Her Majesty's Fire-Ship

Firebrand

Shipwreck Recording Project

Project Design 2009

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Sponsors of the *Firebrand* Shipwreck Recording Project

The *Firebrand* project is funded entirely by sponsorship and donations. If you are interested in supporting this project please contact:

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Cover photograph – Survey in progress using a Sonardyne Homer-Pro electronic tape measure.

Project Name

Firebrand shipwreck recording project

Background

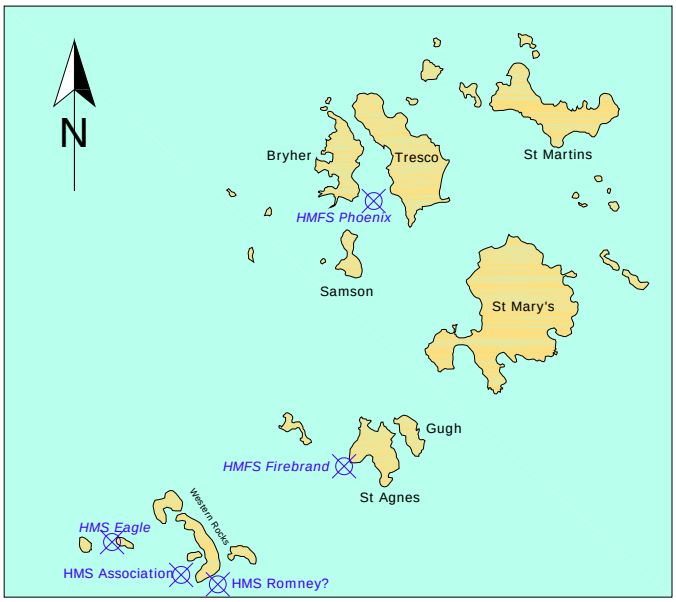

Fig 1 The locations of Sir Cloudesley Shovell's ships lost or damaged in 1707

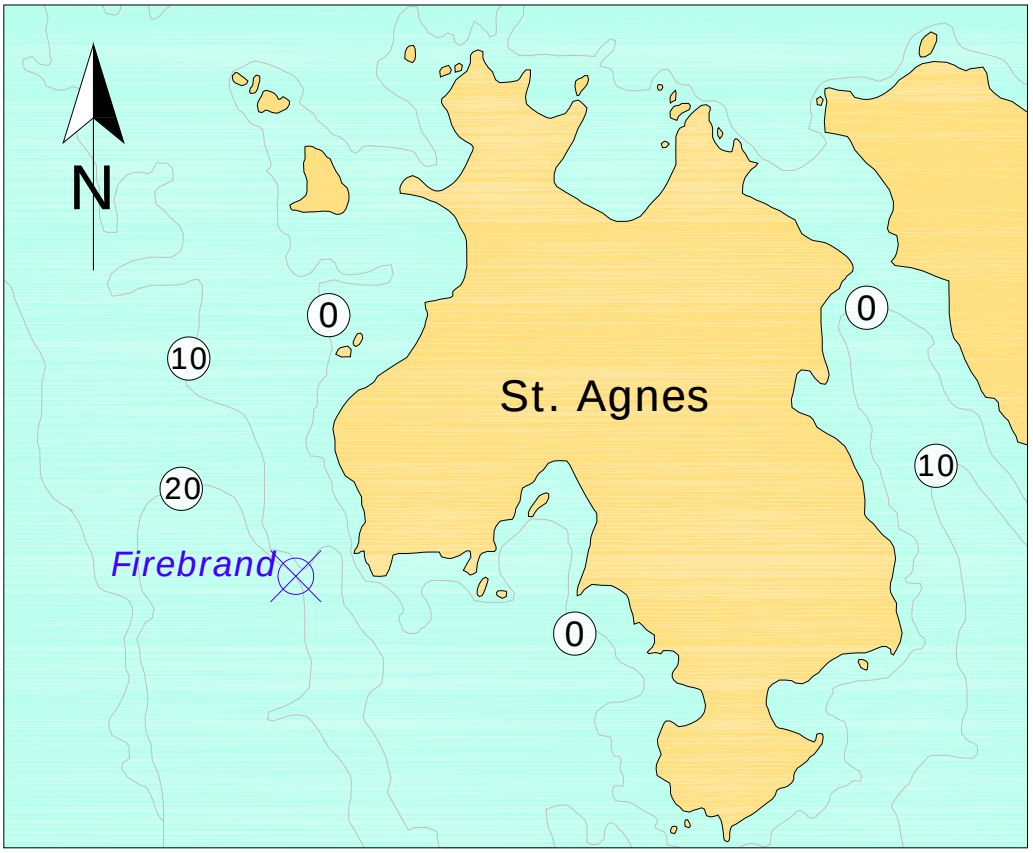

Fig 2 Location of the wreck of *HMS Firebrand*

The Ship

Firebrand, a purpose-built fire-ship, was launched at Limehouse on the River Thames in 1694. During her 13-year career she saw service in Newfoundland, the English Channel, the Mediterranean and the West Indies. In 1707 Firebrand was part of Sir Cloudesley Shovell's fleet in the Mediterranean at the siege of Toulon. As winter approached, Sir Cloudesley left a squadron blockading Toulon and set off for England with the rest of his fleet. This consisted of 21 ships including four fire-ships: *Firebrand, Griffin, Phoenix* and *Vulcan* (Cooke, 1883). Having miscalculated their position, the fleet ran into the Western Rocks off Scilly on the night of 22nd October 1707. Three ships, *Eagle, Romney* and Sir Cloudesley's flagship *Association,* were lost with only a single survivor between them. The fire-ship *Phoenix* struck a rock and eventually grounded between Samson and Bryher. Refloated and beached at New Grimsby (Tresco), she took three and a half months to repair. *Firebrand* also struck the rocks but managed to get off again. Leaking badly, she made for the beacon of St Agnes lighthouse. *Firebrand* foundered in Smith Sound close to the island of St Agnes. Of *Firebrand's* 45 crew members, 25 - including Captain Percy - managed to reach the safety of St Agnes. Over 1500 men perished in this incident, making it one of the worst disasters in British naval history (Larn, 2006).

Firebrand vital statistics (Lyon, 2001)	
Length	92' 3" (28.1m)
Beam	25' 5" (7.7m)
Draught	9' 7" (2.9m)
Tonnage	268
Guns	6 minions (c.3lb) 2 falconets (c.1.5lb)
Crew	45
Built	At Limehouse by John Haydon
Ordered	13th December 1693
Launched	31st March 1694
Wrecked	22nd October 1707

Site Description

The wreck lies on a gently sloping seabed at a depth of 25 to 30m. The seabed consists of regions of silty sand lying over coarse crystalline granite bedrock. The visible wreckage consists of several areas of exposed timber (oak), four large bower anchors, two smaller anchors (kedge and stream) and eight iron guns. There are also considerable amounts of concreted iron work as well as a number of exposed small artefacts. The wreckage is flanked to the east and west by low-lying granite reefs. A short description of the site geology by Phil Rees appears below in appendix III.

Fig 3 One of the Firebrand's four bower anchors – note the missing upper fluke.

Most of the wreckage appears to be *in situ*. A striking exception is the gun and bower anchor standing propped against each other at the northern end of the site (Fig 2). This gun and anchor are not shown in this position on the 1981 Morris sketch – they may have been moved there and used as a mooring by the Morris team.

Fire-ships

Originally these were old vessels adapted as fire-ships, but by the 17th century the Royal Navy was having purpose-built fire-ships constructed, 23 being built between 1691-4 (Coggershall, 1997). Fire-ships were specialised attack craft, but were rarely used as such; they spent their working lives as 'sloops-of-war' (Woodman, 2005). The principal features which characterise a British fire-ship are:

- Fire-room ports hinged at the bottom edge (gun ports hinged at the top)
- Iron chambers filled with gunpowder to blow open the fire-room ports
- Sally ports towards the stern for crew escape
- Fire-room with special ventilation and combustibles
- Fire trunks or chimneys to spread the fire from the fire-room to the rigging
- Grapnels to tangle the enemy vessel (Falconer, 1780)

Fire-ships were used with success in a number of actions including those by Drake against the Spanish in 1588; Tromp, again against the Spanish, in 1639; Holmes against the Dutch (Holmes' bonefire) in 1666; Ruyter against the English fleet in 1672 and by Shovell against the French at La Hougue in 1692 (Roger, 2004). The beginning of the 19th century saw the last fire-ships built by the British navy.

