

**Πανεπιστήμιο Πειραιώς-Τμήμα Ναυτιλιακών Σπουδών**



Πρόγραμμα μεταπτυχιακών σπουδών στη ναυτιλία.

**Διπλωματική εργασία με τίτλο:**

« Ποιότητα Επισκευών σύμφωνα με ISM Code»

Από

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### Δήλωση αυθεντικότητας

Δηλώνω υπεύθυνα ότι η συγκεκριμένη διπλωματική εργασία για τη λήψη του μεταπτυχιακού διπλώματος ειδίκευσης του Τμήματος Ναυτιλιακών Σπουδών του Πανεπιστημίου Πειραιώς, δεν έχει υποβληθεί ούτε και εγκριθεί, μερικά ή ολικά, στο πλαίσιο κάποιου άλλου μεταπτυχιακού ή προπτυχιακού τίτλου σπουδών στην Ελλάδα ή στο εξωτερικό. Η εργασία έχει εκπονηθεί από εμένα προσωπικά με την βοήθεια της εταιρείας Υ ναυτιλιακή και αντιπροσωπεύει τις δικές μου απόψεις. Οι πηγές που χρησιμοποίησα αναφέρονται όλες στο οικείο μέρος.

## Ευχαριστίες

Ευχαριστώ πρώτα τους γονείς μου που ότι είμαι «φταίνε» αυτοί για την υλική και πνευματική τους συμπαράσταση όλα αυτά τα χρόνια. Ευχαριστώ κατά δεύτερο τους καθηγητές μου που σχεδόν ότι ξέρω προέρχεται από αυτούς και για τις φιλότιμες προσπάθειές τους. Τέλος ευχαριστώ τον εαυτό μου που αν και εργαζόμενος κατάφερα να φέρω σε πέρας αυτές τις τόσο σημαντικές σπουδές και να πάρω αυτή την ειδίκευση που πιστεύω θα με κάνει καλύτερο στην εργασία μου αλλά και στην προσωπικότητά μου. Ειδικότερα θέλω να ευχαριστήσω τον επιβλέποντα καθηγητή μου Κο Αλέξανδρο Γουλιέλμο για την συνεχή συμπαράστασή του και βοήθεια του, ως επίσης και τον καθηγητή μου Κο Κώστα Γκιζιάκη για τις πολύτιμες υποδείξεις του. Τέλος ευχαριστώ και τον Αναπληρωτή καθηγητή Κο Ερνέστο Τζαννάτο. Θα ήταν παράλειψή μου να μην ευχαριστήσω και την εταιρεία στην οποία εκπόνησα την εργασία μου.

## ΕΙΣΑΓΩΓΗ

Η Ναυτιλία δυστυχώς υπήρξε μια βιομηχανία που χαρακτηρίζεται από «αντιδράσεις μετά το συμβάν». Δεν μπόρεσε η ναυτιλία στους αιώνες που πέρασαν να προλαμβάνει τ' ατυχήματα και την ρύπανση του περιβάλλοντος.

Είναι αλήθεια ότι από την αρχή της σύστασης της εμπορικής ναυτιλίας και με την ίδρυση των πρώτων νηογνωμόνων (1760, Lloyds Register of Shipping) το όλο θέμα της ασφάλειας της ναυσιπλοΐας θεωρήθηκε *τεχνικό*. Παρά την τεχνική επίβλεψη των νηογνωμόνων για παραπάνω από 250 χρόνια τα ατυχήματα στα πλοία δεν έπαυαν να συμβαίνουν.

Κάθε ατύχημα δημιουργούσε και νέα νομοθεσία, αλλά πάλι τεχνικής φύσης. Ο Τιτανικός δημιούργησε για παράδειγμα την SOLAS με καθυστέρηση μερικών δεκαετιών λόγω κύρια του Α' Παγκοσμίου πολέμου. Πριν από αυτήν υπήρξαν οι γραμμές φόρτωσης.

Βέβαια περίεργο είναι ότι σωρεία δικαστικών αποφάσεων ανέφερε σχεδόν μονότονα ότι το 80% τουλάχιστο των ναυτικών ατυχημάτων οφειλότανε στο ανθρώπινο στοιχείο και ειδικότερα στο ανθρώπινο λάθος. Αλλά τίποτε δεν γινότανε.

Κατά την κλασική διαδικασία ένα ατύχημα οδήγησε σε μια νέα και διαφορετική νομοθεσία.

Το ατύχημα του πλοίου Herald of Free Enterprise το 1987 δεν ήταν δυνατό να δικαιολογηθεί με καμία τεχνική εξήγηση...Το πλοίο ήταν νέο, η σημαία ήταν η Βρετανική, το πλήρωμα ήταν Βρετανοί, ο Νηογνώμονας ήταν στους 5 πρώτους κ.ο.κ. Τι έφταιξε; Προφανώς η διοίκηση της εταιρείας και το ανθρώπινο λάθος ή η αμέλεια. Ο βοηθός λοστρόμου δεν έκλεισε την πόρτα εισόδου των αυτοκινήτων διότι ...τον πήρε ο ύπνος... και από εκεί μπήκε το νερό.

Το πιο πάνω ατύχημα οδήγησε στην ανάγκη ενός προτύπου μη τεχνικού για το επίπεδο της διοίκησης και το ανθρώπινο λάθος-ο ISM Code (1998). Αυτός περιέλαβε και την προστασία του περιβάλλοντος καθόσον «με ένα σπάρο δύο τρυγόνα».

Βέβαια παρόλο που το πιο πάνω ήταν ένα βασικό βήμα, το ανθρώπινο λάθος ίσως δεν περιορίζεται από νόμους και διατάξεις που κανείς δεν γνωρίζει και αν τηρούνται και πόσο στην πράξη.

## ΣΚΟΠΟΣ ΤΗΣ ΕΡΓΑΣΙΑΣ

Ο σκοπός της εργασίας αυτής είναι να εξετάσει την επίπτωση και τις διαδικασίες του Κώδικα σε σχέση με τις επισκευές ενός πλοίου και τον δεξαμενισμό του. Ο ΔΚΑΔ έχει διαθέσει ένα ολόκληρο κεφάλαιο, το κεφάλαιο 10 στο θέμα αυτό. Αυτό αφορά στην συντήρηση του πλοίου και του εξοπλισμού. Το τμήμα αυτό είναι σημαντικό διότι ασχολείται με την κατάσταση του πλοίου και των μηχανημάτων, των συστημάτων και του εξοπλισμού. Φυσικά αυτά σχετίζονται ή επηρεάζουν τις συνθήκες ασφάλειας και προστασίας του θαλάσσιου περιβάλλοντος. Το τμήμα αυτό είναι διαφορετικό από τα άλλα, διότι εδώ αναγνωρίζονται η σπουδαιότητα και η αναγκαιότητα της καλής κατάστασης του πλοίου και του εξοπλισμού.

## ΚΕΦΑΛΑΙΟ 1:

### Η ΠΟΛΙΤΙΚΗ ΤΗΣ ΠΟΙΟΤΙΚΗΣ ΕΠΙΣΚΕΥΗΣ ΤΩΝ ΠΛΟΙΩΝ

#### 1.1 Εισαγωγή

Σε αυτό το τμήμα περιγράφω τις γενικές αλλά και συγκεκριμένες οδηγίες πολιτικής επισκευών, τις οποίες το προσωπικό του τμήματος δεξαμενόπλοιων πρέπει ν' ακολουθήσει κατά τον προγραμματισμό και την ολοκλήρωση όλων των επισκευών των πλοίων.

Αυτές οι πολιτικές προορίζονται φυσικά να ενεργήσουν ως οδηγίες κατά την ανάληψη και την αξιολόγηση των απαραίτητων επισκευών.

#### 1.2 Οι στόχοι της επισκευαστικής πολιτικής

Η γενική αρχή εδώ είναι μια: Η διατήρηση του ασφαλέστερου (και αποδοτικότερου<sup>1</sup>) στόλου, με το ελάχιστο δυνατό κόστος.

##### 1.2.1 Επισκευές εν πλω

Η βελτιστοποίηση των επισκευών εν πλω<sup>2</sup> (και μη), πρέπει να γίνεται χωρίς καθυστέρηση, έτσι ώστε η συχνότητα των επισκευών σε ναυπηγεία και η τυχόν χαμένη υπηρεσία (off-hire) να περιορίζονται στο ελάχιστο.

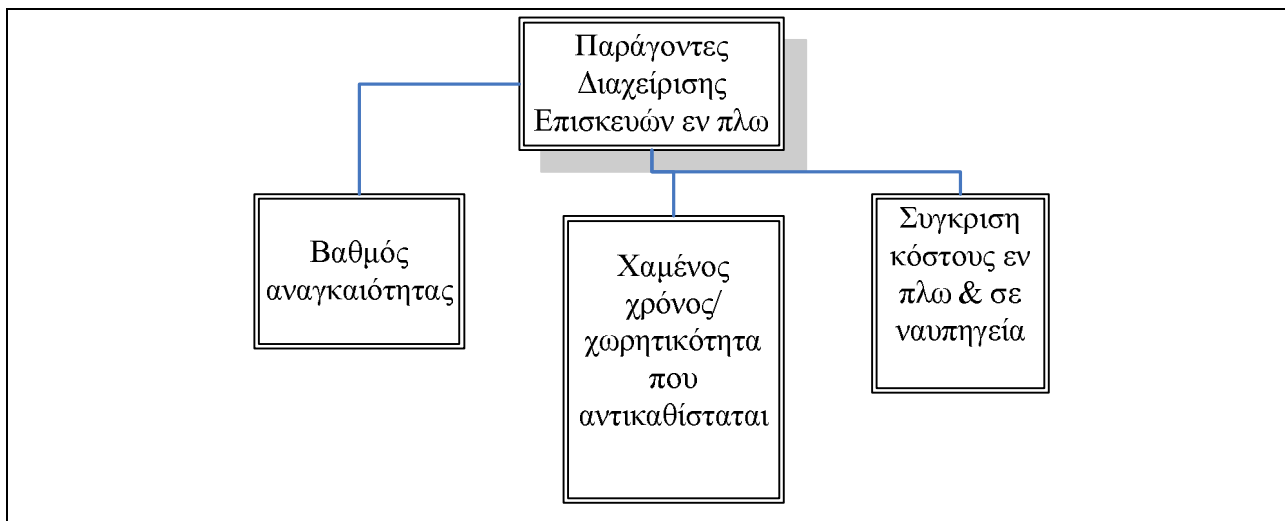
Κατά τη διαδικασία λήψης της απόφασης σχετικά με το ποια μέθοδο πρέπει να χρησιμοποιηθεί, προκειμένου να διεξαχθούν επισκευές σε ένα συγκεκριμένο σκάφος, η διαχείριση (management) παρακινείται από τα εξής τρία ζητήματα που παρουσιάζονται στο πιο κάτω Διάγραμμα 1:

Διάγραμμα 1: Παράγοντες που πρέπει να λαμβάνονται υπόψη για μια εν πλω επισκευή.

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<sup>1</sup> Η ασφάλεια διαχείρισης των πλοίων αποτελεί υποχρεωτική μέριμνα των επιχειρήσεων και των πλοίων από 01/07/1998 με τον ISM Code. Πρέπει φυσικά και απαραίτητα να συνδυαστεί άριστα με τη κερδοφορία του πλοίου, και όχι να λειτουργήσει εις βάρος του.

<sup>2</sup> Όπως είναι γνωστό η υπεροχή των Ελληνικών πλοίων ήταν επειδή οι επισκευές στο παρελθόν γινόταν 100% εν πλω, χωρίς το πλοίο να χάνει παραγωγικό χρόνο on-hire.



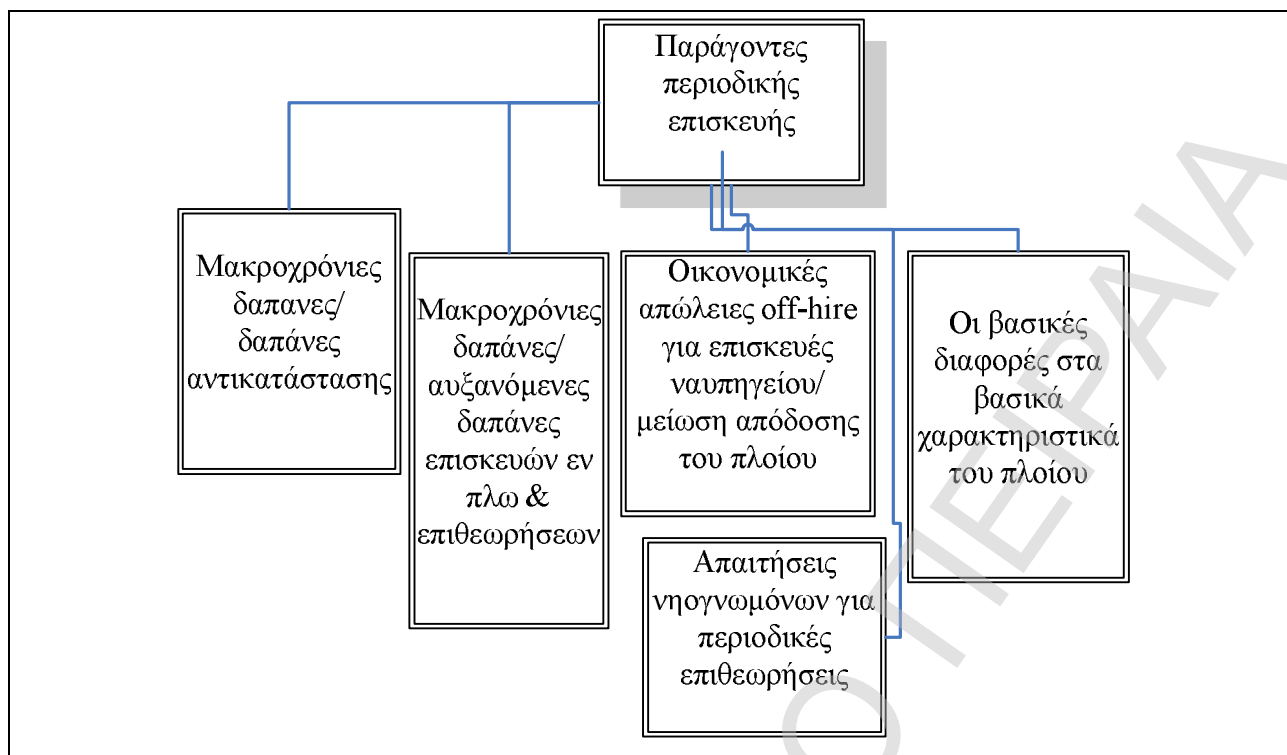
Δηλαδή εξετάζονται: - ο βαθμός αναγκαιότητας, - ο πιθανός χαμένος χρόνος και οι δαπάνες της χωρητικότητας που αντικαθίσταται, και, - η διαφορά στο κόστος όταν συγκρίνεται με αυτό των επισκευών στα ναυπηγεία.

### 1.2.2 Επισκευές εκ περιτροπής

Υπάρχει και ο σχεδιασμός περιοδικών ή εκ περιτροπής επισκευών σε «κύκλους» που καθορίζονται και που εγκρίνονται από τη διαχείριση. Αυτές οι «κυκλικές» αποφάσεις λαμβάνονται με βάση την αξιολόγηση των εξής ζητημάτων που παρουσιάζονται στο πιο κάτω Διάγραμμα 2:

Διάγραμμα 2: Περιοδικές επισκευές/ Παράγοντες που πρέπει να ληφθούν υπόψη.





Εξετάζονται δηλαδή τα ζητήματα: - Των μακροχρόνιων δαπανών σε σχέση με τις δαπάνες αντικατάστασης. - Των μακροχρόνιων δαπανών σε σχέση με τις αυξανόμενες δαπάνες των επισκευών εν πλω και επιθεωρήσεων. - Των οικονομικών απωλειών λόγω του χαμένου χρόνου σε επισκευές ναυπηγείων σε σχέση με τη μείωση της απόδοσης του πλοίου. - Τις απαιτήσεις των νηογνώμωνων (classification societies) ως προς τις περιοδικές επιθεωρήσεις. - Τις βασικές διαφορές στα χαρακτηριστικά των πλοίων όπως το μέγεθος, η ηλικία, η ικανότητα, η πρόωση, η περιοχή εμπορικών συναλλαγών, το σχέδιο, και ο τύπος του φορτίου.

Η εκτέλεση ικανού αριθμού των επιθεωρήσεων του νηογνώμονα κατά τη διάρκεια των περιόδων, ώστε ο χρόνος που ξοδεύεται εκτός υπηρεσίας/ off-hire να περιορίζεται στο ελάχιστο.

### 1.2.3 Δεξαμενισμοί

Ο σχεδιασμός του δεξαμενισμού των πλοίων που ανήκουν στην ίδια εταιρεία, πρέπει να γίνεται έτσι ώστε οι θυγατρικές να μην ανταγωνίζονται η μια την άλλη για τους ίδιους χώρους προσόρμισης (berths). Η χρήση του "έτους επιείκειας" που παρέχεται από τους νηογνώμονες να χρησιμοποιείται μόνο όταν είναι οικονομικά ή λειτουργικά ευεργετικό για την επιχείρηση. Αναβολή των μη αναγκαίων

εργασιών επισκευής που θα έπρεπε να γίνεται κατά τη διάρκεια της τρέχουσας περιόδου και εκτέλεση τέτοιων εργασιών, η ανάγκη των οποίων να προκύπτει μετά από σχεδιασμένες «βασικές» επιθεωρήσεις.

Η εγκατάσταση ειδικού εξοπλισμού στα πλοία (όπως ο εξοπλισμός συγκόλλησης) να γίνεται έτσι ώστε τα πληρώματα να είναι σε θέση να εκτελέσουν τις επισκευές, που σε κάθε άλλη περίπτωση θα έπρεπε να υποδειχθούν από τους επιθεωρητές, ή θα απαιτούσαν επιπλέον χρόνο. Να γίνεται αποτελεσματική χρήση του προσωπικού των πλοίων, συμπεριλαμβανομένων και των επιπλέον ατόμων (έξτρα), για τις επισκευές τόσο κατά τη διάρκεια των κανονικών περιόδων λειτουργίας όσο και κατά τη διάρκεια παραμονής των πλοίων στα ναυπηγεία, έτσι ώστε να μειώνεται το κόστος επισκευών και ο χρόνος για τον οποίο το πλοίο μένει εκτός υπηρεσίας/off hire.

