BOOK REVIEWS

PRESTON, Anthony and MAJOR, John. ***Send a Gunboat***. Conway Maritime Press, London 2007, 208 pages, 100 photographs and plans. ISBN 10:0 85177 923 9. Price £25.00.

(Reviewed by Eur Ing David K BROWN, RCNC)

This book is largely a reprint of the original book written by the two authors in 1967. (A helpful note reminds us that 'the present day', means late 1960s). To this is added a lengthy introduction by Andrew Lambert discussing Victorian gunboat philosophy and its relevance to today's world. In a new end note Eric Grove makes much the same point. I would disagree with these two historians when they suggest the USN Littoral Combat Ship as the successor to the gunboat – it is far too expensive. There is also a fascinating new Appendix on the reconstruction of the composite sloop, *Gannet*.

The big question is whether this book written so long ago is relevant in the light of the many new studied on the 19th century navies. In this reviewer's mind the old text stands up well as the late Tony Preston was a leader in the new look at the Victorian RN.

The story proper begins with the War against Russia (Tony always hated "Crimean War" since much of the Navy's effort was in the Baltic). The strategy was to overpower outlying forts and then attack Kronstadt which would make it possible to threaten St Petersburg itself. Gunboats played a key role in these operations. In the Black Sea the main gunboat activity lay in the Sea of Azov which both held stores and provided the transport route to the Russian armies in Sevastopol. The victory review at Spithead concluded with a mock attack by gunboats and mortar vessels on Southsea Castle demonstrating the RN capability in coastal attack. This is an operational history and there is little on the technical and industrial effort which went into the gunboats. Tony frequently claimed that the Crimean War was 'the last old fashioned war for the Army and the first modern war for the Navy'.

Once the war was over, there was still plenty of work for the gunboats. Cheap, with a small crew and mounting a heavy armament on a shallow draft they were the ideal policemen for Imperial Britain's growing Empire. The authors avoid political judgements on the growth of that Empire. The gunboats were active in China, firstly in war and later in suppression of piracy. There was even a not very successful bombardment in Japan. The West Indies occupied another force. The original gunboats, built in a hurry, often using unseasoned timber soon wore out. In the late 1860s two new classes were built, the *Plovers* which were the last wooden vessels and the *Beacons* which introduced composite construction. The distinction between gun vessel and gunboat was never entirely clear though vessels were always larger than boats.

One point in which modern research would probably have changed the authors' mind is the views on the so-called flat iron gunboats of the early 1870s. These were iron hulled vessels mounting a single heavy gun for coastal defence. They were slow (7½ knots) and not used on Foreign Service. However, it is now known

that they were designed to be towed at nearly double their own speed in possible assaults on French or Russian forts.

This was an early success for Froude's model test tank at Torquay. They had a long life, at least one operated on the Belgian coast in 1914 whilst *Handy* is still in existence – and there is a 2006 photo to prove it.

Part 2 of 43 pages take the gunboat fleet class by class with all the usual figures for ship, machinery and armament. The launch date and brief fate is given for each ship. The numerous new illustrations are well chosen and clearly reproduced; a real improvement over the original book. Original appendices follow on losses (up to 1889), gunboats afloat at various dates and requests for gunboat assistance. Finally, there is an appendix on the life and restoration of Gannet. Though she was a sloop rather than a gun boat the style is similar.

The editorial team has done naval history a great service in making this book available to a new readership.

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JORDAN, John (Ed). ***WARSHIP 2007.*** Conway Maritime Press, London 2007, 208 pages, 100 illustrations. ISBN 10: 1 88486 041 8. Price £30.00

(Reviewed by Eur Ing David K BROWN RCNC)

At first sight this annual is much the same as earlier Annuals but there are many changes in detail as a result of an appeal for readers' views. The nominal index is dropped, replaced by an expanded list of contents. It is hoped to produce a web site with an index to all years of WARSHIP. There is more space for 'feed back' on earlier issues. There are also five new authors.

Jon Wise opens with a detailed account of *Girdleness*, the Sea Slug trials ship. Inevitably it is also a history of the missile itself. David Hobbs contributes the story of the plan to launch a torpedo bomber attack on the High Seas Fleet at the end of World War I. (This is an expanded version of his account in Journal of Naval Engineering).

Your reviewer then discusses the designs of Sir Nathaniel Barnaby, a much under-rated constructor. The editor concludes his series on French destroyers with the *Mogadors*, big, fast and very impressive but with many problems. The big destroyer theme is continued by Hans Lengerer with the Japanese *Hatsuharu* class, a classic example of trying to get a quart into a pint pot (What is the metric equivalent?) They were overweight with appalling stability and had to be re-built with reduced armament.

Bill Schleihauf provides a detailed account of the firing trials against the ex German battleship Baden after World War I. The new shells were far better in penetration, particularly at oblique impact but the fuses were still inconsistent. Enrico Cernuschi and Vincent O'Hara describe the Italian navy's abortive attempts to obtain an aircraft carrier.

The other three features articles are variations on the detective story. Phillipe Caresse considers the magazine explosion which destroyed the fairly new French

battleship *lena* on 12 March 1907 with heavy loss of life. The enquiry blamed spontaneous combustion of 'Power B' propellant and while other explanations have been put forward this seems most likely. The explosion initiated in a 10mm magazine which was known to have much elderly material and had no cooling system.

Stephen McLaughlin explores the sinking of the Soviet battleship *Novorossiisk* (ex Italian *Giulio Cesare*). She moored in Sevastopol on the evening of 28 October 1955 and at 0130 the next morning there was a massive explosion under the bow. She sank about 0415 with the loss of over 600 lives. The Soviet inquiry concluded that the explosion was due to a German mine which had lain dormant for 11 years and finally activated. They did say the sabotage could not be ruled out. The enquiry was confused by Soviet politics. There are many difficulties with the mine explanation and this has given rise to numerous conspiracy theories. (In explaining a disaster 'Cock up beats Conspiracy' almost every time). Italian frogmen, RN midget submarines stand fast. The main difficulty is to explain how a mine could function 11 years after laying without being activated earlier in a busy harbour.

Mark Brady writes a brief but fascinating account of the Port Edgar destroyer base opposite Rosyth dockyard. He then adds to the detective story theme by showing an aerial photo of the base with 34 destroyers visible. Using a few markings, logs and records of ship movements he identifies almost all. Going on from there he was able to identify the airship from which the photo was taken and time it to within 5 minutes.

Conrad Waters the reviews naval developments of the year in 19 pages. This is followed by 16 pages of Naval Notes and A & As. The topics covered include a replica AA gun for the monitor M33, the French battleship *Bouvines*, plans to preserve the *Whimbrel*, the RNs early attempts at anti torpedo systems, some puzzle pictures and others. Book reviews occupy 15 pages followed by 4 pages of photos of Soviet cruisers.

This issue has much new material, is well written and well presented. The editorial team are to be congratulated.

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PATERSON Lawrence. ***U-Boats in the Mediterranean 1941-1944***. Chatham Publishing 2006. 202 pages with 45 b/w photographs. Together with an Appendix, Endnotes, Biography and a comprehensive Index. ISBN - 13: 9781861762900. Price £19.99.

(Reviewed by Iain HIME)

HMS *Partridge* is sinking, hit by a single torpedo from U-443, the Captain is on the bridge wing, one side of his face is lathered from a half complete shave, he yells,

"Stick by the ship, boys, stick by the ship"

We yell back

"F**k you."

It was every man for himself. I just walked down the port side into the water. (Elmer Russell DOBSON, survivor).

Now any book that includes a quotation like that must have a Good Tale to tell and the chances are it will be Well Told. And so it is with Lawrence PATERSON's lively account of the U-boat war in the Mediterranean. U-boat experience of the Mediterranean started during the Spanish civil war but it was not until 1941 that, against his better judgement, DONITZ was 'persuaded' to deploy the first 6 U-boats to the East of Gibraltar. From the start, they struggled. The clear, shallow seas made hiding more difficult. There never were adequate, safe, dockyards to service, repair and refit the survivors. Of course there were great successes not least the sinking of *Ark Royal* which is well told with detailed accounts from both sides. But the increasing difficulties of passing safely into the Mediterranean as allied air and sea resources built up drove most of the U-boat actions further to the East. Astonishingly, there were 40 failed attempts by U-boats to pass Gibraltar of which 18 were sunk and 8 others damaged. Only one submarine out of a total of 63 U-boats that entered the Mediterranean got out again and, of those 62, all but 4 were sunk.

Not a healthy place for German submarines but some names crop up regularly in the story, usually for honourable reasons. Although Albrecht BRANDI's record of battle damage assessment leaves much to be desired despite his Iron Cross with Oak Leaves and Swords.

This book works well because Lawrence PATERSON has included a wealth of personal anecdotes and extracts from war diaries that bring the story to life and he has woven them into the bigger picture of the land war in the Mediterranean that so closely determined the operational role of U-boats. This is a smooth flowing saga, an enjoyable read with a wealth of unexpected detail. Any reader with an interest in naval history will appreciate this book. Why not add it to your collection?

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PAPWORTH Dennis S. ***Pappy's War Capers***. Papworth & Partners 2006. 244 pages, 106 Photographs, 3 Colour. ISBN 978-0-9554682-0-9. Price £25.00 p&p in the UK)

(Reviewed by John SHEARS)

In the Prologue the author writes:

"… at least my children and grandchildren can now see what Pappy and GranPappy did during six years of his life."

With that in mind one could be surprised to find the headings:

- Night Life;
- Italian Mobile Brothels;
- An Elegant Brothel.

It is nice to read memoirs in which the author tells the whole story and does not concentrate on the technical side alone. The book is A4 size, heavy to carry and not ideal for beach reading. Out of the 244 pages, there are 76 pages of Appendices, which are there for their historical content, and unless you are a researcher they can be ignored.

After completing flying training the author was not destined to go to sea. Instead he was appointed to 775 in the Western Desert and then 803. During this period a lot of travelling was achieved and due to a lack of resources, not much flying. Eventually when they were equipped with new FULMARs, 803 and 806 were tasked to fly out from Alexandria to Ceylon. This flight required a considerable logistic exercise combined with many hours flying over difficult and dangerous terrain.

During one refuelling stage the author experienced an engine failure on take off and made a landing in the desert. The engine was restarted and he managed to taxy back to the airstrip. Examination of the aircraft showed 2 gallons of water in the fuel. Further examination showed that some of the fuel cans supplied contained water and that the 'natives' could not be trusted! Now on his own, the remainder of the journey can be described as interesting. At one stage he joined up with six BLENHEIMs, who naively thought a so-called fighter might be an asset. The author fails to inform them that the aircraft ammunition cans were full of his personal gear!

Their arrival in Ceylon coincided with the Japanese attacks would result in the loss of HMS *Hermes*. Due to the losses of both aircrew and aircraft, the author is transferred to 806 to make up numbers and then onto RAF 273 Squadron. Eventually as RAF pilots arrived in theatre, the naval pilots were eased out and he returned to the UK.

After a short spell at RNAS *Donnibristle* as a test pilot he was appointed to 885 and the 'D' Day landings. Then as an Air Support Advisor to the Army, he found himself ashore in France. The Squadron then returned to Northern Ireland, where they were equipped with HELLCATs and became HMS *Ruler's* squadron. After work up they were off to the Far East. Once there they saw out the War as part of the BPF.

This part of the story in covered in *Ruler's Reign*. It is interesting that the author does not agree with the suggestion in that book that the Admiralty redesigned round-down had some influence on the number of accident that happened.

A good read, where the author is not shy in stating his views about the poor equipment he and others were expected to fight with and the attitude of some of the 'old' General Service officers, who were unfortunately in charge of aviation. A good tale which is thoroughly recommended, but do not try to put it in your hand luggage!

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WHITE Rowland. ***Vulcan 607. The Epic Story of the Most Remarkable British Air Attack since WWII***. Transworld Publishers, 61-63 Uxbridge Road, London W5 5SA. 410 pages, 68 photographs. ISBN 978-0-593-05391-5. Price £16.99.

(Reviewed by Douglas MACDONALD)

Maybe the book title is slightly over the top but this is a remarkable book. It is a terrific story, well illustrated and reads like an adventure novel. However, it is the true, extremely well researched factual story of the VULCAN crew who bombed the vital landing strip at Port Stanley in the Falklands on 30th April 1982. A page turner if ever there was; never mind the Air Force bit, this book reminds us of a piece of aviation history which will never be repeated and brought to you in vivid detail by an exciting young aviation historian.

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WRAGG David. ***Royal Navy Handbook 1914-1918***. Sutton Publishing 2006. 310 pages with 130 b/w photographs and illustrations. Together with 6 Appendices, a Chronology, Bibliography and comprehensive Index. ISBN 0 7509 4203 7. Price £25.00.

(Reviewed by Iain HIME)

Do you remember a small book called *The Naval Rating's Handbook?* I was given a copy whilst in the RN section of the CCF (a cushy little number that avoided most of the mind numbing activities of the Army Section). This book was a mine of fascinating snippets that whetted the appetite for more information. It was, as CHAMBERS defines handbook:

"A handy compendium of a large subject or treatise."

And so it is with David WRAGG's Handbook of WW1.

To start with he takes us through the chronology of the war at a pretty sharp pace (7 chapters and 95 pages). A hundred years on from Trafalgar and hardly a decent war waged, at the turn of the century the RN was huge but untested. Despite efforts to make best use of advancing technology,

"The fact is that the Royal Navy was almost totally unprepared for war and remained in that condition for most of the period 1914-1918."

(COMMANDER Stephen KING-HALL)

WRAGG leads us through the Navy's main fighting from the Dardanelles and Gallipoli, on through Coronel and the Falklands and thence Rufiji River. A chapter on Guarding the North Sea leads, inevitably to Jutland and then the war is over! But, as promised by the 'Handbook' you have had a good read and a good overview of the war.

But there are still 200 pages to go! And now the chapters have an independence that makes this a true compendium. The Royal Naval Air Service gets its own chapter of 24 pages followed by The Submarine Service and The Royal Naval Division. Then come Recruitment and Training, Personal and Personnel – some fascinating stuff here. The chapter on Warships covers every one of 'em! And the main book is rounded off with details of all the Naval Air Units. Is it correct? No doubt one of you will check it out. It starts with a quote from the FAA Songbook – "An aviator bold am I" …. So it probably is.

But we haven't finished yet. Because the Appendices have some of the best bits; including one on Battle and Campaign Honours and a brief piece on every maritime VC. Including our very own SQUADRON COMMANDER Richard Frederick BELL DAVIES of No 3 Squadron, RNAS.

Everyone will enjoy this book and almost everyone will learn something new (well not HOBBS of course) from it so you should seriously consider adding it to your library.

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DOUST Michael. ***Buccaneer S1***. Adhocpublications 2007. 104 pages, over 140 (8 in colour) photographs. ISBN 978-1-946958-62-7. Price £15.95 (p&p £2.00).

(Reviewed by Peter RICKARD)

With his series *From the Cockpit*, Roger CHESNEAU of Ad Hoc Publications is filling some long time gaps in the world of aviation publications. The books are all by well known and experienced pilots with significant contributions by those who will have flown the aircraft or been involved in development and maintenance aspects. The latest of the historic Fleet Air Arm aircraft to be covered in the series is the BLACKBURN BUCCANEER S1 Mk1.

Author Michael DOUST has produced a very fine book which carries not only his own experiences of the aircraft but includes contributions from a representative selection of those who flew this aircraft, especially in the early development period of its life.

Thus within an excellent presentation covering its squadrons' history, many well reproduced pictures – including those of early examples of the aircraft – are also contributions which address the flying characteristics, weapon system, the maintenance. There is even one chapter entitled 'A Crab Goes to Sea' by AIR COMMODORE Graham PITCHFORK. He not only seemed to enjoy the experience but would go on with the RAF to fly the aircraft in its Mk 2 guise (that's after they gave it some proper engines) as the Last All British Bomber. The aircraft in its up-rated version as the Mk 2 would last until early 1994 having in that time taken part in the First Gulf War.

Initially on opening the book it was a disappointment to see the lack of contributions from the back seat, only CAPTAIN Mike CLAPP (700Z Flight and Senior Observer 801 NAS) providing such a contribution (others had been asked but evidently declined). But on further reading it became very clear that in most cases within the articles from the pilots there were very generous comments towards the experience in the back seat.

The aircraft came into service at RNAS *Lossiemouth*, recognised then as the home of the single seat fighter pilot and the concept the Naval Appointers adopted at the early days of the aircraft's trial life, at 700Z Flight and 801 NAS in particular, was peculiar to say the least. Most of the pilots came from this somewhat insular world of the single sear aircraft with experience in SEA FURYs, ATTACKERs, SEA HAWKs and SCIMITARs, and to whom the observer was viewed by many as rather an unessential piece of luggage. On the other hand the observers, far from merely being solely jet orientated individuals from the all-weather fighter

world down South were from all specialisations, anti-submarine, AEW and all weather fighters, some indeed with trails experience at Boscombe Down. In 700Z Flight, to overcome some of the difficulties and to provide trials balance, perhaps not intentionally but with justifiable results, pilots and observers were not crewed up.