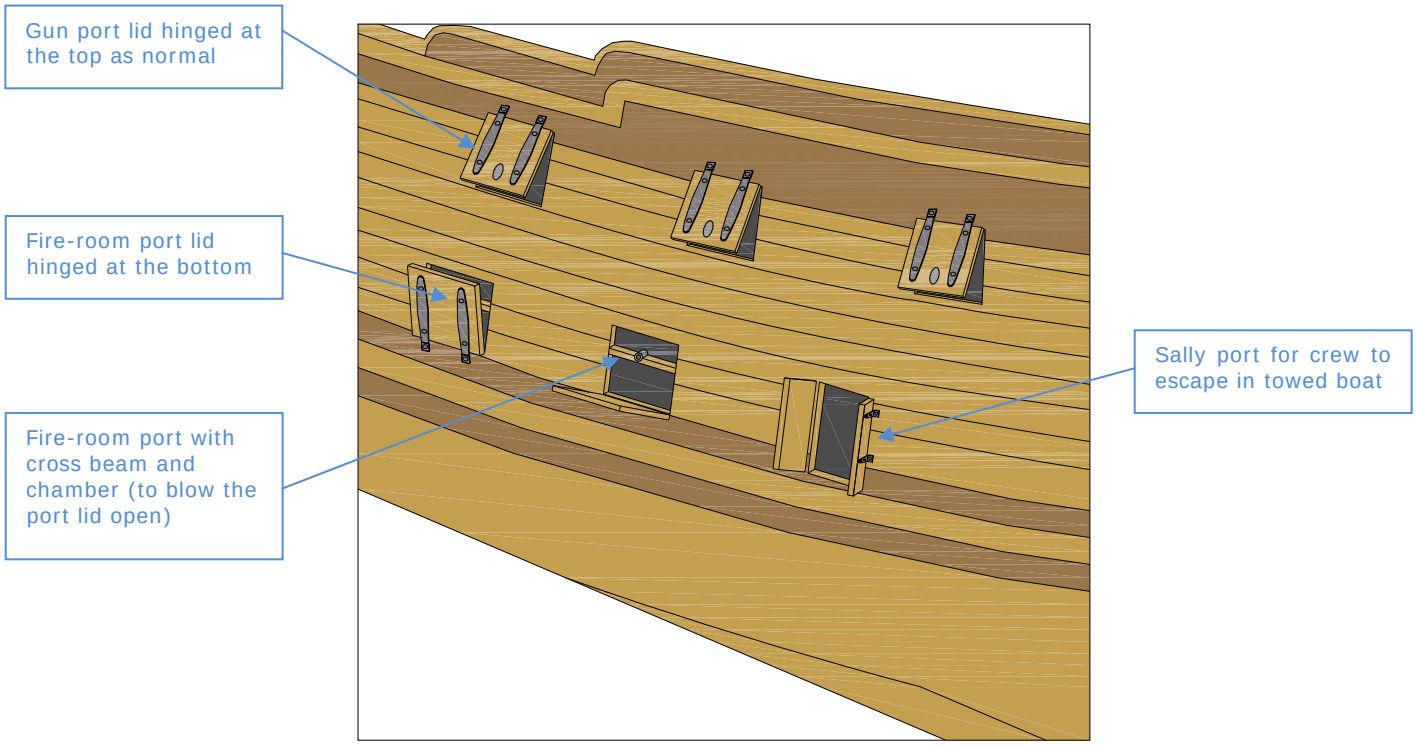

Fig 4 Typical 18th century fire-ship showing the arrangement of the gun ports, fire-room ports and sally port

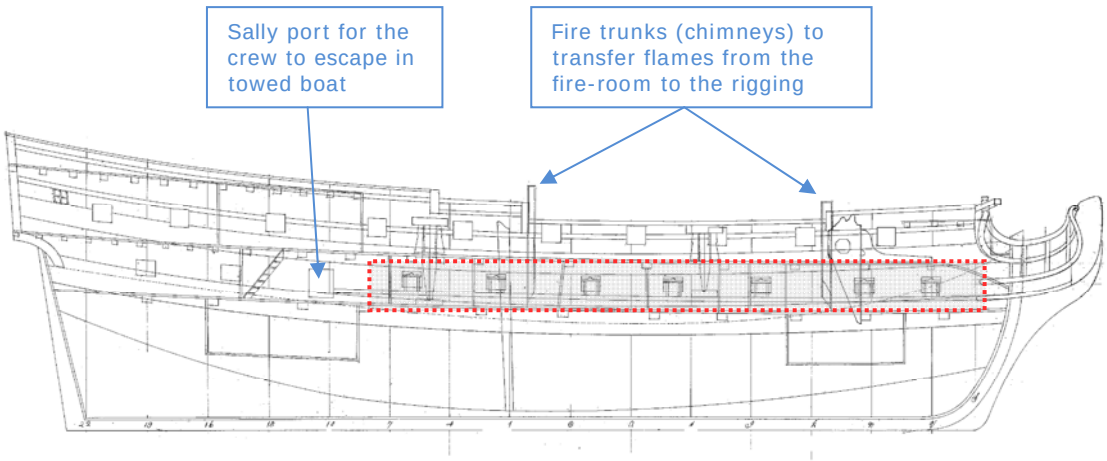

Fig 5 Sheer plan of the fire-ship Griffin (1690) with the fire-room outlined in red

Feature	Dimensions & composition	Source
Fire port chambers	10" long x 3.5" diameter (0.25 x 0.09m) Iron	Falconer, 1780
Fire Trunks (chimneys)	18" square section (0.45m) Extending from fire barrels in the fire-room to the shrouds Wood, copper or brass (iron?)	Coggershall, 1997
Fire barrels	Inside diameter at least 21" (0.53m) Height at least 30" (0.76m)	Falconer, 1780

Fig 6 Table showing known dimensions and composition of fire-room features

Previous Work

The wreck of *Firebrand* was located in 1981 by a team led by Roland Morris, a Penzance salvor and private shipwreck museum owner. The team recovered a number of items from the wreck including the ship's bell, a nocturnal (a navigational instrument) and a carved wooden cherub. They also made a sketch of the exposed remains (Morris, 1981). The ship's bell is owned by Mark Groves, but the whereabouts of the other items is uncertain. We do not know the extent, position or results of the excavations undertaken by the Morris team. Sketches were also made by Ken Dunstan in the early 1990s and by Todd Stevens in 2005. It has also been reported that a NACSAC team have excavated on the site – at this stage no further details are known.

In 2006 a survey of the seabed remains was started as a field school for Bristol University post-graduate archaeology students. Ten days were spent on site during which the survey control point network was established and the guns and anchors were recorded and mapped. The team consisted of eight students and four tutors.

The survey was continued in 2007 by a team of four divers from CISMAS and Bristol University. This work was jointly funded by Bristol University and Sonardyne International Ltd. The work concentrated on detailed recording of the exposed wreck material and seabed topography using planning frame drawing at a scale of 1:10. Approximately 30% of the site was surveyed during six days' diving.

In 2008 the pre-disturbance survey was completed by a team of six CISMAS divers in six days. This work was funded mainly by Sonardyne International Limited, with additional support from The Isles of Scilly Steamship Company, Kerrier Developments, 3H Consulting and Ambient Pressure Diving.

The survey to date is reproduced below in appendices I & II.

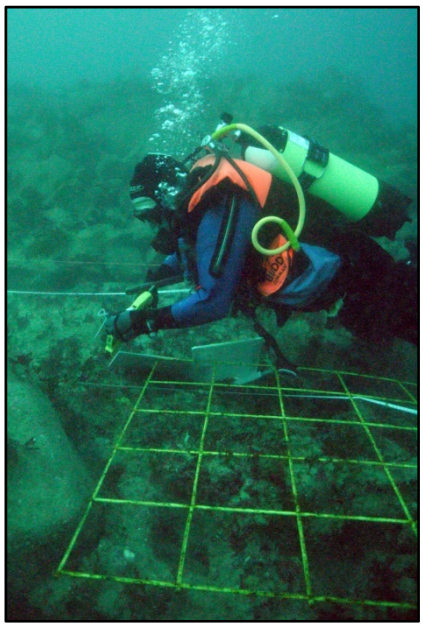

Fig 8 Survey in progress 2008

Fig 7 An iron gun, G4, propped against one of the bower anchors, A5

Research Aims and Objectives

- Produce a pre-disturbance survey of the wreck
- Determine which elements of the wreck (if any) are peculiar to *Firebrand's* role as a fire-ship.
- Establish the extent and preservation of the buried elements of the wreck.
- Establish the extent of previous excavation on the site if possible
- Assess a number of different survey techniques
- Trial and evaluate different recording systems
- Complete the documentary history of *Firebrand*
- Research the role and nature of fire-ships in the Royal Navy

Business Case

No fire-ship wrecks have been investigated in British territorial waters. This site offers a unique opportunity to investigate this type of vessel. Although builders' plans exist for the fire-ship *Griffin*, a contemporary of *Firebrand*, these plans show very few of the specialised fittings of a fire-ship. Exploration of this site offers the chance to investigate the actual specialised weapons system of a fire-ship of this period.