Η αξιοποίηση των τεχνικών επισκευής, όπου και όταν αυτό είναι εφικτό, τεχνικές οι οποίες εκμηδενίζουν τις υψηλούς κόστους αντικαταστάσεις και οδηγούν στις αποτελεσματικές και αποδοτικές επισκευές με ελάχιστο κόστος. Η χρήση προϊόντων της εταιρείας, όπως οι χημικές ουσίες, επιστρώματα και λιπαντικά στη μεγαλύτερη δυνατή έκταση<sup>3</sup>. Η εφαρμογή επιστρωμάτων τέτοιας ποιότητας (σε συνδυασμό πάντα με τον οικονομικό παράγοντα) έτσι ώστε η φυσική φθορά να μειώνεται και κατά συνέπεια να επεκτείνεται ο κύκλος βαφής.

Η χρήση των δυνάμεων της αγοράς (ανταγωνισμού) έτσι ώστε να εξασφαλίζεται το ελάχιστο δυνατό κόστος επισκευής, εξαιρουμένης της περίπτωσης όπου συντρέχουν ισχυροί και εγκεκριμένοι λόγοι για τη διαπραγμάτευση σε θέματα τιμών ή πακέτων συνεργασίας. Ο περιορισμός στην έκδοση πρόσθετων διαταγών εργασίας στο ελάχιστο, συμπεριλαμβανομένων όλων των ουσιαστικών επισκευών των αρχικών προδιαγραφών. Η διασφάλιση της ομαλότητας της όλης διαδικασίας επιτυγχάνεται, έχοντας ήδη ορίσει τον Πλοίαρχο και τον Πρώτο Μηχανικό στο πλοίο, πριν από, κατά τη διάρκεια, και αμέσως μετά από τις περιοδικές επισκευές και επιθεωρήσεις.

Να μην αναγκαστεί κανείς να επιβάλει τους όρους του «liquidated damage clauses<sup>4</sup>» όταν υπάρχουν ισχύοντες, εγκεκριμένοι λόγοι, για διαφορετική ενέργεια. Η διασφάλιση των συμφερόντων της εταιρείας, εγκαθιστώντας και διατηρώντας ικανοποιητικούς και επαρκείς εσωτερικούς ελέγχους της

<sup>3</sup> Εδώ πρόκειται για εταιρεία παραγωγής και των προϊόντων αυτών.

<sup>4</sup> Το ποσό που έχει συμφωνηθεί σε ένα συμβόλαιο να πληρωθεί ως αποζημίωση για την αθέτησή του και για το οποίο υπάρχει πρόθεση διεκδίκησης, άσχετα με το ακριβές ποσό των ζημιών από την αθέτηση.

ιδιοκτησίας και των διαδικασιών. Ο καθορισμός και διορισμός επιθεωρητών επισκευών σε συγκεκριμένα πλοία έτσι ώστε να μπορούν να γίνουν καλοί και πεπειραμένοι γνώστες των μοναδικών χαρακτηριστικών και της κατάστασης του κάθε πλοίου που έχουν υπό την επίβλεψή τους.

#### 1.2.3.1 Η Κουλτούρα της εταιρείας

Εισέρχεται εδώ η ιδιαίτερη κουλτούρα της επιχείρησης. Η δέσμευση όλου του προσωπικού για την τήρηση της πολιτικής της εταιρείας σε ότι αφορά στα «διαπλεκόμενα συμφέροντα» και η *απαγόρευση* στο προσωπικό συμπεριλαμβανομένων και των ανώτερων υπαλλήλων και των μελών των πληρωμάτων των πλοίων, της *αποδοχής δώρων* από τις εταιρίες με τις οποίες η εταιρεία μπορεί να συναλλάσσεται είτε άμεσα είτε έμμεσα.

Πρέπει να γίνει κατανοητό ότι η εταιρεία δεν αποδέχεται, και κατά συνέπεια δεν συγχωρεί, την αποδοχή από μέλη του προσωπικού της προτάσεων των επισκευαστών σχετικά με δαπάνες στέγασης ή οποιασδήποτε άλλης προσφοράς πληρωμής δαπανών αντιπροσώπου της εταιρείας, δαπάνες οι οποίες καλύπτονται κανονικά στην εμφάνιση του απολογισμού της δαπάνης του αντιπροσώπου.

Σε περίπτωση οποιασδήποτε προσφοράς του επισκευαστή προς τον αντιπρόσωπο της εταιρείας, είτε υπό την μορφή κάλυψης εξόδων, είτε άλλης μορφής χρηματισμού, είτε άλλου είδους δώρου η αξία του οποίου υπερβαίνει αυτή ενός δώρου *συμβολικού χαρακτήρα*, τότε ο υπάλληλος πρέπει να αρνηθεί την αποδοχή του και να αναφέρει την προσφορά αυτή στον τομέα διοίκησης του στόλου της εταιρείας (Fleet Management Division) αμέσως, είτε προσωπικά, είτε μέσω άλλων μέσων άμεσης επικοινωνίας.

Το γενικό συμφέρον πρέπει να επικρατήσει σε όλες τις αποφάσεις που έχουν επίδραση στην επιχείρηση μιας ή περισσότερων θυγατρικών της ίδιας της εταιρείας. Παραδείγματος χάριν, οι υπερωρίες για την εργασία επισκευής ναυπηγείων θα μπορούσαν να εγκριθούν πριν να επιταχυνθεί η όλη διαδικασία ολοκλήρωσης της επισκευής. Αυτό μπορεί να είναι οικονομικά ωφέλιμο για την εταιρεία λόγω των απαιτήσεών της για ένα ιδιαίτερο τύπο πλοίου ή λόγω μιας ανόδου των δεικτών των ναύλων γι' αυτό το είδος.

### 1.3 Οι Αρχές και οι ευθύνες του τμήματος διοίκησης του στόλου.

Αυτό το τμήμα καλύπτει τις ευθύνες και τις αρμοδιότητες του τμήματος διοίκησης στόλου πριν, κατά τη διάρκεια, και μετά από τις επισκευές πλοίων. Αυτές οι ευθύνες περιλαμβάνουν: Προσφορές και διαπραγματεύσεις συμβάσεων, έγκριση συμβάσεων, κρίση και εκτέλεση αυτών, έγκριση πρόσθετων εργασιών και αλλαγή πλαισίου συμφωνιών, έγκριση των πληρωμών και των ολοκληρωμένων συμβάσεων.

Η πρόθεση της περίληψης αυτών των πληροφοριών είναι το να καθιερωθεί η κατανόηση των διοικητικών ευθυνών σε σχέση μ' εκείνες τις ευθύνες, τις αρμοδιότητες και τον περιορισμό των αρμοδιοτήτων του μηχανικού επισκευής (repair superintendent). Το τμήμα διοίκησης στόλου και ο βοηθός διευθυντή έχουν τις ακόλουθες ευθύνες και αρχές, σε ότι αφορά στις συμβάσεις επισκευής:

#### (1) Προσφορές και διαπραγματεύσεις συμβάσεων.

Αναζήτηση προσφορών και έναρξη διαπραγματεύσεων για μεμονωμένα προγράμματα δαπάνης επισκευής και, όταν ζητηθεί, η μεταβίβαση αρμοδιότητας εντός των ορίων του οργανωτικού/ λειτουργικού τμήματος στο οποίο υπάγεται<sup>5</sup>. Κατά την κρίση του, μπορεί να θελήσει να υποβάλει στη λειτουργούσα για το σκοπό αυτό επιτροπή για αναθεώρηση οποιασδήποτε εργασίας λόγω μιας σημαντικής αναλογίας ή ασυνήθιστου τύπου, αν και η αρχή του δεν περιορίζεται σε οποιοδήποτε πεπερασμένο μέγεθος.

#### (2) Έγκριση συμβάσεων, επεξεργασία και εφαρμογή

Έγκριση, επεξεργασία και υπογραφή, ή εκτέλεση των συμβάσεων επισκευής μέσα στις αρχές που ορίστηκαν στην παράγραφο 1 πιο πάνω και, όταν ζητηθεί, η μεταβίβαση αρμοδιότητας εντός των ορίων του οργανωτικού τμήματος στο οποίο υπάγεται<sup>6</sup>.

<sup>5</sup> Βλέπε: "όρια της αρχής για υποχρεώσεις - επισκευές δεξαμενόπλοιων" στο τέλος αυτού του τμήματος.

<sup>6</sup> Βλέπε: "όρια της αρχής για υποχρεώσεις - επισκευές δεξαμενόπλοιων" στο τέλος αυτού του τμήματος.

### (3) Έγκριση πρόσθετων εργασιών / αλλαγή πλαισίου συμβάσεων

Αρμοδιότητα έγκρισης - διαταγής, έγκριση και εκτέλεση πρόσθετων εργασιών ή μια αλλαγή του πεδίου συμφωνίας σε ότι αφορά στις συμβάσεις που εκτελούνται από τον ίδιο και, όταν ζητηθεί, η μεταβίβαση αρμοδιότητας εντός των ορίων του οργανωτικού/ λειτουργικού τμήματος στο οποίο υπάγεται<sup>7</sup>.

### (4) Έγκριση πληρωμών

Έγκριση μερικής και τελικής πληρωμής που σχετίζεται με τις συμβάσεις που εκτελούνται από τον ίδιο και, όταν ζητηθεί, η μεταβίβαση αρμοδιότητας εντός των ορίων του οργανωτικού/ λειτουργικού τμήματος στο οποίο υπάγεται, ακολουθώντας την αναθεώρηση και τις συμβουλές του τμήματος του ελεγκτή.

### (5) Ολοκληρωμένα συμβόλαια

Κάλυψη της ανάγκης τήρησης επαρκών αρχείων συμβάσεων που θα περιλαμβάνουν τις προσφορές και τις αιτήσεις των προσφορών, εάν η σύμβαση υπογράφηκε στη βάση της ανταγωνιστικής προσφοράς, ή διαπραγματεύτηκε και, εάν έλαβε χώρα κάποια διαπραγμάτευση, οι λόγοι της διαπραγμάτευσης.

### 1.4 Όρια δικαιοδοσίας για δεσμεύσεις-επισκευές Δ/Ξ.

Καταγράφονται στο πίνακα 1 πιο κάτω.

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<sup>7</sup> Βλέπε: "όρια της αρχής για υποχρεώσεις - επισκευές δεξαμενόπλοιων" στο τέλος αυτού του τμήματος.

Πίνακας 1: Άτομα έχοντα την δικαιοδοσία επισκευών.

Λειτουργία <sup>8</sup>	Διευθυντής θαλάσσης	Διευθυντής OPS	Διευθυντής τομέα, OPS	Διευθυντής ομάδας πλοίων	Αρχιμηχανικός επισκευών ή OPS
Περιοδικές επισκευές ναυπηγείων (Γνωστές από πριν και μέσα στις αρχικές προδιαγραφές – ανά πλοίο)					X
Περιοδικές επισκευές ναυπηγείων (έξτρα) – ανά πλοίο	X				
Επισκευές εν πλω – επίβλεψη από αρχιμηχανικό – ανά πλοίο	X				
Ανταλλακτικά (παραγγεληθέντα μέσω κεντρικού)				X	

#### 1.4.1 Ευθύνες σχετικά με τις επισκευές. Ευθύνες διαδικασιών -Τμήμα επισκευών

Αυτή η ενότητα περιγράφει τις ευθύνες του τομέα επιχειρήσεων (operations division) σχετικά με τις επισκευές δεξαμενόπλοιων. Οι πληροφορίες περιλαμβάνουν τις γενικές ευθύνες όλων αυτών που αποτελούν το τμήμα επιχειρήσεων, διευθυντές και προσωπικό, κατά την προετοιμασία, την αξιολόγηση και την εφαρμογή επισκευών σε πλοία. Περιλαμβάνει επίσης γενικές και λεπτομερείς ευθύνες "on-site"/ «επιτόπου» για τον επιθεωρητή της επισκευής, συμπεριλαμβανομένων των διοικητικών απαιτήσεων, πριν, κατά τη διάρκεια και μετά από την επισκευή του πλοίου.

<sup>8</sup> Όλες οι υποχρεώσεις ατόμων πέρα από εκείνους που απαριθμούνται ανωτέρω πρέπει να εγκριθούν είτε από το βοηθό διευθυντού, είτε από το διευθυντή του τμήματος επισκευών/ τεχνικού, σύμφωνα με τις αρχές που αναφέρονται στην παράγραφο II. Σε περίπτωση που και τα δύο άτομα είναι απόντα, οι εγκρίσεις πρέπει να ληφθούν από το διευθυντή επαφών εκτός και αν κάποιος άλλος είναι εξουσιοδοτημένος γι' αυτό. Οι πλοίαρχοι μέσω των πρακτόρων μπορούν να εγκρίνουν επισκευές, το κόστος των οποίων δεν πρέπει να υπερβαίνει το ποσό των 20000€.

Οι τομείς στους οποίους το τμήμα επιχειρήσεων έχει πλήρη ευθύνη είναι οι εξής: Ο συντονισμός και η κατεύθυνση όλων των επισκευών συμπεριλαμβανομένων των επισκευών εν πλω, που λαμβάνουν χώρα στα πλοία που ανήκουν στην εταιρεία. Έλεγχος των δαπανών όλων των επισκευών, μέσω αναγνωρισμένων αριθμητικών και άλλων οικονομικών τεχνικών.

Ανάπτυξη και εφαρμογή των περιοδικών επισκευών στα πλοία που ανήκουν στην εταιρεία. Αυτές οι επισκευές πρέπει να έχουν σχεδιαστεί από πριν έτσι ώστε να μπορούν να ικανοποιήσουν, με το βέλτιστο κόστος, τις απαιτήσεις των νηογνομόνων, της διεθνούς σύμβασης για την ανθρώπινη ζωή στη θάλασσα (SOLAS 74), και τις σωστές πρακτικές λειτουργίας.

Συντονισμός και κατεύθυνση των κύριων βελτιώσεων όταν αυτές πραγματοποιούνται παράλληλα με τις επισκευές στα πλοία που ανήκουν στην εταιρεία. Έναρξη διαδικασιών εξεύρεσης προκειμένου να διασφαλιστεί η έγκαιρη παράδοση των ανταλλακτικών και των υλικών για τη χρήση τους στα πλοία της εταιρείας.

Αφού προηγηθεί συμφωνία με μια θυγατρική, ακολουθεί τακτοποίηση των θεμάτων για τις επισκευές εν πλω και ναυπηγείων. Παροχή του εποπτικού προσωπικού και ανάληψη της τελικής ευθύνης για τις τιμές και την ποιότητα της εργασίας. Κατόπιν αιτήσεως, παροχή γνωμοδοτικών υπηρεσιών και στοιχείων σε άλλα τμήματα μέσα στην εταιρεία.

Παροχή οποιουδήποτε είδους συμβουλών και βοήθειας είναι απαραίτητη στα μέλη του πληρώματος δεξαμενόπλοιων, έτσι ώστε να μπορούν να επιτύχουν τη βέλτιστη λειτουργική απόδοση. Η αναφορά στα τμήματα κατασκευής – σχεδιασμού και έρευνας – ανάπτυξης προτάσεων συμβουλευτικού χαρακτήρα και συστάσεων σχετικά με τυχόν αναξιόπιστο και δαπανηρό στη συντήρηση εξοπλισμό. Οι τομείς και τα αντικείμενα για τα οποία το πρόσωπο που επιβλέπει και γενικότερα επιθεωρεί τη διαδικασία επισκευής ενός πλοίου, έχει πλήρη ευθύνη, είναι τα εξής:

Στο να δίνει συμβουλές στους πλοιάρχους και στους πρώτους μηχανικούς των πλοίων για προβλήματα συντήρησης, επισκευών, εφεδρικών μηχανημάτων. Έχει επίσης την ευθύνη για την ανάληψη του ρόλου του απαραίτητου συνδέσμου μεταξύ πλοίου και γραφείου προκειμένου να

επιτευχθούν οι απαιτήσεις και οι χαμηλότερες δυνατές δαπάνες<sup>9</sup>. Στο να καθορίζει ποιες επισκευές είναι απαραίτητες, και ποια ανταλλακτικά ή υλικά πρέπει να προμηθευτούν μετά από διαβουλεύσεις με τον πλοίαρχο ή τον πρώτο μηχανικό.

Στο να προετοιμάσει τις πλήρεις προδιαγραφές οι οποίες πρέπει να τηρούνται από ένα ναυπηγείο προκειμένου να υπάρξει συνεργασία με την εταιρεία. Στο να καθορίσει την πηγή από την οποία πρόκειται να ληφθούν τα υλικά επισκευής (προμηθευτής).

Στο να προετοιμάσει τον προϋπολογισμό δαπανών των προδιαγραφών της επισκευής. Αυτές οι εκτιμήσεις χρησιμοποιούνται στον καθορισμό του σκεπτικού των προσφορών που λαμβάνονται και στη διαπραγμάτευση με τα ναυπηγεία. Οι προϋπολογισμοί δαπανών θα πρέπει να αρχειοθετούνται και να προστίθενται στο αρχείο συμβάσεων μέσα στον εν λόγω φάκελο του πλοίου μαζί με ένα αντίγραφο των προδιαγραφών και του καθορισμού των εργασιών.

Κατά την εποπτεία των επιτόπιων επισκευών, είναι υπεύθυνος ο επιθεωρητής του να εκδίδει, (μέσα στα όρια της δικαιοδοσίας που χορηγείται από την κεντρική διαχείριση της εταιρείας), τις γραπτές οδηγίες εργασίας που καλύπτουν ακυρώσεις στοιχείων των αρχικών προδιαγραφών, όπως επίσης υπεύθυνος και του να εγκρίνει πρόσθετα στοιχεία που δεν καλύπτονται στις αρχικές προδιαγραφές.

Κάθε οδηγία ή εντολή εργασίας, με την εξαίρεση του αντιγράφου που δίνεται στο ναυπηγείο, πρέπει να περιλαμβάνει εκτίμηση της αξίας δαπανών / πίστωσης και την κατ' εκτίμηση χρονική μεταβολή. Ένα αντίγραφο από κάθε διαταγή εργασίας, με τις ανωτέρω προσθήκες, πρέπει να στέλνεται στο γραφείο κάθε εβδομάδα με μια περίληψη, συμβουλευοντας σχετικά με τη γενική κατάσταση του κόστους και του χρόνου. Το άλλο αντίγραφο πρέπει να διατηρείται από τον επιθεωρητή και να συμπεριλαμβάνεται στην τελική έκθεση.

Κατά την εποπτεία των επιτόπιων επισκευών, θα πρέπει να συμπληρώνεται το αναλυτικό λογιστικό φύλλο<sup>10</sup>. Αυτό το φύλλο θα πρέπει να συμπληρώνεται και να τηρείται ενήμερο κατά τη διάρκεια της

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<sup>9</sup> Βλέπε τη παραπομπή I στο τέλος αυτού του τμήματος που είναι μια επιστολή δείγμα που στέλνεται σε όλα τα πλοία για τα οποία έχει προγραμματιστεί επισκευή σε ναυπηγείο.