CAPTAIN John de WINTON, in coming to 700Z Flight from the crew-orientated world of the night and all-weather fighter alludes in the book to how observers were regarded in his second of two contributions (which probably would have been better to be printed in the reverse order as regards correct time-frame). His arrival certainly eased some of the rather anti-social aspects which, outside of the actual flying, were being experienced by some of the observers.

Given that all concerned, including the maintainers, realised that they had been given a quite superb opportunity to be a part of transition of the FAA with the introduction of a heavy, long range, highly capable aircraft, which they viewed as rather of more use than some of the other aircraft to be found at the air station. The unnecessary presence of this 'excess luggage' was all too frequently made clear by those outside the BUCCANEER world probably as a result of the little green god of envy.

That the appointing system actually worked as is evident from the contributions in the book but the actual social integration aspects, which can only have been overlooked by the Appointers were in the end overcome by the concerted efforts of all concerned, aircrew and maintainers to 'make the thing work'. There was thus also a social element with the introduction of the BUCCANEER which whilst it did not affect the inter-cockpit relationships was nevertheless a part of the history of the aircraft coming into service. Despite the emphasis on cockpit aspects, for completeness, the book might have looked in the round at the environment into which this important aircraft was being introduced, trailed and made operational for sea.

Thanks to the GYRON JUNIOR engines and given the excitement of a fully bombed up BUCCANEER desperately trying to get airborne from the short runway at *Lossiemouth* or the nearly fuel-less aircraft taking off from the just as short and thrill making runway at *Lee on the Solent* there was every need for crews to concentrate on flying the aircraft and other difficulties had to be put aside. The experience of flying this robust aircraft is in the main well covered although not mentioned but worth asking is in what other aircraft might the wheels be unintentionally lowered at 380 knots with only the undercarriage light sequencing system reflecting any problem!

The book has in addition good representation of the many and various colour schemes employed throughout its life in the Fleet and the layout of the front cockpit (but not the observer's cockpit) is shown as is also the BUCCANEER S1 record of ejections! Indeed it is questionable if the layout of the back cockpit is available on photographs there are line drawings to be found.

A few glitches arise in the captions to some of the pictures but do not detract from the book's worth.

- That of the parade at the Commissioning Ceremony attributed to 700Z Flight (P 61) is actually that of 801 NES being Commissioned on 17 July 1962 (one similar picture taken shortly afterwards appeared in the next month's *Tatler*!);
- The Admiral addressing the Parade in the July picture is VICE ADMIRAL D.P. DREYER CB, CBE, DSC then Flag Officer Air (Home);
- Page 63 shows the two-tone aircraft actually sent up to *Lossiemouth* for the earlier Commissioning of 700Z on 7 March 1961;
- Similarly the picture heading Bob EDWARDS article (P 48) showing a BULLPUP firing was by XN948 (rather than XN928) and was taken on the 12 November 1963. Just previously the first missile had been fired and 'dropped out';
- My other contribution to accuracy relates to the picture of 700Z Flight sometime in the autumn of 1961 (P 65) where the un-named gentleman towards the right is INSTRUCTOR LIEUTENANT COMMANDER D.C. BAIN BSc who, despite all the talent amongst the aircrew had to do all the mathematical calculations resulting from the trials. He fully deserves a mention.

The book can be well recommended. The BUCCANEER S1 has in other BUCCANEER books been mainly glossed over in preference to the S2 version especially as that later aircraft was the one unwillingly accepted and then taken to heart by the RAF. This book does the S1 aircraft and its aircrew full justice.

The author and the publisher are to be congratulated on a worthy addition to the aviation library.

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HARSANT Frederick. ***Search the Endless Sea***. Book Guide Publishing 2007. 262 pages. ISBN 978 1 84624 1017. Price £16.99.

(Reviewed by John SHEARS)

This is the sequel to the *Sea and the Sand* and once again we are with 999 squadron and HMS Peregrine. In this book the main characters are still there; BOLLO as Senior Pilot takes a secondary role to that of Bill HEWETT and Killer COMPTON, two young officers in the squadron. We follow their adventures and romances as the ship is sent first as escort to a hospital ship and then in search of an Armed Raider.

As for the romance, well the girls are two VAD nurses on the hospital ship and when they go onboard it is very hard not to hear, in ones mind, FRASER from *Dad's Army* saying,

"We're doomed Mr MANNERING, we're doomed."

Seriously, many of the incidents are based on the author's experience when operating in HMS *Eagle* and the search for the Armed Raider *Atlantis*. There is an account of the capture of an enemy surface ship by aircraft, oiling the carrier at sea and the fire in the hanger these are all based on true incidents. Also described is

the arrival of ASV and reliable RT, which was to prove a major step forward in air warfare. The description of one crew not finding mother on one sortie is told with feeling as it is based on the author's own experience.

In my review of the first novel I commented on the relationship between aircrew and maintainers and assumed that it was an 'age thing'. This time the only thing I will comment on is, that as an AEO, I am very impressed by how the crews seem to get their own aircraft every time. In my day they were lucky to get what they were given!

The courtship of the main characters does appear dated, but I am sure it reflects how things were. Even after 'nuddy bathing' the two main characters don't get together, but this could be due to the fact they are exhausted after all the ballroom dancing they have been doing! (The author is obviously an expert). This does mean, as with the first book, that the reader is left wondering if they actually do and what happens to them next.

I took this book on holiday as I did with the first and enjoyed it immensely. Thoroughly recommended and a very good read.

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WAKEHAM Geoff. ***RNAS Culdrose 1947-2007***. Tempus Publishing Ltd, 2007. 160 pages, 285 photographs (16 colour). ISBN 978 0 7524 43812. Price £12.99.

(Reviewed by John SHEARS)

This is an update of the author's original book published ten years ago to celebrate the 50th anniversary of the base. There are seven chapters, each covering a decade. Obviously when reviewing this book, a reviewer would naturally go to the period when he served there, in my case 1966 to 1970.

The first photograph that brings back memories is the WHIRLWIND in a field on page 70. As the AEO of Station Flight I was responsible for Crash and Salvage and consequently spent many a 'happy hour' around the base recovering downed WHIRLWINDs from farmer's fields and HILLERs from Predannack.

In the introduction the move of the Wessex 5s to *Yeovilton* is missing. On page 98, the 846 camouflage trial is noted, but there is no mention of the fact that the Squadron had four aircraft and five colours to trial. Yes there was one aircraft flying around with a different colour each side!

Also in the introduction the Fastnet race rescue is mentioned and once again nothing about 819. It does state that it was during summer leave and of course Prestwick was not on leave. As the AEO of Gannet I remember our aircraft going south and coming back with a lot of hours on the clock!

A small point is that the colour photograph section has been put together in the wrong order i.e. starts with picture no. 5.

One knows when one is getting old when on page 158 we are shown the new accommodation block that replaced the 1970 **vintage** blocks!

Thoroughly recommended and a snip at £12.99.

PERSONAL NEWS

From the JNE Editorial Team Manager:

Following the announced demise of the Officer's Appointments List the decision has been made not to carry news of a personal nature in the Journal of Naval Engineering.

London Gazette

Historically the Armed Forces have used the London Gazette MoD Supplements to make announcements of a similar nature to the contents of the OAL. Currently details that once appeared in the OAL are now available for publication in the London Gazette. You can gain access to the London Gazette via the internet at: www.gazettesonline.co.uk.

NOTICES
NOTES FOR AUTHORS

Articles on all aspects of Naval Engineering, in the broadest sense, will be considered for publication in the Journal of Naval Engineering (JNE). Its readers include all Royal Navy Engineer and Warrant Officers, all DLO Technical Development Officers, all Naval Scientists, the navies of NATO, Commonwealth and other friendly countries, as well as leading Naval Defence Firms.

Articles may be targeted at any part of the readership, provided they are comprehensible to all. Authors need not be in Government Service.

Articles used to be accepted on the understanding that they will not be published elsewhere. This is now no longer the case although the more limited circulation of the JNE should allow scope for a more personal perspective from one's own experience to be included and such views are seldom acceptable in conference papers.

The JNE is intended to be UNCLASSIFIED although RESTRICTED editions remain possible. Authors should state the security classification of their proposed article and that agreement for publication has been obtained from their line management.

One hard copy of the text and a copy in MS Word on a CD should be sent to:

Professor Chris Hodge FREng
JNE Editor in Chief,
Maritime House
210 Lower Bristol Road
Bath
BA2 3DQ

Or by email to johnb@bmtdsl.co.uk

The style of recent issues should be followed for general arrangement and for the layout of references. i.e.

- First level headers are centred all in upper case, font size 14 and bold;
- Second level headers are left justified, title case and in font size 10;
- Third level headers are left justified in italics with initial capitals and in font size 10;
- Periodical titles are printed in full in the list of references;
- Titles should be as brief as possible consistent with clarity;
- An abstract should come before the main text;
- Each figure and table should be numbered and provided with a title;
- Captions for illustrations should be typed separately from the text;
- Although the pictures are primarily to illustrate the text, they are often looked at independently, so the captions need to be self-explanatory;

- Articles should normally be submitted by mid-March and mid-October for the following issue;
- Authors will be sent proofs of their articles for correction and to allow for minor alterations.

OTHER ABSTRACTS

These abstracts have been taken from BMT's monthly publication BMT Abstracts, which contains bibliographic information, providing a reference and description, for technical articles, reports, conference and transaction papers and other material on all aspects of maritime technology published worldwide, in at least 10 languages.

BMT Abstracts are published monthly, with an annual index. Sample issues can be sent on request. For further information, please contact David Griffiths at the address below.

The abstracts published in BMT Abstracts are now also available in a searchable database, called Marine Technology Abstracts. Access to this database, which contains about 85,000 abstracts, is available on subscription, for periods ranging from one week to a full year.

For further details of either of these services, please contact:

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NAVAL VESSELS AND DEFENCE TECHNOLOGY

JULY 2007

2007071746

Tango Bravo: breaking down barriers in submarine design.
Jane's Navy Intl, v 112 n 3, April 2007, p 14 [4 p,5 fig]
Glassborow, K.
English

The US Navy (USN) and Defence Advanced Research Projects Agency (DARPA) are seeking to rationalise submarine platform infrastructure requirements in order to reduce the cost and increase the flexibility of future designs. Under the Tango Brave programme, DARPA and the USN gave a team of industry partners a set of challenges to develop and demonstrate technologies for shaftless propulsion, external weapon storage and launch, and electric actuation of ship control surfaces for reduced infrastructure.

Ship design
Submarines

2007071747

Going with the current: navies move inshore and up river.
Jane's Navy Intl, v 112 n 3, April 2007, p 20 [5 p, 7 fig]
Hammick, D., Scott, R., Trimble, S.
English

Navies worldwide are increasingly finding themselves tasked to perform patrol and counter-insurgency operations in coastal waters, estuaries and inland waterways. This article examines how this is driving requirements for improved shallow-draught watercraft for littoral and riverline operations.

Naval vessels
River vessels
Shallow draught vessels

AUGUST 2007

2007081988

Institutionalising the electric warship.
Naval Engrs J, v 118 n 4, 2006, p 57 [8 p, 11 ref, 4 fig]
Doerry, N.
English

The US Navy has invested a considerable amount of resources in developing Electric Warship technology in the past twenty years. There have been a number of early technology demonstrations as well as incorporation of Integrated Power System (IPS) technology into ship programs such as LHD 8, T-AKE, DD(X), and CVN 21. Although these early adopters have paved the way for establishing the practice of electric warship design, it is now a critical point in time for institutionalising the electric warship. A technology is institutionalised when the following activities have occurred: establish a common architecture and interfaces; establish common design processes; incorporate the architecture and design processes into design tools; codify the practice in government or industry specifications, standards, and guides; and teach the architecture and design process as part of a typical engineering school curriculum. This article reviews the progress in electric warship technology, describes progress (including ongoing efforts) in institutionalisation, and highlights critical near term shortcomings. Some of the shortcomings in design processes and tools include: undefined (in authoritative documentation) concepts such as tonal survivability and quality of service; obsolete requirement terms such as "sustained speed" and "endurance speed/range"; conflicting design practices for propulsion and ship service prime mover sizing; customised system protection strategies for different classes of ships; ambiguous methods for the sizing of tonal distribution system components; lack of integration of IPS design algorithms into ship concept tools such as ASSET; lack of knowledge as to how to effectively use modelling and simulation to make electric plant design decisions for each stage of ship design. Additionally, the article details progress in updating standards and specifications, such as the Naval Vessel Rules and DOD-STD-1399. Finally, efforts to incorporate electric warship design into the curriculum at [RA1] traditional naval architecture are described.

Electric power
Naval vessels

2007081989

An alternative comparison of DDG 2 to DDG 51 costs.
Naval Engrs J, v 118 n 4, 2006, p 65 [8 p, 1 ref, 9 tab, 3 fig]
Sims, P.
English

The fact that there has been a 123% real cost growth between cost comparison of a DDG 2 guided missile destroyer ship to a DDG 51 flight IIA class ship has received a great deal of publicity in presentations by senior officers and in an

independent RAND analysis of shipbuilding costs. The basis of this comparison is a unit-to-unit analysis which compares unfavourably to a real cost growth of automobiles over the same time. However, a DDG 51 displaces twice as much as a DDG 2. If on normalises the destroyers to a cost per ton basis, the majority of the real cost growth goes away and it is closer to the commercial items real cost growth. In an appendix, a series of tables compares the features of a DDG 2 with those of DDG 51.

Cost optimisation
Naval vessels

2007081990

SIGMA puts geometry back on the design syllabus.
Jane's Navy Intl, v 112 n 4, May 2007, p 23 [6 p,7 fig]
Scott, R.
English

Schelde Naval Shipbuilding in the Netherlands is building four 91m corvettes for the Indonesian Navy. The vessels are the first to be built to a new proprietary design methodology known as SIGMA (Ship Integrated Geometrical Modularity Approach), which is based on the widespread adoption of commercial standards and the use of standardised hull modules. This article discusses the design philosophy and outlines the main particulars of the corvettes.

Corvettes
Naval vessels

2007081991

US Navy gives a lift to its amphibious capabilities.
Jane's Navy Intl, v 112 n 4, May 2007, p 30 [5 p,4 fig]
Hammick, D.
English

The US Navy is engaged in a major modernisation of its amphibious lift capabilities in order to meet future operational requirements. This article looks at the components of the programme.

Amphibious transport vessels
Naval vessels

2007081992

MT-30 gas turbines drive DDG-100 destroyers.
Marine Propulsion & Auxiliary Machinery, v 29 n 2, April/May 2007, p 73 [1 p, 1 fig]
No author given
English

The US Navy's most advanced surface combatant ships, the DDG-1000 Zumwalt-class destroyers, will be powered by Rolls-Royce MT30 gas turbines. Each electric-drive destroyer will be fitted with two MT30 generating sets rated at 36MW APIECE. The merits cited by Rolls-Royce for the M30 engines are outlined.

Destroyers
Gas turbines

2007081993

MTU engines selected for FREMM frigate programme.
Marine Propulsion & Auxiliary Machinery, v 29 n 2, April/May 2007, p 74 [2 p, 2 fig]
No author given
English

The first eight ships in the Italian and French Navies' multi-mission FREMM frigate programme will incorporate MTU Series 4000 high speed engines in their CODLAG propulsion plants. Each will be fitted with four gensets driven by V16-cylinder models having an individual power rating of 2,200kW. In 'silent' mode up to 16 knots, for antisubmarine operations, the twin fixed-pitch propeller shaftflines will be driven by electric motors. High speed service (around 27 knots) will see the deployment of a single General Electric LM2500+G4 gas turbine alone or in conjunction with the electric motors in a combined diesel-electric and gas turbine system.

Frigates
Gas turbine electric propulsion
High speed diesels

SEPTEMBER 2007

2007092216

CADET – IT support for joint naval shipbuilding projects.
COMPIT '07, 6th Intl Conf on Computer and IT Applications in the Maritime Industries; 23-25 April 2007; Cortona, Italy. Publ by INSEAN, Italy, ISBN 88-7617-002-2. P 54 [6 p, 1 tab,7 fig]
http://www.compit07.insean.it/proceedings/Proceedings.pdf
Renard, P.
English

The basic idea is to develop methods and tools dedicated to European cooperative naval (military) projects. The project proposal CADET, and its software tools in particular, will support all decision steps recognised as contributing to the success of any naval cooperative project. They provide a common methodology, a common language, as well as the same structure of information for all partners (navies and shipbuilders).

Information technology
International cooperation
Naval shipbuilding
Projects

2007092217

Introducing damage structural assessment to onboard decision support tools.
COMPIT '07, 6th Intl Conf on Computer and IT Applications in the Maritime Industries; 23-25 April 2007; Cortona, Italy. Publ by INSEAN, Italy, ISBN 88-7617-002-2. P 386 [14 p, 5 ref, 2 tab, 11 fig]
http://www.compit07.insean.it/proceedings/Proceedings.pdf
Bole, M.
English

This paper discusses the introduction of structural assessment technology into onboard tools in response to incidents such as grounding and demonstrates how the tool can be used to assess an emergency scenario. A number of assessment techniques are demonstrated including a progressive collapse method used to analyse the longitudinal strength of the hull girder and fatigue methods are also incorporated to allow the management of any cracks that may occur in the structure as a result of damage or during operation. The information produced by the tool augments the extensive damage control training provided to UK Royal Navy crew extending the capability to assess scenarios to identify potential recovery plans or whether further failures will result in the lost of the ship.