It is hoped that further benefits will accrue from the research into recording techniques and the quantification of their efficacy that will be undertaken on this project. Very little intrusive work is currently undertaken in British underwater archaeology. It is therefore important that we evaluate the recording techniques which we employ to determine the most appropriate methods to use. This work should benefit future projects. Similarly, the paucity of current practical work means that there are very few opportunities for students and new practitioners to learn the practical techniques of their trade. We hope to make places on the team available to suitable students and new practitioners to help address this problem.

The *Firebrand* is not a designated wreck under the Protection of Wrecks Act 1973. This is partly due to the unusual local arrangements concerning access to the *Firebrand* site. One of the reasons that this site has survived so well, especially in an area where wrecks are often exploited for their commercial value, is the unique informal guardianship of the site. Mark Groves, one of the original team which found the wreck, has managed to deter local exploitation of the wreck. Mark was very keen for our team to begin survey of the wreck in 2006 and he continues to be supportive of our work. However, he has been very eager to avoid publicity as he believes that this will only encourage irresponsible exploitation of the wreck.

Project Team

Firebrand – Core Team		
NAME	ROLE	ORGANISATION
Sharon Austin	Photographer & survey assistant	CISMAS
Kevin Camidge	Archaeologist – project manager	CISMAS & Darkwright Archaeology
Peter Holt	Surveyor & GIS	3H Consulting
David McBride	Skipper & videographer	CISMAS & Tamarind
Kimberly Monk	Archaeologist	Bristol University
Luke Randall	Student archaeologist	CISMAS & Bradford University
Phil Rees	Marine geologist	CISMAS
Bren Rowe	Draughtsman	CISMAS
Janet Witheridge	Draughtsman	CISMAS

Methods Statement

Pre-disturbance Survey
This was effectively completed in 2008. All the obvious wreckage along with associated topography has been drawn. We aim to instigate a detailed search around this area so that any outlying wreckage can be added to the survey. The search area will extend up to 50m from the current survey.

More bathymetric data needs to be collected to refine the existing contour survey. The most effective method identified to date is collection of bathymetric data by divers using digital depth gauges (dive computers).

The survey methodology used on this project is discussed in detail in appendix IV below.

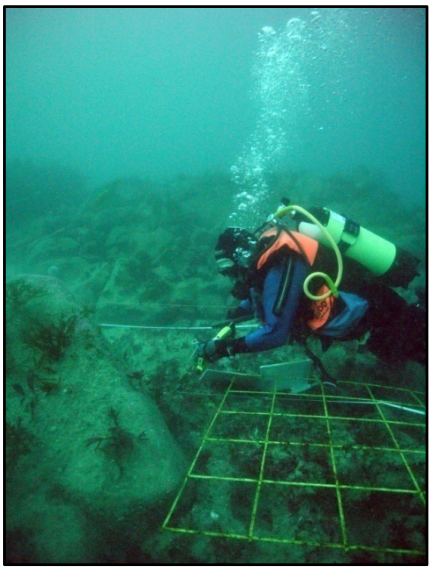

Fig 9 Planning frame survey in progress, 2008

Elements Peculiar to Fire-ships
Between guns G6 and G7 there is an area of concentrated iron concretion possibly associated with the fire-room fire trunks. This will need to be cleaned and recorded in more detail. Cleaning will be confined to removal of marine growth to allow detailed survey and recording. No ironwork will be deconcreted – this would be likely to lead to destabilisation of the iron in question. It will be worth cleaning and evaluating the rest of the iron concretion in this area.

Buried Elements
It would be useful to know the extent and condition of any buried elements of the wreck. In 2008 a limited wire probe survey was conducted – but the results were inconclusive due to the difficulty of identifying the material the probe contacted from 'feel' alone. It is proposed that in 2009 three small sediment test pits (c. 0.25 x 0.25m) are employed to record the sediment sequence, depth and nature. In each case sediment samples will be retrieved to enable physical sediment analysis. All stratigraphy and artefacts within test pits will be meticulously recorded. Any artefacts encountered will be recorded, placed in perforated gripseal bags containing sediment from around the object, and then reburied at the bottom of the test pit prior to backfilling. Excavation will be carried out by hand, using archaeologists' trowels and other small implements. Spoil will be removed and placed in containers for backfilling. All backfill will be consolidated using a covering of geotextile weighted down with sandbags. See the site plan in appendix I for the proposed sediment sampling locations.

Previous Excavation

Study of the distribution of surface rocks on the site plan (appendix II) shows two areas relatively clear of rocks – these may be where the rocks were cleared away prior to excavation, by the Morris team. This hypothesis needs to be tested. Limited hand fanning will be employed in the first instance to see if trench edges can be detected (this will only work if the excavation was conducted in defined trenches).

Survey Techniques

In addition to the aims relating to the wreck itself, we also intend to research different survey techniques and compare their efficacy. In particular, we intend to quantify the efficiency of planning frame recording at different scales. Different scales produce different levels of detail, but the larger the scale the longer the plan takes to draw. By making drawings at 1:5, 1:10 and 1:20 we hope to quantify time and quality implications for these three scales. In 2007 the project made use of a Homer Pro acoustic measuring system loaned by Sonardyne International Ltd. We hope to be able to continue to evaluate the value of acoustic measuring and positioning systems in underwater archaeological projects.

We also intend to conduct comparative trials using drawings made from digital photomosaics. Similar work undertaken on the *Colossus* project by members of the *Firebrand* team has suggested that poor detail and accuracy can result from such surveys. The aim of this trial is to quantify the time savings, inaccuracies and detail loss when using photomosaic-generated site plans. We also intend to investigate improving photomosaic plans by diver post-plan survey.

Recording Systems

The typical archaeological record generated for the majority of maritime sites consists principally of a drawn site plan. Produced either by direct survey methods or from photomosaic / videographic surveys, such site plans record the extent of structural components as well as the 3D positions of artefactual material. Although separate records of artefactual material are often also made, particularly for recovered material, the site plan is often the only record of the structural elements.

As Chadwick (1997: 2) indicates, this was also very much the case in terrestrial archaeology prior to the Second World War. However the discoveries of complex archaeological sites during urban re-development led to the development of contextual or stratigraphic recording systems which are now integral to the record and interpretation of all terrestrial archaeological data. These recording systems consist of pro-forma ‘context’ sheets which prompt for relevant information to be recorded where it is available and are modelled upon the systems developed by the Museum of London Archaeological Services and English Heritage’s Central Excavation Unit (Chadwick 1997: 4).

The use of contextual recording systems in maritime archaeology is very rare. This is perhaps because some believe that maritime archaeological sites represent a single depositional event, a wreck event. However, site formation processes lead to discernable ‘events’ and can as such be used to create a stratigraphic matrix.

Besides the advantages of recognising and recording the stratigraphic information contained within any archaeological site, the adoption of a formalised written record also offers other advantages. Information which is often hard to record on site plans, such as condition and dimensions such as thickness of timbers which are not visible, can all be recorded to facilitate site interpretation and monitoring. A simple pro forma sheet has been devised and will be trialled in the sediment sampling process as well as in recording some timbers which have already been surveyed. The value and cost of collecting this data will then be assessed.

Site Recorder GIS

The project is also being used for field trials of a generic recording schema for use in maritime archaeology. This research builds on work started during the excavation of the Dutch East Indiaman *Vliegent Hart* in 2000 and continued on other excavations including the *Mary Rose* in Portsmouth and the Roman shipwreck at Kizilburun in Turkey.

Photography

Although photographs have been taken on site during all previous phases of work, more detailed pictures taken in good visibility are needed. The quality of underwater photographs depends on a number of factors, principally water clarity (visibility) and light levels. For this reason it is not always possible to predetermine a photography strategy for underwater sites until the water visibility is known – on this site it can vary between 0.5m (bad) and 10m (good). In particular we need good pictures (oblique and vertical views) of the area of concentrated iron concretion and of the guns and anchors.