επισκευαστικής περιόδου. Πρέπει επίσης να συμπληρωθεί με τέτοιο τρόπο ώστε να επιτρέπει σε οποιονδήποτε άλλο επιθεωρητή να οριστικοποιήσει το τιμολόγιο με τον ελάχιστο δυνατό βαθμό δυσκολίας. Κατά την ολοκλήρωση των εργασιών και μετά από την έκδοση του αρχικού και τελικού τιμολογίου, θα πρέπει να συμπληρωθούν οι τελευταίες δύο στήλες και να προσαρτηθεί η τελική έκθεση για το συνυπολογισμό της, στο αρχείο συμβάσεων του γραφείου.

Η πιστοποίηση ότι τα υλικά και οι υπηρεσίες επισκευής έχουν παραληφθεί και περατωθεί. Κατά την εποπτεία των επιτόπιων επισκευών, θα πρέπει να επιβλέπει τα υλικά που έχουν παρασχεθεί από την εταιρεία. Η καταμέτρηση των υλικών επισκευής που είτε έχουν παρασχεθεί από την εταιρεία είτε έχουν αφαιρεθεί από το σκάφος.

Ο υπολογισμός των δαπανών επισκευής και η διαπραγμάτευση των τιμών όλων των θεμάτων εργασίας που εκδίδονται από τον ίδιο ή /και που ακυρώνονται από τη σύμβαση. Η διαβεβαίωση ότι όλες οι επισκευές ολοκληρώνονται κατάλληλα και όσο το δυνατόν αποδοτικότερα. Το πραγματικό εργατικό δυναμικό που χρησιμοποιείται για κάθε επισκευή πρέπει να καταγράφεται όσο το δυνατόν ακριβέστερα προκειμένου να υπάρχει πλήρη γνώση αυτού κατά τη διάρκεια της διαπραγμάτευσης των τιμών.

Με την ολοκλήρωση μιας ανάθεσης επισκευής και πριν εκδοθεί η τελική έγκριση περάτωσης, πρέπει να αναθεωρούνται λεπτομερώς, οι δαπάνες του αναδόχου για να εξακριβωθεί ότι οι αναλυτικές τιμές είναι ακριβείς και ότι όλες οι πιστώσεις ως αποτέλεσμα των ακυρώσεων, απεικονίζονται στο τιμολόγιο των σχεδίων<sup>11</sup>.

Η υποβολή μιας έκθεσης αξιολόγησης του ναυπηγείου, που θα απεικονίζει τη γενική απόδοση αυτού κατά τη διάρκεια της περιόδου επισκευής. Αυτή θα πρέπει να περιλαμβάνει όλες τις θετικές και αρνητικές πτυχές της προσφερόμενης από το ναυπηγείο εργασίας, καταγράφοντας τόσο τους τομείς που χαρακτηρίζονται από επάρκεια όσο και αυτούς που κρίνονται ανεπαρκείς.

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<sup>10</sup> Βλέπε τη παραπομπή στο τέλος που περιγράφει μια χαρακτηριστική μέθοδο που χρησιμοποιούν κάποια ναυπηγεία στον υπολογισμό και τις διαπραγματεύσεις. Βλέπε και τη σύνδεση II στο τέλος αυτού του τμήματος.

<sup>11</sup> Κατά τη διάρκεια σημαντικών επισκευών σε ναυπηγεία, ο διευθυντής ομάδας ή κάποιο πρόσωπο αντίστοιχου βαθμού ιεραρχίας, θα πρέπει να παρευρίσκεται στο ναυπηγείο ενόψει ή και κατά την ολοκλήρωση των εργασιών προκειμένου να συμμετάσχει στην διαδικασία τακτοποίησης του τελικού τιμολογίου.

Η υποβολή πλήρων και αναλυτικών εκθέσεων κατά τη διάρκεια της εκάστοτε επισκευαστικής περιόδου σε ναυπηγείο όπως υποδεικνύεται στην παράγραφο ΙΧ. Επιπλέον, πρέπει να γίνεται μια σύντομη, συνοπτική έκθεση σχετικά με όλα τα στοιχεία που ανακαλύπτει κατά την παρουσία του σε επισκευές εν πλω ή κατά τις εκάστοτε επισκέψεις του στο πλοίο.

Η πλήρης εποπτεία, σε περίπτωση που ανατεθεί καθήκον επίβλεψης επισκευής σε ανώτερο αξιωματικό του πλοίου. Η συνεχής ενημέρωση σχετικά με τους τελευταίους κανονισμούς της κλάσης του πλοίου και ειδικότερα με αυτούς που αναφέρονται στις επιθεωρήσεις μετά από την κατασκευή του πλοίου. Αναθεώρηση και έγκριση όλων των αγορών/ προμηθειών του πλοίου που σχετίζονται με αναλώσιμα και προμήθειες κατά τη διάρκεια της περιόδου επισκευής, με την προϋπόθεση ότι οι αγορές αυτές έχουν προηγουμένως πάρει την τελική έγκριση από το αρμόδιο τμήμα της εταιρείας.

Η υποχρέωση για τη λήψη αντιγράφων όλων των εγγράφων που αφορούν τα στοιχεία των αντικειμένων που πρόκειται να επισκευαστούν, πριν από την αναχώρησή του για το ναυπηγείο. Σε αυτά περιλαμβάνονται και στοιχεία που αφορούν την ασφάλιση καθώς επίσης και αναφορές προηγούμενων επισκευών, απαιτούμενων προς επισκευή αντικειμένων, κ.λπ. Επιπλέον, υποχρεούται να λάβει αντίγραφα όλων των εντύπων που απαιτείται να συμπληρώνονται κατά τη διάρκεια των επισκευών σε ναυπηγείο<sup>12</sup>.

Η υποβολή αξιολογήσεων απόδοσης όλων των αξιωματικών του πλοίου κατά τη διάρκεια των ταξιδιών, των επισκευών σε ναυπηγείο ή των μακροπρόθεσμων επισκευών που γίνονται εν πλω.

Κατά την ολοκλήρωση των επισκευών, το ημερολόγιο του πλοίου θα πρέπει να ενημερωθεί εξολοκλήρου, συμπεριλαμβανομένης της αφαίρεσης όλων των ολοκληρωμένων στοιχείων επισκευής, όλων των πεπαλαιωμένων εκθέσεων της εταιρείας, όλων των πεπαλαιωμένων εκθέσεων του νηογνώμονα και όλων των ολοκληρωμένων ασφαλιστικών στοιχείων που συγκλίνουν στο ίδιο αποτέλεσμα. Επιπλέον, θα πρέπει να συμπεριληφθούν όλες οι νέες μόνιμες πληροφορίες δεδομένων.

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<sup>12</sup> Βλέπε την παράγραφο ΙΧ με τον κατάλογο των απαραίτητων φορμών.

## ΚΕΦΑΛΑΙΟ 2: VESSEL'S REPAIRS

Ο ΔΚΑΔ απαιτεί σε κάθε περίπτωση και την εκπόνηση ενός καταλλήλου εγχειριδίου στην Αγγλική. Αυτό το εγχειρίδιο επισκευών αποτελεί το περιεχόμενο του κεφαλαίου αυτού.

Αυτό το κεφάλαιο αποτελεί οδηγίες προς τους μηχανικούς της εταιρείας με πλήρη ανάπτυξη των πρακτικών και μεθόδων των ναυπηγείων προκειμένου για μια μεγάλη ή μικρή επισκευή. Για μια εταιρεία με μεγάλο στόλο με 22 πλοία και 1761053 τνβ όπως η παρούσα η προσεκτική αντιμετώπιση του κόστους των επισκευών καθώς και των μυστικών αυτών, είναι κρίσιμη. Θεωρώ θετική την συνεισφορά μου στο κεφάλαιο αυτό.

### 2.1 Introduction

The manual is designed for use by the personnel responsible for repairing tankers owned or managed by the Company. This is a convenient vehicle for conveying management's policies to supervisory personnel and a ready reference as to the major functions involved in tanker repairs, as well as some of the techniques utilized in carrying out prime responsibilities. It provides uniformity and consistency also in reporting to the various levels of management. Moreover, it is a general guide for Repair Superintendents to be used during repairs, as well as in the office, for both Administrative and Repair responsibilities.

### 2.2 Vessel's repair policies

The task here is to maintain the safest and most efficient fleet possible at a minimum cost. To optimize the voyage and turnaround repairs without delay so that the frequency of shipyard repairs and the attendant lost service off-hire to be kept to a minimum (see also text above in Greek).

### 2.3 Shipyard estimating and negotiating procedures.

The shipyard will receive a set of specifications, and either attempt to survey the vessel, if a survey is being held, or if the vessel is not available, it will try to clarify any grey areas in the specifications by talking to the "Repair Superintendent". This is one of the reasons why specifications should be clear for their intent and quantity, otherwise the Estimator will "cover" himself by making the

estimate *high* and thus increasing *price*.

Upon receipt of the specifications the Estimator will obtain from shipyards' files the last year's estimate and copy out most of the *standard* or *recurring* items. These records and estimates have been standardized over a period of years using cost returns in labor hours and carefully analyzing labor charged to each item before deciding on what to use as a standard. A standard repair specification can be completed in this manner by using cost returns which will cover 80% of the estimate. The remaining 20% will be estimated by "rule of thumb" units. Using his knowledge of cost returns, an Estimator can judge if steel work should be done for 6, 8, or 10 hours per hundred pounds.

**Piping** in cargo tanks is estimated at  $\frac{1}{2}$  per inch diameter — for 12-inch diameter pipe, 6 hours per lineal foot is used. This would include removal and replacement, welding flanges and elbows, etc. Renewal of tee pieces or piping in a pump room are estimated by operation or by using a shop or craft estimate which would be added together, and a percentage will be added for supervision. Supervision in the shipyard not only includes the ship supervisor, but also craft leaders, foremen and assistant foremen, which are all considered overhead charge (details of overheads mentioned within).

The estimate is presented to the management who will normally use *present day billing rates* which are generally *below the current market sales value*. It is then anticipated that the difference between billing rate and current sales value would be obtained when pricing additional work or extras to the original contract.

The yard cost of labor rate is determined by making a composite figure or flat cost rate by an average labor rate which includes all crafts. Added to this is insurance, social security or other benefits, given to the workers<sup>13</sup>.

The 85% overhead figure is used as an average figure in order that a billing rate can be established. Overhead rate can vary from 65% up to 120% depending on the yard work load. However, because

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<sup>13</sup> As an example, consider the flat cost rate to be \$4.15 per hour. Added to this is an overhead figure of 85%, then 10% for profit which results in a final total of \$8.44 or \$8.50. This is the billing rate which will be the selling rate and at which rate the estimator will be asked to negotiate.

you have the only ship in the yard, you don't negotiate any higher than the advertised or agreed labor rate selling value.

Included in the overhead figure is the ship supervisor, estimator, all office personnel, guards, yard maintenance, etc. It is the practice of some yards to charge this time to ship contracts and will show you hours expended on an item which is excessively high. Many other yards will add this charge at the end as services to the vessel, which will be included in the cost returns of a contract.

When settling prices for additional items, a rough estimate can be prepared in the following manner: pipe and steel work as mentioned previously, can be estimated by using unit values. Therefore when an item is large in magnitude a price should be obtained before putting the work in hand. If the yard is using sub-contractors the sub-contractor's price should be obtained and 10% added for using yard facilities and profit. However, an estimate is best prepared by taking the item in an operational sequence.

If a pump has to be opened for rotating element repairs, one must consider the various crafts involved and allow so many man hours for each required action and movement. In addition, consideration must be given to time that will be required in getting to and from the work (on a large ship this can add to the labor hours). Time and money can be saved if the Repair Superintendent is readily available to give instructions and examine equipment, otherwise the shipyard labor will stand around waiting for a Superintendent<sup>14</sup>.

If piping has to be removed, electrical disconnects and reconnects, pipe fitters and electricians should be added as other crafts involved. The total amount of hours involved in completing this work may seem excessive, but time is expended obtaining instructions from leaders, tools, tool rooms, storeroom and getting to and from the ship. Estimating in man hours gives a sound basis for

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<sup>14</sup> Inspection of a condensate pump will require opening pump, remove casing, disconnect and remove impeller to floor plates. Estimating this work the following would be required: Machinist & helper -12 hours; Riggers - 2 hours. Assuming after inspection, it is necessary to send the rotor to the shop for repair. This would involve removing impeller from engine to deck, from deck to truck and then transporting to machine shop: 2 Riggers -4 hours; Transportation - 1 hour; Crane & Hook on - 1 hour; Unload impeller in machine shop: Crane & Hook on - 1 hour; Disassemble element for examination: Machinist - 4 hours; Machine impeller, machine new wearing rings: - 12 hours; Machine new gland sleeves:- 8 hours; Install new bearings: - 2 hours; Assemble rotor and balance: -8 hours; Return element to engine room: - 6 hours; Install in pump and replace cover, repack gland and test run: Machinist & helper - 16 hours Riggers - 2 hours; TOTAL 77 hours.

negotiation as an item can be broken down into craft labor indicating where the estimator or negotiator is out of line with his price. The Superintendent should make his estimate on the basis of what man hours he witness coupled with his experience on man hours required for such work. Inefficient activity should not be accepted. In addition to the number of man-hours, supervision and material cost must be included for estimating total cost.

**Overtime:** Overtime or premium time is not clearly understood by most people. The basis of overtime cost is calculated on a 2/2 time, double time or 1 1/2 time day. Normally when the yard is asked to quote on overtime for a certain item, they will quote for Saturday time and a half, however, they should have quoted on 1/2 time as the straight time will be negotiated at time of settlement. When overtime price for work on Saturday and Sunday is requested, the yard should be asked for the overtime rate per hour. This rate should not include overhead costs as that is being included in the straight time and one would be paying double overhead costs if included in overtime - overtime is actually what the worker is paid.

**Scheduling & Production:** Shipyards at first were opposed to planning and scheduling, but as time progressed, it became evident that planning and scheduling of work was an important tool and most yards now will not operate without a schedule. The system which was and still is best suited for ship repair is a *critical path* or *schedule of events chart*. A job of ten days or less does not necessarily require a production schedule, for in terms of time this is not extensive work. However - it may be beneficial to have a schedule made so that progress can be easily checked and events kept up to date, especially the major items.

On *scheduled repairs* over ten days, etc, a production schedule should be made up and kept up to date by daily conferences with the ship supervisor. Procurement and availability of material, which possibly the "Repair Superintendent" can expedite to assure an earlier delivery, and sufficient manpower are all important to assure that work is completed on schedule.

Daily meetings should be held with shipyard and "Repair Superintendent" to review the work progress and what is required to maintain the schedule. A production schedule will assist in this review if used properly and can be a very useful tool both to the Superintendent and the Shipyard for the Company's benefit. If the work schedule dictates 30-40 days or more of work, the above mentioned meetings should only be required two or three times per week.

## 2.4 Repairs specifications and work orders

This is a guide for the Repair Superintendent in preparation of Repair Specifications and issuance / cancellation of repair items. Included are specific procedures which must be applied in order to properly complete the specifications. There is also a listing of procedures used for issuing work orders for both extra work and cancellations during "on-site" repairs.

Specifications should be written in a clear, concise manner, sufficiently detailed so to be explicit as to the repairs required. Unless circumstances require it, excessive details should be avoided, since they may convey the impression that the work is more extensive than necessary. However, sufficient information should be included so that the costs can be accurately estimated by the shipyard.

"*Standard Specifications*" should be used whenever possible and are available for various classes of ships. The advantages of standard specifications are: (a) they act as an informal check list; (b) omissions are avoided; (c) the "Repair Superintendent" saves time in drafting the specifications; and (d) clarity (which varies from writer to writer) is maintained.

All major repair specifications should begin with a standardized preamble which covers items of a general nature, usually applicable to all shipyard repairs. Currently, the preamble in use is entitled "Agreement to Specifications and/or Guidance Plans for Repairs, Renewals and Alterations". A sample copy of the preamble is included at the end of this section in appendix. In addition, the first two items of the specification, Services and Gas Free, are also included. All Repair Superintendents are to carry copies of these pages on all trips as they may be required to prepare and submit an emergency specification for a damaged vessel.

The specifications should instruct contractors to submit their bids or estimates with each item in the specification priced. This allows Company management to make better evaluations and to keep *abreast of worldwide pricing conditions*, as well as familiarizing themselves with the idiosyncrasies of individual shipyards.

When using "*Standard*" Specifications, care must be exercised to tailor them to the actual case in

hand. They are not to be copied verbatim, unless actually called for. When required, additions and cancellations can be included at the end of the Standard Specification in order to be more specific. Normally, the Company does not award contracts for repairs on a cost plus basis. However, if cost plus basis is utilized a clause, similar to the following, should be included: "At its option and expense, AVIN or its representatives shall have the right of access to whatever records are necessary to verify and evaluate that the amounts charged to us are in accordance with this contract."

The approximate quantity of repair materials should be clearly described for each item. Also, the supplier of the repair materials should be identified<sup>15</sup>. When possible, the Chief Engineer and Captain should review the specifications for completeness and accuracy prior to final issuance for authority to the shipyard to proceed with work.

Specifications should not be written in the following manner: "open, inspect, repair if necessary, and close". It must be remembered that the description required for a unit suspected of needing repairs may have to be far more detailed than that required to describe a known repair requirement. The preferable method is to describe more repairs than may be required, and to issue a cancellation for that part which actual inspection reveals as not being necessary. This technique is valuable in helping to reduce the number of extras issued. It is desirable to avoid extras, since they are priced under non-competitive conditions and may be more expensive than prices otherwise obtained.

Intimations of possible cancellations should be avoided whenever possible. This is to preclude contractors from submitting fictitiously low prices in anticipation that only minor credits will be generated on the final billing. Prior to drafting repair specifications, the Repair Superintendent should refer to the "Ship's Ledger" and "Certificate Record Book" maintained in the Office. This ledger and record book will contain information about: - Equipment that will definitely require repair, renewal or replacement during the next scheduled repair. -Equipment that should be examined or opened up for inspection and possible repair because of subnormal functioning. - Accidents or other circumstances that may have caused some damage to unobservable areas of the

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<sup>15</sup> Repair Superintendents are to check ship's repair requests for spares and material requirements and determine how they should be acquired. If material and spares are to be supplied by the Company, the Repair Superintendent determines if already stocked or if it requires necessary follow-up with Head office purchasing for ordering.



vessel. -Recommendations for future repairs which were included in the last report filed by a Repair Superintendent. -Historical information concerning the vessel. -updating of prior repair recommendations. -Classification society survey status.

