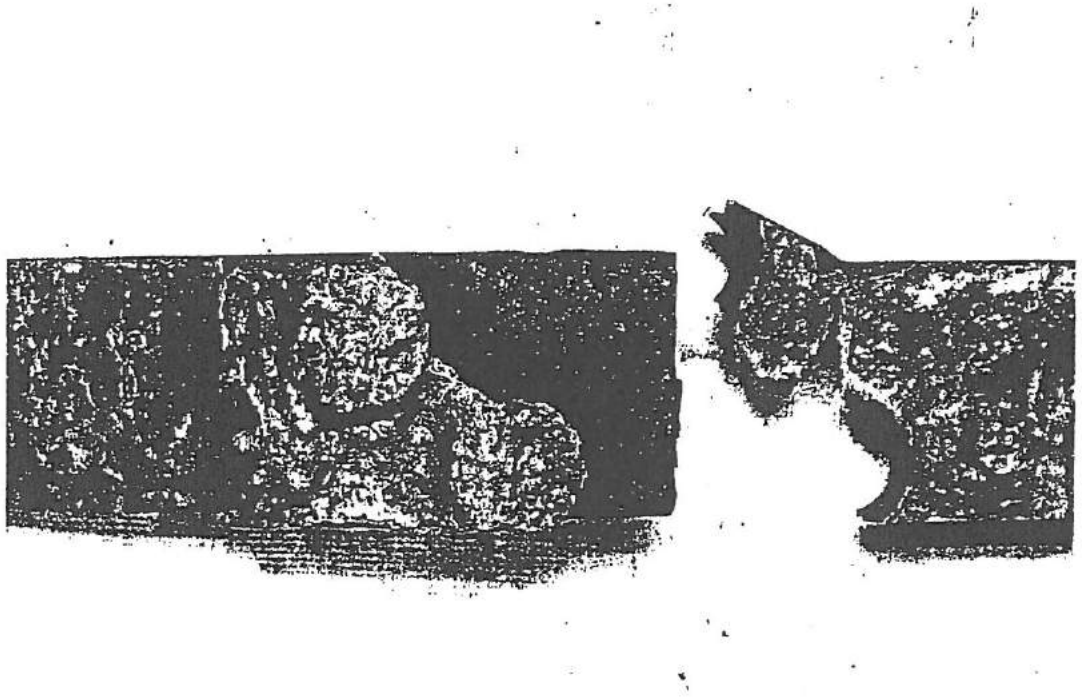

Plate No.13 Showing a tensile test specimen taken across the rivetted joint after testing. This shows the sample failing by tearing of the parent plate around the rivets rather than due to shearing of the rivets.

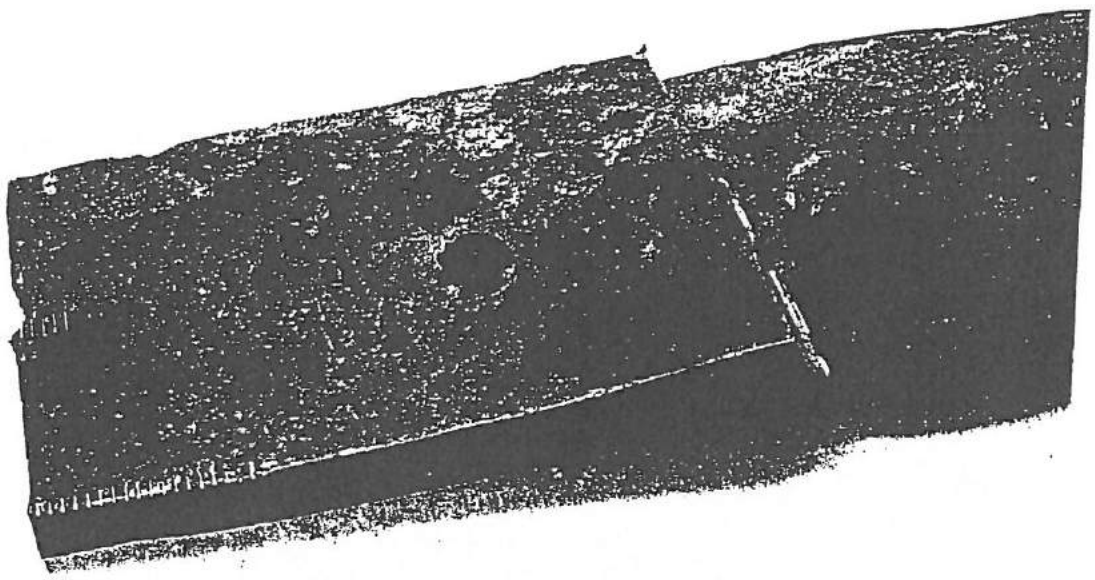

Plate No.14 Showing a shear test on a rivetted sample carried out in tension. This sample failed by the plate pulling over the badly corroded head of the rivet.