Limited Excavation

The detailed methodology for this phase of the project can only be formulated after the sediment sampling pits have been excavated and the results analysed. In general terms it is proposed that a single east-west trench, no more than 2m wide and 7m long, is excavated. The position of the trench will be informed by the results of the test pit survey. If buried structural timbers are located this should enable us to establish exactly how much of the wreck survives and exactly how the remains lie. No structural timber will be disturbed; it will be recorded and left in place. No more than 5% of the site will be excavated – thus ensuring that the site is available for future research. The actual excavation method employed will be informed by the test pit excavations. Once completed, the trench will be backfilled using the spoil removed from the trench. The surface of the backfill will be consolidated using a geotextile such as Terram 4000 held in place with sandbags – this will prevent erosion of the un-consolidated backfill. This phase of the project will only be possible if sufficient funds are available to cover the extra resources required, which are:

- Extra manpower – probably need 10 divers
- Two week season – due to bottom time constraints
- Conservator/finds recorder
- Museum or institution to receive any recovered objects
- A conservation strategy will need to be developed
- Permissions (Crown Estates, FEPA) – these can be expensive

Only once all these are in place will this phase of the project be able to proceed.

Diving Constraints

The depth at which the site lies imposes severe constraints on the amount of bottom time divers working on the site have. Diving is currently undertaken using air tables and a regime of no-stop diving. Decompression diving is avoided for safety reasons. Divers undertake two dives per day with a two hour surface interval. This results in a 20-25 minute bottom time for each of the two dives – a total time on the bottom of about 40 minutes per day per diver. The actual times depend on the state of the tide (water depth). If the project is to undertake excavation on the site, this limitation clearly needs to be addressed. To increase the amount of useful activity a number of options have been considered:

- Increase the size of the team
- Use NITROX breathing gas instead of air
- Use closed circuit constant ppO_2 rebreather sets

Any increase in the size of the team brings increased costs for accommodation, travel etc. It also brings increased problems of control and of finding suitably skilled individuals. The use of NITROX would be expensive – there are no NITROX facilities on the islands, and so we would have to transport large quantities of premixed nitrox or oxygen and an oxygen-clean compressor to Scilly. We would also need to find premises from which to operate the compressor and oxygen blending – the NITROX blending would also be costly in terms of operator time. The rebreather option, however, would offer significant increases in no-stop bottom times. The Ambient Pressure Inspiration Vision unit would give 35-60 minute no-stop times for each dive – a significant increase over open-circuit air. The rebreather also maximises no-stop times as the partial pressure of oxygen is optimised for each dive. The low oxygen consumption of these units would mean that sufficient oxygen for a week of diving could be easily transported to the islands. The downside is the very high initial cost of the unit. An Inspiration Vision unit with training, spares and essential supplies costs £7000, and the minimum useful number of units would be two. If sponsors could be found to underwrite this aspect of the project, productivity could be enhanced. The actual strategy used will depend on the level of funding secured – in the current economic climate this is not likely to stretch to rebreather sets.

Archive and Dissemination

The project to date will be summarised in a project report which will be produced by December 2009/January 2010. This report will be available to download from the CISMAS website. Copies will be deposited with Cornwall HER and the Isles of Scilly Museum. All records will be contained within the Site Recorder GIS, which will also be made available (along with a free reader) on the CISMAS website.

Interfaces

This project will need to interface with the following ongoing projects:

- Research into the other 1707 losses
- Research into fire-ships in general
- Documentary research into *Firebrand*
- *Colossus* shipwreck stabilisation project
- Swash Channel wreck stabilisation project

Stages, Products and Tasks (up to end 2009)

No	Stage	Date	Output	Personnel	Days
1	Planning	May 2009	Project design – define work for 2009 and outline for 2010	KC LR, JW, BR,PH	5
2	Logistics	March-April 2009	Book accommodation Book dive boat Book transport Organise equipment and supplies	KC	1
3	Survey	1-8 Aug 2009	Control point maintenance Add to survey on W,E & S Start 50m peripheral search Clean iron concretion (G6 to G7) Draw 'fire trunk' 1:5 Photomosaic of iron concretion Photograph iron concretion in detail Photograph guns and anchors Collect additional bathymetric data 3x Sediment sample pits Recording trials	PH & SA JW, BR, LR, SA BR, LR, PR PR, SA KC, JW KC, SA LR KC & SA SA & PR PH, BR, LR ALL ALL	2 2 1 1 2 1 1 1 1 2
4	Post processing	Aug 2009	Complete input to Site Recorder Output AutoCad file for printing large plans	KC, PH KC, LR	3 2
5	Reporting	Dec 2009	Produce project report	KC LR PH JW	5 2
6	Review	Jan 2009	Make funding applications Detailed design (PD) for 2010 work Outline different projects depending on likely funding levels	ALL	1

Firebrand – Estimated Timescale					
SEASON	TEAM	DURATION	TASKS	OUTPUTS	COST
2009	7	1 week	Complete PDS Bathymetry Peripheral search Recording trials Sediment test pits	Updated site plan GIS database Progress report Updated project design	£3700
2010	10	2 weeks	Update the survey Limited excavation Recording trials Finds recording & conservation Finds disposition Reporting	Updated site plan GIS database Finds to museum or reburial Report	£10k

Budget 2009

Item	Detail	Cost
Transport PZ-IoS-PZ	7 x £65 (subsidised fare)	£455
Dive boat charter	6 days hire of *Tiburon*	£1750
Accommodation	At Schiller B&B	£1050
Dive air	7x12x£2.85	£239.40
Survey materials	Tags, drafting film, control points etc	£150
Total		**£3644.40**

We have £3000 from sonardyne.
The shortfall of £644.40 will need to be made good by securing extra sponsorship or by a contribution from each team member (644.4/7) of £92.06.

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Appendix I – Site Plan

Appendix II – Site GIS and reader (CD ROM)

Appendix III – Geology (Phil Rees)

The geology of the area in the vicinity of the *Firebrand*, which lies in Smith Sound to the west of the Island of St. Agnes, is comprised of coarse grained granite with large crystals of feldspar. The present landforms above and below sea level have been largely influenced by the jointing in the granites which has resulted in preferential weathering along the joint plains. The predominant alignment of the joints is in a NNW/SSE direction which in this instance has been eroded to form the channel known as Smith Sound.

The wreck site itself lies directly adjacent to a line of tors or carns on the shoreline some 20-25 metres high in the form of an imposing arrangement of large blocks. At or just below sea level, the granite along the shoreline has been broken up to form large individual blocks up to several metres across. From the shoreline towards the wreck site some 100 metres offshore, there is a tendency for the granite blocks to become progressively smaller with depth.

Although the channel has some protection from an area of rocks to the west known as “Hellweathers”, Smith Sound represents a very high energy environment where the seabed is subject to wave induced current and strong tidal stream currents. The wreck site itself is characterised by an assortment of angular blocks of granite up to one metre across interspersed with areas of coarse gravelly sand.

Appendix IV – Survey Methodology (Peter Holt)

The primary aim of the pre-disturbance survey was to accurately record the positions of the guns, anchors, ship's structure and artefacts in relation to one another. Secondary aims were to position the site in absolute co-ordinates and to record the topography of the site.

As the highest position accuracy was required, 3D trilateration was initially used to record the positions of the guns and anchors relative to a network of primary survey control points. The site was then drawn in detail using planning frames positioned using tape baselines laid between survey control points, with the points themselves positioned within the primary control network.

As is common when recording underwater sites, the shape of the survey point network evolved as the work on site progressed. The rock outcrop that runs the length of the site on the West side was used as the starting point for the primary control point network. Three primary control points (CP1 – 3) were hammered and cemented into fissures in the top of the rock in positions where each had a good line of sight to other points around the site. The remaining control point positions were defined by the distribution of guns and anchors that comprise the main site. The other primary points were simply hammered into the seabed as suitable fixing points on rocks were not available.

Stainless steel rod in 500mm lengths of 10mm diameter were used for the primary points. Each point was labelled with a yellow Disk-mark tag (*ref York Survey*) and a length of yellow flagging tape was tied around the top of the rod to make the points more visible. The exception to this was CP30 where a chisel mark on the top of a very large boulder was used to mark the survey point.

Survey points were named in sequence starting with CP1 (Control Point). Primary and secondary points use the same naming format for convenience as the role of any point could change as the survey work progressed.

Direct distance measurements were made between the survey points using standard fibreglass tape measures. The tape measures were calibrated against a steel cored survey tape before use to check for errors. Depth measurements were made using a dive computer. The same dive computer was used for all of the measurements to minimise offset errors.

Surface buoys were attached to two points at the extreme ends of the site and were positioned on the surface using fixes from a Garmin 76C hand held GPS receiver.

The positions of the primary survey control points were calculated by processing the distance, depth and surface position measurements using the Site Recorder 4 computer program. The adjustment program calculates the best estimate of the position of the points, an estimate of the position error for each point and calculates quality metrics for each of the measurements. Any measurements that were found to be in error were re-measured and the point positions recalculated.