The Tanker Department publishes a list of "recommended machinery manufacturers for new construction". Whenever a piece of equipment has to be replaced, all efforts should be made to obtain the replacement from one of the manufacturers on the recommendation list. The repair specification in its final form is to be reviewed by the Group Manager prior to issuance.

#### 2.5 Repair specifications and work orders-Issue of Extra Work Orders and Cancellations

Each extra or cancellation should be issued in writing so that duplicate charges can be avoided<sup>16</sup>. Each order is completed in triplicate: the white copy should be given to the shipyard (without estimate price or time); yellow copy forwarded to the office each week with the Repair Superintendent's estimated price and time changes included; blue copy retained by Repair Superintendent and included with the final Repair Report<sup>17</sup>.

When possible, extras and cancellations should bear one of three notations concerning the amount of money involved, listed below in their order of preference: a firm price, or a maximum price, or an estimated price (not be shown on the work orders handed to the contractor),

It is desirable to avoid extras whenever possible, since their costs may be higher than can be obtained under competitive conditions. The easiest way to avoid extras is to get all known repair items into the original specifications. The efficacy of this maxim is heavily dependent upon a smoothly operating information system between vessels and the head office. If there is some question regarding a repair requirement it is more advantageous to include the repair in the specification and then cancel same later if the work is unnecessary.

Before issuing an extra, the Repair Superintendent should endeavor, if practical, to strike a firm price with the contractor. Failing this, he should investigate the possibilities of arranging a maximum price that would not be exceeded unless the specifications changed. Extras should be written as

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<sup>16</sup> Use form "Field Order for Labor and Material. A sample is included at the end.

<sup>17</sup> This form should also be utilized when issuing work orders during voyage repairs.

explicitly as possible so that misunderstandings are avoided and so that charges can be accurately evaluated. The description of each cancellation should bear a reference to the original specification number or work order number which it first appeared. Each cancellation, especially partial cancellations, should be clearly described so that credits can be accurately computed and evaluated.

## 2.6 Repair specifications and works orders -How to Number Items in Repair Specifications and Extras or Cancellations.

Each repair item should bear a separate, sequential number with the letter "R" for repairs. This is extremely important for purposes of cross-referencing subsequent changes. In case of repair specifications for shipyard work, the next three digits (known as "item codes") will identify the exact nature of the repair. These will fall into broad categories of general, cargo, hull, machinery, electrical, or communications. A detailed listing of these "item codes" is supplied to each Repair Superintendent<sup>18</sup>.

2.7 Agreement to specifications and /or guidance plans for repairs, renewal and/or alterations to (Appendix contains the full text of a repair agreement).

## 2.8 Bidding, negotiating repair contracts & final invoices

Competitive bids-company's policy à it is company's policy to obtain competitive bids on all repair contract work, except as specified below. Requests for bids with repair specifications shall be solicited from as many reputable and qualified contractors as practicable. Bids are required to be submitted by contractors by a specific date and, except in very unusual circumstances, the work is awarded to the lowest bidder. Assuming that competitive conditions exist, this method allows the Company to obtain the lowest prices available with a maximum of internal control.

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<sup>18</sup> See Attachment III for code list. For example, repairs to a condensate pump done during a shipyard repair could be coded - 122R/555. If an item is listed for insurance an "EA" number would be used -122R/ $\frac{EA-123}{555}$ . For capital items no code is used, thus - 122R/CAP ETCO 72-1. For further identification of charges, the following numbers should be used on orders and invoices (this will allow for proper accounting when processed in Head Office). 47 Technicians, 48 Voyage Repairs, 49 Spare Parts, 50 Shipyard Repairs.

Type of competitive bidding - Company solicits, evaluates and awards repair work to the lowest bidder. The Company is currently cooperating with other affiliates by providing details of awards which may result in a further reduction in price due to volume placement of vessels.

*Standard Repair Specifications* - The Company has developed a set of "standard" repair specifications which are circulated to selected contractors. The contractors quote their best price for each item; in effect, this then becomes their price list. Negotiations are then instituted with the lowest bidder for further discounts in return for being awarded a group of ships on a scheduled basis<sup>19</sup>.

A *disadvantage* of the bid/award process is that constant surveillance by the Company is necessary to ascertain that contractors have not quoted fictitious low "standard prices" in anticipation that actual specifications will vary sufficiently from the "standards" to permit them to alter prices upward at the time of negotiation.

*Advantages of Bidding - Grouping of Repairs and Standard Repair Specifications* can both be considered as "package deals", since they call for more than one ship being committed to the program in return for additional discounts. This can be advantageous because shipyards are willing to quote lower prices due to the large volume of work and scheduling advantages. In addition, lower repair days are possible when ships are of a same class, since special equipment, tooling, and know-how acquired on the first ship may permit savings on subsequent ships. Conversely, it is recognized that the Company loses some flexibility because it must commit a sufficient number of vessels to the program to make it sufficiently attractive so that the shipyard will grant additional discounts.

*Individual Vessel Bidding* - The Company also solicits bids on individual vessel specifications especially in cases where there is only one of a class of vessel owned by the Company.

Cases in which competitive bidding may be waived and contract may be negotiated: **à** The *contract*

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<sup>19</sup> In most cases we have found that contractors have quoted the lowest price possible and they cannot offer further discounts.

*authority*<sup>20</sup> may dispense with competitive bids for repair contracts for \$75,000 or less per vessel. In the following rare and exceptional cases, the Company's competitive bidding policy may be waived when, based upon past experience and knowledge of current market conditions, the contract authority can negotiate an acceptable price with the contractor: When a genuine emergency exists in which any delay that would be caused by obtaining competitive bids would result in a definite and obvious disadvantage or loss to the Company. Where there is definitely only one contractor available who is properly qualified to handle the project.

Some examples of such cases when it may be *advantageous* to the Company to negotiate with only one contractor are: - Competitive conditions do not exist, i.e., there is only one contractor who is qualified to do the specialized repair work required. -Time is more valuable than money, i.e., economical replacement tonnage is unavailable. -Past documented experience has proven that the selected contractor's technical competence far outweighs any economic differences expected to accrue from competitive bidding.

Possible *disadvantages* when competitive bidding is waived and contract is negotiated are:

- With the absence of competitive bidding, the Company is not always assured of receiving the "best price".
- If contracts are negotiated on a more or less exclusive basis, the Company loses the knowledge of worldwide conditions concerning repairs and prices.
- Internal controls are more difficult to maintain.

*Unity of contracts* - Repair contracts shall not be broken into separate parts in order to circumvent the requirement of competitive bidding, or to circumvent maximum authorities delegated to various management levels for contract execution.

*Extra work and changes of scope* - A contractor already performing work under a repair contract may be authorized to perform additional work not originally provided for in the repair specifications without competitive bidding by means of a negotiated extra work order or change of scope agreement which is an amendment to the original contract. To qualify as "extra work" or "change of

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<sup>20</sup>"Contract authority" is used to designate the FLEET MANAGEMENT DIVISION DEPARTMENT, or other person authorized by it to award, execute and administer a repair contract. Normally, this is the person who is empowered to sign the contract on behalf of the Company.

scope", the work should be closely related in nature, time and purpose to the work already being performed. The Company shall be protected by a statement in the original contract that no additional payment will be made for any extra work or change of scope, unless such work has been authorized in writing prior to the execution of same. Extra work orders/change of scope agreements to contracts shall be avoided wherever possible. The following are examples within the foregoing definition of extra work or change of scope: a. Remove, relocate or work around unforeseen conditions such as replacement of brick work, boiler plate, burners, etc. b. Apply an additional coat of paint.

*Panel of qualified contractors -Establishment of Panel* – The fleet management division department must establish a panel of contractors which he regards as reliable and qualified to perform repair work for the Company. Use of Panel - Bids will normally be solicited only from Contractors on the panel of qualified contractors. The panel of qualified contractors will be held as confidential and will not be made available to persons other than those required to invite bids or deal with contractors.

*Engineer's estimate of cost* - On all repair work, the Company organization responsible for the work to be performed shall prepare an itemized estimate of the cost of the contemplated repairs at the time the bids are released or prior thereto. This estimate will be made a matter of record and will form the basis for the bid summary sheet. The estimate shall be supported with sufficient data or a satisfactory indication of how it was calculated, in order to be of value to the contract authority in evaluating the bids received.

*Release of an invitation to bid* - before invitations to bid are issued repair specifications and instructions to contractors for preparation and submission of bids shall be prepared by the Operations Division of the Tanker Department. Selection of Contractors - The contract authority will select as many contractors as practicable, normally not less than three, from the panel of qualified contractors. Bids should be itemized - Bids should be requested on an itemized basis, rather than in total only. This is not only helpful when evaluating the bids, but helps to disclose abnormalities such as:  
-pricing errors - price manipulation (bidder quotes extraordinarily low on anticipated cancellations)-  
unusual bidding patterns which might warrant investigation or solicitation of additional shipyards.

*Mailing of Invitations to Bid* - The invitations to bid should be mailed or delivered by the Company

organization responsible for the work to be performed enclosing an appropriate "return address" to the contract authority or appropriate designee to provide for receipt of sealed bids from the contractors. Bidding papers adequate in scope should be mailed early enough to allow a reasonable period of time for: (1) Contractors to submit realistic well-calculated bids. (2) The contract authority to evaluate the bids upon receipt, resolve questions, and if necessary, re-solicit the same or other contractors.

Receiving and opening bids-Receipt of Bids - Contract authority or appropriate designee will receive and record all bids on a bid summary sheet and, after a study of the bids, record the recommendations as to award together with the reasons thereof. This record shall be made a part of the contract file.-Analysis and Comparison of Bids - Bids should be studied carefully by the contract authority or appropriate designee to ascertain whether the bids are responsive to the invitation to bid. When the bids are voluminous it may be desirable to prepare abstracts of the bids received in order to facilitate final review by the contract authority.

The contract authority should inspect low bids with care in order to ensure that the contractor will be able, at the price quoted, to furnish his personnel with the wages and benefits required by law and by his contract with the Company. Bids should be reviewed thoroughly, tabulated systematically, and adjusted to a common basis in order to determine the actual low bidder. Adjustments should take into consideration the following factors: (1) Items not priced or for which alternates were proposed. (2) Differences in continuous running days. (3) Ship's deviation required by various locations. (4) Differences in out-of-pocket expenses for supervision. (5) The delivered costs of materials supplied by the Company to the shipyard. (6) Differences in labor rates and material markups quoted for billing extras. (7) Cost of gas freeing. (8) Efficient cargo allocation requirements' of certain type vessels in designated areas. When the contract is awarded to other than the lowest bidder, the contract authority should make a notation on the bid summary sheet or other appropriate record of reasons therefore.

*Package Deals* are based on negotiations subsequent to the receipt of a contractor's prices, should be subjected to the following considerations: (1) Offers should not be limited only to those contractors capable of accommodating the entire package. It may be found favorable for the Company to split the package into smaller groups. (2) Solicitations for specific bids should be circulated not less than

once a year so that the Company may be certain that it is receiving full advantage of conditions in the repair yard industry. (3) If only the lowest bidder is approached for negotiations of further discounts, the Company weakens its bargaining position. When there is not too great a margin between the lowest bidder and the nearest competitors, more than one contractor should be approached for further discounts.

*Numbering the Contract* - A contract number shall be assigned to each repair contract by the Operations Division of the Tanker Department.

*Awarding the Contract and Notification of Unsuccessful Bidders* -The contract authority shall select the best bid after reviewing all of the bids. The contract authority should then arrange for signature on behalf of the company on two copies of the contract (i.e. letter of acceptance) addressed to the successful bidder and request the successful bidder to return one signed copy to the Operations Division, Tanker Department. The contract authority should also arrange to notify unsuccessful bidders in writing that their bids have not been accepted.

*Signatures on Repair Contracts* - The contract authority is responsible for: (1) Securing the signature of the Company executive who is authorized to execute the contract (i.e. letter of acceptance) and for determining that the executive holds the proper power of attorney to execute the contract on behalf of the Company. In some cases, the contract authority himself may be the signer. (2) Assuring himself that the person signing as or for the contractor is authorized to do so. In some cases, legal counsel should be requested to assist in making this determination.

*Distribution of Contract Copies* - The following distribution of copies of contracts will be made immediately after the contract is signed. One signed copy: to the Contractor. One signed copy: to the Operations Division for filing. Conformed or facsimile copies to: Repair Superintendent supervising the work in the field, as a working copy. Accounting Office where payments are to be made.

*Method of Preparing Final Repair Invoices* - A letter should be sent to all shipyards at time of requesting bids advising them of our method for preparing repair invoices<sup>21</sup>.

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<sup>21</sup> Repair Superintendents are responsible to assure the final invoice is completed in the same manner as designated below. -One item of work to one sheet of paper. If a specification has one hundred (100) items, we would expect an invoice of 100 sheets. -The Repair Specification (include complete repair number) as issued to the contractor is to be

## On site procedures for repair superintendent

This section includes recommended procedures for the Repair Superintendent when initially arriving at the shipyard prior to a vessel repair. This includes recommended procedures for organizing the repair both prior to and immediately after the vessel's arrival.

### A. Prior to drafting repair specifications

Before drafting the repair specifications, the Repair Superintendent should visit the vessel so that he can evaluate repair recommendations submitted by the ship, and add to the list any additional items that may be discovered during his visit. This is accomplished by physically inspecting, testing, and opening as many pieces of equipment as possible, supplemented by discussion with the ship's officers and crew.

Whenever feasible, the Repair Superintendent should make this visit during a ballast voyage in order to include an inspection of most cargo/ballast tanks for determining both steel and internal pipe requirements. During a loading or discharge, when stem may be sufficiently elevated, propeller and rudder should be examined for condition. b. During his visit, the Repair Superintendent should decide with the Ship's Master and Chief Engineer those items which the crew can perform or assist while in the shipyard.

### Prior to ship's arrival at the repair yard

Before commencing work, the Repair Superintendent should arrange with yard personnel a predetermined completion schedule, in a coordinated sequence. To indicate the completion schedule, a "Critical Path" chart should be constructed by the shipyard listing the schedule of all repair items.

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shown completely written up as the first part of the invoice, together with individual prices. -Any extra, credit or cancellation applicable to an item of the original specification is to be shown with price, or credit, immediately after each item of the specification. A separate number is not required for these extras, credits or cancellations. Please also show the net amount due of each item on each sheet. -All extras that cannot be added to items of the original specification are to be shown as the second part of the invoice with appropriate serial and code numbers, as well as price. -A recapitulation is required on the last sheet showing original contract, credits, extras, and net total. -Itemized prices to be shown in U.S. dollars or local currency. If local currency, designate the conversion to U.S. dollars with current rate of exchange. - Original invoice and two (2) copies only are required. Under no circumstances should the cost of items in the final invoice be manipulated for budget, insurance or capital considerations. The actual value of each item should remain as negotiated. Where an item resulted in higher than normal expenditures, due to unusual conditions or difficulties, an explanation of same should be included in both the invoice and repair report.



This chart will then assist in planning the overall repair, designate the completion date, provide a ready reference for determining the progress of each repair item and indicate if the work is on schedule. If a complete "Critical Path" is not made a schedule of all major work should at least be established. Arrangements should be made so that materials and parts supplied by the Company are properly safeguarded and used only for authorized work. In addition, verify that all Company-supplied material required for repairs has arrived in the shipyard.

*The Repair Superintendent* should verify that representatives of classification societies and equipment manufacturers will be available to inspect all items subject to survey or repairs. d. Shipyard quotes on any item which is considered not correct should be discussed and a final agreement made prior to commencing work. Misunderstanding of the spec is often the reason discrepancies occur in the initial price quote. Before commencing work the Repair Superintendent should advise the shipyard that all items must be approved by the Repair Superintendent only. No repairs are to be accepted from the vessel's senior officers without approval of the Superintendent.

#### *Ship's arrival at the repair yard*

Immediately upon the ship's arrival in the repair yard, the Repair Superintendent should board the ship in order to: Gain first-hand knowledge of any change in general condition and the adequacy of the repair specifications (at least for major items). Review the planned completion schedule with the Ship's Officers, assigning follow-up responsibilities to those who are chosen for assistance.

For example, the following assignments are generally utilized: Captain: all general activity both by shipyard and crew on deck and in tanks with exception of winches and windlass repairs. Chief Officer: assist Captain with above; checking ail steel work on deck and tanks; all work undertaken by crew; all cleaning, painting and coating in dry-dock; recording all material supplied by vessel to shipyard for repair items and all lifeboat work (generally assisted by cadet). Second Officer: all work/tests on deck and tank pipelines including heating coils; all cargo/ballast valve repairs including testing of same (generally assisted by Third Officer). Deck Cadet: Recording the total number of shipyard personnel boarding the vessel in the morning and leaving at night.

*Chief Engineer:* all activity in the engine room both by crew and shipyard; all machinery repairs/testing in the engine room, pump room and on deck. First Engineer: assist Chief Engineer

with above; all ship's material supplied to shipyard for repair items; repair and testing of all system valves excluding cargo/ballast system. Second Engineer: all work on boilers including cleaning, soot blowers, combustion control, refractory and tube renewals. Third Engineer: assist First Engineer - also responsible for noting all electrical work (assisted by Electrician)<sup>22</sup>.

To assist in valve test inspections, the officer designated for these tests should establish a "check off chart" listing all valves sent ashore. He then is to assure that all valves have been satisfactorily tested prior to returning same to vessel. Review with Master and Chief Engineer the work which is to be carried out by the ship's force. Confirm that ship's force will provide an effective procedure for issuing to the shipyard the spare parts that will be required from vessel's stock. All material issued from the vessel's stock should be recorded with the corresponding repair item in order to assure that appropriate accounting/credit is established.

Undertake prompt cancellation of items to be deleted following a review of contract specifications with Master and Chief Engineer. Inspect all new repair requirements that have developed since completion of the specification. Immediately issue new work orders to the shipyard for all extra work deemed necessary. Develop a night watch system with the vessel's force so that a Deck and Engine Officer is available/on duty every night even if the shipyard is not working. Generally, the watch is rotated between all Officers with one Deck and one Engine Officer assisted by one crew member each assigned the watch from 1700 to 0600 daily.

#### *Procedures and repair methods during repairs. General "On-Site" Procedures during Repairs*

This section is a guideline for the Superintendent in conducting repairs during the repair period. This includes: General recommended procedures for maintaining cost control of all repairs; Inspection procedures for most equipment aboard the vessel; recommended repair methods for various type repairs. The Superintendent must realize these procedures are only guidelines and in some instances meet particular situations. With the numerous variables which are possible in repairs of equipment it is impossible to include all conditions or types of repair in this Section.