Damage stability
Decision support systems
Naval vessels
Structural analysis

2007092218

Plastic deformation analysis of a damaged ship under non-contact explosion.
ISOPE 2006, 16th Intl Offshore and Polar Engng Conf; 28 May-2 June, 2006; San Francisco, US. Organised by ISOPE. Procs. CD-ROM. ISBN 1-880653-66-4. Vol IV, p 487 [4 p, 5 ref, 2 tab, 8 fig]
Sun, L., Nie, W., Fu, J.
English

The plastic deformation of the hold section of a warship subjected to non-contact explosion pressure caused by an anti-ship missile or a laser guided bomb is analysed in this paper. The explosion load is transformed to static load on the basis of explosion theory and some correspondence literature. Both nonlinear material and nonlinear geometrical are considered in the finite-element analysis. The correspondence conclusions on the compartment attacked by an antiship missile or a laser-guided bomb were obtained.

Damage
Explosions
Naval vessels
Plastic deformation

2007092219

Modelling of an Integrated Reconfigurable Intelligent System (IRIS) for ship design.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [12 p, 16 ref]
Hughes, R., Balestrini, S., Et al
English

As the mission and performance demands for naval ships have increased, they have become more complex comprising an increasing number of heterogeneous interdependent subsystems. This increased complexity requires new methods for the design and operation of these naval systems. This paper discusses an initiative called Integrated Reconfigurable Intelligent Systems (IRIS) which is helping the US Navy change its design practices to achieve reduced total ownership costs, increased survivability, and increased mission effectiveness. Using traditional systems engineering practices for the early design environment, IRIS seeks to shift ship design to a distributed, intelligent control architecture through increased automation.

Integrated shipboard systems
Naval vessels
Ship design

2007092220

Unmanned sea surface vehicle technology development.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [8 p, 4 ref, 2 tab, 3 fig]
Brizzolara, R.A., Sokol, W., Et al
English

The utility and effectiveness of unmanned vehicle systems is clearly recognised by the US DoD and the military services. Currently, most unmanned surface vehicles (USVs) are based on existing, manned boats that have been adapted or converted to be unmanned. These craft were designed to meet certain human-based factors; therefore, their performance in terms of speed, seakeeping, payload capability, endurance, towing capacity, and adaptability to various naval missions is not optimised. The Unmanned Sea Surface Vehicle (USSV) S&T program is focused on the development of technologies to extend the capabilities of USVs for naval missions. The approach focuses on purpose-built USSVs, rather than converted, manned craft, autonomous control of these vehicles, and launch and recovery. Two USSVs have been designed and constructed: the USSV-High Tow Force, which is optimised for payload fraction, endurance and high towing capacity, and the USSV-High Speed, a hydrofoil, which provides high speed in a sea state. Also, progress has been made toward autonomous launch and recovery and toward a greater degree of vehicle autonomy. The technology development described in this paper will help to optimise the mission capabilities of USVs and help to maximise the combat effectiveness of the littoral combat ship.

Unmanned vehicles

2007092221

Aperstructures: an integrated self-controlling photonic crystal.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [6 p, 9 ref, 15 fig]
Ransom, P., Copley, L., Et al
English

In an effort to satisfy signature requirements, the next generation of naval ships will remove the antenna mast and integrate antennas into topside deckhouse structures using a variety of planar arrays. The US Navy has developed antennas that conform to the facets of the ship's structure which improves signature control. Issues have arisen because the number and size of the apertures required to maintain functionality and perform the mission overwhelms the available area. Planar antennas are typically embedded into the deckhouse by cutting out regions of the deckhouse and fitting the antenna aperture into the vacated space. This procedure negatively impacts the structural integrity of the deckhouse, the

performance of the antenna and the signature of the deckhouse. The Aperstructure concept seeks to resolve the stability and signature issues by integrating structural characteristics and antenna functionality. The Aperstructure concept can be implemented using a variety of designs that to integrate structures and antenna functionality synergistically creating a multifunctional antenna structure. The Aperstructure approach presented within utilises photonic crystal technology to design and develop multifunctional passive (RF) feed networks. Conventional RF feed networks are historically comprised of metallic waveguides and two conductor RF cables. This study investigates the use of dielectric photonic crystals as an alternative to metallic waveguides and RE cables. The planar nature of PhC structures enable them to be integrated within the core of a structural composite and become a load bearing part of the structure while providing the RE feed to the antenna.

Ship signatures

2007092222

Composite high speed vessel: study of lifting body technology.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [15 p, 3 ref, 7 tab, 20 fig]
Hackett, J., St. Pierre, J.C., Et al
English

This paper presents an overview of the Composite High Speed Vessel project sponsored by the US Navy Office of Naval Research. An important goal of this project was to determine the hydrodynamic benefits of the innovative new technology of lifting bodies through computational studies and model testing. The project's purpose and methodology is discussed along with a brief overview of results.

Composite materials
High speed vessels
Lifting surfaces
Naval vessels

2007092223

Nonlinear time-domain simulation of a destroyer hull form in extreme waves.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [15 p, 28 ref, 1 tab, 8 fig]
Hess, D.E., Faller, W.E., Et al
English

A program to develop and implement a faster-than-real-time software platform for nonlinear time-domain simulation and automatic control of a ship in wind and waves is described. A key element of the Real-Time Nonlinear Simulation (RNS) system described is a Recursive Neural Network (RNN) which serves as the rapid response ship simulation engine. Methods to incorporate environmental

conditions such as wind and waves within the RNS approach are described. New results comparing the measured response of a free-running model ship operating in an extreme, regular wave field are presented and compared with simulation predictions. Earlier results capturing the effect of wind forcing on a full-scale ship operating at sea are reviewed. Taken together, these successes demonstrate the potential for an RNN-based plant model for use in nonlinear time-domain simulation, and predictive control applications on manned or unmanned sea-going vessels.

Destroyers
Hull form
Simulation
Time domain

2007092224

Development of the autonomous submarine model.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [10 p, 11 fig]
Cubbage, S.J.
English

The US Naval Surface Warfare Centre (NSWC) has developed a free-running autonomous submarine model for use in determining the manoeuvring characteristics of navy submarines. The Autonomous Model (AM) builds on the technology of the existing radio-controlled models (RCM), in use at the NSWC, with extended capabilities to be able to operate independently and at a remote facility. These additional capabilities allow the AM to perform manoeuvres that are not currently possible due to the limitations of RCM. This paper outlines the development of the AM and discusses the new technologies that make the AM possible.

Manoeuvrability
Submarines

2007092225

The advanced electric ship demonstrator: a test platform for the next navy.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [13 p, 3 ref, 3 tab, 11 fig]
Martin, W., Blake, W., Et al
English

Under a program sponsored by the US Office of
Naval Research (ONR), a quarter-scale destroyer-sized test platform has been constructed and is being used as a technology demonstrator and to provide data to improve ship design and analysis methods. This test platform, the Advanced Electric Ship Demonstrator (AESD), named Sea Jet, is based on an advanced, wave piercing hull form that was considered early in the DD(X) program. The

focus of the maiden application of the Sea Jet has been the demonstration of the Rolls Royce Naval Marine Inc (RRNMI) water jet concept, named AWJ 21TM. The initial Sea Jet tests assessed the maneuverability and stability of an advanced hull form incorporating a thrust vectoring propulsion system. These preliminary trials provided data to assess maneuvering performance and to compare against numerical predictions and small-scale model tests. Subsequent testing evaluated AWJ 21TM efficiency and acoustic signatures. Tools and methods used to design the AWJ 21TM pumps have been evaluated using the data collected during the trial. The test program and data collected has also permitted verification of the thrust vectoring and reversing system developed as part of the AWJ 21TM propulsion system. The AWJ 21TM test has also provided preliminary data to assess an advanced motor drive system in a realistic environment. This data will allow improvement to motor drive models. The motor drive assessment will be more rigorously assessed in the RIMJET technology demonstration on Sea Jet. Preparations are underway for Sea Jet modification and installation of the RIMJET propulsion pod. In summary, the Sea Jet AWJ 21TM test effort has provided large-scale demonstration of a non-conventional propulsor concept for large combatants and has provided data and understanding to improve design and analysis methods across a range of systems for future ship designs.

Manoeuvrability
Naval vessels
Tests
Waterjets

2007092226

The role of magnetic physical scale models in the design of ship degaussing systems in the age of computer modelling – DDG-51 as a case study.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [10 p, 4 ref, 10 fig]
Gay, W.H., Wingo, R.A.
English

Specification of the underwater ferromagnetic signature reduction system, or degaussing system, is an important part of the design effort for new classes of naval warships. At present, the use of magnetic physical scale models is the only validated method of predicting all components of a ship's ferromagnetic signature prior to the construction and measurement of the actual ship. Despite known capability shortfalls, and against the recommendations of the Navy's magnetic silencing community, there has been disturbing interest in abandoning the use of expensive, "old-fashioned" physical scale models in favour of computer models. This case study uses the DDG-51 physical scale model to illustrate the ongoing need for physical scale model use in degaussing system design for new ships. The results of this case study show that only the use of a physical scale model would have resulted in the specification of an adequate degaussing system for the DDG-51 class. Additionally, future ships with far lower signature limits will have similar signature issues but lower margins of error in initial signature prediction. The physical scale model remains the only proven signature prediction tool at the

Navy's disposal.

Control systems
Degaussing
Naval vessels
Scale models
Signatures

2007092227

Application of web-topology to enhance survivability of the integrated power system in an all-electric warship.
Ships and Ship Systems Technology Symposium (S3TS); 13-14 Nov 2006; West Bethesda, MD, US. Procs. Organised by ASNE [15 p, 8 ref, 10 tab, 20 fig]
Poroseva, S.V., Woodruff, S.L., Et al
English

In the battlefield, survivability of an all-electric warship depends critically on the ability of the integrated power system (IPS) to withstand simultaneous multiple faults. The IPS provides power for all ship systems, including control, propulsion, and combat systems, as well as ship service loads. Therefore, power interruption, let alone total loss, would most certainly lead to mission failure, as well as personnel and economic losses. The objectives of this study are i) the analysis of the topological survivability of currently existing IPS architectures and ii) the design of an IPS architecture with maximal resistance to simultaneous multiple faults built directly into the architecture. As a first, but critical, step, the study focuses on the topology of a single IPS level – the generator bus. Failure of the bus to supply power to the rest of the IPS will immediately result in failure of the entire IPS. In previous studies, the authors developed a mathematical approach for quantifying the topological survivability of a generator bus under simultaneous multiple non-recoverable faults, compared survivability of various topologies containing two and three generators, analysed the effectiveness of different design strategies, and proposed a new web-topology of enhanced survivability. The current paper compares survivability of various topologies (ring, mesh, star, and others) implemented in a generator bus containing four generators with survivability of the web-topology containing smaller numbers of generators.

Integrated shipboard systems
Naval vessels
Ship power plants
Ship survivability

2007092228

CAVOUR takes to sea.
Tecnologie Trasporti Mare, v 38 n 2, March/April 2007, p 54 [1 p, 2 fig]
Vené, A.
Italian and English

A brief description of the aircraft carrier CAVOUR is given. The vessel was built by Fincantieri for the Italian Navy. CAVOUR has a full load displacement of 27,100t, an overall length of 244m, a maximum breadth of 39.00m and a maximum draught of 8.70m. The operative range is 7,000 miles at a speed of 16 knots.

Aircraft carriers
Vessel descriptions

2007092229

Instantaneous current prediction for naval operations.
OCEANS 2005; 18-23 Sept 2005; Washington, D.C., US. Procs. Sponsored by Marine Technology Soc and IEEE. Vol 1, pp 884-890
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=1639867
Chu, P.C., Armstrong, A.E.
English

Naval operations depend highly upon environmental conditions that can either adversely affect successful completion or hinder the safety of personnel. Each warfare community has defined environmental thresholds and operating limits that restrict the execution of any intended manoeuvre. As the warfare environment continues to shift from the open ocean to the littoral, prediction of the shallow water environment is an urgent need in order to support these operations. The value-aided of using a hydrodynamic model (WQMAP) for the mission planning of the naval operations in San Diego Bay is demonstrated in this study. A new model verification procedure (i.e., compatibility verification) is proposed for the tidal dominated littoral basin prediction.

Littoral currents
Naval vessels
Shallow water
Tidal currents

2007092230

Flywheel energy storage system for naval applications.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-90270
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D90270
Huynh, C., McMullen, P., Et al
English

A recent trend in designing naval ships is to improve performance through using more electric equipment. The reliability and quality of the onboard electric power, therefore, becomes critical as the ship functionality would entirely depend on its availability. This paper investigates the possibility of using Flywheel Energy Storage Systems (FESS), similar to those earlier developed for commercial applications, to address issues related to onboard power supplies. A design of a FESS for onboard power backup and railroad electrical stations is presented. The FESSs power output parameters are 500kWx30sec in high-duty mode and up to 2MW in pulse mode. High power output is one of the main advantages of FESS over commercially available electrochemical batteries. The other advantages include essentially an unlimited number of charge/discharge cycles, observable state of charge and environmental friendliness. Designs of the main FESS components are discussed: low-loss magnetic bearings, an energy-storage hub, a high-efficiency motor/generator and power electronics.

Electric power
Naval vessels
Power supplies

2007092231

Investigation of compressor rear frame cracking of United States Navy LM2500 gas turbine engines.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-90115
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D90115
Driscoll, M.J., Descar, P.D.
English

In December 2000, a 7" long axial crack was visually identified on the compressor rear frame of an LM2500 propulsion gas turbine engine aboard the USS MITSCHER (DDG 57). This was originally thought to be a unique failure mode possibly caused by misaligned brackets external to the engine imparting undo thermal stresses onto the engine casing and flange. Since that time, 17 additional engines in the Navy fleet have been identified with either the large axial crack on the compressor casing or a small craze crack on the CRF flange, which appears to be the origination point prior to crack propagation. This paper discusses the extent of the cracking problem in the US Navy, the engineering investigation undertaken by the OEM and Navy to determine the root cause of the cracks and development

of a field repair strategy to mitigate the impact of these cracks. The focus of the paper includes metallurgical analysis of failed compressor rear frame hardware, vibratory evaluation of the engine's external piping system as a contributory failure mode and results of strain gage testing of the mid flange region.

Cracks
Gas turbines
Naval vessels

2007092232

LHD 8 propulsion machinery control system design and integration.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-91313
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D91313
Tolotta, V.P., Harris, H.
English

The LHD 8 machinery plant represents a significant departure from previous LHD class ships with a propulsion system that combines an LM2500+ and electric motor per shaft. The propulsion system integrates the first US Navy application of this gas turbine engine ultimately with the ship service electric plant. This complex system affords many advantages to the ship designers with respect to re-configurability, survivability and manoeuvring. However the design challenges the ability of the Machinery Control System (MCS) to maximise the effectiveness of this complex machinery plant. The MCS is a software-based distributed system utilising a high bandwidth network. The system relies on the VME platform for control processing, data acquisition and operator control. The MCS design and architecture is presented. Decisions concerning network capabilities, distribution of control, and processing are considered. The impact of electric plant complexities upon the propulsion system requirements is also addressed. The MCS architecture solution will describe LM2500+ integration issues with an electric motor.

Control systems
Gas turbines
Electric propulsion
Naval vessels

2007092233

Mitigation of marine gas turbine water wash risks.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-91167
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D91167
Shappell, L., Myers, L., Hunter, J.
English

The US Navy Landing Craft, Air Cushion (LCAC) engines, like all marine gas turbines; use water washes to preserve performance and increase reliability by removing salt and other contaminants from the compressor. Due to the severity of the operating environment and unfavourable operations base, water washing can pose risks to the LCAC engines. Galvanic corrosion, crevice corrosion, insufficient contaminant removal and incompatibility among seal materials, contaminants and wash solvents can outweigh the benefits of water wash. The US Navy has incorporated water wash procedures and materials such as silicon rubber seals and glass fibre and Teflon bushings to mitigate these risks.

Gas turbines
Naval vessels
Washing

2007092234

More efficient applications for naval gas turbines: addressing the mismatch between available technology and the requirements of modern naval gas turbine inlets.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-90305
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D90305
Oswald, A.D., Hiner, S.D.
English

The US Navy has operated gas turbines (GTs) on board different types of vessel for several decades. To safeguard these engines against the harsh marine atmosphere several types of air inlet filtration system have been employed, with varying degrees of success. The purpose of this paper is to explore the various filtration technologies which are currently used in all GT inlet filtration applications; point out the benefits of each; and debate how these may be practically applied to the "Modern" Naval GT application. The changing vessel operational requirements; environmental requirements; advances in GT design; and how these impact the design of the GT inlet filtration system are discussed. The current trends in Naval GT inlet filtration system specifications are also detailed. The significant divergence of these from the capabilities of current marine GT filtration technology used are highlighted. Recommendations are proposed regarding how this situation may be addressed with the use of filtration technologies currently used in other GT applications.