As the surface position measurements were included in the position calculation the computed positions for the points was already in real-world co-ordinates.

Once the positions for the primary control point network had been calculated the points were used to position detail survey points on guns, anchors and artefacts.

Measurements were made from each detail point to the four nearest primary control points. Guns were positioned using two detail points, one on the top of the cascabel and the other the top of the front face of the muzzle. The name of each detail point included a 'G' prefix, the gun number and either 'c' for cascabel or 'm' for muzzle (for example, the two points on Gun 6 were G6c and G6m). Anchors that were intact were positioned using four detail points, one on the shank, one on the crown and one on each of the two flukes. The name for each detail point included an 'A' prefix, the anchor number and one of four identifiers for each location 'S', 'C' 'fW' and 'fE' (for example, Anchor 4 used the four points A4S, A4C , A4fW, A4fE). Artefacts were positioned using a single detail survey point.

Secondary survey control points were added in places where it was not possible to make four measurements to a detail point or where it was necessary to add a tape baseline to be used to position a planning frame. Each secondary point was positioned relative to the primary network using four or more distance measurements to primary points and a depth measurement.

Drawing frames were positioned relative to a tape baseline or to two or more survey points. Where a baseline was used the two points where the tape crossed the edge of the frame were recorded along with the distance along the baseline of one of the points. The positions of survey points were also recorded on the drawing frame drawing so these could be used to position the frame or as an additional cross-check on position.

For each drawing frame drawn underwater a Drawing Frame object was added to the Site Recorder program and positioned on the chart using a baseline (Distance Measurement). For each Frame the points where the baseline crosses the edge of the Frame was set and it then automatically positioned itself on the chart in the correct location. The drawing made underwater was then scanned and added to the correct Frame in Site Recorder where its image was then shown on the chart at the correct scale and in the right place. The scanned drawing was then traced (digitised) separating rock, concretion and timber onto different Layers. As a final step, the traced lines at the join between two frames were joined up.

Horizontal Control

All positions are given using the WGS84 datum and grid positions use the Universal Transverse Mercator (UTM) projection Zone 30U.

Position of the centre of the site (Crown of Anchor 4)

49° 53.252 N 006° 21.286 W (WGS84)

259036 E 5531523 N (WGS84 UTM30U)

In the 2006 season the primary control points CP1 to CP8 were added. In 2007 we found that the pins marking CP2 and CP3 had been removed so they were replaced with points CP2B and CP3B in new positions close to the original locations. The primary point CP12 was added in the middle of the site along with secondary point A4C2, CP9 to CP11. In 2008 the primary point CP15 was added to extend the site to the North and CP30 to extend it to the South. Points CP16, 23-25 were added to the East of the site to improve the network shape by making it wider. Secondary points CP17, 20 and 31 were added to support the planning frame survey and were left in place. Secondary points CP18, 19, 22, 26, 27, 28, 29, 32 were added for the same reason but were subsequently removed.

Surface positions were taken using a WAAS enabled Garmin 76C GPS receiver on buoys attached to two points on the site. The estimated position error for a static fix at the surface using this receiver is 4m however additional offset error will occur because of the rope attaching the buoy to the seabed.

Fix	Easting	Northing	Notes
GPS001	259021.760 E	5531541.550 N	Crown of Anchor 5
GPS002	259039.750 E	5531514.760 N	Gun 1 Cascabel

The site was moved and aligned to these positions so that the crown of anchor 5 was at the position GPS001and the cascabel of Gun 1 was placed as close as possible to GPS002. The position of the cascabel computed from the trilateration survey differs from the GPS fix by only 3.6m, a small difference given the inherently inaccurate method used for position fixing. If a better estimate of the absolute position and orientation of the site becomes available at a later date then the whole site plan can be shifted and rotated accordingly.

For the adjustment of the primary control point positions the measurements fit together to within 22mm (RMS of residuals). A total of 151 measurements were processed together to collectively position the 32 primary and secondary points giving an overall RMS of 20mm. The adjustment of the positions of the detail points positioned from the fixed control network gave an RMS of residuals of 40mm, resulting in position error estimates of 100mm (95% semi-major) for a typical point inside the network. These results are as expected for a survey of this type under the given conditions.

Vertical Control

The positions on the site are recorded with Z positive downwards so Z measurements are given as depths. All depths are reported relative to a temporary benchmark (TBM) defined as the top of the cascabel of Gun 1, at survey detail point G1c. This point was given a fixed value of 25m and all depth measurements have been corrected for the effects of tide height using this point.

Further Work

Check Anchor 4

The position of the crown of Anchor 4 computed from the trilateration survey differs from the position given by the drawing frame recording. This difference of 240mm in the position of the crown results in a 4° alignment error for the anchor. As a first step to determine the source of this error the detail points on the anchor need to be re-measured.

Primary Network

The distance between control points CP4 and CP30 needs re-measuring.

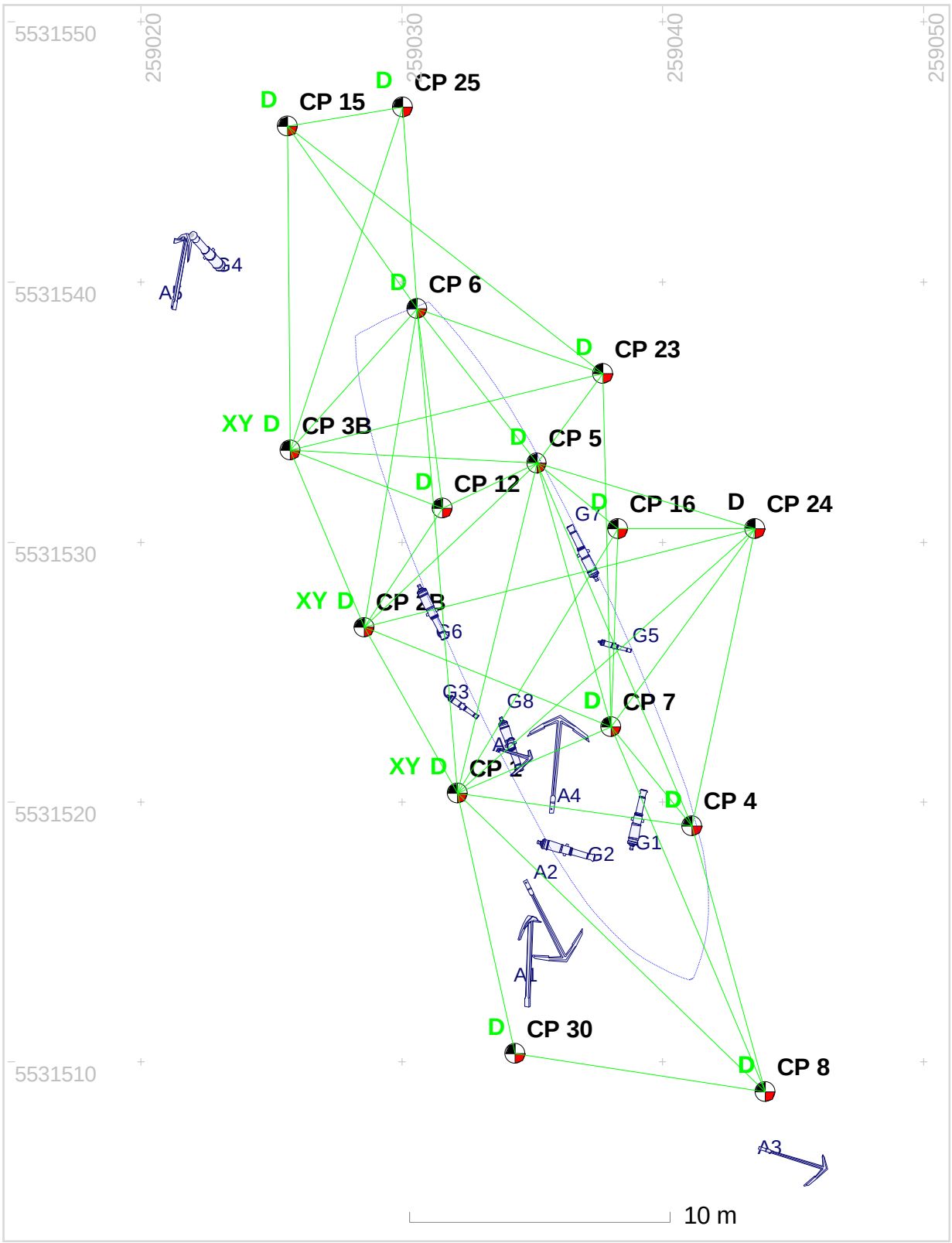
Additional CP

An additional control point is required at 259046.953, 5531519.042 tie in to CP24, CP4, CP8, CP30. This will improve the robustness of the network and will improve the positioning of points at the south end of the site.