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<sup>22</sup> All decisions regarding renewals, repair requirements, types of repairs, extra items, etc., are to be made by the Repair Superintendent. The above assignments are only made to assist in obtaining/reporting information regarding efficiency of repair, quality of repair, quantity of manpower utilized, safety procedures, repair deficiencies and testing/inspecting of equipment.

*General procedures-* The Repair Superintendent is responsible to assure that he and those delegated for assistance are to undertake the following while repair work is in progress:

*Conduct* daily inspections of all work both on the vessel and in the workshops assuring that work is progressing satisfactorily. All inefficient/incorrect work must be immediately corrected to establish satisfactory results and eliminate unnecessary man-hours which results in higher requested prices - especially for extra items. Inefficient activity on wasted man hours should be recorded, for assisting in final negotiations, and noted to shipyard management for the above mentioned reason. The progress of each item should be maintained on the specification and kept up to date.

*During* all inspections the quantity of men working on each item should be recorded in order to know the amount of man-hours utilized for each repair item. This is necessary to effectively conduct final price negotiations.

*To assist* in item above the total amount of people coming aboard in the morning and leaving in the evening should be recorded. This coupled with an actual count or estimate (generally 20%) for service and shop personnel working on the vessel's repair items, will indicate the total man-hours utilized for the entire repair work. Such items as: Service, Gas Freeing, Dry-docking and Painting should not be included in a total count since these are "set" bid items not necessitating a man-hour count. Equating the total man-hours with the billing rate per hour, plus addition of the four above mentioned items and material an approximate total price will be established. This total can then be used as a check against the total which results from addition of each individual item cost and estimated value of work.

*Maintain* a separate record of the entire service item (IR/110). Although this item is quoted and considered as a bid price there are numerous particulars which if unattended can result in costly extras. Generally, the quoted bid supplied by the shipyard includes stipulations on most of the individual sections<sup>23</sup>.

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<sup>23</sup> Fire watchmen - Section B, the shipyard will normally quote on one fire watchmen for a 24-hour watch, but generally will utilize two and three fire watchmen per 24 hours resulting in an unexpected cost. Sometimes Port/Shipyard regulations stipulate the amount of fire watchmen required for each vessel and also the amount required for vessels where particular type work is undertaken (especially large steel work where excessive welding/burning will be required). To eliminate any misunderstandings or problems during negotiations, this should be discussed prior to the vessel's arrival and a final agreement made as to the number of fire watchmen. In addition, during the repair a record of the number of fire watchmen utilized should be maintained; Electric Power-Section C-the shipyard generally quotes on (X) many cents per kilowatt hour and to supply a final price quote, will allow a said amount of kilowatt hours. To assure an accurate final cost the machinery and running hours aboard the vessel using shore power should be recorded (a responsibility generally given to the third engineer or electrician). In addition, a clamp amp meter should be used daily on the lead wire entering the ship/shore connection circuit breaker recording the total amperage utilized by the vessel's machinery. This

*Conduct* frequent meetings with all assistants in order to review the overall repair progress, discuss manpower quantities and noted repair deficiencies, report safety hazards, determine that the "Critical Path" schedule is maintained and any other pertinent information. In addition, such meetings periodically should also be conducted with the shipyard supervisor and foremen for the same reasons, especially noting any deficiencies and establishing corrective action. During this time the Shipyard Supervisor should advise the Superintendent of all extra work required which is not included in the specification. With this information an agreement can then be made as to what constitutes additions/extras to an item while the work is still in progress. This will eliminate most problems identifying extras when conducting final negotiations. To assist in identifying additions/extras to specification items, it is recommended to advise the Shipyard, prior to commencing repairs, that all work which in the shipyard's opinion is not included in a specification item must be submitted to the Superintendent in writing before the vessel departs.

Always carry a copy of the specifications and require same from all assistants, shipyard supervisors and foremen. This will often save valuable time for both the Superintendent and Shipyard employees. Write up all extra items as soon as possible and be sure the shipyard supplies your assistants with a copy. Keep up to date with cost accounting on all items noting credits and extras where required.

Maintain an accurate recording of all pertinent information of value to the office regarding hull, steel, machinery etc. All unusual findings/modifications, work done, problems encountered, clearances, conditions, additional requirements, etc. should be recorded in order to accurately report upon completion and assist in price estimations/negotiations. Since only one item (in most cases) is listed on one page of the specifications, the back of the preceding page is a convenient area to record

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can easily be converted to kilowatt hours; Shore Steam-Section F- Generally the shipyard quotes a cost per hour which in many shipyards is very expensive. To supply a bid price, they will allow so many hours for the entire shipyard period which often is minimal. To assure an accurate final cost and eliminate a large extra, a daily record should be kept indicating total hours per day steam is supplied to the vessel during the period when the vessel's steam facilities are secured. The Superintendent should also record the dates when the vessel's steam supplying facility is in operation and secured. It is recommended not to use steam 24 hours per day unless absolutely necessary due to frigid weather. A steam supply schedule should be developed for those days shore steam is required keeping in mind that crew are living aboard the vessel therefore requiring steam after meals, for quarters heating when necessary and for washing. Generally, time arrangements are made with the shipyard shortly before securing the vessel's entire power plant and an average of 8-12 hours a day is sufficient. The above mentioned three items are the most essential to watch. However, it is good practice to maintain a close record of the entire item to maintain good cost control and eliminate a large extra. In U.S. shipyards service items are part of "overhead" and therefore a general minimal quote is given for the entire item and extras within reason are normally not requested. However, European and Japanese shipyards are generally expensive and normally

the above for each noted item.

Complete all forms supplied by the company at the time of inspection when information is immediately available so that incorrect/memory quest mate type reporting is eliminated. When repair items are completed .and information for that item is required in the final report, it is recommended that the said information be immediately written in report form. This will assure accuracy, eliminate re-writing for the final report and assist in submittal of final reports immediately after repair and negotiation.

Procedures and repair methods during repairs-Specific On Site Procedures/Inspections For Superintendent- drydocking a vessel.

Whenever a vessel is placed on dry-dock, the Repair Superintendent with class and shipyard representatives will enter the dock as soon as possible, and examine the underwater parts for the following: *The Rudder*: Cracks in the plating. Eroded or worn areas including welds. Inspection plate loose or missing. Zinc plates consumed or missing. Not required with impressed current system. Any damage to the basic rudder framing. *The Propeller*: Bent or otherwise damaged blades. Loose or missing rope guard. Abnormal erosion of the blades. *The Stern Frame*: any abnormal amount of pitting on the plating or stem frame. Zinc plates that are consumed, loose or missing (not required with impressed current system). If the frame is cast in more than one piece, note the condition of the welding at the connecting joints. *Sea Chests*: Missing strainer plates. Loose strainer plates and overall condition. Missing bolts for securing strainer plates. Condition of sea chest (corrosion, pitting). Strainer plate hole diameters reduced due excessive coats of paint-restricting water flow. e. *The Bilge Keels*: Bilge keels that are bent, badly damaged or missing<sup>24</sup>. If the bilge keels have a riveted connection, determine if any of the rivets are loose or missing.

The Entire Bottom and All Underwater Parts: Indented or buckling plates<sup>25</sup>. Badly pitted plating. Cracks in plating. Badly eroded welding<sup>26</sup>. Loose leaking rivets. Badly eroded rivet points. Extra attention should be given to welding at butts in keel plates. Closely inspect for leaking riveted seams.

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require close supervision.

<sup>24</sup> Section can be removed without replacing if necessary - There are no classification class requirements on Bilge Keels except for the hull attachment both riveted and welded.

<sup>25</sup> Size of indent can be easily measured by using string stretched across the indent.

If impressed Current System installed, condition of anode and insulation coating. Ide Shell Plating on the Main Body of the Vessel: When the vessel is on dry-dock, the side shell plating on the main body can be examined by looking up in a vertical line while standing on the bottom of the dock. In this manner, indents in the plating can be easily detected<sup>27</sup>.

*Vessel's undocking* well before the vessel is scheduled to be removed from the dry-dock, the Repair Superintendent or delegated assistant will enter the dry-dock and verify the following: that paint has not been applied to the Fathometer plate on the bottom of the vessel. That all sea chest strainer plates are properly secured to shell. That all zinc plates are properly secured to shell and rudder. That all draft marks are painted in. That the rudder inspection plates have been secured. Verify that all docking plugs which were removed have been reinstalled. When the dry-dock is to be flooded, the Repair Superintendent will ascertain that all of the sea valves are closed.

While the dry-dock is being flooded, he will enter the engine and boiler rooms, the pump room, the cofferdams and all other compartments having valves directly connected to the sea. At this time, he must ascertain that none of the sea valves have been opened by mistake, The Repair Superintendent may assign Engineers and Deck Officers to this examination, but the prime responsibility for verification is still his.

#### Painting and coatings -a. Painting - Underwater Part of Vessel:

All underwater parts of the vessel will be examined, noting the density of marine growth, the areas particularly affected, the length of algae growth, the areas with barnacles, etc. This will allow the Repair Superintendent to estimate the time necessary to remove the growth prior to preparing the surfaces for the application of paint. If deemed of value for Office assessment, good photographs are to be authorized taken by the shipyard or vessel's photographic equipment. Examine the underwater areas prior to the application of the first coat of paint. Verify that the surfaces have been properly prepared for the paint application including proper installation of scupper extensions which are not leaking water. This duty may be delegated to the chief officer or another officer<sup>28</sup>.

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<sup>26</sup> Prominent in many vessels in way of the bulbous bow.

<sup>27</sup> Any unusual findings or damage, photographs may be taken if deemed of value.

<sup>28</sup> Under no circumstances is paint to be applied over dampness, heavy rust or loose paint. In addition, sand sweeping is not to be used on areas of special coatings since good coating can be damaged. However, sand sweeping could be used in local areas of extensive pitting or active corrosion and then a full coat of primer should cover the swept areas. High pressure water systems are acceptable for hull cleaning.

Each coat of paint must be examined as to the quality of coverage and if sufficiently dried before the next coat is applied. The specifications should call for primers to be of different colors so that each coat of paint applied can be easily identified. Whenever possible, he should attempt to have all painting done in daylight hours. However, when the vessel is only on dock for one or two days, the paint must be applied as quickly as possible and it may be necessary to agree to night painting. To keep the vessel on dock for longer periods than the scheduled time is expensive, and all efforts should be made to avoid same.

When all paint has been applied, the Superintendent will personally make the final examination of the bottom and all underwater areas. Particular attention is to be paid to the quality of the coverage. When a special type of paint, especially paint for experimental purposes, is applied, the work is usually supervised by representatives of the paint manufacturer, in addition to the Repair Superintendent. The presence of these manufacturer's representatives in no way reduces the Repair Superintendent's responsibility for ascertaining that a good paint application has been completed.

The Superintendent should also estimate the quantity of paints that are to be used, taking into consideration the condition of the surfaces to be covered. If he notes that excessive or too little amounts of paint are being used, he should contact the shipyard's representative to correct this condition. Care should be taken when spraying paint since it is possible to "feather" the paint not applying a sufficient amount. Special Coatings all Areas of the Vessel: Special coatings requiring sand or grit blasting or other special preparation are usually supervised by representatives of the paint manufacturer on an around-the-clock continuous basis. In addition, there will often be a company specialist who will undertake the entire supervision requirement from surface preparation, mixing the product, to the application. The Repair Superintendent, however, has over-all charge of the project and his authority will prevail in all disputes with the Contractor.

Life boats International regulations require that life boats be examined and repaired at least every two years in order to qualify for a safety certificate. The following instructions are designed to meet the certification requirements of the classification society carrying out the inspection. Interim examinations are to be performed by the Repair Superintendent and the extent of these examinations

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and the repairs required are left to his discretion. However, it is recommended that older lifeboats be inspected during every repair period. Prior to examination, all equipment in each of the life boats is removed. This includes sails, oars, food, water, as well as air floatation tanks.

All base paint and rust spots are then scraped and cleaned prior to examining closely for possible leaks. Generally holes are often indicated by raised bubble type areas noted in the paint exterior - especially those raised areas where a brown color is prominent indicating rust penetration. On motor lifeboats plate areas beneath the motors should be closely inspected. After the necessary repairs have been made, the life boat is then tested for water tightness. The bottom plates are tested by filling the bottom of the life boat with water. The side plates are usually hose tested. When water testing, care must be taken to insure that the keel is adequately braced to support the weight of the water, or the boat could be damaged by overloading. This is accomplished by placing the life boat flat on the deck in its chocks.

After the life boat hull has been found satisfactorily water tight the plates are then thoroughly, dried, primed and painted. All of the floatation tanks are to be air tested, and any repairs necessary to make them air tight should be completed. All of the food is to be examined where feasible. Can supplies should be examined for rusting, pitting, the extent of which could designate replacement. Bulging of the cans would indicate that the contents are no longer edible, requiring replacement. The maximum period of retention for food and water supplies is usually dependent upon the judgment of the classification society representative attending the survey. All other equipment such as sails, oars, signal flares etc. are to be examined and replaced where necessary.

During the examination of the life boats, the releasing gear is to be examined and should be in good working order. With motor life boats, the Repair Superintendent can require the, motor to be run at any time during the repair period. Any defects in the motor are to be corrected. After all repairs are completed; the air tanks and flooring are then replaced in the boat, secured in the proper manner, renewing all defective bolts, steel straps, etc. All other equipment is then reinstalled in its proper locations. If equipped with a motor, the life boat is then taken on a test run using only the motor as means of propulsion.

The classification society representative may also require a test of the life boats' hoisting and



lowering equipment. For the purpose of this test, 150 pounds is considered the weight of a person. The test is accomplished by placing the necessary weights (sand bags, iron weights, etc.) equal to the weight of the number of persons for which the boat is certified to carry. This weight is in addition to the equipment normally carried in the boat.

**Deck winches** → In general, the examination and repair of winches is similar to that carried out to the windlass. Operating condition of winches does not come under the scrutiny of the classification society and requests for repairs to these units come from the Deck or Engine Departments. A good gauge of their general condition can be determined from the noise level and smooth operation when running under load. Normally the crew can accomplish all necessary repairs except under special conditions.

**Windlass** → it is very important that the windlass be kept in good order, since failure of any component part could result in a delay to the vessel. The windlass is subject to examination by the Classification Society at least every four years. The windlass is usually fitted on the forecastle head deck, where it is exposed to wind, seas, and continuous salt spray. Because of this exposure to the elements, the wear on bearings is considerable and generally lack of grease is the major reason for windlass failure. It is recommended that prior to all arrivals and after departure the windlass and other deck machinery be thoroughly greased — also periodically when turning over during freezing weather. On long voyages all exposed deck machinery should also be greased (even if not previously operated) at least every (8-10) day.

For a reciprocating engine type windlass the following normal inspections should be made when visiting the vessel and during every repair period: (most of the following pertains to all types). Condition of brake bands, lining and drum (clean where required). Linkage pins free and all grease fittings in place. Wear of wild cat cogs (teeth). Extent of grooving in hosepipe. Crosshead slipper wear. Gear guards condition. Observe the unit in operation assuring smooth running condition. On turbine driven windlasses the friction clutch should be inspected. Every four years the Classification Society requires the windlass to be thoroughly inspected internally.

During this time the following should be inspected in addition to above: Pistons, piston rings, piston rods and connecting rods. Cylinders and extent of grooving or wear. All bearings and journals

including clearances. Condition of neck bushings. Crosshead slippers and guide rods where installed. All gearing including brake worm gear. Control valves and valve stems. Throttle/Reversing Valve. Piston Valves where fitted. If any doubt (indicated by bearing wear or oval shaft journals) crankshaft alignment. This would then require machining shaft and re-metal bearing. Not necessary if bearing wear or journals are true indicating true alignment.

After repairs are completed the windlass should be tested by running with load proving its reliability. Consult classification society, if he requires his presence. Any time the windlass is operated in the shipyard, for either testing or ranging chain, it is important that all required areas be greased prior to operation.

In addition to the windlass, anchor chain should also be closely inspected for overall condition and wear (calibrated for classification society every four years). The chain swivels, shackles and crown pins should be noted for excessive wear. If wear exceeds 25%, it is a good policy to renew or plan for renewal<sup>29</sup>.

Cargo pumps are a very critical component part of a tank vessel's equipment. The following repair procedures are recommended. After the pump has been opened for inspection, the Repair Superintendent will examine all parts, authorizing additional repairs that he may consider necessary. At the same time, he may find it advisable to cancel some of the repairs written into the original specifications, if in his opinion they are not necessary.

If it becomes necessary that any of the renewals or repairs have to be done in the shops, the Repair Superintendent will oversee the work, giving instructions as to how the work is to be done and examining the finished items before they leave the shops. After the repairs have been completed, but before the pump is secured, the Repair Superintendent will again examine the pump.

When pumps have been repaired, they are to be given a trial by pumping water from the sea and

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<sup>29</sup> During special survey the classification society should be consulted prior to opening the windlass. It will generally agree to open only 50% of what is required. (Such as: one cylinder, one valve, random bearings, etc. which can result in a cost saving.) However, it is recommended to always open the throttle/reversing valve.

discharging it overboard. This trial should consume from one to two hours. In all cases, the pumps must be in good running condition before the vessel leaves the repair yard. If circumstances prevent the Repair Superintendent from personally witnessing the test, he may assign one of the ship's engineers or chief officer to witness the test. In such cases, he should make an effort to be present for at least the last 15 or 20 minutes of the test.

Cargo stripping pumps à Cargo stripping pump operation should be witnessed for proper operation. The pumps should also be opened for overall repair at least every two years- either by crew or shipyard. Inspection is similar to that of the windlass and mooring winches, however, with reciprocating pumps, the liquid and piston/piston rings, cylinder liners, suction and discharge valves and springs should be inspected.

Cargo line valves à When preparing the repair specifications, the Repair Superintendent will include, in addition to the valves known to be leaking, an additional number of valves as a cushion. The amount of the cushion will depend upon his judgment as to the general condition of the ship, its age, particular conditions, etc. Those valves indispensable to designed cargo segregation will always be listed in the original repair specification and repaired as required.

Depending on the nature of the repairs needed, cargo line valves may either be repaired in place or they may have to be repaired in the Contractor's shop. When valves are repaired in place, they are opened up and ground or the fit of the seats may be done by scraping. Repairs done in the shop are much more expensive, since extra cost involving the labor of removing the valve, the use of the crane to lift the valves from the deck of the vessel, transporting to and from the shops, testing in the shops, return to the vessel, and fitting in place are then added to the initial cost of repair.