Gas turbines
Naval vessels

2007092235

Resolving landing craft air cushion main engine starter valve corrosion issues.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-90848
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D90848
Hampshire, J.D., Myers, L.
English

The Navy's Landing Craft Air Cushion (LCAC) hovercraft vehicles use two Auxiliary Power Units (APUs) to provide bleed air to start the main propulsion TF40B or ETF40B engines. Each main propulsion engine is assigned a normally closed starter shutoff valve to permit APU bleed air to pass to the main propulsion engine air starters. These starter shutoff valves are seizing due to corrosion and prohibit airflow needed to start the main engines. This paper describes the planned study to identify and resolve starter shutoff valve failures.

Air cushion vehicles
Corrosion
Landing craft
Starters

2007092236

Swedish Navy YS2000 Visby class propulsion system.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-90713
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D90713
Braccio, K.M., Ranero, J., Et al
English

The YS2000 program is a 73m length and 10.5m width all composite Corvette class vessel. It displaces 640 metric tons when fully equipped and drafts 2.5m. It is to be crewed by 18 officers and 25 enlisted men. It is a CODOG propulsion system, with two MTU 16V 2000 M90 diesels and four TF50A gas turbine engines. Both the diesels and gas turbines are connected to a pair of MA-107 SBS gearboxes that run two 125 SII KaMeWa waterjets. The Visby is designed to be difficult to detect by enemy using radar, infrared, hydro-acoustic monitoring or any other sensor system. The Visby has been in development in Sweden since 1999. To date, four craft have been constructed and sea trailed out of the five totals. The fifth ship was on schedule to complete construction and sea trials late in 2006. Many refinements to the overall propulsion package and related supporting systems have been incorporated since the first ship "Visby" has been sea trailed and since put in service. This paper reviews various areas of the

propulsion package, explaining the challenges that had to be overcome. The areas of interest include: the FADEC digital engine control, the exhaust & inlet systems, the turbine engine and starting system, engine room cooling and turbine engine enclosures. The paper focuses on some of the before and after results and attempts to highlight the specific challenges that had to be overcome.

Diesel engines
Gas turbines
Naval vessels

2007092237

Technology insertion in the US Navy.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-91075
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D91075
Quinones, M., Fauvell, K.D.
English

With a new perspective on how to conduct business through acquisition reform, the US Navy faces infrastructure challenges that are not necessarily in sync with acquisition principles. Historically, the US Navy has always spearheaded the means of developing design for form, fit, and function of Navy machinery. This leadership role has its roots on the unique requirements that the US Navy has to fulfill its mission. Unfortunately, this process does not always prove to be cost effective since its implementation normally carries heavy restrictions, unique applications, and little competition. This is commonplace for most technology insertion efforts into US Navy ships.

Naval vessels
Technology assessment

2007092238

The evolution of gas turbine generator set reliability in the US Navy.
ASME Turbo & Expo 2006, Power for Land, Sea & Air; 8-11 May 2006; Barcelona, Spain. GT2006-91301
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2006&product%5Fid=GT2006%2D91301
Russom, D.M., Pineiro, I.
English

This paper looks back at the evolution of the Gas Turbine Generator sets (GTGs) in the US Navy's DDG 51 Class, reviewing lessons learned, successes and areas where work is still required. Topics are discussed in the context of Mean Time Between Failure (MTBF) Total Ownership Cost (TOC) and maintainability. It reviews changes that resulted in MTBF increasing by a factor of five and TOC dropping by a factor of four. It also looks to the future, identifying potential areas

of further improvement.

Gas turbines
Naval vessels
Turbogenerators

2007092239

Bathymetric navigation for submarines and surface ships.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Leblang, M., Carik, C.
English

The advent of reliable world-wide Global Positioning System (GPS) navigation has resulted in nearly a universal reliance on GPS as the primary positioning source. This reliance, especially for submarine applications, is a potential vulnerability. With more nations developing advanced missile technologies, submarine reliance on GPS could prove catastrophic in a wartime situation. A Bathymetric Navigation Demonstration Program has been developed which shows how different echo sounders would perform in areas of varied sea floor topography as a reliable position fixing system, without reliance on external GPS data, should GPS availability ever be denied. This technique is applicable to both subsurface and surface vessels operating in areas with featured topography.

Bathymetry
Naval vessels
Navigation
Submarines

2007092240

The importance of resolving turbulence in navy flow problems.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Jordan, S.A.
English

In many Navy-related flow problems, resolving the internal turbulence levels is the foremost step towards remedial solutions. Highest intensities are well known as the prime irritant of flow problems leading to structural damage and/or self-noise, but conversely, the recognised pressure reductions can sometimes serve as the sole source for a viable answer. Historically, the salient turbulence characteristics were acquired by experimental means that restricted the spatial resource to a local level. But together with recent computational strategies, engineers can achieve a global knowledge base sufficient to understand the underlying root cause of the problem at-hand. In the following paper, we will spotlight this latter capability as well as a few noteworthy contributions. The specific technical methodology under view is called the Large-Eddy Simulation

(LES). This technique centres on resolving the energy-dominate scales of turbulence by computational means with the remaining smallest scales represented by a phenomenological model. In this paper, the importance of the LES method as a viable tool for solving Navy-related flow problems is embodied in three recent applications. The first problem dealt with designing (and at-sea testing/verification) of a prototype device for controlling the excessive pressure inside the SEAWOLF submarine vehicle launchway. The second application provided the necessary understanding of the turbulence nature to offer an alternative solution for mitigating the external noise source outside of the SEAWOLF high recovery inlet system. And finally, the most recent application uncovers the spatial turbulent character surrounding submarine towed arrays including mild manoeuvres.

Numerical models
Submarines
Turbulence

2007092241

Delivery of continuous design enhancements for the Collins class submarines.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Burnside, J.
English

This paper describes some of the approaches taken by in delivering continuous design enhancements for the Royal Australian Navy's Collins Class submarines, including: 1) an overview of contracting arrangements established for submarine through-life support; 2) a description of the upgrade project life-cycle from initial concept through to first-of-class validation at sea; 3) project management approaches used for the planning and monitoring of capability upgrades; 4) management of class-wide design margins; 5) scheduling of capability upgrades into the existing maintenance program for the submarine fleet; 6) prioritisation and allocation of resources between the competing demands of submarine maintenance, major and minor upgrades, and support services; and 7) establishing and maintaining a technical support network for the ongoing enhancement and support of the Collins Class. The real-world challenges faced, solutions adopted, results obtained, and lessons learned are described.

Ship design
Submarines

2007092242

The S1000 submarine – key design characteristics.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Borelli, P., Kormilitsin, Y.N.
English

The S 1000 submarine design is a modern type of conventional submarine of reduced displacement devoted to carry out special operations in deep waters as well as in coastal environments. The S 1000 submarine design is the result of the cooperation, promoted by Italian Ministry of Defence, between FINCANTIERI Russian Partner State-Owned Enterprise Central Design Bureau For Marine Engineering. The project focused on performances optimisation and costs reduction. The paper describes S1000 submarine's operational tasks and technical characteristics.

Ship design
Submarines

2007092243

SMX-23: the affordable sovereignty according to DCN.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Gauthier, J.
English

The SMX-23submarine is aiming to meet the current littoral defence needs of navies seeking to establish a submarine force for the first time or to maintain an existing force on a reduced budget. This paper focuses on this new submarine. It first records the initial architect choices. Then, the physical and functional characteristics are highlighted to understand her very affordable operational capabilities.

Submarines

2007092244

Fuel cell propulsion of submarines.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Hammerschmidt, A.E.
English

Polymer-Electrolyte-Membrane (PEM) Fuel Cells are known for reliable and efficient conversion of chemical energy into electrical energy at low temperatures. Comparative studies with various air independent propulsion (AIP) systems such as Stirling engines, closed cycle diesel and steam turbine systems in conventional (non-nuclear) submarines have demonstrated the clear superiority of fuel cells

over combustion based technologies. The PEM fuel cell was selected to provide a new generation of submarines with an AIP system enabling heretofore unattainable performance in terms of submerged endurance and acoustic performance. Design principles, properties, and operational characteristics of submarine fuel cells as well as key system component descriptions will be presented. The PEM fuel cell technology developed and manufactured by Siemens has been highly successful, the advantages and limitations of this application are discussed. The experience gained in development, manufacture and deployment of the 34kW modules as applied to the German and Italian U212 class submarines has served as the basis for accomplishing significant capability improvement. The new U214 class submarine, currently under construction for use in the Hellenic, South Korean, Portuguese and Israeli Navies will utilise an even more compact 120kW module.

Fuel cells
Submarines

2007092245

A simple method to measure ship's underwater electric field.
UDT Europe Conf; 5-7 June 2007; Naples, Italy. Organised by Nexus Business Media Ltd, Swanley, UK.
Hirota, M.
English

Underwater electric field (UEF) signatures of ships have been of great concern because of the threat of advanced underwater mines equipped with high-sensitivity sensors. The paper reports on a method developed to measure UEF intensities around ships by using simple sensors, hung into the water from the deck. The measured data on the wooden-hull ships were compared with the measurement obtained by UEF sensors on the seafloor, and it was confirmed that the method is effective. By this method, the UEF of a steel-hull ship equipped with impressed current cathodic protection systems was measured. The measured data agreed well with the UEF as calculated by the electric- current source model using UEF signatures measured on the seafloor.

Electric fields
Measurement
Ship signatures
Underwater

OCTOBER 2007

2007102465

Italians eagerly await their 'cruiseship' aircraft carrier.
Jane's Navy Intl, v 112 n 6, July/Aug 2007, p 22 [5 p, 11 fig]
Peruzzi, L.
English

This article describes the Italian Navy's new multi-role aircraft carrier ITS CAVOUR due to be delivered at the end of 2007. CAVOUR is the largest warship built in Italy since the Second World War. It displaces 27,000 tons full load and 22,000 tons light. With an overall length of 244m and breadth of 40.3m, the ship is constructed in FE510D steel both for the hull and superstructure. The carrier features luxury accommodation and state-of-the-art systems enabling a power-projection capability.

Aircraft carriers

2007102466

Performance metrics for electric warship integrated engineering plant battle damage response.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 22-29
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233795&count=88&index=9
Cramer, A.M., Sudhoff, S.D., Zivi, E.L.
English

In military applications, it is important for a platform (warship, aircraft, etc.) or an installation (airbase, etc.) to maintain war fighting ability after being damaged. In particular, if the unit requires electric power, cooling, or other resources to perform its mission, then these resources must be available following a weapon detonation event. The integrated engineering plant is responsible for providing these services to the mission critical loads in a unit. Novel continuity of service metrics for integrated engineering plants are set forth. These metrics provide a quantitative means of predicting the worst case scenario for a given system, as well as the level of service the plant can provide under the worst case scenario. This provides a method of making meaningful comparisons between different designs. The computation and meaning of the proposed metrics are explored using the notional plant.

Damage
Integrated systems
Naval vessels

2007102467

U.S.S. MAKIN ISLAND: simulation-based analysis and its role in electric-plant control system design.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 30-41
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233796&count=88&index=10
Turso, J., Ainsworth, W., Et al
English

The LHD 8 amphibious assault ship (MAKIN ISLAND) is currently under construction at Northrop Grumman Ship Systems, in Pascagoula, MS. A hybrid propulsion plant, in which the ship has the capability to be propelled by electric propulsion motors or gas turbine engines, exists aboard LHD 8. The electric propulsion motors provide for totally-electric propulsion for the majority of MAKIN ISLANDS operation at low speeds. The MKIN ISLANDS concept for electrical power generation, distribution, and electric propulsion represents the intent of the all-electric warship i.e., a highly automated electric-plant with minimal manning. This and other similar electric-plant system topologies offer alternate means of supplying power to loads by reconfiguring main distribution paths. Automated plant reconfiguration (load shedding) and power management is accomplished by a digital machinery control system for various casualty or loading conditions. An electric plant computer model simulation is used to assess the impact of faults, plant stability, signal latencies, etc. with regards to the electric plant. Several system design configurations were analysed during ship construction based on simulation results. This paper illustrates the role that dynamic simulation-based analyses can play in influencing electric plant designs as it applies to the parallel diesel generator load sharing algorithm and plant reconfiguration as well as an evaluation of the response of the existing simulated system and the relative improvement in response with the proposed upgrades.

Control systems
Electric propulsion
Hybrid propulsion
Naval vessels
Simulation

2007102468

The reduction of simulation software execution time for models of integrated electric propulsion systems through partitioning and distribution.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 53-59
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233799&count=88&index=13
Norton, P.T., Deverill, P., Et al
English

Software time-domain simulation models are useful to the naval engineering

community both for the system design of future vessels and for the in-service support of existing vessels. For future platforms, the existence of a model of the vessel's electrical power system provides a means of assessing the performance of the system against defined requirements. This could be at the stage of requirements definition, bid assessment or any subsequent stage in the design process. For in-service support of existing platforms, the existence of a model of the vessel's electrical power system provides a means of assessing the possible cause and effect of operational defects reported by ship's staff, or of assessing the possible future implications of some change in the equipment line-up or operating conditions for the vessel. Detailed high fidelity time-domain simulation of systems, however, can be problematic due to extended execution time. This arises from the model's mathematically stiff nature: models of integrated electric propulsion systems can also require significant computational resource. A conventional time-domain software simulation model is only able to utilise a single computer processor at any one time. The duration of time required to obtain results from a software model could be significantly reduced if more computer processors were utilised simultaneously. This paper details the development of a distributed simulation environment. This environment provides a mechanism for partitioning a time-domain software simulation model and running it on a cluster of computer processors.

Electric propulsion
Naval vessels
Simulation
Time domain

2007102469

Multi-objective design optimisation of submarine electric drive systems.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 65-71
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233801&count=88&index=15
Skinner, B.A., Palmer, P.R., Parks, G.T.
English

The design of an Integrated Electric Propulsion (IEP) system is considered for naval submarine propulsion. A multi-objective genetic algorithm is used to explore potential IEP topologies and designs, including direct-drive, geared-drive and hybrid steam-turbine/electric drive. Typical submarine mission scenarios are simulated and trade-offs in performance are investigated. Compromises in propeller and electric motor efficiency are found, as are large discrepancies in electric motor technology and the technology required for the realisation of direct-electrical propulsion. Multiple electric motors and a hybrid drive approach are found to reduce this discrepancy to an extent that IEP becomes a feasible propulsion option.

Electric drives
Submarines

2007102470

Dynamic simulation based analysis of a new load shedding scheme for a notional destroyer class shipboard power system.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 95-102
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233806&count=88&index=20
Ding, Z., Srivastava, S.K., Et al
English

In this paper, an expert system based load shedding scheme for ship power systems is revisited. In this load shedding scheme, a popular decision making tool termed the analytical hierarchy process, is utilised for prioritising the loads to be shed onboard a notional all-electric ship power system. The analytical hierarchy process based load shedding scheme overcomes some of the major drawbacks of traditional load shedding schemes implemented on ship power systems by minimising the number of loads disconnected, differentiating the priority of loads based on system conditions, and considering a wider range of factors that may potentially influence the shedding of electrical loads. An illustration of the developed load shedding scheme implementation to a destroyer class shipboard power system simulated in a real time digital simulator is presented.

Destroyers
Electrical loads
Expert systems
Ship power plants

2007102471

ABS Naval Vessel Rules (NVR) for mission critical networks, software development, and safety critical control systems.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 138-144
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233812&count=88&index=26
Roa, M.
English

The paper provides a rationale, background, and summary of how modern information technology is being used effectively by the US Navy in mission critical applications for shipboard control, navigation, and interior communication systems. The paper provides a background and summary of the updated American Bureau of Shipping (ABS) Naval Vessel Rules (NVR) requirements for mission critical networks, software development, and safety critical control systems. The Naval Sea Systems Command and ABS have partnered to co-write these rules

which were initially drafted by comparing the existing commercial Steel Vessel Rules (SVR) in these areas with current US Navy shipbuilding practice from recent shipbuilding programs. The requirements for safety critica l systems were then derived from the safety of flight criteria for US Navy submarine ship control systems. The paper explains the relationship between the Naval Technical Authority and ABS and their respective roles in the certification of control, automation, and navigation systems software and networks. The current requirements prescribed in the NVR are compared and contrasted with the commercial SVR and the merits and rationale behind each approach are discussed.

Naval vessels
Classification society rules

2007102472

Circuit breaker technologies for advanced ship power systems.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 201-208
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233822&count=88&index=36
Krstic, S., Wellner, E.L., Et al
English

The AC power systems on navy ships use circuit breakers based on traditional commercial technology. New naval power systems employ higher voltage DC distribution and use solid state power converters that actively (and instantaneously) limit the available fault current. When conventional circuit breakers are used in these systems, they have a relatively long clearing time, causing the voltage to collapse for a significant time. The application of fast-acting solid state circuit breakers, based on IGBTs and IGCTs will eliminate such voltage dips and result in a superior power system. Solid state circuit breakers also offer advantages when used in traditional ship power systems by limiting fault currents to levels far below those dictated by the supplying generators. This leads to lower magnetic and thermal stresses on distribution components, lower energy delivered to faults, faster fault isolation and minimal voltage disturbance.