Table of Survey Point Positions

Name	Easting	Northing	Depth	Description
A1c	259034.883	5531515.646	24.380	Anchor Detail
A1flow	259033.754	5531514.475	25.576	Anchor Detail
A1fU	259034.548	5531514.702	23.556	Anchor Detail
A1s	259035.011	5531512.006	24.219	Anchor Detail
A2c	259036.321	5531513.867	25.511	Anchor Detail
A2fE	259036.698	5531515.099	24.884	Anchor Detail
A2fW	259035.227	5531513.969	25.417	Anchor Detail
A2s	259034.695	5531517.006	24.051	Anchor Detail
A3c	259046.244	5531505.843	23.200	Anchor Detail
A3f1	259046.175	5531506.407	23.100	Anchor Detail
A3f2	259045.131	5531505.263	23.500	Anchor Detail
A3s	259043.652	5531506.673	23.687	Anchor Detail
A4c	259036.062	5531523.310	24.951	Anchor Detail
A4C2	259035.829	5531523.453	24.963	Secondary
A4fE	259037.144	5531522.396	24.984	Anchor Detail
A4fW	259034.912	5531522.627	25.051	Anchor Detail
A4s	259035.766	5531519.594	25.002	Anchor Detail
A5c	259021.920	5531541.871	26.599	Anchor Detail
A5f1	259021.305	5531541.482	27.493	Anchor Detail
A5f2	259021.795	5531540.733	26.600	Anchor Detail
A5s	259021.256	5531538.920	27.500	Anchor Detail
CP 1	259032.119	5531520.323	22.979	Primary Control
CP 2	259028.771	5531526.692	23.398	Primary removed
CP 2B	259028.541	5531526.701	23.411	Primary Control

Name	Easting	Northing	Depth	Description
CP 3	259024.160	5531533.406	24.702	Primary removed
CP 3B	259025.726	5531533.534	24.768	Primary Control
CP 4	259041.165	5531519.080	25.064	Primary Control
CP 5	259035.170	5531533.034	25.088	Primary Control
CP 6	259030.559	5531538.976	26.160	Primary Control
CP 7	259038.031	5531522.887	25.150	Primary Control
CP 8	259043.938	5531508.858	24.394	Primary Control
CP 9	259033.552	5531529.803	25.403	Secondary Control
CP 10	259035.204	5531531.273	25.291	Secondary Control
CP 11	259033.386	5531533.737	25.689	Secondary Control
CP 12	259031.554	5531531.292	25.018	Primary Control
CP 15	259025.597	5531545.965	26.005	Primary Control
CP 16	259038.292	5531530.515	24.996	Primary Control
CP 17	259039.443	5531515.416	25.121	Secondary Control
CP 18	259040.252	5531519.389	25.005	Temporary for drawing frames
CP 19	259038.377	5531520.164	25.006	Temporary for drawing frames
CP 20	259037.590	5531516.110	25.101	Secondary Control
CP 22	259034.274	5531530.695	25.140	Temporary for drawing frames
CP 23	259037.703	5531536.495	24.921	Primary Control
CP 24	259043.549	5531530.536	24.215	Primary Control
CP 25	259029.996	5531546.706	25.025	Primary Control
CP 26	259028.682	5531538.306	26.179	Temporary for drawing frames
CP 27	259032.604	5531529.784	25.460	Temporary for drawing frames
CP 28	259026.998	5531537.271	26.339	Temporary for drawing frames
CP 29	259036.356	5531526.767	25.018	Temporary for drawing frames
CP 30	259034.346	5531510.328	25.304	Primary Control
CP 31	259035.393	5531519.555	25.279	Secondary Control
CP 32	259033.234	5531526.096	25.213	Temporary for drawing frames
G1c	259038.830	5531518.251	24.999	Gun Detail
G1m	259039.300	5531520.462	25.111	Gun Detail
G2c	259035.274	5531518.458	25.194	Gun Detail
G2m	259037.424	5531517.847	25.219	Gun Detail
G3c	259031.764	5531524.066	24.351	Gun Detail
G3m	259032.910	5531523.249	24.475	Gun Detail
G4c	259023.144	5531540.460	27.494	Gun Detail
G4m	259022.029	5531541.700	26.500	Gun Detail
G5c	259037.580	5531526.166	24.847	Gun Detail
G5m	259038.806	5531525.804	24.948	Gun Detail
G6c	259030.729	5531528.214	24.667	Gun Detail
G6m	259031.615	5531526.379	24.755	Gun Detail
G7c	259037.466	5531528.590	24.870	Gun Detail
G7m	259036.443	5531530.636	24.782	Gun Detail
G8c	259034.561	5531521.161	24.802	Gun Detail
G8m	259033.801	5531523.210	25.044	Gun Detail


5531550
5531540
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D CP 25
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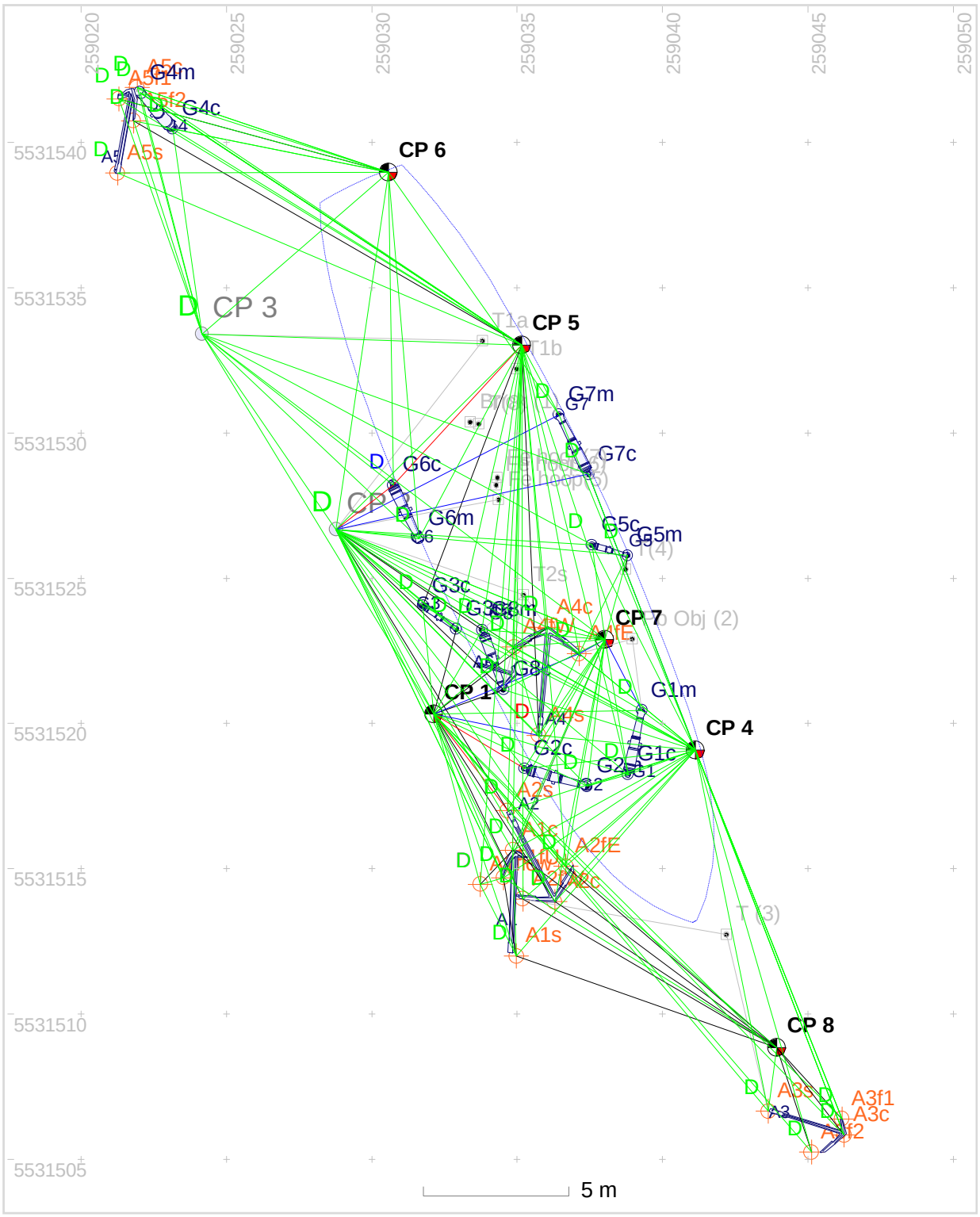
D CP 5
D CP 12
D CP 16
D CP 24
XY D CP 2B
D CP 7
XY D CP 1
D CP 4
D CP 30
D CP 8
A5
G4
G7
G6
G5
G3
G8
A6
A4
G1
G2
A2
A1
A3
10 m

Detail Points



Appendix V – Documentary History (Janet Witheridge)

Introduction.
This is very much work in progress at this stage. A number of primary sources of information have been studied and are listed in the table which follows. In addition fire-ship models have been studied at the National Maritime Museum and a number of secondary sources are quoted. The search has concentrated on two main areas; the construction particular to fire-ships to help to explain the large quantities of iron found on the seabed, and analysis of the active service of the *Firebrand*.