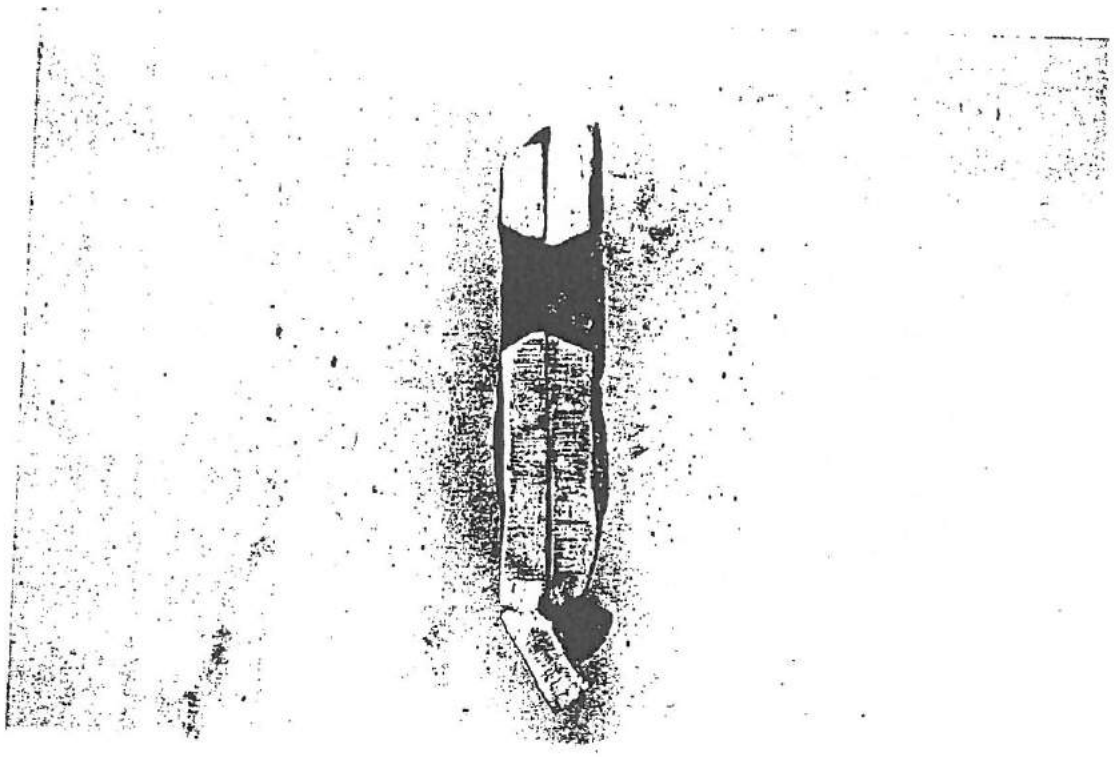

Plate No.15 Showing a shear test sample, in compression, where failure has occurred due to fracture of the parent material outside of the rivetted joint due to the large loss of section in this area.