Circuit breakers
Naval vessels
Ship power plants

2007102473

Sizing power generation and fuel capacity of the all-electric warship.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 1-6
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233792&count=88&index=6
Doerry, N.H.
English

Current sizing algorithms for warship power generation and fuel tank capacity were developed over forty five years ago when ship service loads were a small fraction of the overall power demand. Electric load growth, particularly with the introduction of high power mission systems will soon result in ship service maximum margined loads being nearly the same as the maximum propulsion load. In many operating conditions, ship service power demands exceed propulsion demands. This paper proposes new sizing methods for all-electric warships that are tied to operational effectiveness. These sizing methods are based on mobility mission tactical situations such as high speed transit, economical speed transit, and on station time. Additionally, the methods are sensitive to drag reduction efforts, temperature, and the ability to maintain speed in higher sea states. The goal is to optimise shipboard power and propulsion system life cycle cost while meeting operational requirements.

Naval vessels
Power requirements
Ship electric power systems

2007102474

DC protection on the electric ship.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 294-300
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233837&count=88&index=51
Hamilton, H., Schulz, N.N.
English

The need for DC power at continuous uninterrupted rates is a reality for ship survival during highly intense combat and regular travel. One of the new proposed distribution systems on the all-electric ship (E-ship) is designed using a DC distribution method (zones) in which the use of transformers and possible frequency issues/manipulations can be eliminated with the use of power electronics. These power electronic devices can greatly simplify the system by providing more available space, possible cost reduction, and variable control. One key feature is to make sure that the DC buses/systems and converters/rectifiers are protected from faults/arcing, transients, and other malicious events that can cause unwanted interference, shutdown, and possible damage or destruction. DC faults/arcing can have a detrimental impact on the ship performance. DC protection should permit high speed and high sensitivity detection of faults

enhancing reliability in the supply of electric power. DC fault protection geared towards a lower voltage scenario/system has not yet been studied and analysed rigorously. The research goal has been to develop a method in which the system can detect a DC fault and arcing phenomena and return to normal operating conditions once the fault is removed. The method also ensures that transient load changes will not be detected as faults tripping a false alarm. The use of power electronics, logic, and DC fault detection methods will be employed to solve how to protect the system and maintain stability.

Circuit protection
Direct current
Naval vessels

2007102475

Directly-coupled gas turbine permanent magnet generator sets for prime power generation on board electric ships.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 340-347
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233844&count=88&index=58
Vijlee, S.Z., Ouroua, A., Et al
English

Prime power generation on board all-electric ships presents several options that affect fuel consumption, power density, operational effectiveness, and survivability. A study that aims at understanding the effects of some of these options has been conducted and results are reported in this paper. It is found that direct coupling of gas turbines to permanent magnet generators reduces system mass and volume significantly as compared to electric power generation systems installed on present-day navy ships. Furthermore, it is found that a significant benefit this topology brings is a reduction in gas turbine air duct volume if the compact gen-set units are relocated on or near the ships upper decks. In addition, a combinatory analysis revealed that the choice of the number of generating units and their respective power levels has a significant influence on overall efficiency.

Electric power
Magnetic motors
Gas turbines

2007102476

A generic digital model of multiphase synchronous generator for shipboard power system.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 348-355
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233845&count=88&index=59
Lin, M., Srivastava, A.K., Schulz, N.N.
English

Electric ship power system loads, such as high power weapons and laser guns require flexible controlled power with high power quality. A multiphase synchronous generator provides high quality power with fewer ripples and a smoother current on the DC side. Improving the modelling and simulation of synchronous generators has been a subject of investigation for several decades. Modelling is traditionally based on the dq reference frame to obtain constant coefficients and to simplify the calculations. In this paper, a multiphase synchronous generator has been modelled. Better modelling of a multiphase machine is needed for shipboard power system analysis. The digital model is developed on the simulation platform of PSCAD/EMTDC, using the implicit integration method as the solver for a set of algebraic-differential-integral equations describing the performance of devices. The validity and accuracy of the modelling algorithm are verified by comparing steady state and transient performance of user-defined model with the standard model.

Electric power
Generators
Naval vessels

2007102477

T-AKE Lewis and Clark class auxiliary dry cargo / ammunitions ship sea trails (March 2007).
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 414-420
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233855&count=88&index=69
Goy, X., Clarence, R.
English

Electric propulsion systems are more and more frequently chosen in the marine business to meet environmental requirements, flexibility during manoeuvring operations and reliability. Resulting from many years of experiences in this field Converteam (Formally Alstom Power Conversion) have developed specific power and control architectures for the marine requirements. The US Navy USNS Lewis and Clark built by General Dynamics NASSCO (San Diego, CA) was delivered on June 20th. This ship presents a particularity in that it is propelled by a tandem motor supplied by four independent drives. Sophisticated control and regulation systems are required to manage an isolated power network and the propulsion

drive. Fine-tunings during dock trials and sea trial ensure the optimum performances. Sea trial test procedures are designed to prove the operation of the power network and the propulsion drive in the worst possible conditions.

Auxiliary ships
Electric propulsion
Sea trials

2007102478

Development of a low-EMI advanced variable speed drive for shipboard applications.
ESTS '07, Electric Ship Technologies Symposium; 21-23 May 2007; Arlington, VA, US. Organised by IEEE, US. ISBN 1-4244-0947-0. pp 478-482
http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?isnumber=4233785&arnumber=4233865&count=88&index=79
Limpaecher, E.R., Holveck, M.P., Ryder, B.J.
English

The US Navy fleet has yet to widely adopt variable speed motor drives (VSDs), despite maturation of commercial inverter technologies. The stringent electric power (MIL-STD-1399) and electromagnetic interference (MIL-STD-461) requirements are a significant obstacle for standard VSDs, which require large and heavy filters to comply with these specifications. A commercial AC-link VSD was modified, tested, and shown to have compliant harmonic levels and conducted EMI levels.

Electromagnetic interference
Naval vessels
Variable speed drives

2007102479

Developing and deploying ICAS-capable CMB software modules: best practices and lessons learned.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. Ppr GT2005-68812
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68812
Watson, M.J., Byington, C.S., Et al
English

The US Navy's Integrated Condition Assessment System (ICAS) is a shipboard monitoring system that helps enable the Navy's condition based maintenance initiative. ICAS is installed on a large number of Navy surface combatants and provides data acquisition, display, and logging, as well as equipment diagnostic analysis for troubleshooting and maintenance tasking of hull mechanical and electrical systems. In recent years, it has been desirable to integrate specialised, third party diagnostic or prognostic software as plug 'n play modules within the

ICAS environment. A specific effort focused on such modules for shipboard LM2500 and Allison 501K gas turbine engines is well underway. Over the course of this three-year prognostic enhancement to diagnostic system program, many lessons have been learned, best practices for ICAS integration have been identified, and the important steps required to field ICAS-capable modules have been realised. This paper summarises these lessons and processes for future 3rd party integration efforts and provides specific examples for the developed gas turbine modules. The successful deployment of these modules aboard Navy ships is used to validate the ideas presented.

Condition monitoring
Gas turbines
Naval vessels

2007102480

Development of the full authority digital engine control (FADEC) system for the enhanced TF40B gas turbine engine on the US Navy's Landing Craft Air Cushion (LCAC) vehicles.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. Ppr GT2005-68249
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68249
Shappell, L., Myers, L., Yee, R.
English

The Landing Craft Air Cushion (LCAC) Service Life Extension Program (SLEP) upgrades the current main propulsion engine and analog control system to the Enhanced TF40B (ETF40B) gas turbine configuration with a Full Authority Digital Engine Control (FADEC) system. The FADEC system is an integral part of the ETF40B gas turbine configuration and interfaces with the new LCAC Control and Alarm Monitoring System (CAMS). In addition to increased reliability, the FADEC requires minimal maintenance and can provide uninterrupted engine diagnostic capabilities. This paper outlines the FADEC development effort and the lessons learned during the design, environmental qualification, testing and operation for the LCAC.

Control systems
Gas turbines
Landing craft
Naval vessels

2007102481

Fuel oil in-line sampling analysis.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. PprGT2005-68940

http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68940
Salvucci, L.A., Donnelly, T.C., White, M.A.
English

The US Navy is pursuing endeavours in support of propulsion gas turbines in terms of in-line fuel oil quality. Using a prototype laser technology, the US Navy is proceeding to expand its capabilities to monitor sediment and free water in Naval Distillate, NATO Code F-76, under flow conditions. The maximum fuel quality limitations for the US Navy propulsion gas turbines are 40 parts per million (PPM) free water and 2.64 milligrams per litre (mg/litre) sediment contamination. The current prototype unit, being tested in aviation fuel (JP-5) systems, is capable of monitoring fuel quality within these systems where the maximum fuel quality limitations are 5 PPM free water and 2.0 mg/litre per litre sediment contamination. Current naval shipboard policy for gas turbine propelled hulls requires fuel quality testing at the discharge of the fuel oil service system filter separator discharge, which is the last sampling point prior to admittance into the gas turbine module. Incorporating this technology in unison with monitoring capabilities will eliminate the subjective and laborious laboratory sample testing presently conducted, reducing workload and provide ship's force with real-time quality assurance data. Future enhancement of this technology is being initiated to develop the capability to analyse other potential fuel properties, such as specific gravity, in addition to sediment contaminant size distribution measurement. This will provide ship's force with real-time data that can be used to detect off-specification fuel properties or on-board filtration equipment problems sooner than present. This can aid in more effective shipboard fuel quality control and prove essential in the selection of filtration systems aboard US Naval vessels.

Fuel oil quality
Gas turbines
Naval vessels

2007102482

Improvements to compressor prognostics algorithm for US Navy ship service gas turbine generator sets.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. PprGT2005-68105
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68105
Caguiat, D.E., Patterson, J.S., Et al
English

The US Naval Surface Warfare Centre Gas Turbine Emerging Technologies section conducted land-based testing on a gas turbine generator set in December 2003. The purpose of this testing, which was conducted on a Rolls Royce/Allison 501-K17 gas turbine, was to collect data that could be used to improve a previously developed computer program for predicting optimal compressor wash time intervals. For the purpose of Phase I of this testing, fouling was

accomplished by injecting salt into the gas turbine inlet air stream. Phase II of this testing will consist of fouling the middle and back regions of the compressor. Influence coefficients can then be developed for each of these regions indicating how a given region affects overall performance. Typically, in a marine environment, fouling of the front stages occurs due to ingested salt while fouling in middle and rear regions occurs from a combination of ingested salt and oil seal leakage. A number of sensors, including compressor inlet and discharge condition probes, bleed air flow and fuel flow meters, were added in order to monitor engine performance during the testing. In addition, hardware was added to both ingest and monitor the concentration of salt in gas turbine inlet air. For Phase II testing, middle and rear stages of the 14-stage compressor shall be accessed through existing 5th and 10th stage bleed ports. A salt solution will be physically applied to the blades while the compressor is rotated by hand. Results from Phase I indicate that front stage compressor fouling causes a clear increase in inlet static pressure. This is due to the mass flow restriction through the compressor. Additional results are currently being summarised, and data is being utilised to improve the 501-K17 compressor wash prognostics algorithm previously noted.

Compressors
Gas turbines
Naval vessels

2007102483

Improving operational availability of gas turbine generators aboard US Navy DDG-51 class ships by combining the capabilities of the integrated condition assessment system (IACS) and the generator set's full authority digital controller (FADC).
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. PprGT2005-68952
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68952
Russom, D.M., Leinbach, R.A., Et al
English

Operational availability of Gas Turbine Generator Sets (GTGs) aboard the US Navy's DDG 51 Class ships is being enhanced through the combined capabilities of the ship's Integrated Condition Assessment System (ICAS) and the GTGs Full Authority Digital Control (FADC). This paper describes the ICAS and FADC systems; their current capabilities and the vision of how those capabilities will evolve in order to improve equipment readiness and reduce life cycle costs.

Condition monitoring
Gas turbines
Generators
Naval vessels

2007102484

US Navy qualification of a GE LM2500+ gas turbine engine.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. PprGT2005-68954
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D68954
Hatcher, S., Batory, T., Et al
English

This paper is a comprehensive document citing the events pertaining to the qualification of the GE LM2500+ gas turbine engine for US Navy service. The purpose of this paper is to serve as documentation of the entire qualification process that includes the 500-hour rating qualification test and subsequent teardown inspection, high impact shock testing, and the subsequent 100-hour post shock endurance test and teardown inspection. This paper includes an assessment of the overall performance of the engine, General Electric's capacity to meet specified test requirements, any questions or concerns that may have arisen during testing, and a conclusive statement about the outcome of the tests.

Gas turbines
Naval vessels

2007102485

Upgrading the LCAC APU system.
ASME Turbo Expo 2005: Power for Land, Sea & Air; 6-9 June 2005; Reno-Tahoe, Nevada, US. PprGT2005-69083
http://store.asme.org/product.asp?catalog%5Fname=Conference+Papers&category%5Fname=Marine%5FGT2005&product%5Fid=GT2005%2D69083
Hillen, M.M., Hampshire, J.D.
English

The US Navy's Landing Craft Air Cushion (LCAC) hovercraft vehicles use two Auxiliary Power Unit (APU) engines to provide AC power to the craft and bleed air to start the main engines. The APU Engine Sequencing Unit (ESU) and bleed air valve have consistently been high failure items. A Component Improvement Program (CIP) has been developed to increase the APU reliability and reduce repair/replacement cost by upgrading the ESU and bleed air valve. This paper documents and outlines the APU CIP development effort, along with the installation, testing, and operation of the new APU components.

Air cushion vehicles
Auxiliary power
Landing craft

2007102486

US Navy high speed craft – comparison of ABS and DNV structural requirements.
SNAME Trans, v 113, 2005. CD-ROM. Publ by SNAME, Jersey City, NJ, US. ISBN 0-939773-54-6. p 340 [27 p, 6 ref, 13 tab, 30 fig]
Kramer, R.H.
English

Recent experience with the Littoral Combat Ship, Focused Mission Ship, Ship Structure Committee (SSC) Project SR 1437 and other programs for the US Navy has required the development of structural designs for the unique loads that occur on high speed craft. Using the ABS Rules for Building and Classing High Speed Naval Craft and the DNV Rules for Classification of High Speed, Light Craft and Naval Surface Craft, the hull girder, slamming and vehicle deck loads required for the design of a US Navy high speed craft/combatant are reviewed. Materials and allowable stresses associated with each of the class society's rules are summarised along with the required loads and resulting structural modifications for SSC Project SR 1437, which used each of the two rule sets to determine the structural modifications for converting a commercial, high speed ferry into a high speed military transport capable of unrestricted (i.e., open ocean) operation.

Design criteria
Design loads
High speed vessels
Naval vessels

2007102487

Leading a sea change in naval ship design: toward collaborative product development.
J of Ship Production, v 23 n 2, May 2007, pp 53-71
http://puck.ingentaconnect.com/vl=7692773/cl=18/nw=1/rpsv/cw/sname/8756141 7/v23n2/s1/p53
Keane, R.G., Fireman, H., Billingsley, D.W.
English

In October 1989, the US Naval Sea Systems Command (NAVSEA) conducted the Ship Design for Producibility Workshop with broad participation from the Navy, shipbuilders, ship design agents, and academia. The Workshop was one of NAVSEA's first Total Quality Leadership (TQL) initiatives and was subsequently expanded for Ships into the Ship Design, Acquisition, and Construction (DAC) Process Improvement Project. The authors describe one of these major process improvement initiatives, NAVSEA's 3-D "Product Model" strategy to extend throughout the enterprise-wide process of warship development a primary focus on the bridge between ship design and shipbuilding. The Workshop and subsequent process improvement initiatives have had a profound impact on the naval ship design process. To realise transformational innovations in their ship designs, as well as transformational innovations in the entire warship development process, the National Naval Responsibility in Naval Engineering (NNR-NE) was

recently established by the Navy. To support NNR-NE the Office of Naval Research NAVSEA created the Center for Innovation in Ship Design (CISD). A summary of some recent CISD Innovation Cells and how CISD can contribute to breaking down the existing organisational cultures and institutionalising a collaborative product development environment are also discussed.

Naval vessels
Ship design

2007102488

Long-term retention of product model data.
J of Ship Production, v 23 n 2, May 2007, pp 118-124
Kassel, B., David, P.
English

This paper discusses strategies for the long-term data retention of Weapons System Information based on the Standard for the Exchange of Product Model data and the development of a set of product model test data.

Data
Product models
Weapons

2007102489

Designing all electric naval surface ships.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 1, ppr 1 [29 p, 19 re, 3 tab, 7fig]
http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Fireman, H., Doerry, N.H.
English

The Integrated Power System (IPS) offers the naval architect considerable flexibility to achieve mission requirements at reduced cost. This flexibility results from the ability to separate the prime movers from the propulsion train, maximise efficiency of prime movers and propulsors, and optimise the number and rating of prime movers. Unfortunately, many naval architects are unfamiliar with how to exploit this flexibility, resulting in unfavorable comparisons with mechanical drive alternatives. This paper provides guidance for selecting the number and rating of IPS modules and incorporating these modules into the design of ships. Often, the resulting general arrangements for an optimally designed IPS ship will differ significantly from an optimally designed mechanical drive ship.