Construction unique to a fireship.
A fireship is a specialised vessel converted, or specially built, to attack moored vessels by setting them on fire. Fireships were sailed towards the target by a small crew who set the vessels alight at the last minute before escaping in the ship's boat. The models, particularly that of the *Dolphin* (SLR 0226) which shows half of the ship in its original state and the other half converted into a fireship, were very helpful. Together with the lists of the stores required, their stowage and the method of priming a fireship (ADD 49102 see the box below), the following characteristics and their uses has been compiled;

- Sally Ports to allow quick access on either side to the boats to escape once the fireship was ignited. In conversions these appeared to be constructed from the aft gun port;
- A fire-room extending from the bow to astern on the main mast with two doors and 'troughs of communication' (sic) leading from each fire-room door to the Sally Port;
- Two fire trunks (chimneys) on each side, leading from each end of the fire-room to spread the fire to the shrouds. (Lyon, 1993 suggests that these would have been copper of brass);
- Fire-room ports to drop downwards to open (rather than being pulled upwards) and thus to stay open and create a draught for the fire (David Lyon (1993) describes these as opening when the retaining ropes burnt through and having *a "firework" of the Roman Candle variety placed inside"*. Other reports have described the ports as being 'exploded open by an exploding cylinder'); NB the gun ports of the upper "gun" deck open in the normal way - upwards.
- One model showed an intricate system of wooden troughs filled with rushes covering the fire-room floor.
- According to Richard Woodman (1997), additional conversions included the fitting of grapnels to yard arms, removing planking from part of the decks, providing chocks for barrels of gunpowder, inflammable pitch, spirits and other combustibles.

Dimensions (The Society for Nautical Research 1939)
Length: 92'3"
Beam: 25'5"
Tons: 268 (is this tonnes?)

The National Maritime Museum does not have a plan of the *Firebrand*. A plan of another fireship – *Griffin,* built in 1690 - is available

There would have been several fireships in the fleet. A lieutenant's log for 1705 (ADM / F/L/138v describes Sir Cloudesley Shovell's fleet as being 39 ships of the line of battle, 7 fireships and 4 bombs together with several light frigates and a great many transports and tenders.

The *Firebrand* had a compliment of 45 men, and the Pay and Muster Books list a Commander, Lieutenants , a physician, a master and midshipmen.

Active service of *HM Fireship Firebrand*

HM Fireship Firebrand, an 8 gun (ADM 8 4)[6 Minion and 2 Falconette (NMM ADL/H/222), 5th rate sloop of war, was launched on 31st March 1694 from John Haydon's Yard in Limehouse and wrecked on 22nd October 1707 in Smith Sound in Scilly, to the west of the island of St Agnes. According to a letter written by Captain Francis Piercey, dated 25th October 1707, "*17 men were saved in the boat, with the Captain and five drove ashore on a piece of the wreck*". It is recorded that Edw Wilford, midshipman died in the wreck; her physician Chas Bradford, lieutenant Wm Probyn and midshipman B Marshall were listed with the survivors.

Examination of her logs shows that she spent the majority of her active service on Channel Service, protecting trade. She was briefly in Newfoundland in Canada in 1702. Between 1704 and 1707 she made several voyages to the Mediterranean, was engaged in the battle of Valez, off Malaga in 1704 with Sir Cloudesley Shovell and Rear Admiral Leak's Squadron, and was present when the army took possession of Barcelona in 1705 under Admiral Sir Cloudesley Shovell. She was returning from the Mediterranean with Admiral Sir Cloudesley Shovell's fleet following the siege of Toulon, when the flagship (HM Ship *Association)* mistook the longitude and led the fleet onto the rocks on Scilly - see the abbreviated time line below for sources.

Abbreviated Time Line

	Event	Officers	Ref
	Firebrand ordered		1
1694 31 Mar	*Firebrand* launched at Haydon's Yard in Limehouse		1
Jul-Oct		Captain William Carter	(Coggeshall, 1997)
Oct - Dec	Voyage to the West Indies ?	Captain John Soule Master William York	ADM 52 33 1
1695 Jan - Nov	Returning from the West Indies ?	Captain John Soule Master William York	ADM 52 33 1
Oct - Dec	Returning to Channel	Captain Joseph Hickman Master William York	ADM 52 33 2
1696 Feb	Refitted in Portsmouth harbour prior to Channel service	Captain Joseph Hickman (or Josiah Hickman) 45 men 8 guns Master William York	ADM 8 4
May - Dec	Channel Service With Sir Cloudesley Shovell	Captain Joseph Hickman Master William York	ADM 52 33 2 & 3
Sept	Portsmouth Designed on foreign voyage with Sir Cloudesley Shovell		ADM 8 /5
1697 Jan - Nov	Channel Service Cruising in ye soundings for security of the trades expected home Con from Plymouth with ye Virginia ships	Captain Joseph Hickman Master William York	ADM 52 33 3 ADM 8 /5
Nov	Plymouth	Ordered to be laid up at Plymouth	ADM 8 /5
1698 Jan - Dec	Laid up in Plymouth		ADM 106 489 91
1699 Jan - May	Laid up in Plymouth		ADM 106 489 91
May - Dec	Plymouth	Commander Joseph Hickman Master Geo Richardson	ADM 52 33 iv
1700 Jan - Dec			
1701 Jan - Mar			
Mar-Dec	Channel Service Portsmouth & Plymouth	Commander John Balchin	ADM 51 355 3 i
1702 Jan-Mar			
Apr-Nov	Voyage to St Johns, Newfoundland and return to Portsmouth	Commander Henry Turville Lieutenant Tho Knowles	ADM 51 355 3 ii
1703 Jan - Dec	Channel Service in company with Sir Cloudesley Shovell on *Triumph*	Commander Henry Turville Lieutenant James Rooke Aug 03 – Jan 04	ADM 51 355 4 ii ADM L F 138 i ADM L F 138 ii & ADM L F 138 v
1704 Jan –Dec	Initially in the Channel and then Cruising in the Straits of Gibraltar, engaged in the battle of Velez, Malaga in August and returned to UK in October	Commander Henry Turville Lieutenant James Rooke	ADM 51 355 4 ii ADM L F 138 i ADM L F 138 ii ADM L F 138 iii & ADM L F 138 v, & ADM51/4189/4
1705 Jan - May	Channel Service		ADM L F 138 v

	Event	Officers	Ref
May - Dec	Voyage to Spain where "our army took possession of the city (Barcelona)" and back. Fleet was commanded by Sir Cloudesley Shovell but one source refers to joining the fleet commanded by Lord Peterborow	Commander Henry Turville Samson Bourne Sept 05 Lieutenant Tho Knowler(s) Charles Vanbrugh from October	ADM 51 355 4 ii, & ADM51/4189/4 (Coggeshall, 1997) ADM L F 138 iv ADM L F 138 v
1706 Jan	Deptford		ADM L F 138 v
Feb - Aug			
Aug - Dec	Torbay Lisbon Alicante Gibraltar Lisbon	Commander Francis Percy 1/06 - Lieutenant Tho Harvey 24/4/06 – 8/06 Fra Wallis 19/8/06 – 3/07 Wm Probyn 01/4/07 -	ADM 51 4189 5 ADM 39 789 & ADM 33 257 And ADM 33 2571
1707 Jan - Mar	Lisbon		ADM 51 4189 5
Mar – Oct			
22 Oct	Sank in Smith Sound in the Isles of Scilly	Commander Francis Percy Lieutenant William Probyn Physician Charles Bradford Midshipmen Edward Wilford Ben Marshall	1, ADM 39 789 & ADM 33 257

Research still to do

1. Locate the contract for the *Firebrand* ? ADM 106 3069
2. Locate the letter from Captain Percy dated Oct 25th 1707 recording the loss of the vessel - ?SP 42.
3. Identify the construction of the chimneys.
4. Explore the period of her history when she is said to have been in the Caribbean but for which there are no logs.
5. Put her active service into historical context by looking at sailing orders etc ? ADM 136 and 137.
6. Look at successful actions of fire-ships in naval history
7. Identify numbers of fire-ships deployed - ADM 8 series Monthly list of disposition of ships
8. Verify date of order – thought to be December 1693.