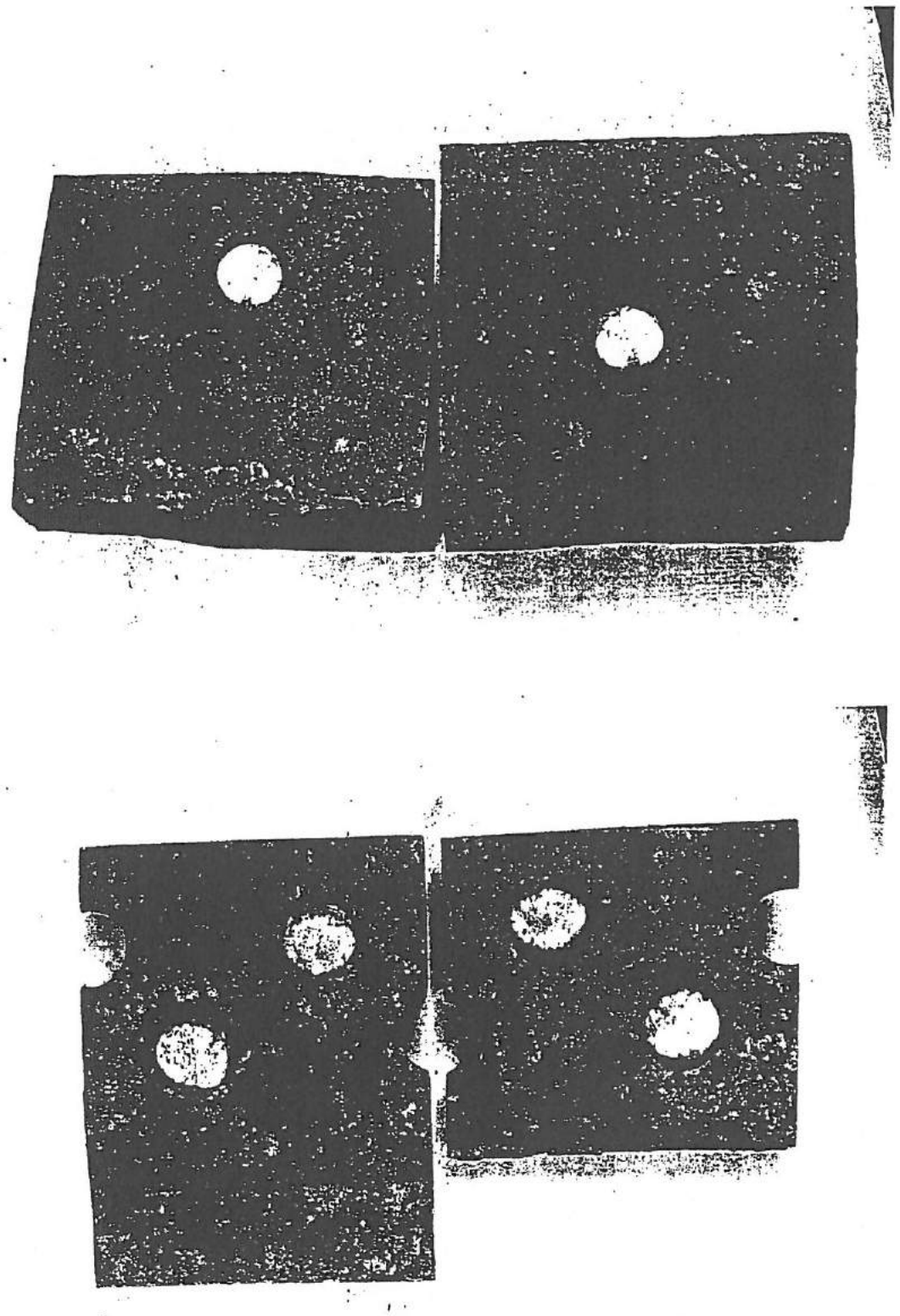

Plate Nos.16 and 17 Showing the shear mode failure of two of the samples tested in compression. Both samples contained 1" rivets which failed with typical fracture faces and distortion in the holes in the plate.