Integrated shipboard systems
Naval vessels
Ship design
Ship electric power systems

2007102490

SWORDSHIP, a concept ship by DCN.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 1, ppr 2 [18 p, 5 ref, 18 fig] http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Goubault, P., Bardes, C., Lacoin, A.
English

A new concept for an "ultimate" stealth surface combatant is discussed. The SWORDSHIP will be virtually invisible, which will enlarge its range of action in the littoral area and further enhance its survivability. Featuring many technological developments all expected to be achievable by year 2030; the SWORDSHIP presents a higher firepower in a more efficient ship than today's frigates. In addition, the SWORDSHIP will benefit from the new achievements in data processing and communications to offer a radical new approach in the combat management system. The various features of the SWORDSHIP are discussed in this paper, which offers a glimpse at what a future surface combatant could be. As most often is the case with visions of the future, this dream ship will certainly see many modifications before being built some day. It is anticipated however that many of its key technologies will be found in ships to come.

Naval vessels
Ship design
Stealth

2007102491

The class 210MOD submarine – the synthesis of compactness and efficiency.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 1, ppr 3 [9 p, 4 fig] http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Hauschildt, P.
English

Within the last decades the trend for national as well as international newbuilding designs was basically a one way road towards larger submarines, due to the constantly increasing requirements of navies. There are justified demands for improved crew comfort, higher payload with regard to sensor outfit and weaponry, lower indiscretion rate and extended submerged as well as overall endurance ranges. The improved capabilities of the respective platform allow world wide ocean going operations but usually result in a higher cost per unit. As a result of

limited armament budgets this tendency is accompanied by the trend towards procuring a steadily reduced number of submarines per batch. In order to disarm this effect a compact, mission orientated design is needed. Consequently the Submarine Division of ThyssenKrupp Marine Systems has developed another future orientated submarine solution based on customer feedback and experience from building submarines for 18 navies from all over the world.

Submarines

2007102492

Multi-static sonar concept study for shallow water environment.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 2, parallel session 1, ppr 1 [7 p, 5 ref, 3 fig]
http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Ho, W.C., Chia, C.S.
English

Today, it is increasingly difficult for sonar systems to detect conventional submarines which have become quieter and with low target strength. Modern navies are now placing more emphasis on the use of active low frequency sonar systems as they offer a better detection performance for anti-submarine warfare operations. In the transformation of major modern navies into the next generation force, the sharing of information between different systems for modern warfare is a key area of focus. Multi-static sonar concept presents a network-centric based approach through the use of active sonar transmitters with multiple receivers to improve target detection performance. Several studies in multi-static sonar techniques have been reported in the open literature. However, the majority of these studies were carried out in deep water environments. This paper presents the simulation results carried out to explore the potential of using multi-static sonar in shallow waters to improve detection performance. The simulation study aims to compare the detection performance in shallow waters for various multi-static sonar configurations in different tactical situations, such as area clearance and convoy protection.

Shallow water
Sonar

2007102493

State of the art CFD analysis for hydrodynamic design in submarine development.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 2, parallel session 1, ppr 3 [9 p, 16 fig]

http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Gustafsson, H., Eriksson, A., Et al
English

Computational Fluid Dynamics (CFD) is widely used for analysis in submarine development. This technique is primarily used to study different areas regarding hydrodynamic performance of the submarines. One important area of interest is hydrodynamic resistance but several other subjects are also studied. Much effort is spent on determining the characteristics of the wake in order to optimise the flow conditions for the propulsor. Detailed studies are performed for e.g. fin (sail) and control surfaces to point out the most favourable position on the hull. Different locations of sensors are also studied in order to ensure optimal performance of each device. Simulations of surface piercing masts are performed in order to analyse the resulting wave pattern and water spray. By using a more advanced turbulence modelling technique called large eddy simulation, analysis of flow induced noise is performed. Additionally, CFD is also applied within other, i.e. non hydrodynamic areas of submarine design, such as on-board environment analyses with regard to climate control. In order to increase the efficiency even more for the well proven Stirling AIP-system, CFD analyses are conducted to optimise the design of the combustion chamber.

Computational fluid dynamics
Design
Submarines

2007102494

CFD analysis of the battery room in DSX1300 submarine.
NPTS 2007, Naval Platform Technology Seminar; 16-17 May 2007; Singapore. Organised by Ministry of Defence, Singapore. Day 2, parallel session 1, ppr 4 [12 p, 4 ref, 16 fig]
http://www.mindef.gov.sg/imindef/mindef_websites/atozlistings/navy/microsites/npts/npts_2005_papers.html
Kim, J.-S., Kim, K.-R., Et al
English

Submarine main batteries are of vital importance as the only energy source to provide electric power to submarine propulsion system and auxiliary system during submerged operation. Main batteries are periodically charged by diesel generators at snorkel operation, close to sea water surface, in order to compensate the discharged electrical energy during submerged operation. During charging and discharging of main batteries by diesel generators, hydrogen gas evolves off main batteries, which is flammable at more than 4% and explosive at more than 8% of concentration. Main batteries as many as to cover propulsion power and hotel load are installed inside battery room where is air tightened, arranged for uniform air flow and fitted with ventilation system consisting of air inlet duct, air outlet duct and battery room fan. In this study, hydrogen concentration of battery room in DSX1300 submarine (designed by DSME, propelled by the diesel-electric

system, and with about 1390m^3 of surface displacement) is analysed by CFD software for the purpose of optimising the designed ventilation system. The analysis result shows that hydrogen concentration of battery room is always less than 1.1%.

Computational fluid dynamics
Electric batteries
Submarines

NAVAL ENGINEERING YESTERYEARS

Taken from the Journal of Naval Engineering and Papers on Engineering Subjects archives, BMT Defence Services are pleased to introduce this historical section to the Journal. This section will provide readers access to reference material on Past Naval Engineering processes.

BMT Defence Services are also conducting a study to determine feasibility of providing the Journal of Naval Engineering archive papers on-line for the wider readership.

It should be noted that BMT Defence Services, under contract to DLogME have archived the total holdings for the Journal of Naval Engineering including the Papers on Engineering Subjects as far back as 1920. This information is available on request.

PAPERS ON ENGINEERING SUBJECTS

FIRE BRICKS AND FIRE CLAY

THE YEAR IS 1920

The study of the qualities necessary in refractory linings to meet the conditions obtaining in the furnaces of oil-fired boilers is a subject which has attracted little interest outside Naval circles, as the problems which have to be faced do not arise in any commercial process. The problems are quite different in the two cases. In commercial practice the qualities required are mainly resistance to withstand high temperature and rough usage which, given a suitable material, can be surmounted by suitable dimensions and construction. Rapid changes in temperature can, moreover, be avoided in general.

In water tube boilers for Naval purposes, on the other hand, considerations of weight and furnace volume, the unavoidable rapid changes of temperature, the necessity of rigidity to withstand the strains caused by the rolling and pitching of the vessel and the occurrences of vibratory burning or pulsation are such as to render the experience and practice regarding refractories employed in shore practice of little use.

It may be said that firebricks and fireclay of the highest class with a high silica content are unsuitable for boiler work; they will not stand changes of temperature or heating after the absorption of atmospheric moisture; their weight generally is high, and their structure is unaffected by the highest furnace temperatures attained; their shrinkage is small after exposure to that temperature but with sudden coolings such as are experienced when sprayers are shut off the structure of the brick may collapse, and this risk is acute if any moisture has been absorbed by the brick at any time previously. The rate of cooling in a Yarrow boiler with air doors closed average above 100° F. per minute over the first 15 minutes.

The coefficient of expansion of firebrick within the range of its working temperature is about .0000043 per degree F. the brick does not usually suffer from shrinkage to any harmful extent, but the linear shrinkage of the fireclay used in the bonding may be as great as 5.8 per cent, after the first firing. In certain cases it may be of advantage therefore to fill in any interstices after first firing.

The specific heat and thermal conductivity of firebricks are important properties as affecting their insulating qualities, but they are not factors which vitally influence the choice, reliability being of outstanding importance. The thermal conductivity varies with the porosity and the average for an ordinary service brick in B.T.U.'s per degree Fahrenheit per inch cube per second is .000122 against .000254 for magnesite, .00072 for silica, and .00054 for carborundum.

The chemical composition should show an absence of those ingredients tending to lower the refractory properties but should contain sufficient to allow a slight surface glazing after being brought into use to prevent the absorption of water or

oil and carbon particles. As already indicated the absorption of water may cause rupture, while the absorption of oil which is subsequently carbonised increased the weight appreciably, but generally adds to the rigidity of the brick.

Experience shows that a suitable composition of high quality bricks for oil fired furnaces is:

	Per Cent.		
Silica from	74.	-	63.
Alumina	22.	-	33.5
Oxides of iron	2.7	-	2.2
Lime	.4	-	.3
Magnesia	.3	-	.6
Potash and soda	.4	-	-
Loss, &c.	.2	-	.4
	100		100

The principal constituent which reduces the melting and softening points of a brick is the oxide of iron and lime and alkaline have the same effect. Bricks for oil-fired boilers should not contain more than 3 per cent. of iron oxides. Bricks employed for blast furnaces which are exposed to very high temperatures contain only traces of iron oxide, lime and magnesia.

The colour of bricks is an indication of the presence of iron oxide and it varies from a light cream to a light red with percentages of iron oxide from 1 per cent. to 5 per cent. There are notable exceptions, however, especially in those bricks where a foreign material such as cinders or sawdust is used to reduce the density and increase the porosity of a clay which is otherwise too dense for satisfactory bricks. The Chinese bricks which are made at Hong Kong are white when manufactured, but develop a slight green tinge after first heating; these bricks are of the most suitable quality, as may be expected from such experts as the Chinese undoubtedly are in the selection and treatment of refractory clays.

The practical test in the furnace is the only reliable one for the manufactured article and no so-called light bricks, i.e., bricks of a weight below 128 lbs. per cubic foot, have so far proved equal to a test of only moderate severity. The size and shape of the brick have an important bearing on their rigidity - large segmental bricks of 4 inches thickness can only be made reliable by the greatest care in selection of material and in firing.

The tests to which bricks are subjected before acceptance at Haslar are:

a) Structural rigidity before and after heating;

b) Porosity before and after heating; the difference is a measure of the conversion and fusion that has taken place.

The percentage and nature of the grog, i.e., the quartz-like substance present in varying quantities throughout the structure of a brick, the nature being determined from the specific gravity of a sample.

The effect of absorbed water is tested in selected cases, as is also the elemental composition.

After firing tests the colour, the ring of the brick, and the facility with which it may be cut are noted together with particulars of the nature and depth of any surface glaze.

The heating test consists of intermittent heating to 2700° F., or alternatively for special cases to 3000° F. for a similar time. Light bricks or large shaped bricks will only in special cases stand up to this latter test, and light bricks as a rule will not stand up to the lower temperature.

The ability to stand sudden cooling is tested with cold air only.

The effect of the addition of carbon to the constituents composing the brick appears in general to be favourable to the bricks, their rigidity after heating is high and the spalling effect, i.e., a particular type of flaking of any small percentage of water or rapid cooling, is lessened.

Glazing of firebricks improves the appearance of a furnace, but there is not evidence that its wearing qualities are improved.

The action of salt or alkaline glazing agents on bricks is a reduction of the iron oxide content, resulting in a slagging action and the bricks most suitable for oil-fired boilers are less resistant to the attack than other and higher qualities of brick.

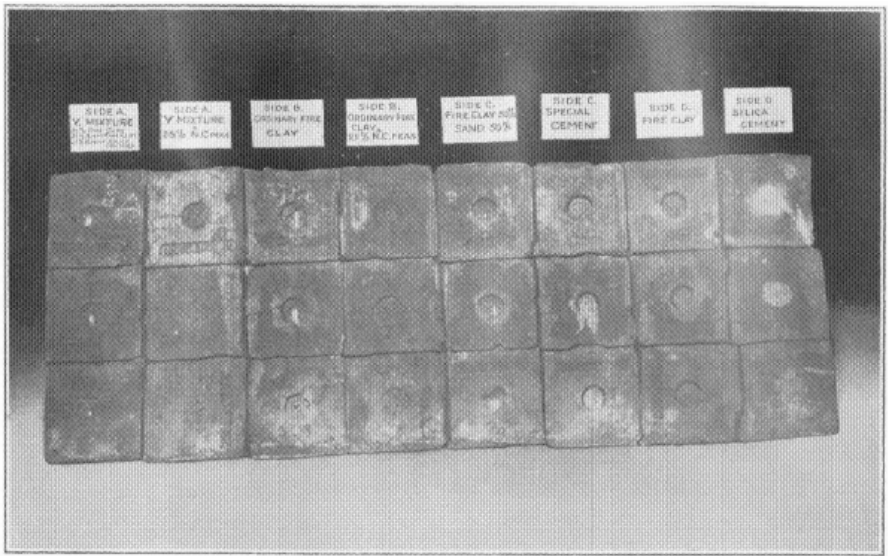
It is found that the tendency to shrink which occurs in fireclay for bonding purposes is reduced if a certain proportion of old burnt brick and burnt fireclay is added to the mixture. Any other material added should be kept below the following percentage as the effect is to reduce the fusion point of the mixture below the possible temperature that may be experienced.

Portland cement - - - -	10 per cent
Lime - - - - -	8 "
Asbestos - - - -	9 "
Water glass - - - -	24 "
Salt - - - - -	7 "

The most satisfactory mixture is probably 75 per cent. fireclay, 25 per cent. burnt material or 75 per cent. fireclay, 15 per cent. burnt material, 10 per cent. sea sand; if a high percentage of sea sand is used it is inadvisable to use salt water for mixing as the percentage of salt may then be above the safe figure.

For bolt plugging material, the most satisfactory composition is undoubtedly silica cement, but in Yarrow boilers, 50 per cent. fireclay, 25 per cent. ground bricks, and 25 per cent. ground fireclay is satisfactory.

It appears of advantage to bring to a point the exterior of the plugs and if any shrinkage is observed it can be reduced by the addition to the mixture of a small proportion of North Country coal of the size of peas.



The plate shows the appearance of test plugs of various compositions after being subjected to a furnace temperature of 3000° F.

It is to be noted that the furnaces of Babcock and Wilcox boilers may when forced attain a somewhat higher temperature, about 3000° F., than Yarrow boilers.

The melting points of a number of refractories and metals are shown in the following table, observing that the furnace temperatures in highly forced water tube boilers range from about 2700° to 3000° F.

° F.			
3270	-	-	Best firebricks melt.
3260	-	-	Bauxite clay.
3190	-	-	Platinum.
3180	-	-	Pure Silica.
3145	-	-	Vanadium.
3090	-	-	Silica brick.
2850	-	-	Bauxite brick softens.
2820	-	-	Silica brick softens.
2820	-	-	Inferior firebricks melt.
2740	-	-	Pure iron.
2690	-	-	Steel (5 per cent. C.).
2645	-	-	Nickel.
2615	-	-	Steel (1 per cent. C.).
2590	-	-	Silicon.
2550	-	-	Inferior firebricks soften.
2460	-	-	Steel (2 per cent. C.).

The influence of the method of storing on the water content and the consequent fragility of firebricks has been tried exhaustively with the results indicated below:

Bricks from -	Max. Water Content.	% Average Water Content.	Order of Fragility.
Sheerness - -	Ozs. 4	1.7	2
Chatham - -	6	3.9	4
Portsmouth - -	5	3.0	3
Devonport - -	6	4.7	5
Pembroke - -	9	5.0	5
Rosyth - -	11	9.6	6

The numbers in column 4 represent the average number of pieces the brick was broken into in 3 falls after being subjected to a temperature of 2700° F. It will be noted that the order of moisture follows approximately the order of fragility.

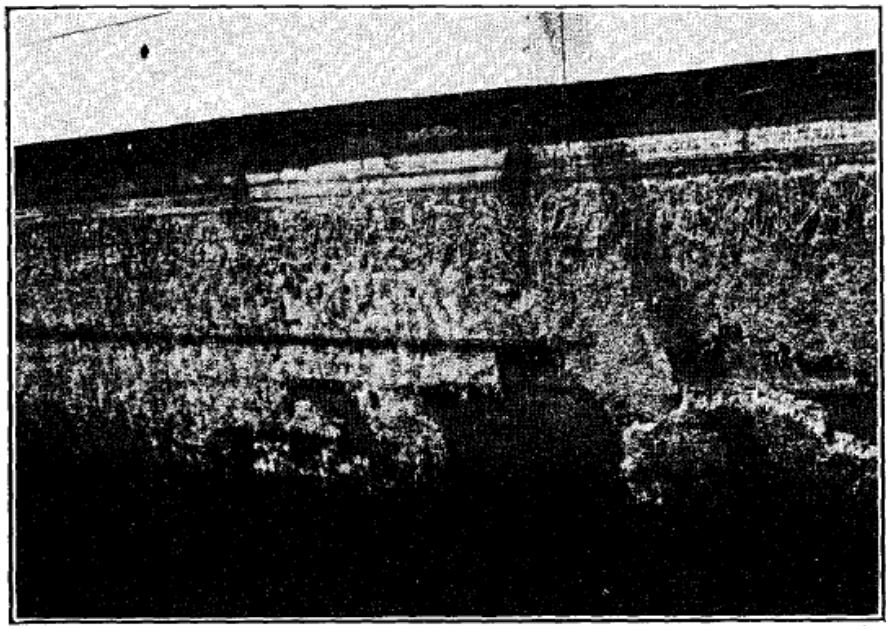


FIG. 1. - PORTION OF PORT SIDE OF H.M.S. "SIRIUS" SHOWING HEAVY GROWTH OF TUBEWORMS AFTER A PERIOD OF SERVICE IN THE MEDITERRANEAN

BIOLOGY OF THE UNDERWATER FOULING OF SHIPS' HULLS

THE YEAR IS 1947

By

H.G. STUBBINGS, M.A., PH.D., B.SC.