Secondary Sources

Lyon D. (1993). "The Sailing Navy List – A Ships of the Royal Navy (1688-1860)
Woodman R (1997) "The History of the ship" ISBN 1 844860043, NMM ref 623 8 WOO Page 112.
The Society for Nautical Research Occasional Publications No 5 ,"Lists of Men of War 1650 – 1700", Cambridge University Press 1939.

Source: ADD 49102; Napier papers Vol XVII – Recipes / instructions for the manufacture of ordinance supplies including instructions for fitting out a fireship. (There are several handwritten accounts of the priming of a fireship all similar to the one recorded here.)

To place the Stores in a Fireship

The Eight Fire barrels to be placed four under the four fire Trunks and the other four between them, two on each side the fire Scuttles the longest reeds are to be put in to the Troughs and tied on, the shortest Reeds are to be put into the Troughs athwart and tied on the Bavins which are something like a fan and dipt and at one end are to be tied fast to the Troughs over the Reeds: The Curtains are to be nailed up to the Beams equal quantities on each side, the remainder of the Reeds to be put in a Position very near upright at all the angles of every Square in the fireroom and there to be tied on. If any Reeds or Bavins are left they are to be put round the fire Barrels and the other vacant places and tied fast.

To Prime a Fireship

Take up all the Reeds one after another and strew a little composition in the Bottom of all the Troughs under the Reeds. Then tie them gently down again, then Strew Composition upon the upper part of the Reeds throughout the fireroom and upon the said composition lay double Quick Match upon all the Reeds in all the Troughs. The remainder of the Composition strew over all the fireroom and then lay your Bavins loose: Cut off all the Covers of the Fire Barrels and hang the Quick Match loose over their sides: There must be leaders of Quick Match from the reeds into the Barrels and from thence to the Vent of the Chambers in such manner as to be certain of their blowing open the Ports and setting fire to the Barrels. The Quick match is to be tied round the Chambers to prevent its falling off: Two troughs of Communication from each door of the fireroom to the Sally Ports must be laid with a strong leader of Quick match four or five times double also a cross piece to go from the Sally Port the ship is fired at to the Communication Trough laid with leaders of Quickmatch that the fire may be communicated to both sides at the same time

What Quickmatch is left place it so as the fire may be Communicated to all parts of the fireroom at once especially about the Ports and the fire Barrels of which particular care must be taken and that the Chambers are well and fresh primed

The Portfires used for firing the ship burn about twelve minutes each, great care must be taken to have no Gun Powder on Board when the Ship is fired.

1758

Proportion of Stores for one Fire Ship as settled at Woolwich.

		Number of stores of each nature to compleat one Fireship	Interior diameter at each end	Interior diameter at the bugle	Height of Composition	Greatest Height	Weight empty	Length of One	Diameter or Breadth of One	Composition: Swedish Pitch	Tallow	Corned Powder	Salt Petre	Rosin	Sulphur	Meald Powder
		no	F . I	F . I	F . I	F . I	Lb. Oz	F . I	F . I	Qr lb	lbs	Qr lb	lbs	C. Qr lb	Qr lb	lbs
Fire Barrels		8	1 . 8 half	1 . 9 half	2 . 1	2 . 4	26 . 12			0.12	3	1..2	6			
Curtains		40						3 . 9	3 . 9							
Bavins		250						4 . 6								
Portfires		24														
Reeds	Long	150						3 . 5	0 . 5	2 . 4	6			1 . 08	3 . 6	12
	Short	100						2 . 6								
	Short Double dipt	100														
Composition in Barrels for priming sprinkled with Linseed Oil		3 half														
Quickmatch Barrels		1														
Handgrenadoes		60														
Chambers for blowing open Ports		12														

Primary References Examined	Location
ADM 1 5266 Courts Martial	PRO
ADM 8 / 4	PRO
ADM 8 / 5	PRO
ADM 8 / 6	PRO
ADM 33 257 - Firebrand Pay Book 1705 - 1707	PRO
ADM 33 200	PRO
ADM 33 215	PRO
ADM 33 233	PRO
ADM 33 257	PRO
ADM 33 333	PRO
ADM 39 788 - Firebrand Muster Book	PRO
ADM 39 789 - Firebrand Muster Book 1704 - 1706	PRO
ADM 49 /29 Abstract of contracts ends May 91 No order for Firebrand	PRO
ADM 49 /30 Abstract of contracts ends May 93 No order for Firebrand	PRO
ADM 51 355 4 ii - Captain's Logs	PRO
ADM 51 4189 4 i, ii - Captains Logs	PRO
ADM 51 4189 5 - Captains Logs	PRO
ADM 52 33 i - Masters Log Firebrand 1694 - 1699	PRO
ADM 52 33 ii - Masters Log Firebrand 1694 - 1699	PRO
ADM 52 33 iii - Masters Log Firebrand 1694 - 1699	PRO
ADM 52 33 iv - Masters Log Firebrand 1694 - 1699	PRO
ADM 51 355 3 i and ii - Captain's Logs	PRO
ADM 51 355 4 i and ii - Captain's Logs	PRO
ADM 104 484 /224 15th August 96 Letter saying Firebrand fit for foreign voyage	PRO
ADM 106 489 /320 Aug 26 1696 order to go into harbour for refitting	PRO
ADM 106 489 /91 Survey	PRO
ADM 106 478 /51 Warrant for refitting for Channel Service	PRO
ADM 106 /3070 - Contracts	PRO
ADM 106 /3071 Contracts Phoenix Fireship	PRO
ADM 106 /3583 Abstract of contracts from 4th October 1693 No order for Firebrand No order for Firebrand	PRO
ADM F L 138 i, ii, iii, iv and v - Lieutenant's Logs	NMM
ADL H/22 Ordnance supplied to Defyance, Mary, Firebrand and Isabella 1697	NMM
ADD 29587 ff 164 13 Aug 1702 Proposals of Peregrine Osborne – fitting out of fireships	BL
ADD 37041 Includes explanation of fire-room and combustibles and bombardment of Copenhagen	BL
AAD 49102 Napier papers Vol XVII Recipes / instructions for the manufacture of Ordinance and fitting out a fireship	BL
Additional manuscripts 41362 British Museum Martin Papers Vol XVII Method of priming a fireship written in the back of a signal book	BL
Kings 249 -French tracts on artillery too early	BL
SP 42 /2 - Assorted letters - nothing	PRO

Appendix VI – Diving Safety Policy (Brendon Rowe)

Diving supervisor will be Brendon Rowe. The diving supervisor, Kevin Camidge, David McBride or Peter Holt may assume the role of "surface support" as required. At least one of these people will remain on the surface in this role at all times.
The diving supervisor's responsibilities are as follows:

- To check weather and tides daily
- Complete daily risk assessment
- Decide and inform divers of assembly and "ropes off" times
- Decide diving pairs and order
- Task the divers
- Consult and liaise with the boat's master
- Ensure surface support is maintained
- Ensure oxygen, first aid and evacuation procedures are in place.

The "surface support" responsibilities are as follows:

- Check divers' equipment for suitability and operation
- Complete the divers' checklist
- Complete and maintain the diving control sheet
- Monitor the conditions and divers and take emergency action if necessary
- Liaise with the boat's master.

All diving will follow BSAC safe diving practices and BSAC 88 /ambient pressure diving closed circuit rebreather decompression tables as appropriate with the following additions/clarifications:

- All divers must hold a CMAS 2 star qualification or equivalent and a current certificate of fitness to dive
- All divers will carry an alternative air source independent of their main air supply
- All divers will carry an alternative means of buoyancy inflation independent of the main air supply
- All divers will carry a surface marker buoy. This should be deployed immediately if the diver is in trouble or feels it is not possible to return to the fixed upline.
- Dive times and instructions from the dive supervisor are to be adhered to unless an emergency situation arises.

Communication to/from divers will be by means of rope signals, all divers to understand these rope signals.

Rope signals:

Signal	**Surface**	**Diver**
One Pull	Attention/Are you OK?	I am listening/OK
Two Pulls	Stay put	I am stationary
Three Pulls	Go on down/move away	I am going down/away
Four Pulls	Come up/ move towards	I am coming up/towards
Continuous Pulls	Emergency-come up immediate	Emergency-I am coming up immediately