To avoid an excessive high cost, all valves known to be in bad condition are designated as items to be removed from the vessel and repaired in the shops ashore. In addition most gate valves will be required to be sent ashore since it is difficult to effectively repair same in place. For a general practice, all leaking gate valves which are key valves for effective discharge should be sent ashore, repaired and tested.

When a valve is first opened, it is examined by the Repair Superintendent and all the necessary

repairs are then designated. When the repairs have been completed, but prior to closing, he will examine the completed repairs to ascertain that they are satisfactorily completed. The Repair Superintendent or his designated assistant will witness the hydrostatic test in the shop. After all cargo line repairs have been completed, the system must be tested again to prove the equipment sound assuring that all of the joints in the lines are tight. The Repair Superintendent or his designated assistant will witness this test, usually assisted by three or four members of the "ship's officers. However, in all cases, he exercises overall supervision and approval.

Cargo vent system – The repair requirement in the cargo vent system is usually for pipe renewals or pressure vacuum valves (which are a class requirement). The vent lines are continuously subject to corrosion attack by petroleum gases and the life of bare steel pipe under these conditions is short. When the lines become cracked or holed, gas from the cargo tanks can escape directly into the deck, creating a fire or explosion hazard. For newer vessels it is generally recommended to repair defective lines with renewed galvanized pipe. However, the pipe must be in very poor condition before complete renewal, since the line contains minimal pressure and quite often welded patches can be utilized which result in an effective but inexpensive repair. In choosing such a repair, consideration must be given to extent of deterioration and the fact that the said repair must last for approximately two years.

Repairs to vacuum-pressure valves and flame arresters are normally undertaken at periodic intervals, usually coinciding with a scheduled repair or with a classification society requirement. These valves are usually made of bronze, or having the valve body made of cast iron with bronze trim. Repairs to the valves usually consist of cleaning all parts, and grinding in the valve to ensure that they are tight and operating properly. Unless in extremely poor condition, the removal to shop is not necessary.

Prior to preparing the repair specifications, the Superintendent will note the size of all lines to be repaired or renewed, the amount of material required, the number of bends, defective clamps, including all this information in the specification. After valves have been opened, the Repair Superintendent will examine them to ascertain exactly what work is required. One of the most common repairs to valves is renewal of springs. After cleaning and grinding, he will examine the valves, either all at one time, or separately whichever manner best suits the Contractor, the objective

being to save on the reinstallation time<sup>30</sup>.

Cargo heating coil system unless made of non-corrosive material, the life of the cargo heating coils is relatively short with corrosive petroleum cargoes. Proper maintenance of these coils is very important since certain cargoes must be heated for pump ability. Additionally, leaky coils allow oil to return to the condensate carrying with it the danger of contaminating the boiler feed water, system. Heating coils are tested at regular intervals, and small leaks are usually made good during an operating period by the ship's force. Major renewals are made during a shipyard repair period although depending upon extent; the ship's force can undertake renewals using screwed fittings.

The nature of the cargo heating system prevents an exact determination of what repairs will be required when in a shipyard. When preparing the repair specification, the Repair Superintendent will allow a certain cushion which, in his judgment, will cover potential repairs not brought to light during the shipboard test. The repair specifications must include an item calling for the testing of all coils at a designated pressure. The crew should be instructed to make a final comprehensive test prior to arrival in the shipyard at which time final repair requirements/testing can then be determined.

Once the vessel is in the repair yard, and testing is still required, he will designate one of the ship's personnel to accompany the yard foreman in charge of heating coil repairs. After the yard has completed testing the coils-as specified, they will supply the Repair Superintendent with a list of all repairs necessary to the heating system, both in the tanks and on deck. This list is to state the number of feet of coils to be renewed, the number and size of all valves to be repaired, the number of joints to be renewed, and the size of the joints. The presence of the ship's officer who witnessed the test will ensure that all repairs have been included on the list, and also will protect the list against being "beefed up".

Extra work orders will then be issued for any heating coil items not included in the original specification. Regardless of whom he assigns to aid him in, verifying that the work is done, the

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<sup>30</sup> Since opening and repair of these type valves are not too difficult the crew can be assigned to repair same depending upon both manning and other crew repair requirements. When repairs to the vent piping are completed, the pump man will generally be assigned to test the bolts in the flanges for proper tightness.

Repair Superintendent continues to have over-all responsibility for making certain that the work actually has been performed in a satisfactory manner. When all repairs to the coils have been completed, he will request several of the ship's officers to assist him in determining "the system tight during the hydrostatic test.

Evaporators à Repairs/inspections to evaporators are usually done in place on board the vessels. The primary inspection to evaporators should consist of the following: Condition of coils and extent of cleanliness. Condition of salt water side of the evaporators. Condition of the salt water and fresh water pumps (generally repaired by crew). Condition of various valves on the evaporators. Adjustment requirements of the various controls. Testing the shell and safety valve to satisfaction of classification society.

After the repairs and cleaning have been completed, and when the boilers are steaming and-ship's generator running, the evaporators are tested for a period of not less than 24 hours, operating at full capacity and a record of the rate maintained.

Heat exchangers à Heat exchangers are used for various purposes such as heating fuel oil for use in the boilers, feed water heaters, cooling lubricating oil, condensing returns from the cargo heating system, or heating sea water for use in cleaning cargo tanks. The principle inspection/repairs to a heat exchanger are as follows: Cleanliness of the tube bundles -inside of the tubes and outside of the bundle<sup>31</sup>. Cleanliness of the head and water boxes (where salt water is used as a cooling agent). Renewing of zinc or soft iron plates attached to the heads<sup>32</sup>.

Coating requirements of the cooler bodies, when salt water is used as a cooling agent. Plugging of leaky tubes. Complete renewal of all tubes. The Repair Superintendent should personally supervise all repairs to heat exchangers. In the event that he has assigned some of the inspection to the ship's engineers, he should personally witness the hydrostatic test on tube bundles.

Boilers à because the interior of the boilers are inaccessible, except when secured, the Repair

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<sup>31</sup> Chemical cleaning internally is sometimes required to remove heavy scale deposits.

<sup>32</sup> Where salt water is used as a cooling agent. An all condensers with Yocalbro tubing, zinc anodes are not to be used. Soft iron is an effective anode for both Cu Ni and Yocalbro tubing although zinc can be used for Cu Ni if necessary.

Superintendent must rely upon information supplied by the Chief Engineer, as well as his own past experience, when preparing the repair specification. Because of the high cost of extras, a maximum amount of the necessary repair work should be included in the original repair specifications. Whenever possible without delay, at least one boiler should be secured for overall inspection by the Repair Superintendent prior to completion of the Repair Specification.

Once the vessel is in the repair yard, and the boilers have cooled sufficiently both internally and externally, he will examine both steam and fire side of the boilers for the following: In the furnace brick work and refractory, noting whether the written repair specifications are sufficient to cover the repairs needed. Overall exterior condition of all tubes, looking for blister, sagging, pitting and any other conditions which are not normal. After the hand hole plates have been removed from the headers, he should examine the interior of the headers. At this time he should also examine the tube ends where rolled into the headers for pitting and the landings on the hand hole plates for perfect seating of gaskets.

When all removals have been made from the water and steam drums, he should enter the drum and examine the tube ends where rolled into the drum, and as far down into the tubes as possible. While in the drums, he should look for pitting on the interior surfaces. At this time the sides of the drum (especially the steam drums) should be closely examined for the possible presence of any indication of oil or iron oxide. Any other unusual sediment in the drums should also be noted. After the tubes and drums have been cleaned, a second examination of the drum surfaces and tubes should be made<sup>33</sup>.

During the examination of the boilers, he should be accompanied by the *Chief Engineer* or his designated representative. After this examination is completed, he should issue extra work order for any repairs not covered in the original specification.

Valves are to be examined as they are opened for inspection, and extra work orders issued for any additional valve repairs found necessary. Every two years valve inspection is required by the

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<sup>33</sup> At least one boiler should be secured immediately in order to commence external cleaning as soon as possible eliminating any possible delay because of cleaning and repair requirements. The Repair Superintendent should assure that all boilers are thoroughly cleaned externally, especially in way of the super heater and generating tube banks. See

Classification Society. However, if the Chief Engineer advises that certain valves are positively operating properly, one type valve in each boiler can be opened, assuming the Classification Society representative is in agreement. The Repair Superintendent may be assisted by the ship's engineers in supervising the repairs to the boilers. However, he should personally witness the hydrostatic test on the boilers and look at all boiler valves which have been repaired or replaced. He should also personally ascertain that refractory repairs have been properly completed.

Main engines → Turbines<sup>34</sup>. When the main turbines are opened the following inspections should be completed: Condition of all bladings including cleanliness (rotating and stationary). Condition of interstage seals and springs, clearances and if seals are free<sup>35</sup>. Condition of journals and bearings including clearances and bridge gauge readings. Condition of thrust bearings and respective collars. Condition of nozzle valves and nozzle block. Condition and clearances of flexible couplings and respective bolts<sup>36</sup>.

Gears<sup>37</sup>. When the bearings are opened clearances must be recorded and journal and bearing conditions noted. As with the turbine bearings, any burrs or sharp edges must be removed. All gear tooth contact should be inspected at least every two years. It is recommended that prior to tooth inspection or arrival in the shipyard, "Dykem Red" or equivalent should be applied to the gears. Intermediate inspections, on a more frequent basis, are desirable especially where potential problems are known to exist or unusual operating conditions have been encountered. Good records of findings should be maintained and whenever possible individuals familiar with the gears past condition should conduct the inspections. Gear teeth should be inspected at a minimum of three angular positions. Pinions should be inspected completely<sup>38</sup>.

Diesels → Condition/overhaul requirements of pistons and cylinders. Check the cylinders for wear and shoulders and also the piston rings for wear. Total running hours for the piston since last overhaul are criteria for overhaul requirements. Condition of exhaust and air scavenging valves

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attachment I and drawings I and II (end) regarding method of cleaning standard B & W type boilers (non membrane type).

<sup>34</sup> Required to be opened at least every 5 years.

<sup>35</sup> Also gland seal packing.

<sup>36</sup> Should be completed every two years.

<sup>37</sup> All bearings required to be inspected at least every 5 years.

<sup>38</sup> VLCC vessels with GE Propulsion Gearing should be inspected at least every year rather than the recommended two.



where applicable<sup>39</sup>. Examine overall condition of turbochargers. Check condition of rotors/blades including cleanliness. The turbocharger housings, especially on gas outlet side, should be examined and sounded for signs of thinning caused by corrosion on both the gas and cooling water side. Labyrinth seals should be inspected for clearance and/or wear and all sealing air passages and drains blown-out.

Turbo-charger air coolers should be inspected and cleaned as required. After cleaning, weather done by crew or shipyard, cleaning efficiency should be closely checked. This can be done by shining a strong spotlight through the fins of the tube nest to assure that the center of the tube nest is clean. Check that crank case, coolers and scavenging trunk are properly cleaned. Closely inspect bearings opened for survey, checking condition and clearances. Check condition of camshaft and chain. Check main engine crank deflection before and after repairs. Prior to securing after any repairs, check for tools, rags, etc.

Propeller –tail shaft-stern tube à each time a vessel enters dry-dock, a check must be made of the wear-down of the tail shaft. Classification Societies require that the shaft be removed at regular intervals, but the possibility exists that the shaft may have to be removed for re-wooding or re-metaling before expiration of regular intervals. Because of its importance, the Repair Superintendent should personally witness all examinations and work done on propeller and tail shaft. The wear down on wooden tail shaft bearings is measured by inserting a small wooden wedge between the top of the tail shaft and the top of the stern tube<sup>40</sup>. On vessels with metal bearings, a micrometer reading is taken. These last readings are checked against a permanent record of prior readings, which are stamped on a brass plate affixed to the micrometer storage box.

On vessels equipped with metal stern bearings (sealed on the outside and the inside of the vessel and lubricated by gravity oil pressure), the Repair Superintendent must ascertain that the seals are tight and secure each time the ship is in dry-dock.

When it becomes necessary to remove the shaft for re-wooding or re-metaling of the stem tube, he will personally examine the following: If a wood bushing, examine and note the condition of bronze

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<sup>39</sup> Generally repaired by ship's crew.

<sup>40</sup> Long feeler gauges can also be used.

liner on the shaft and general condition of wood. On special occasions only the bottom half of the wood bearing could be renewed assuming the bottom half is bored correctly in relation to the upper half. However, it is good engineering practice and generally recommended to renew both halves at the same time. If a wood bushing, the shaft is cleaned and the diameter of the liner measured for re-wooding and possible need for machining or renewal. A magniflux test of the shaft is then witnessed, paying special attention to the junction of the liner, the shaft forward of the keyway and also to the keyway itself.

Metal bearing -the shaft is wiped dry, and a visual check of the surface condition made. Special attention is then paid to the magniflux test of the keyway and wear of the shaft (grooving) in way of the shaft liners. The inner and outer liners can be machined approximately 3mm before the liner is considered condemned.

If a wooden bushing, examine the interior of the stern tube to ascertain that all of the old wood has been removed. On older ships, the stern tube is designed with bronze strips in the tube between the wood strips. These bronze strips must be examined for any possible breaks requiring repairs. In addition, the stern bushing should also be thoroughly inspected for any cracks or defects.

After the boring of the tube has been completed, if the tube is wooded, be sure there is sufficient clearance at the end of the tube to allow for possible expansion of the wood in the tube. If this clearance is too small, the expanding wood could break off the retaining rings on the end of the tube and result in damage to the shaft.

If deemed necessary an alignment check between the center of the bearing and that of the intermediate shaft can be taken<sup>41</sup>. Once the tail shaft has been slipped-back in the tube and coupled to the line shaft, the propeller is ready to be refitted on the shaft. At this time, the Superintendent will personally witness the following: If a new or different propeller is being fitted, witness the fit onto the tail shaft taper the fit should be at least 80% of contact<sup>42</sup>. Witness the tightening of the propeller nut on the shaft. A sharp ring and no further movement of the hub will designate proper tightness. In

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<sup>41</sup> All wood bearing renewals are to be bored in place for proper clearance and not fitted by machining ashore each individual wood section unless boring equipment is not available.

<sup>42</sup> On VLCC vessels, the propeller is keyless and therefore press fitted on the shaft. Instructions on procedure are aboard the vessel and should be consulted prior to installing.

cold weather it may be necessary to apply evenly distributed heat (400 F maximum) to the propeller hub to assure both proper fit and assist in removing the propeller<sup>43</sup>. Before fitting of the fair water cap, verify that the keepers for securing the tail shaft nut have been fitted and properly secured.

Verify that the fair water cap has been properly secured. If a wood bushing, ascertain that the bolts at the outer end of the stern tube are properly secured and wired with a copper or bronze split pin. If a metal bearing, make sure that the outer seal is tight. Make certain that the rubber ring for holding the rubber in place is properly secured with copper wire or bronze split pins. Witness the filling of the fair water cap and all void spaces in the propeller with Rust Ban 326 or, if not available, tallow.

Salt water lines à Salt water piping is usually of various materials - galvanized steel, black steel, brass, bronze, and copper. It is used in the sanitary system, the various cooling systems, the fire fighting system, and in the water cooling lines of the refrigerating system<sup>44</sup>. Salt water piping is considered to be low pressure piping with the pressure varying according to use<sup>45</sup>. Another use of salt water is for ballasting. In addition to the regular ballast tanks, many vessels still use the cargo system for ballasting.

In recent years, special coatings or anodes have been applied to the ballast tanks, but on occasions of bad or severe weather, other tanks still have to be used for ballast. If a cargo tank has a special coating, the exterior of the cargo piping in that tank will also be coated. Those tanks which generally carry clean ballast and are not coated or have anodes are susceptible to accelerated corrosion and should be inspected at each scheduled repair, determining condition of both pipe and steel.

One of the critical points for inspection by the Repair Superintendent is the suction and discharge piping from the main circulating pump which should be inspected each dry-docking. These are either made of copper, or coated steel pipe to prevent galvanic action. If they are steel pipe the coating should be closely inspected for failure and recoated if required. Coal tar epoxy or a plastic epoxy can be used if the coating failure is localized and not extensive. If this is done, the affected area must be thoroughly cleaned with all loose coating removed.

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<sup>43</sup> Oxy-acetylene is normally used but care should be taken not to localize overheating which could cause stress cracking or distortion. If available, steam is an excellent source of heat and is generally preferred over gas torches.

<sup>44</sup> Some newer vessels use fresh water for the sanitary and some cooling water systems.

<sup>45</sup> Maximum 250 psig on Butterworth System.

Whenever possible it is recommended that deck fire lines be renewed with galvanized pipe<sup>46</sup>. It is also recommended that all copper lines be thoroughly inspected before determining type of repair or renewal. Frequently, copper pipe can be patched and annealed, or a small section removed affecting a proper repair at considerably less cost than complete renewal.

Electrical system → in general, electrical repairs/inspection consists principally of the following: Main/aux. generators. Various motors used for driving the auxiliary machinery. Repairs and adjustments to the starting boxes and controllers of the motors used for driving auxiliary machinery (often can be completed by ship's electrician). Repairs, adjustments and cleaning to the main switchboard, circuit breakers, switches, relays, voltage regulators and instruments. Renewal of electric cables, especially those which are exposed to the weather.

Generators → Because of their importance, generators are opened periodically (at least every special survey) and the various parts noted below are examined for condition and wear. Governors. All bearings (condition and clearances). All reduction gearing (condition and contact). Trip valve assembly. The turbine rotor and blading. Interstage seal clearances. The stationary turbine blading. Inlet steam nozzle valves. The lubricating oil pumps. The condition of the generator rotor or armature, as to cleanliness or presence of oil. Also, note the condition of the insulation. The connection of the electric cables to the generator.

The Repair Superintendent must follow-up all repairs to the generators, giving special attention to the testing of the units while generating power after the repairs have been completed. During each scheduled repair the over speed trip and reverse current relay should also be tested on each generator<sup>47</sup>.

Pumps (excluding cargo pumps) → Pumps fall into three general categories - centrifugal, rotary

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<sup>46</sup> Generally 15% higher cost than black steel.

<sup>47</sup> It is recommended that during every scheduled repair period (assuming 2-year cycle) at least one generator rotor (electrical end) be removed and sent ashore for thorough cleaning, reconditioning of commutator and collector rings (if required), full inspection of coils, baking and reinstating. In addition the stator should be thoroughly cleaned, reinsulated where required and heated with heating lamps. Consideration can be given to the other unit depending upon condition found in unit when opened. Caution: Excessive coats of varnish can result in failure to dissipate heat through the coils resulting in eventual overheating and possible coil failure.

geared and reciprocating plunger. All three types of pumps can be either steam or motor driven. Most repairs to pumps can be undertaken by the ship's crew unless major machining or rebuilding is required. However, a repair to the main circulating pump, which is recommended for inspection at least every two years, is generally undertaken by the shipyard.