APPENDIX B

PLATE NUMBERS 18 to 20

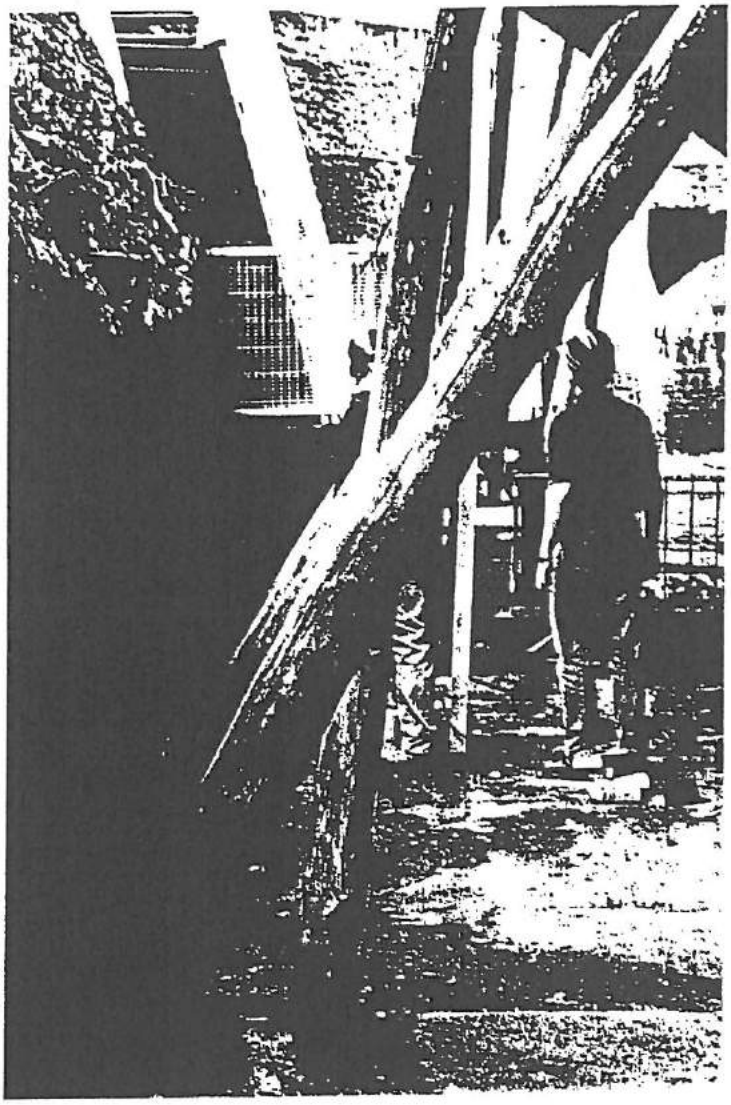

Plate No.18 Showing a view looking forward on the starboard side of the ship. This shows the distortion in the angled props where they are locked in against the side wall of the dock.

Plate No.19 Showing a view looking aft on the starboard side of the ship. This shows the distortion in the angled props where they are locked in against the side wall of the dock.

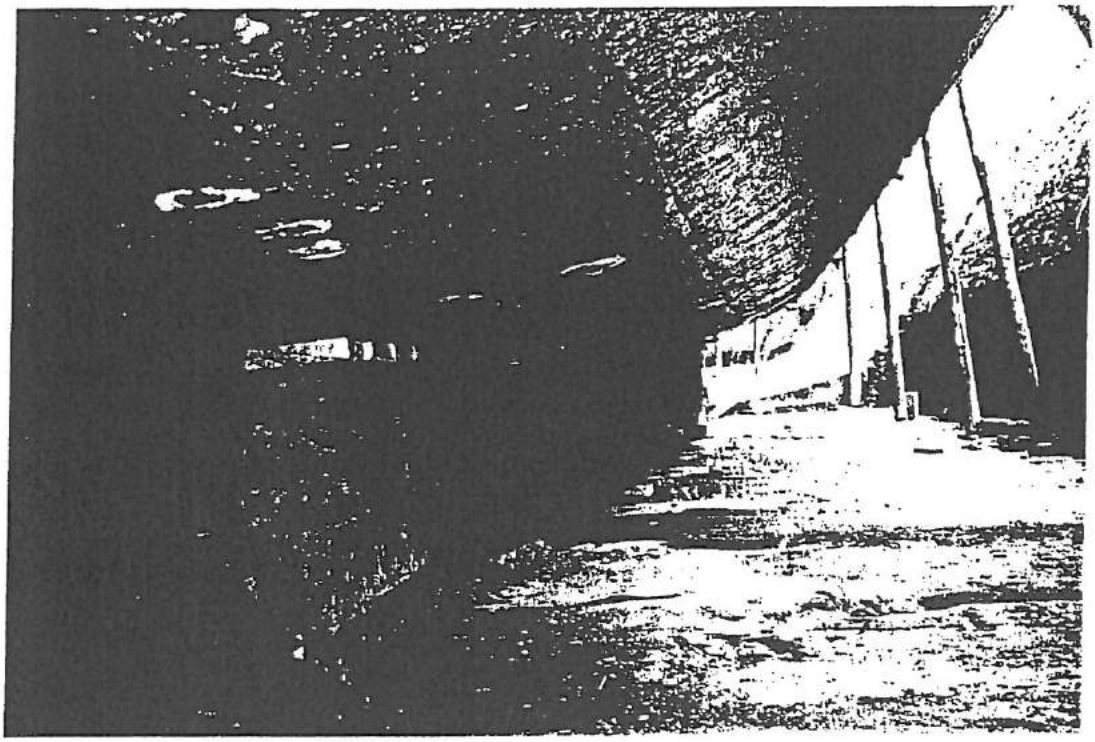

Plate No. 20 Showing a view looking forward on the starboard side of the ship. This shows the local distortion in the bilge keel where it passes over the third prop visible. This position coincides with the tear in the hull plates on this side of the ship.