TYPES OF FOULING ORGANISMS

The organisms capable of settling on the outer bottom of ships and causing fouling comprise an assemblage of more or less lowly animal and plant species derived for the most part, from the coastal regions of the seas of the world. The natural habitat of most of these species is the intertidal zone and the sea bottom to a depth of perhaps 20 fathoms. In this zone, nearly all live attached to rocks, to the larger hardshelled animals and to the larger seaweeds. Inevitably they colonise any structure introduced by man unless this is adequately protected. Thus breakwaters, piers anchors and submerged ropes and, most important from the economic standpoint, the outer bottoms of vessels may rapidly be covered by a variety of these organisms. Because they are essentially inshore or neritic species, they tend to be rare away from the land and a vessel rarely receives its quota of fouling

species while on the high seas. It is on entering inshore waters and especially when alongside or at anchor, that settlement of fouling organisms occurs.

There is no uniformity of distribution of fouling species in coastal regions. It is, of course, well known that some ports are exceptionally bad from the fouling standpoint whilst others are good and "scouring" ports may even cause cleaning of a fouled bottom through the abrasive action of suspended silt.

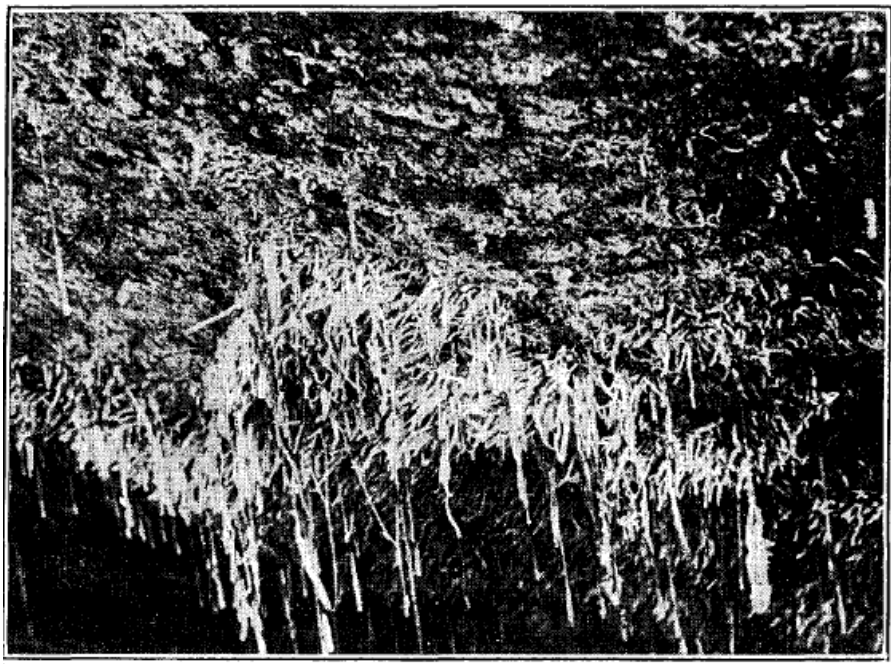


FIG. 2. - "CLOSE-UP" OF TUBEWORM FOULING ABAFT THE OUTER PORT PROPELLER OF H.M.S. "SIRIUS"

Density of occurrence of species is generally highest in tropical and subtropical waters whilst fewer organisms occur in higher latitudes and very few in polar seas. There is a general similarity between the types of fouling experienced in different parts of the world, because the groups of animals and plants concerned are world-wide in their distribution. Locally, however, one or more may be predominant.

Thus, exceptional growths of tubeworms ("coral") may develop on ships in Mediterranean waters (Figs. 1 and 2). There are, however, considerable specific differences between the fouling types from different regions. Green, brown, and red algae (seaweeds) foul ships in all parts of the world but the species settling on a ship in U.K. waters, will be mainly different from those settling in a West African port and again both will be distinct from those settling at, say, Singapore. Similar differences exist between the barnacles, tapeworms, and other animal growths causing fouling in different parts of the world.

The various types of seaweeds and animal causing fouling have been outlined and illustrated in the booklet "Fouling of Ships' Bottoms: Identification of Marine

Growths" by the Marine Corrosion Sub Committee of the Iron and Steel Institute and distributed by Admiralty to H.M. Ships. The genera and species mentioned there occur in British waters but closely allied types are found in all seas. Four species of British seaweeds are shown in Fig. 3. It will not be necessary to describe these forms afresh and this paper will attempt to indicate some of the biological and physical factors affecting settlement of fouling organisms and to outline the methods of preventing fouling and the work that is being done on the subject.

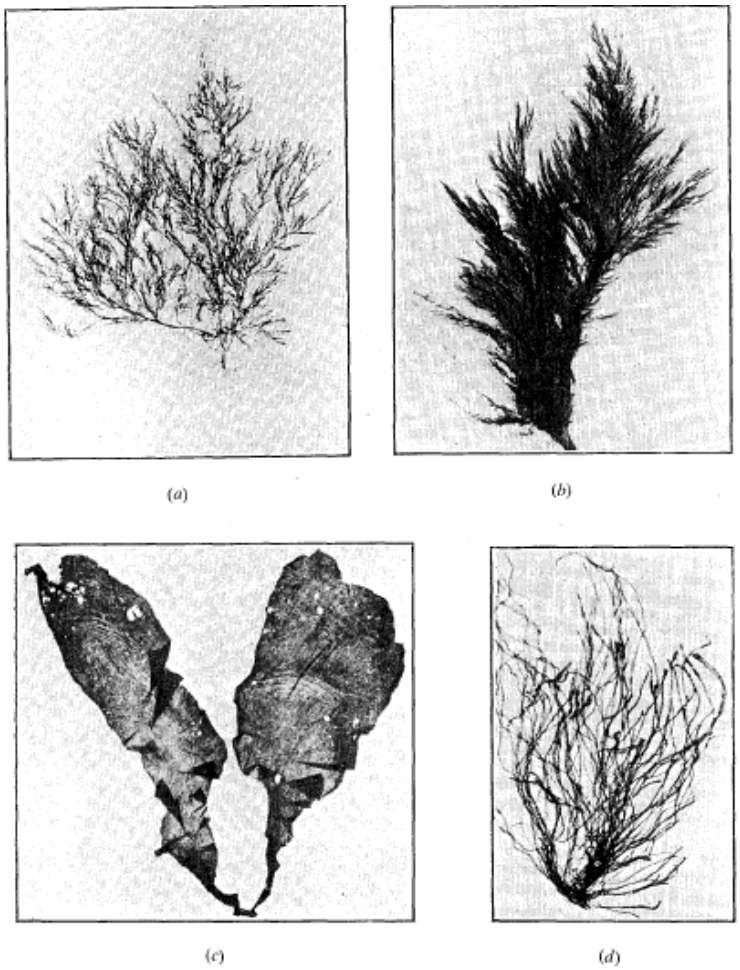


FIG. 3. - FOUR SPECIES OF COMMON FOULING SEAWEEDS:

(a) CERAMIUM, ONE OF THE FEW COMMON RED SEAWEEDS (USUALLY PURPLISH IN COLOUR) FOUND ON SHIPS
(b) ECTOCARPUS, A FINELY BRANCHED BROWN SEAWEED
(c) THE SEA-LETTUCE (ULVA), ANOTHER COMMON

GREEN SEAWEED
(d) ENTEROMORPHA: THIS IS THE COMMONEST GREEN SEAWEED COMPONENT OF THE "GRASSLINE"

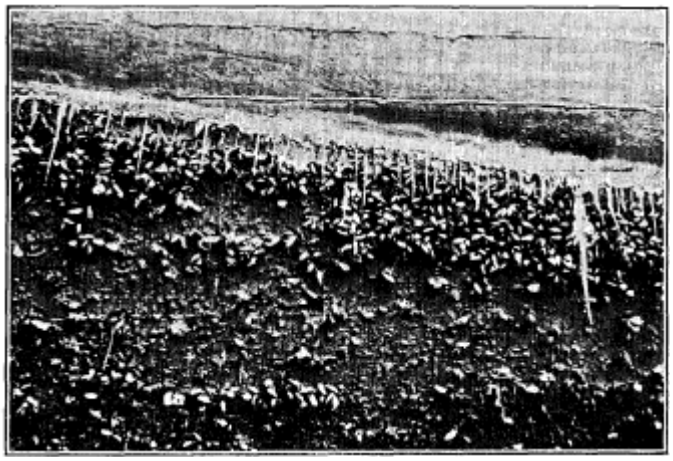


FIG. 4. - WATERLINE FOULING ON TIMBERS OF R.R.S. "RESEARCH." THE FOULING AT WATER LEVEL CONSISTS OF NARROW BANDS OF A RED ALGA (BANGIA), YOUNG ENTEROMORPHA AND LONG FRONDS OF THE BROWN OAR-WEED (LAMINARIA). FOULING AT ALL LOWER LEVELS IS MAINLY THE EDIBLE MUSSEL AND A FEW BARNACLES

Occurrence and Settlement of Species

The geographical distribution of fouling species has been stated to be practically world wide. If the distribution in time is considered, a different picture is obtained. In tropical waters, many species of tubeworms and barnacles and probably some seaweeds may breed throughout the year. Thus young settling individuals of these species are present at all seasons, searching for a suitable place to attach themselves. To take one case only; on the Florida coast barnacles settle during most months of the year and it is doubtful if the settling stages are ever entirely absent. There is a peak period for settlements, lasting for most of the summer months, followed by a short 'winter' period when fewer larvae are present. In contrast, barnacles breed in this country during fairly well defined periods, in the spring and again in late summer or early autumn. In the English Channel there is a very sudden appearance of young newly settled barnacles in late March and April and another fairly heavy settlement occurs in August-September. Relatively few settle at other seasons of the year. Similar 'seasons' occur for most if not all fouling species in British waters.

From this fact alone it is clear that the particular fouling appearing on a ship at any place will depend upon the time of the year, controlling the presence of settling organisms. Further the numbers present may vary considerably. The experience of several investigators working on fouling in the U.K. is that there are "good" and

"bad" seasons for, say, barnacles. The factors governing these "good" or "bad" seasons are not easy to ascertain but from general considerations, it appears they are related to the physical and chemical condition of the waters and to the food supply. The former affect the reproduction of the microscopic plant forms of the sea e.g., low light intensity and low phosphate or nitrate content will all tend to reduce the microscopic flora of the waters. The food shortage so produced will seriously affect the production of young barnacles because during the period from egg to settlement they undergo a free-floating larval existence when they are dependent on micro-organisms for food. For further details on the relationship between the abundance of marine organisms and food supply, the reader should consult the various text books of marine biology and oceanography where the subject is dealt with more fully than is possible here.

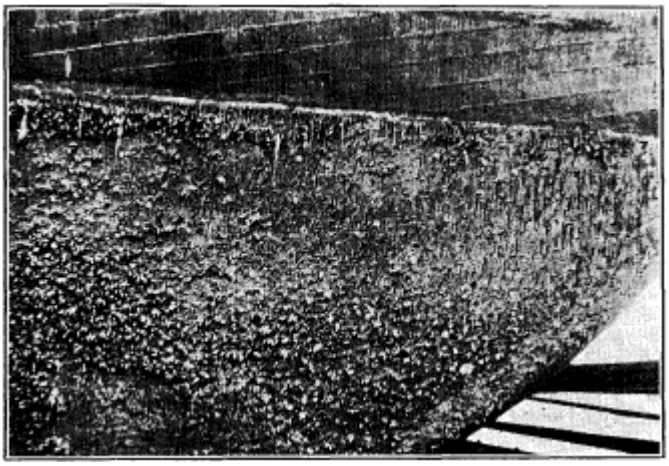


FIG. 5. - FOULING ON THE BOWS OF "RESEARCH". RED SEAWEEDS OCCURRED HERE AS MUCH AS 3-4 FEET BELOW THE SURFACE, PROBABLY BECAUSE OF THE GREATER ILLUMINATION DUE TO LACK OF CURVATURE OF THE HULL

The places in which the young organisms settle are also conditioned by a number of factors. Broadly speaking, plants seek the light which is necessary for their metabolic processes (photosynthesis) whereas animals, not so dependant seek the less well illuminated regions. This is the reason for the concentration of algae at the waterline of ships - forming the "grass-line" on a foul bottom (Fig. 4). Closer inspection of the waterline and below on a fouled hull will show that mixed with and below the green belt are a number of brownish seaweeds and below these (very seldom in the green zone) occur reddish seaweeds (Fig. 5). This distribution is precisely similar to that found on a shelving shore where green species occur near high water mark, brown ones at half tide and red seaweeds only near and below low water mark. On the lower parts of the hull, a few red weeds may be found, but fouling here and on the bottom flats is almost entirely of an animal nature.

Given a structure suitable for settlement, many of the animal species appear to exercise some degree of "choice" as to where they attach. Crevices are quickly colonised as these give protection from the flow of water and from enemies. The

lee-side of projections, e.g., a rivet head or the faying edge of a plate, are also readily colonised. When suitable sites are limited, settlement appears to be more general and any area not covered by other species may be colonised. In times of heavy competition, e.g., at the height of the barnacle settling season, these animals have been known to settle on highly toxic experimental paint surfaces for want of better places. The result can be most striking a month or so later when all around on innocuous surfaces there is a heavy barnacle growth whilst the toxic surfaces are bare and clean, the young barnacles having been poisoned and their insecurely attached, weak shells, having fallen off.

The quantity and kind of fouling occurring on a vessel clearly depends upon the interaction of a number of factors. The ports and anchorages visited and the time of year will determine broadly what species of organisms are potential settlers. The extent of fouling will be conditioned by the degree of success in breeding of these organisms, to the extent of there being virtually no larvae of any one species, or so many, that they may completely cover any suitable, or even unsuitable, surfaces.

FIG. 6. - A TEST PANEL EXPOSED ON A RAFT IN THE MENIA STRAITS, CAERNARVON, FOR 10 MONTHS. THE PAINT HAS WORN THIN IN THE BRUSH MARKS AND ALGAE HAVE GROWN IN THE LOCALLY NON-TOXIC "TROUGHS"

Finally, fouling will depend upon the precise condition of the outer bottom paint. If this is *efficient*, there may be no settlement at all, or the few organisms that

settle will soon die and drop off. The first places to foul on an otherwise flat paint surface, are the marks left by the brush in laying off the paint. These marks are really minute "troughs" in the paint film where the film is thinner than over adjacent areas. These thin troughs lose their toxicity before the thicker parts of the paint film and fouling can develop on them. Fig. 6 shows a raft test panel after ten months immersion on which various green algae have settled over the vertical brush marks. This phenomenon also illustrates the value of a thick anti-fouling coating. In raft trials, several months extra life have been obtained by applying a second coat of anti-fouling paint to a test panel.

It is clearly at this point - the period of settlement - that the problem of ship-fouling is best attacked. The small, relatively unprotected larval stages will be more easily poisoned than the adults, owing to the greater permeability of the surface and the nearness of the whole body surface to the poison dissolving out from the paint. Secondly, the adult organisms stand up some distance from the paint surface, and are bathed in part in a less toxic medium, whilst their basal parts may be protected by a thick layer of calcium carbonate. Thirdly, the period of metamorphosis (change from the free swimming larval stage to a very different attached adult) is frequently a critical period in the life history, when the mortality rate is naturally higher. Fourthly, it may be possible to upset the chemistry of the attaching mechanism, though at present we know very little about this process, except that it appears to be a kind of "tanning" of an adhesive substance similar to the tanning of hides. Fifthly, it is of less value to kill the adult organism as in many cases, e.g., barnacles or calcareous worms, the hard skeletons remain firmly attached long after the animal is dead.

FIG. 7. - PORTION OF A HULL SHOWING DEAD BUT FIRMLY ADHERENT BARNACLES AND CLUSTERS OF MUSSELS

Prevention of settlement of Organisms

The time-honoured method had been to coat the outer bottom with some material or mixture of materials that would discourage settlement or poison such organisms as did settle. Present-day anti-fouling paints are based on this principle, to which end they contain substances known to be toxic to marine life. On the average, anti-fouling paints contain up to 25% of copper as cuprous oxide with or without a small amount (up to 7%) of mercury as mercuric oxide. Other copper or mercury compounds are sometimes used, notably metallic "flake" or "leaf" copper. These latter have been experimented with extensively in the U.S.A. Both copper and mercury in solution are very toxic to marine animals and plants. Less than 1 p.p.m. (parts per million) of copper is lethal to a large variety of plant and animal organisms. Mercury appears to be more toxic than copper to animals but less toxic to plants.