Repair work on pumps, which require removal to shore, should be conducted in the following manner: The Repair Superintendent will instruct the shop foreman to notify when the pumps have been opened up. He then examines the various parts and issues extra work orders for any repairs needed in excess of the original specifications, or issues cancellations for any work found unnecessary. He will visit the shop from time to time to check on the progress of the work. When all repairs have been completed, he will personally witness the shop test of the pumps. The final testing of the pumps is with ship's power.

Main steam line piping is all piping which is under boiler pressure is considered to be main steam-line piping. The steam line leading from the boilers to the main turbine is considered the most important of all main steam lines. Other auxiliary machinery which uses steam at boiler pressure is: The Main Generator Turbines. The Main Feed Pumps for pumping water into the boilers. The Main Cargo Pumps.

The classification societies require that the main steam lines be inspected and tested at least every four years. The test is normally made at the designed working pressure of the boilers. Frequently a test or external inspection is only required -depending upon vessel's age. Preparations for the test, such as the blanking of the lines and the piping of the pumps for applying the test should have been included in the repairs specifications prior to the test itself. The Repair Superintendent personally witnesses this test, along with the classification society's representative.

The requirements for the renewal of any section of the main steam lines or high pressure side of the boiler are rigid, and are as follows: The pipe used must be of a special steel, meeting the requirements of the country of registry and the requirements of the classification society. The piping used must have a stamp showing that it is of a material approved by the classification society. This stamp will show the letters of the classification society, such as ABS or LR, and will also show the number of the surveyor witnessing the test. Any welding that is done on steam pipe must be done by

a certified welder and, when completed, the pipe stress relieved. Welding rods must be of materials approved by the classification societies. AH welding of main steam pipes must be X-rayed, and the films examined by the Repair Superintendent and the representative of the classification society. When all of the welding has been completed, the pipe is then fitted in place and tested to a hydrostatic pressure of not less than the designed pressure of the boilers. The Repair Superintendent will personally witness the hydrostatic test, giving special attention to the requirements listed above.

Communication and navigational equipment à All repairs to the communication and navigational equipment are handled by service companies specializing in electronic gear. Shipyards are not versed in the technique of repairs to this kind of equipment and are seldom, if ever, called on to find and rectify operating faults. Such repairs are generally arranged through the agent while in the shipyard.

The hull à Repairs to the hull normally include any or all of the following categories: Deck houses - This includes any steel or interior finish repairs needed on the inside or the outside. Anything mounted on a deck house. All equipment on the decks, except the windlass and mooring winches, which are considered to be machinery. Any structural part of the vessel, external or internal. All painting and coating. Some hull items have been treated separately below. Any repairs to items not specifically mentioned are considered to be routine repairs and the procedures for completing same are left to the judgment of the Repair Superintendent.

Bulkheads à the testing of bulkheads should be witnessed by the Repair Superintendent; however, he may delegate part of this work to the ship's officers if he so desires. He will endeavor to arrange with the yard to have all bulkhead tests done during reasonable hours; if possible between 8 A.M. and 9 P.M. If the testing must be done at night, the officer on watch will witness the test. Prior to the start of testing bulkheads, he will arrange to have a sketch or drawing made of all the cargo tanks. When a bulkhead has passed the test for tightness, the Repair Superintendent or his delegated representative will place his initials on the sketch adjacent to the bulkhead which has been tested. This will allow him to keep track of the progress of the work being done.

When a vessel assigned to special cargoes, such as lubricating oils, is having its bulkheads tested, he must witness all of the bulkheads tests and be absolutely sure that each bulkhead is tight or the leak

is discovered and repaired properly.

Tanks Bottoms à when, in the course of his duties, the Repair Superintendent goes into any of the cargo tanks, he will examine the bottoms of the tank, looking for pitting, welding with excessive wear, cracks in the welding, etc. When the vessel is for dry-dock special survey, sometimes the bottom of the tanks are flooded to a depth of approximately 8 to 15 feet. The Repair Superintendent will then enter the dry-dock and examine the bottom of the vessel, looking for leaks. Any leaks are to be made watertight. Leaking rivets can be tightened by caulking; otherwise leaks are repaired by welding. After a tank has been made tight, he will again examine the bottom in way of the tank. This procedure continues until the entire bottom has been tested.

Safety equipment à There are many different items making up ship's safety equipment. The separate component parts are discussed below. a. Lifeboats. Complete procedures concerning the repair of lifeboats are found below. The Repair Superintendent supervises the repairs to the lifeboats and checks the equipment in the boats, accompanied by a representative of a classification society. When lifeboat inspection/repairs are required, it is suggested to strip and inspect the lifeboat as soon as possible after arriving in the shipyard. This will allow ample time to cope with extensive repairs, necessary replacement, etc., if required.

Life Preservers. Life preservers and life rings are checked by a classification society surveyor, who is usually accompanied by the Chief Officer, and whenever possible, the Repair Superintendent. Should any of the life preservers or life rings be condemned, it is the Superintendent's responsibility to arrange for their replacement.

Fire Fighting System (Water) à this system is supplied by water from a pump located in the engine room with discharge valves found in various locations. The Repair Superintendent must be assured that sufficient hose is available to reach all parts of the vessel where a fire could occur. Testing of the pipe lines in the fire fighting system, as well as testing of all fire hoses, is done in the presence of the classification society representative, the Repair Superintendent and the Chief Officer, The Repair Superintendent will issue a work order for replacement of any defective piping and will arrange with the Company's agent for the replacement of any defective hose. The hose must be of a type approved by the classification society. Although a standard specification item, the required test is normally

completed by the ship's crew.

**Fire Fighting System (CO<sub>2</sub>-Gas)** à This system is used for fires occurring in the engine room, boiler room and pump room. The gas is released by means of hand pulls fastened directly to gas bottles located in the storage room. The checking of the CO<sub>2</sub> fire fighting system is to be witnessed by the Repair Superintendent, accompanied by the classification society representative. The work done by the yard when necessary will consist of the following: All bottles in which the gas is stored are weighed and charged to their proper weight. Each bottle is fitted with a tag showing the date of the examination and the weight of the bottle. The bottles are then properly secured in place. All gas piping is tested to the required pressure. All copper cable pulls are checked for proper working condition. In order to accomplish this test, the cables have to be disconnected from the bottle assemblies. After the test is finished, the Repair Superintendent must personally verify that the cables have been properly reconnected to the bottle assemblies.

The metal boxes on deck and in the deck houses which house the hand pulls for the cables are checked to verify that they are in good condition and that all name plates are in place. When all repairs and adjustments are completed the shipyard or their contractor will issue a certificate showing the number and weight of each gas bottle in the system. A copy will also be given to the Classification Society's representative, who will use this as part basis for issuing a safety certificate. The Repair Superintendent will include a copy of the certificate as an attachment to his final report.

**Fire Fighting System (Steam Smothering)** à The steam smothering system is used for smothering the gases in the cargo tanks whenever a fire occurs anywhere on the vessel<sup>48</sup>. This smothering system is also connected to the pump rooms, all cofferdams, and all paint lockers. Testing of the steam smothering system is witnessed by the Repair Superintendent, accompanied by the Chief Officer and the classification society's representative. This system should also be tested prior to the vessel's arrival in order to ascertain any extra repair requirements. The steam smothering system is tested at least every two months by the ship's crew to assure that all piping and valves are clear of rust and that the system is in good operating condition.

**Fire Fighting System (Foam)** à in recent years, the foam fire fighting system has been installed on

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<sup>48</sup> On newer vessels a deck foam monitor system is used replacing steam smothering system.



all new construction, and is also being installed upon vessels already in existence. This system is intended to supplement, in most cases, the steam smothering system and in new vessels, it has replaced the steam smothering system. In case of fire, the foam is spread directly on the upper deck, forming a blanket. The foam nozzles can also be directed to place the foam directly into a cargo tank hatch cover, should it be open.

On vessels fitted with the foam system, the pump rooms are equipped with either water fog nozzles or CO<sub>2</sub> system. The foam system also extends into the engine room and the paint lockers. The foam and water fog systems are tested at least annually, witnessed by the classification society's representative; every two years accompanied by the Repair Superintendent and the Chief Officer. Any repairs are made under the supervision of the Repair Superintendent.

The water fog system is tested by putting water under pressure into the pipe line. The foam system is tested by submitting all lines in this system to the designed water pressure. At this time, all nozzles in the system are tested individually to assure that all are free of obstructions. To test the foam pump in the engine room, the water and foam mixture is pumped into the line until the mixture issues from the nozzle the greatest distance from the water and foam pumps.

Hand Fire Extinguishers → these are located in the engine and boiler rooms, galley and passage-ways of all deck houses. Recharging of these hand extinguishers is mandatory each year. The two 50-pound CO<sub>2</sub> gas hand extinguishers in the engine and boiler rooms are checked in the same manner as other bottles of CO<sub>2</sub>. Foam hand extinguishers are emptied and their charge renewed. Each of these hand extinguishers is fitted with a tag showing the date of the last charge and the initials of the ship's officer who witnessed the charging.

When the testing and examinations of all fire fighting and safety equipment has been completed, the classification society's representative will issue a safety certificate. This certificate is retained aboard ship in custody of the Master. A copy of the certificate should be forwarded by the Repair Superintendent to New York as an attachment to his final report. He should also witness issuance of this certificate and all other certificates to the Master assuring they are in order.

LNG vessels → When inspecting tanks on LNG vessels the following should be noted: Check the

"toe brackets" of transverse bottom floor structures. Inspect all piping brackets (fixed type, swivel type and sliding type) for possible malfunctions/fractures. This also applies in area of the interbarrier trunk. Always check that spray nozzles are free. When testing is absolutely sure that dry air (no moisture) is used. It is recommended to use compressed air supplied from the ship's actuator or instrument control compressor where a Hankinson type refrig filter is used. Check the corners of the horizontal ties for cracks. All welding in cargo tanks must be completed by qualified welders certified by ABS, RINA or equivalent. Avoid tack welding on any area of the primary barrier. If a bracket or any other welding is undertaken on the primary barrier, exercise extreme care to avoid burns, undercutting, gouging or poor quality welding.

Boiler cleaning – Although the contents below primarily pertain to cleaning B & W boilers (non membrane type) by the crew, this information can also be utilized for external cleaning of this type boiler while in the shipyard. Rather than using the boiler feed pumps (unless supervised by one Engineering Officer), the shipyard should supply a high pressure water system for cleaning. It has been noted that even after the most stringent boiler cleaning, pockets of ash still remain in the generator tube bank. These deposits are not readily visible and it has been found that blockage occurs in approximately one-third to two-thirds the height of the generating bank and between tube rows 6 to 12. Continued restriction would be detrimental to combustion, resulting in reduced safety and overall plant efficiency.

The obstruction, generally composed of ash deposits, may be effectively removed by spreading the tubes in such a manner as to allow the insertion of a water lance. Normally, the gas passage between the tubes is 3/8" wide and may be increased to 7/8" by insertion of tapered slices, dimensions as per sketch, and rotating the tool through 90 degrees. Although tapered slices noted in the sketch have proved successful, the sizes can be altered as required.

Details of the water lance are shown in the sketch, and for washing of the generating tubes, this should be connected to a heavy duty 3/4" bare hose of high pressure fittings using the boiler filling pump to supply the washing water. A suitable shut-off valve should be fitted to the lance. During the actual washing procedure, the pump relief valve must be adjusted to within the safe working pressure of the equipment being used. This should be brought back to its original setting on completion.

The slice and water lance may be constructed on board and if not readily at hand suitable material should be obtained through the normal channels. The dimensions of the equipment required for the cleaning operation will vary dependent on the class of vessel, therefore, using the sketch as the basic design the actual dimensions required should first be checked before the fabrication of these items.

As previously stated, the ash deposits in this particular area of the generating tube bank are not readily visible and an inspection should be carried out at the first available opportunity.

Procedures and repair methods during repairs à Various Type Repair Problems Encountered and Methods of Repair. HULL. Propeller (in place) à Cavitations, erosion or nicks on trailing blade edges (1-2) inches can be removed by grinding, removing all sharp edges maintaining soft reverse curvature condition. Deeper erosion can be removed, however, a qualified firm, such as Lips, should be consulted before such work is undertaken and approval from New York office obtained. Cavitated /eroded areas on the flat section of blades could be cleaned and filled with epoxy in areas as much as (1 - 1/2) inches deep depending upon thickness of blade in that location. However, the area should be ground out and thoroughly cleaned before applying epoxy. The repair can also be made by grinding out the entire eroded area to a smooth finish eliminating all sharp edges and rounding off the outside edges to form a "dished out" configuration. With a smooth finish erosion is somewhat curtailed. If the eroded area is extremely deep, it may be necessary to remove to shop and build up by welding (consult qualified firm if required).

"Cold straightening" (temperatures below 400°F) by means of dynamic loads can be used when only making minor straightening repairs at the tips or thin edges of the blades. Minor defects of 3mm or less should be left undisturbed. If required, a hammer can be used for such a repair, however, a pad or set hammer should be used to assure that the hammer does not strike the blade directly causing deep dents which would require grinding out and further loss of metal. Propellers made of Mn bronze or Ni Mn bronze require stress relieving of 600 - 800°F. For local stress relief of minor repairs the treatment should consist of gradual spreading and maintaining of dent by means of soft gas torches in the repaired areas so that the stress relief temperature exceeds through the entire thickness for a distance of about 300 mm on all sides of the repaired area, and a temperature gradient of about 100°F per 300 mm or 1 foot is maintained. When completed, a mat of suitable material, such as asbestos, should be laid over the heated blade in order to ensure that it cools slowly and

uniformly<sup>49</sup>.

Propellers (in shop)<sup>50</sup> à Deep Cavitation /Erosion Area must be thoroughly ground out and filled by appropriate welding. Metal arc welding is satisfactory for all repairs on all types of propeller utilizing the proper rod. Gas type welding is preferred on Mn bronze and Ni Mn bronze propellers out it should be limited to repairs on the edges of the outer one-third of the propeller radius and, in general, to sections under 32 mm thick<sup>51</sup>. Welding also requires pre-heating and stress relieving for this type propeller<sup>52</sup>. Welding should be interrupted at intervals to avoid excessive build-up of heat and possible distortions. The filled areas are to be ground down to fair them in place with the rest of the blade<sup>53</sup>.

Cracksà All cracks should have their ends drilled and should be chiseled or ground out to sound metal so that a double-V seam can be welded (see 2 Figures). The cracks should be welded and finished off as described in above<sup>54</sup>. If this type material propeller is required for repair, a suitable repairer [in Hamburg, Germany](#) or elsewhere should be contacted<sup>55</sup>.

Hot Straightening by means of dynamic loads can be made for all major straightening repairs. The portion of the propeller which is being straightened should be kept within the recommended temperature range during the course of the repair by means of soft gas torches supplemented when necessary with heat from moving oxy-acetylene torches. A generous area surrounding the section to be straightened should be heated through its entire thickness to the required temperature (Table II). After the straightening operation has been completed the propeller can be slowly cooled to room temperature as noted above.

Stress relief is required with Mn bronze and Ni Mn bronze propellers and should be undertaken as

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<sup>49</sup> No welding is to be done on the propeller while in place.

<sup>50</sup> All major propeller repairs and welding should be done by a reputable firm.

<sup>51</sup> No arc type welding should be permitted on this type propeller unless prior approval from Head office.

<sup>52</sup> See table I for particulars regarding different alloy propellers and the recommended welding processes.

<sup>53</sup> No soft solders or silver solders are to be allowed on any propeller repair.

<sup>54</sup> Preheating is generally required for all propeller welding repairs with the exception of material called "ALCUNIC", which is used for some propellers manufactured by [Theodor Zeise](#). For these propellers arc welding should be done using a welding rod specially developed for this purpose.

<sup>55</sup> The material is basically a nickel-aluminum bronze alloy.

soon as possible after completion of the straightening operation. After the blade has cooled, it is desirable to check the pitch of the propeller. If the straightening operation was required near the root sections, the hub bore could have been distorted. The propeller should then be fitted to the shaft with scraping of the hub as necessary to correct same, assuring a proper fit. Note: when stress relieving, adequate support should be provided to eliminate possible distortions.

The Rudder → All cracks in rudder plates should be drilled at each end and properly veed-out before re-welding. Any cracks in the framing should be veed-out to sound metal, area preheated and re-welded. Each pass of weld should be caulked prior to the next pass and then ground smooth upon completion. If any welding is eroded it should be veed-out and repaired as above. If a plate is found in very poor condition it can be either renewed or doubled depending upon extent. However, if extensive welding is required, care should be taken not to cause any distortion. If numerous plate repairs are required it may be advisable to remove the rudder ashore. Alignment must then check upon completion of repair.

Eroded areas in plates can be filled by welding or doubled with weaving plate if extensive erosion. Epoxy can also be used in certain areas, especially on erosion in way of the stern framing. It is imperative the affected area is thoroughly cleaned before applying the epoxy<sup>56</sup>.

Stern tube bearings → a. In white metal oil type bearing, the inner and outer liners in way of the seals can generally be machined (3-4 mm) before renewal is required. Machining depends upon extent of pitting and grooving<sup>57</sup>. Other repairs are discussed below.

Rivets → All rivets leaking and/or in poor condition must be repaired. The following are certain suggestions: Rivets leaking with some metal remaining in the head can be caulked. If the head is badly wasted away, the rivet can be welded. Prior to and after welding, the rivet should be caulked. In addition, all rivets in the immediate vicinity of welding should also be caulked. Another acceptable method of repair for wasted rivets, especially for a wasted group in one area, is to sand sweep and coat with an epoxy (non corrosive type). This can also be applied over a group of welded

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<sup>56</sup> All above-mentioned repairs must be in agreement with the Classification Society.

<sup>57</sup> Seals should always be renewed.

rivets to protect both from wastage and accelerated corrosion. If epoxy is used, the surface has to be very clean and sand sweeping is recommended.

Rivet can be renewed if badly wasted. If renewed, the area where the rivet was burned out, especially in way of where the head rests against the shell plate, should be inspected and ground smooth, if necessary, prior to removal. Often, it is necessary to "ream out" the area for installation of a larger size rivet. Leaking lapping plate seams must also be caulked tight. If the seam is badly wasted it can be built up by welding and caulked<sup>58</sup>.