Appendix F

Temporary Dam Proposal
Mowlem Civil Engineering, September 1998.

SS Great Britain Project

Great Western Dry Dock

Temporary Dam Proposal

Prepared for

ura Conservation Ltd
Unit H3
Halksfield 19
Telford
Shropshire TF7 4QT

Central Engineering Services
Mowlem Civil Engineering,
Foundation House,
Eastern Road,
Bracknell,
Berkshire. RG12 2UZ
Tel: 01344 426826 fax: 01344 862027

September 1998

Brief

An outline scheme is required for a temporary dam across the entrance to the Great Western Dry dock to enable the full examination of the existing dry dock caisson. The Dry Dock is located in the Bristol City Docks.

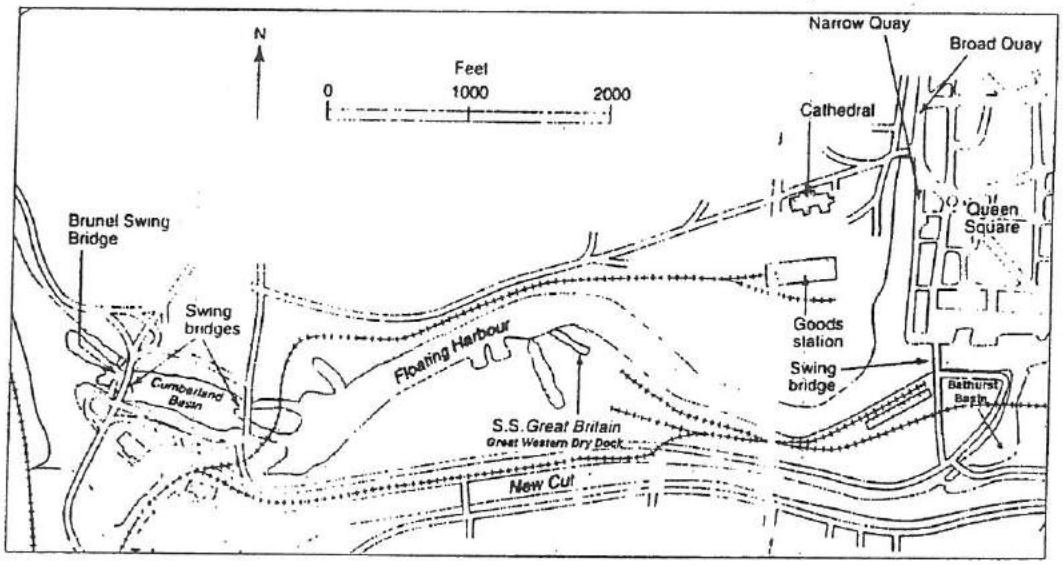

Figure 1. Dry Dock location

Dry Dock

The Dry dock was built around 1840 specifically for the construction of the SS Great Britain. The original Dock layout is shown in figure 2.

Ground Conditions

A drawing of the dry dock and the information contained in the archaeological appraisal indicate that the entrance to the dry dock has been silted to a depth of about one and a half metres above the dock sill level. This silting reduces closer to the main channel. It is assumed that the silt and debris across the dock entrance will be dredged clear before the temporary dam is installed.

Historical accounts of the construction of the floating harbour basins (Cumberland and Bathurst) and the New Cut indicate that the underlying ground consists of soft clays and silts above rock. The only definitive information we have about the underlying rock level is from the Cumberland basin where the rock is about 17m below ground level. The same source also confirms the presence of soft clays and silts.

The docks are non tidal with the water level controlled by locks and sluices therefore no large variations in water level are expected. Design has been based on the normal dock and the HWST levels given in the reference documents.

Dock levels

References levels for the dry dock and approach channel are taken from figure 2.

Reference	Level (feet)	Level (metres)
Normal dock water level	27.36	8.34
HWST	30.00	9.144
Top of Caisson level /Dock level	31.58	9.625
Dock level Upper	35.00	10.688
Dock entrance sill level	15.85	4.831
Bottom level at sheetpile wall location (estimate)		4.544
Maximum height of water to be retained by wall h = 9.144 - 4.544 = 4.6 m		