A few organic compounds such as the thiuram disulphides have been used with varying success in anti-fouling paints. The "war gas" D.M. (chlorphenarsazine) and derivatives, have been used experimentally with some success, and it is believed that this or an allied substance is being used by a section of the industry.

The poisonous pigments are incorporated in the paint medium and the essential problem in formulating an anti-fouling paint is to incorporate the poisons in such a manner that they are available in lethal quantities and yet are not lost at an excessive rate, which would merely have the effect of unnecessarily shortening the effective life of the paint film and be uneconomic. At the same time the paint film must remain intact, and wear at an even rate so that non-poisonous areas do not develop through excessive local losses. To obtain solution of the poisonous pigments, the paint must be permeable to water while yet remaining firmly adherent to the hull. It is further desirable that the anti-fouling effect should extend over a small area at the margin of the paint film, so that small areas where the paint has been removed mechanically may still be kept free from fouling. The anti-fouling composition should be non-corrosive, or nearly so. In practice, these compositions tend to accelerate corrosion slightly, due to the action of the contained cuprous oxide, and protective (anti-corrosive) undercoats are necessary.

These somewhat conflicting requirements have necessitated considerable investigation in the past and are still the subject of active inquiry. They are without doubt, the cause of the short life of many compositions that have been used in the past; a paint that stands up well to water movement may liberate the contained poisons at too slow a rate and consequently foul badly. One that is an efficient anti-fouling agent may, on the other hand, erode so fast as to lead to a rapid breakdown of the film, leaving bare patches that foul readily. Furthermore, it is evident from trials of many different compositions that some anti-fouling paints require a few days soaking before they become fully effective against fouling, presumably because the paint film requires an initial period in which to absorb water before effective leaching out of the poison commences. A ship newly painted with such a composition and meeting a heavy barnacle settlement soon after undocking, may well foul heavily. Once well-established, the barnacles will be able to withstand any subsequent liberation of poison form the paint and persist, though no other colonisation may take place. Such very early settlements, depending upon the chance presence of the settling organisms at the time of

undocking, probably account for the unexpectedly short life sometimes experienced with an anti-fouling composition is not necessarily synonymous with an *effective* coat.

THEORIES OF MODE OF ACTION OF ANTI-FOULING PAINT

Three theories have been advanced to explain the mode of action of an anti-fouling paint and it would seem highly probable that each contributes towards the efficient action of at least some paints. It is most unlikely that the many anti-fouling paints now made, often very divergent in composition, all function in precisely the same manner.

Chalking Theory

The simplest explanation of the mode of action of an anti-fouling paint may be termed the "CHALKING THEORY." In this view it is the steady "chalking" or disintegration of the paint surface that is the protective principle. An unstable surface is presented to a larva seeking a place to settle. If it settles the surface beneath it will shortly disintegrate and the organism will become detached. This has frequently been noticed in raft trials to happen to quite large barnacles which have become detached solely through the chalking of the paint surface. Under service conditions they would probably have become detached sooner owing to the greater water pressure on them whilst the ship was steaming. It is unlikely that a paint depending upon this principle alone for its efficiency would have any length of life as the rate of disintegration would need to be high and the film would soon be broken down unless very thick, when the economic factor would arise. In practice no paints rely on chalking alone; they all contain some poisonous principle. Chalking, however, certainly assists the proper functioning of these paints.

Sponge Theory

A second theory may be termed the "SPONGE THEORY." The paint film is visualised as a sponge formed of the solidified paint vehicle or medium in the interstices of which lie the insoluble (in the paint medium) particles of poisonous pigment. Water is absorbed into the paint film and a portion is thus held in the pores of the matrix "sponge" and remains there owing to the slow rate of diffusion possible from the film. The view is held that this contained dissolved poison deters the searching larvae when they attempt to settle and they do not attach to the paint film. This effect on the living organism is probably correct under some circumstances though there are conditions under which organisms appear to attach regardless of the poison.

If the paint matrix is soluble or erodible, the deeper lying particles are gradually exposed to the solvent action of the seawater and the concentration of poison in the interstices of the film is maintained, as long as there is any solid poison left in the gradually disappearing paint film.

If, however, an insoluble paint matrix, e.g., a synthetic resin, is employed, only those particles will be dissolved which lie at the surface of the paint film. Once

these have been dissolved and the soluble poison diffused out from the pores, the paint may become non-toxic. This will occur unless there is a sufficiently high toxic pigment content present for the particles to be in continuous contact. Under such conditions the deeper lying particles are attacked as the outer ones are removed and the film gradually becomes a matrix sponge containing a saturated solution in seawater of the toxic principle. The amount of toxic pigment required to make such a paint effective may be as high as 80% of the paint and clearly only a very tough vehicle will be able to for a durable film under these conditions. Considerable experimental work has been done on this type of paint, with a high pigment content and insoluble vehicle, but as yet they are not in general use.

A drawback to this "sponge" theory as an explanation of the mode of action of an anti-fouling paint, is that it does not allow for the continuous and sometimes high loss of poison from the paint film; far more than could be accounted for by diffusion alone. Neither does it require the steady breakdown or "chalking" of the film that is so constant a feature of nearly all types of anti-fouling compositions.

Leaching Rate Theory

The third of "LEACHING RATE THEORY" endeavours to incorporate all of the observed phenomena shown by the paint film. This theory holds that an efficient anti-fouling paint must lose poison by leaching or solution, into the seawater at a definite minimum rate; this rate being such as to create a concentration of poison at the paint surface sufficient to deter would-be settlers or to kill such as persist in settling. This theory is widely held in the U.S.A. and a rate of loss of copper from the paint film of 10 mgm/1,000 cm^2 of paint surface/day, is stated to be effective. Work carried out in this country by R.N.S.S. staff for the Admiralty Corrosion Committee and by the Marine Corrosion Committee of the Iron and Steel Institute is in general agreement with this quantity. Much work has been done on paint formulation in attempts to obtain and maintain such a rate for long periods. Increasing the cuprous oxide content of the paint has been shown (a) to increase the initial rate of loss, and (b) within limits to prolong the duration of an effective leaching rate.

A certain amount of work has been published by various American workers on the leaching behaviour of a great variety of experimental compositions and it is clear that the type of vehicle as well as the pigment content has a considerable bearing upon both the initial and subsequent leaching rate of a paint.

The interaction of the rosin or the resin-modified synthetic vehicle with the cuprous oxide pigment, is another factor of importance. Copper abietate or "rosinate" is formed and appears as a green solution in the paint solvent in cans which have stood for some time. Copper abietate is not very soluble in seawater though readily so in organic liquids and so copper converted into this compound may be rendered inactive as a poison. Alterations in the vehicle components or even in the "reaction time" in the preparation of the vehicle, may completely alter the behaviour of a composition. What was an excellent anti-fouling paint may become practically useless, unless such factors are carefully controlled.

The attraction of the "leaching rate theory" lies in the possibility of measuring the effective principle - the Leaching Rate - and methods have been devised for this

purpose. Further, it is possible to correlate the measured leaching rate at different times in the "life" of an immersed paint film with the observed anti-fouling life obtained in raft exposures. Provided that the conditions of experiment are known and carefully controlled, the observed life of exposure panels is in reasonably good agreement with the age at which the leaching rate falls below the effective limit of 10 micrograms/sq. cm/day.

The principles entailed in both the "chalking" theory and "sponge" theory, can be regarded as secondary factors assisting in the maintenance of the leaching rate. "Chalking" of the film removes the outer exhausted portion, thereby exposing further particles of cuprous oxide to the solvent action of seawater. The "sponge" theory offers an explanation of how an adequate leaching rate can be maintained from a paint with insoluble matrix, provided that the pigment/vehicle ratio is high enough.

In practice, it would appear that all three suggested modes of action play some part in the efficient action of an anti-fouling paint. The greater importance of one method over the others probably depends upon the particular composition or type of composition under consideration. It is abundantly clear that the anti-fouling process is an extremely complex chemical system, of which many of the important details are at present unknown. There are even indications, from a number of effective paints, that leaching rate is not the essential factor in preventing fouling, but it is at present too early to speculate on this aspect. Meanwhile, the leaching rate offers a reasonable explanation of how the paint works and a method of estimating its efficiency.

Investigations of the rate of loss of copper and/or mercury ("leaching rate") of anti-fouling compositions had thrown light on the reasons for failure of many experimental formulations both in this country and in the U.S.A. and may well become a generally accepted tool in anti-fouling paint resting. The method has the advantage that tests can be carried out on quite small painted panels and so effects an economy in materials and space as compared with raft exposure tests or service trials. These latter need only be done on those compositions that give promising leaching results.

As, however, no static tests, whether in the laboratory or on a moored exposure raft can duplicate actual service conditions, all three modes of testing are still necessary. Only the best need be selected for service testing and so much expensive and unprofitable testing on a large scale can be eliminated.

Whether a particular coating will foul or not is always dependent upon the living population of the sea present at the moment. There can be no absolute answer to the question of how long any paint will be effective. We cannot, in short, control the occurrence or abundance of the species of marine animals and plants that find a ship's hull a more or less desirable site on which to squat. Out aim must be to ensure that the anti-fouling composition is at all times capable of preventing the attachment and growth of those species capable of affecting appreciably the frictional resistance of the hull.

FUEL PROBLEMS IN WARTIME

THE YEAR IS 1947

The following is an extract of an address given by ENGINEER VICE-ADMIRAL SIR JOHN KINGCOME, K.C.B., *to the Fuel Luncheon Club in London on the 20th December, 1945.*

With the U-boat menace and the immediate institution of the convoy system, it was essential to ensure that fuel supplies should be re-arranged to ensure the shortest sea routes. Pre-war, much of the fuel for British warships came from the sterling areas; in 1939, most of the fuel had to come to Britain from America.

Persian fuels were still available in the Mediterranean and East Indies, but at a later date even the passage of tankers through the Mediterranean became impossible, and all Western Mediterranean supplies also came from America. The major supplies came from Trinidad, Venezuela and East America ports and the quality of the fuel was not quite up to pre-war standards. Moreover, with the increased demands for aviation gasoline a greater degree of cracking was carried out at the American refineries, and the standard of the fuel fell progressively.

It is an ill wind that brings no benefit to someone: these fuels contained more vanadium oxides, and due to the need for this material by British steel manufacturers, arrangements were made to save the ash from naval and merchant ships and send it ashore, where the vanadium was extracted and passed to the steel manufacturers. I believe the greatest amount of vanadium thus obtained was eight tons from the Navy and 20 tons from the Merchant Service in 1943, and although these figures may not appear impressive the material came at a time when it was in extremely short supply and any contribution was vitally important. The higher figure obtained from merchant ships was chiefly due to the higher percentage of heavy residual ash-containing fuels used in these ships.

Problems of combustion and emulsification

In warships, weight and space is of vital importance, and naval boilers are more highly forced than those in the Merchant Navy or in shore practice. Moreover, the essential need to avoid making smoke for operational reasons, has necessitated the development of special burning equipment for naval boilers. These have been developed and perfected over a number of years at the Admiralty Fuel Experimental Station at Haslar. Early in the war, troubles began to be experienced owing t the higher asphalt content in the fuels we were receiving, and research was started immediately to overcome these difficulties. We have now developed an improved equipment capable of handling the lower grade fuels now being supplied.

Anyone experienced in burning oil fuel will know that the admission of water to a fuel tank involves the risk of fires being extinguished, generally at the most critical moments. Early in the war, we started having trouble owing t leakage of sea water into our fuel tanks, due to the straining of hull structures resulting from ships being

driven at high speed under adverse conditions. Furthermore, it is imperative in many ships to admit sea water to fuel tanks in order to maintain stability, thus increasing the risks of water contamination and emulsions.

Early experience in the war indicated that the wartime quality of fuel was very prone to the formation of permanent emulsions which could not be broken be heating. In one instance a cruiser ballasted a partly-filled fuel tank with sea water and then proceeded to sea in atrocious weather with the result that the emulsion so formed had to be removed from the tank by hand with shovels.

These problems were largely solved by the provision of settling and sullage tanks, and by issuing special instructions to the Fleet on the best method of handling fuel and sea water in fuel tanks which required ballasting.

Research has also been carried out at Haslar on the various conditions and qualities of fuels liable to promote emulsions and the possible use of chemical additives with a view to inhibiting the formation of emulsions, or to assist in breaking down emulsions already formed. A certain amount of success has been obtained in this direction and the research is still continuing.

Compatibility of fuels and a common U.S.-U.K. specification

Prior to the war the U.S. Navy had experienced some difficulty from deposition of sludge in storage tanks and excessive pre-heater fouling, due to incompatibility and compatibility tests were included in the U.S. Navy fuel specifications. At the request of the Americans the stability test was included in the Admiralty fuel specification, although our experience had not demonstrated the necessity for such a test.

For the war against Japan it was necessary to include in shipments of oil to the Pacific theatre of operations large quantities of Persian fuel, as well as supplies from the Netherland West Indies and U.S. West Coast production. Tests showed that Admiralty grade Persian fuel was incompatible with U.S. West Coast fuels, particularly those from certain refineries which were very deeply cracked and an extensive compatibility survey was undertaken. To facilitate this investigation, reference fuels representing the extremes of U.S. East and West Coast and Gulf production were established.

With some modification to the refinery procedure at Abadan it was found possible to produce a fuel which would be fully compatible with all U.S. production but the supply of this fuel was insufficient to meet requirements, in spite of the shorter haul from Abadan to the South Western Pacific area. By diverting some of the most deeply cracked fuels of Californian origin from the Pacific theatre to other areas, a blend of one part of the special Abadan production with three parts of normal Abadan Admiralty grade fuel proved to be sufficiently compatible with all the U.S. reference fuels for practical purposes and this blend was shipped to the Pacific theatre and Australia, the balance of Abadan production being absorbed in the East Indies theatre and other areas where it was unlikely to be mixed with fuels of Californian origin.

Much consideration was given to the evolution of a common specification for fuel for the U.S. and British Navies, but full agreement on this question was never

reached largely owing to the great complexity of the compatibility problem. Whilst it is probable that the achievement of complete compatibility of all residual fuels suitable for use in warships without unduly restricting supplies is impossible, the evolution of a common specification which would provide complete compatibility of fuel mixtures in two or more zones appears possible and further investigation on these lines is desirable.

Buoyant rubber hose solves Pacific refuelling problem

The need for fuelling ships at sea had been realised before the war and two systems had been developed. The primary one was called the trough method, the two ships steaming side by side, the supplying ship, usually the larger, passing a hose across to the receiving ship. The alternative plan was called the stirrup method, and was mainly used in harbour when weather conditions prevented the fuelling tanker and the receiving ship lying side by side; in this system the feeding ship lay directly ahead or astern of the receiving ship. In earlier years of the war, many destroyers were fuelled by the capital ships of the fleet. It requires good seamanship to carry out the operation expeditiously.

When the war spread to the Pacific theatre, necessitating prolonged periods at sea, it became necessary not only for the smaller ships to be refuelled more frequently, but for the bigger ships to be fuelled as well.

Our tankers had not been designed for such service and, although the trough method could be employed satisfactorily under moderate weather conditions, a new method had to be devised to ensure the practicability of fuelling under adverse conditions. This was achieved through the development, by British hose manufacturers, of buoyant flexible rubber hoses to replace the stirrup method and the fitting out of our tankers accordingly. This method proved successful within the limiting pumping capacity of existing tankers and of the receiving capacity of ships being fuelled. It will, of course, be appreciated that under operational conditions, with attendant risk of attack by underwater craft and from the air, it is vital that the highest possible fuelling rates be achieved and we are now actively engaged in embodying, so far as possible, in all classes of ships and attendant tankers, such as modifications as are necessary to achieve this. In addition, provision is being made for the transfer of all other types of fuel necessitated by modern conditions of warfare.

Diesel fuel and petrol

It is satisfactory to note that in all the numerous types of Diesel-engined vessels, including converted merchant ships, submarines, minesweepers, escort vessels and landing craft, no difficulty was experienced with the quality of Diesel fuel supplied either by the Admiralty or United States. The fuel was in all cases a high-grade distillate fuel having a Diesel Index of about 53 or Cetane Number of not less than 50 and, apart from a few isolated instances of trouble with water or dirt contamination, the fuel gave complete satisfaction in all the various types of engines.

Towards the end of the war it became essential to simplify the storage and handling of petrol supplies used in the various combined operations and for this purpose a common grade of leaded petrol having an octane number of 80 was employed.

As is well known the introduction of appreciable quantities of T.E.L. (in this case up to 4.5 c.c. per gall.) gives rise to maintenance difficulties in engines which have not been specially designed to take a leaded fuel. Many of the smaller engines used in motor boats and landing craft came into this category and it was necessary to issue special instructions to meet the situation. The use of unleaded fuel was maintained as long as circumstances permitted and engines were adjusted as far as possible to take the higher octane fuel. In general it may be said that the introduction of this fuel did not lead to any major difficulties although it did involve more attention to the care and maintenance of engines.

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