Sea chests à It is most important that the sea chest be thoroughly cleaned before applying epoxy. Any heavy corrosion can be built up by using a non-corrosive epoxy<sup>59</sup>. Side shell/bottom plates (general rules for plate renewals) à Depth, type of indent and location is important in determining plate renewal requirements. If an indent is sharp and at least equal to 12-15 mm deep, it generally will require renewal, especially in the mid-body area and below the waterline. If an indent is gradual and does not disturb internals it should not require renewal. If an indent is gradual and corresponding internals require renewal, the plate can often be faired rather than renewed, especially if the indent does not exceed  $(I-P/2)$  times the thickness of the plate.

If the indent is in way of a seam or butt, then fairing can be made by releasing the seam and/or butt, fairing, and then re-welding. This often will allow an indent of  $P/2$  times plate thickness or slightly more to be faired in place<sup>60</sup>. Indents are only required to be repaired on Special Surveys unless they are of a critical nature<sup>61</sup>. When repairing damaged plate, keep in mind: Fairing in place averages about  $(1/2)$  the cost of a new plate and does not appreciably weaken the plate. New butts and, occasionally, new seams can be made eliminating the renewal of an entire plate. If the plate area affected is 70% or less a new butt can be made which allows part of the old plate to remain. If 75% or more of the plate is affected, then the entire plate should be renewed. Sometimes a section of the plate can be renewed, part of it faired in place, and the remaining good section left intact<sup>62</sup>.

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<sup>58</sup> The immediate adjacent area on both sides of the welding should also be caulked. All above repairs should be in agreement with the Classification Society representative.

<sup>59</sup> Again, the area must be very clean before applying the epoxy — a portable sand sweeper can be used.

<sup>60</sup> Fairing plates without releasing becomes difficult with plates in excess of (28-30 mm) thickness.

<sup>61</sup> Plate is leaking or indent is very sharp, deep and below waterline, etc.

<sup>62</sup> This depends on size of plate, extent renewal, etc., determining cost of this repair vs. complete renewal.

The renewed plate should be inspected prior to initial welding, assuring that slag has been removed and the two plates butting against each other have been beveled, forming a good 45° view on both sides, allowing good welding penetration. In addition, no large gaps (7 or more mm) should be allowed without installing a backing piece of steel in the gap. Once the welding is completed against the backing strip, it should be removed and cleaned out from the other side prior to welding.

After welding, the plate is again inspected on both sides to check for defective welding, sections not completed, poor quality, proper penetration cracks, etc. The welding should be butt welded in layers with the final weld a covering bead. Make sure the shipyard inspection staff has approved their inspection prior to the Repair Superintendents so that valuable time isn't lost. The Classification Surveyor requires inspection of all above-mentioned work and quite often will agree to divide such inspection between himself and the Repair Superintendent. However, it is a good policy to inspect one typical area together assuring agreement regarding procedure and requirements.

During the final inspections, be sure that all plate penetrations made by striking the welding rod or air arching torch on the flat section of the plate, generally near the welded area, are filled with welding and ground smooth. If the outside of plates are to be coated with RB191, this can be done prior to installation, and then finished in way of the welds after installation. g. Keep in mind that cost of steel renewal depends upon amount of steel, amount in one area and shape of plates. Flat plates are less expensive than shaped. In addition, a reduction in price per pound should be possible if 2-3 adjacent flat plates are renewed. Generally, staging is included in the price per pound but, if not, the shipyard will charge 15% of plate cost for same. All riveted plates are normally 15% more than the entire welded plates<sup>63</sup>.

Bulkheads/internals à Most failures occur in tanks which are used for permanent ballast or clean ballast resulting in accelerated corrosion. The bulkheads "work" with resultant cracks in way of the transverse of longitudinal stiffeners most often within the number three and four strakes. Doublers of 3/8" thick can be installed for an effective repair for most type cracks and with cracks as mentioned above a long 8 to 10" wide doublers can be used. Prior to installing all doublers, the crack must be

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<sup>63</sup> All above-mentioned steel repairs are only used as guide lines. All these repairs are normally acceptable to the Classification Society; however, in each instance their representative should be in agreement.

drilled at each end, "veed-out", or preferably" burned out completely.

The doublers are then welded in place with the crack "back welded" to the doublers from the other side, completely sealing the affected area. Welding a crack without doublers is not an effective repair and should not be used unless the crack is vertical and located in the corner between the transverse and longitudinal bulkheads<sup>64</sup>. If cracks are developing because of localized plate wastage in a small area it may be more economical to install an insert in way of this wasted area. If cracks are extensive on one plate and the plate is found thin by drilling or gauging, it may be more economical to renew the plate<sup>65</sup>.

Other type failures are noted around the through brackets located in the tank corners. Often stress concentrations occur in this area resulting in affected plate wasting and cracking. To stop this type leak, the most effective repair is installation of "horse shoe" type doublers generally 3/8" thick. This type of repair causes any stress to form around the doublers, alleviating concentrated stresses and resulting in a long term repair. The crack on the end of the through bracket could also be "veed or burned out" and re-welded on both sides at a cost of approximately (Vi) of that for the horse shoe doublers depending upon staging. However, this type repair often fails in a short time. Such conditions as the thickness of bulkhead, type of cargo carried, cost of doublers vs. welding, what tanks cargoes are normally segregated, etc., must be considered to determine the best type of repair. Considering that expensive staging is normally required for such repairs, it is often most economical to install the doublers.

Although there are various type internal repairs, depending upon vessel, many are a result of unusual stresses, sometimes combined with wasted metal which creates a failure. Depending upon steel condition, most of this type failure can be "veed or burned out" and re-welded. Occasionally, a section around the defective area will require "cropping out" and insertion of a new section. If a vertical crack develops from the top a longitudinal face plate to a "lightening hole" and requires renewal, it is recommended to renew without replacing the "lightening hole". The end of the face plate, where stresses are concentrated and the crack begins, should always contain a rounded rather than square end which often is the cause of such cracks.

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<sup>64</sup> In all cases the crack should be drilled at each end for stoppage.

<sup>65</sup> Depends upon what type of cargo is carried and overall condition of plate.



Where shell longitudinal pass through webs, often cracks are noted on the web protruding from the corner edge of the longitudinal. Providing the crack is only 2 inches or less and the vessel construction is not of reduced scantling, a small oval type section can be burned out removing the crack. If the crack is too long or vessel construction is of reduced scantling the crack should be "veed out", stopped and a doubling plate installed.

Frequently, bulkhead leaks are noted where centerline longitudinal or transverse webs meet the bulkhead in way of the top of these webs. A repair can be made by either "veeding out" and re-welding or cropping out a section of the web in way of the bulkhead crack<sup>66</sup> and installing a 3/s thick face plate against the bulkhead. The second method is most effective acting in a similar manner as a horse shoe doublers.<sup>67</sup> Conditions noted above must be considered for each individual decision<sup>68</sup>.

The machinery à In addition to a normal repair as per respective instruction books and assuring proper clearances, bearing conditions, etc., the following is additional information for assisting in various machinery repairs<sup>69</sup>: *Windlass* (Reciprocating Type). Crankshaft slippers can generally be reversed or machined if required and no spares available. Guide rods, where installed, can be reversed if required. Reversing and/or throttle valves which are steam cut can be "bored out" and a bushing installed for proper valve piston clearances. *Cargo Pumps*. Make sure gasket is correctly cut and covering casing face between stages and area near seals. Mechanical seals must be installed on correct pump end according to the seal spring (right hand or left hand) in relationship to direction of shaft rotation. With rotor secured on either end check to assure that rotor is properly aligned in relationship to the casing rings (use feeler gauges to check both sides and bottom).

Vibrations often are a result of misalignment therefore make sure alignment between gear outlet and pump end are correct (remove jackshaft). If turbine is opened, alignment between turbine and gears should also be correct. Allow about 0.003-0.005 inch low for turbine growth. If clearance is too high between wearing rings and casing rings, with spares not available, it is recommended to install

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<sup>66</sup> Normally 4-5 inches down.

<sup>67</sup> The crack must be "veed out" and re-welded to the face plate from the other side.

<sup>68</sup> The Classification Society representative should be in agreement of all mentioned repairs.

<sup>69</sup> This information does not include all methods or types of repair and is only to be considered as a supplement for various machinery repairs.

either oversized wearing rings (skim the casing ring as required) or machine new casing rings. It is not recommended to install inserts in way of the casing rings. The cargo pump turbine over speed trip should either be tested or checked assuring that it is free and properly trips.

Main Stripping Pumps (Other steam reciprocating type machinery). If the liquid valve seats are required to be machined; the "spider" area should be machined about 1/32 in. lower than the outer seat surface. If the D valves are steam cut or show signs of leaking (black marking over the area) the valves should be skim machined and then "lapped in" with the seat until a complete seating surface is obtained.

Boilers. When boiler floors are renewed be sure that expansion is allowed at each end by installing sections of cardboard or equivalent which will burn away. When the front wall refractory is renewed expansion should also be allowed. In addition, be sure sufficient anchor bolts are installed. On membrane type boilers, tube repairs can be completed per Attachment II at the end of this section. Although this attachment designates an emergency repair, the same repair is made in the shipyard, except with a competent welder the ends could be butted together and welded rather than using a sleeve.

When renewing super heater tubes, after the old tube is machined out and header "dressed", the new tube is installed, expanded, welded and then lightly re-expanded. The initial expansion should be very tight before sea welding. Seal welding should always be in the upper direction and the bead not too heavy. Tube ends should be machined off flush with the header before welding. On most B&W type boilers (except membrane type) there is an air passage (4" - 6" gap) between the lower super heater baffle and the furnace floor. This gap should be left open since it assists in keeping the lower area of super heater and generating tubes clean.

Whenever Edwards type boiler valves are opened the bonnet pressure seal ring should always be renewed. The landings in way of the seal ring should be thoroughly cleaned before re-installing<sup>70</sup>. If the front inner wall casing is distorted, generally it is not necessary to renew upper wall area but only in way of the burner throats assuring a tight register fit. New brick can be installed in way of

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<sup>70</sup> Be sure the Chief Engineer has sufficient spares prior to entering the shipyard.

the upper front wall even with a distorted plate assuming it is not extreme or burned through. If hand hole seats require grinding due to steam cut, the landing width should not be ground below (5/16-3/8) of an inch. It generally is recommended to build up steam cuts by welding and then grind smooth assuring good seat contact.

Generators – If turbine rotor is inspected sound the blades and shrouding in order to determine that both are tight. In addition, check all blades for any possible cracks. Rotor journals in way of bearings and carbon seal rings that are slightly scored can often be stoned smooth. Machining should only be completed if the area is in poor condition. If the blades are found dirty with scale, the rotor should be sent ashore and fly-ash blasted. If this is required the rotor must then be balanced. If new bearings are installed rotor alignment must be closely checked to be sure it is correct<sup>71</sup>. The bearings should be scraped to obtain good even contact and proper clearance. If new couplings are installed, the rotor and pinion with the new coupling halves should be balanced. Interstage seals in turbine casings should be checked to be sure they are free and that spring tension is correct. Occasionally, springs require renewal because of breakage or loss of spring tension. Interstage seal clearances also must be measured and clearances not allowed being excessive.

Make sure all oil passages, gear casing and main sump are clean before re-installing. This also applies to feed pump, cargo pumps, main engines, etc. h. Make sure all insulation pieces are properly cleaned and reinstalled in way of electrical end bearings.

Feed Pumps. When re-installing rotating elements is sure impellers are properly centered and that wearing/casing ring clearances are correct. Gasket must be correctly cut covering casing face between stages and area near seals. The gasket thickness; s important on most pumps and should be checked assuring correctness. Rotor must be properly aligned in relation to casing rings<sup>72</sup>.

Pump/turbine alignment must be correct. Allow (.003-.005) inches for turbine growth, unless otherwise stipulated by the manufacturer. After testing and still in hot condition the coupling can be opened and alignment again checked to assure sufficient growth allowance. Make sure the rotor has been dynamically balanced including the pump coupling half. The casing foundation bolts<sup>73</sup> should

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<sup>71</sup> Make sure bridge gauge readings are correct.

<sup>72</sup> Use feeler gauges to check both sides and bottom.

<sup>73</sup> Generally after end.

be free so that casing is free for expansion. Normally no dowel pins are to be installed on the opposite end of the coupling. The coupling end should contain dowel pins and these should be checked.

Rotating element securing nuts on each end should be tightly secured and not "backed off for fear of shaft distortion. When the nuts are secured the rotor should be on vee blocks and impeller straightness checked to be sure there is no shaft distortion (especially two stage types). It is possible to be too tight; however, normally shaft distortion is caused by extraneous condition such as dirt or metal particles between face edges, etc. Do not allow nuts to be slack or slightly more than hand tight.

As with all pumps, direction of rotation is important and should be checked to assure correct in relation to the impellers, feed pump turbine should be checked for nozzle condition, indication of "blow by" around blades and blade condition.

Main Circulating Pump. When new couplings are installed the rotor should be balanced. If there are signs of erosion between casing and wearing rings then renew same. It is important this clearance is not excessive which results in inefficient condenser operation. Generally after two years of operation the above clearance is found to be 'excessive!' If the casing or impeller-coating is damaged the area should be thoroughly clean and appropriate epoxy reapplied. If the impeller coating requires complete renewal or it is planned to initially coat an impeller, it should be first sand swept, then oven baked before applying the epoxy. When completed, the rotor should then be balanced (applies to all salt water service rotors which are coated).

Condenser. Condenser water boxes should be thoroughly cleaned before applying epoxy. Any deep erosion can be repaired by applying a non-corrosive epoxy. When cleaning condenser be sure the inlet pipe is either covered or thoroughly cleaned later since shells, barnacles, etc., which drop or remain in this area will again plug the condenser when the unit is put in operation. Before applying debecote the inlet tube areas should be thoroughly cleaned.

If excessive erosion is noted in way of the inlet tubes and respective tube sheets an epoxy can be used to coat this area and curtail further wastage. If available, plastic tube inserts can be installed

protecting the affected area. These inserts are the best available repair method and generally should eliminate or prolong expensive tube renewals.

Main Engine (Turbine). Most items listed for main generators also apply for main engines (turbines). Bearing conditions, clearances and proper bridge gauge readings are critical. When taking bridge gauges be sure the bearing and bridge gauge faces are clean. Also be sure the bridge gauge is tightly in place. All bladings should be closely checked. If scale is on the blades it can be fly-ash blasted and balanced. Be sure all interstage seals are free and have proper spring tension.

If new seals are not available and the interstage seal clearances are excessive the following type repairs can be completed: Measure each seal clearance independently and machine the seal segment shoulders accordingly to allow the segments to drop closer to the shaft. Make sure the springs are in good condition and that tension is correct. After the shoulders are machined re-install and again take independent clearances. Dress each seal accordingly to maintain original clearance. Make sure seal ends are properly sharpened.

If a new bearing is installed be sure contact, clearance, bridge gauge reading and alignment are correct. Alignment between turbine and pinion must be correct. However, as long as the turbine is low the alignment tolerances can be slightly exceeded, if necessary, since the flexible coupling will absorb the exceeded tolerances within reason. If there is any doubt the manufacturer should be consulted. Do not take these readings while in dry dock and be sure the condenser level is normal both for salt and distillate water side. h. All rough edges or scored areas of the flexible coupling should be dressed and made smooth. Excessive scoring and high clearance will require renewal.

When renewing a flexible coupling complete the following: Be sure the coupling bolts are originally oversized and a matched set. (Market accordingly). Ream out the coupling bolt holes and machine the bolts accordingly to assure a snug fit throughout the hole. Balance the pinion with the coupling half. Balance the rotor with the new coupling half. Although it is good practice, it is not absolutely necessary to balance the L.P Rotor<sup>74</sup>.

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<sup>74</sup> Depends upon circumstances such as fly-ash blasting and otherwise balancing etc.

Main Engines (Diesels) For B&W type engines the exhaust valve stems are best reconditioned by B&W or a specialty shop as there are very few shipyards qualified to build up and machine the stellite facing on valve stem ends and seats. This also applies to the hard facing on the rocker arms. Working rocker arms should be examined for flat spots on the contact faces and all valve stems and push rod ends examined for indents or wear which would interfere with the sliding contact.

Turbo charger motors are best cleaned by soaking in hot fresh water followed '15y' thorough hosing with hot fresh water or steam cleaning machine to remove any remaining loose deposits. Nozzle rings are cleaned in the same manner paying particular attention that all deposits are cleaned from the ends of the individual vanes or segments so as to allow for expansion. Gratings on turbocharger gas inlet are also cleaned as above and broken piston ring traps should be checked for ring-ends indicating broken rings in the cylinders connected to the turbocharger.

When pressure testing for leaks on turbocharger air coolers the pressure should be maintained an hour or more. All thru-bolts should be tightened in the exact sequence and pressures as recommended in the engine instructions. Care should be taken that the nuts are properly lubricated and free on the threads and that contact faces are clean. Hydraulic tightening is preferred on all studs and bolts where provided. Where not provided, tightening angles as specified in engine instructions should be strictly observed.

When calibrating cylinder liners the micrometer should always be checked with the standard provided as part of the engine tools. Micrometer and standard should be as near to liner temperature as possible. All shoulders in the liners due to ring wear should be ground out and smoothed. Scavenge ports should be ground to the correct radius. Oil ways should be re-cut if required and/or ground to the correct radius. Shiny streaks, especially in way of lubricator holes should be roughed up as these will interfere with piston-rings re-seating.

Cracked piston crowns should be returned a manufacturer or a specialty shop for reconditioning. Pistons should be periodically disassembled to clean and check the cooling spaces. Piston crown to piston rod contact faces should be examined for fretting and signs of leakage and machined if required. Ring grooves should be examined for cracks and calibrated for wear. Wear rings, where fitted, should be tight - loose rings may be re-caulked if only slight movement is noted or best

renewed. Assembled pistons should be air pressure tested while submerged or a soap solution used on all joints around studs/bolts, nuts and ring grooves.

The fresh water cooling system should be recharged and a degreaser added to the water. This mixture should be circulated through the fresh water side of the engine at about 175 F for 24 hours. The system then is dumped, flushed and recharged with Kutwell added. Vibration when testing or noting the operation of rotating type machinery (centrifugal pumps or turbines) vibration and extent of vibration is the primary indicator of overall equipment condition. Vibrations are most often caused by; excessively worn bearings or misalignment. These two conditions should be checked first and if found unacceptable it can generally be assumed that rotor unbalance is the cause of vibration. Damaged bearings, especially when noted to be "pounded out" or worn unevenly, normally indicates an unbalance condition<sup>75</sup>. With turbine/gear units the extent of vibration frequency will generally indicate if the vibration is located in the turbine area<sup>76</sup> or pump area<sup>77</sup>.

Another method used to assist in identifying the area which is causing vibration without opening the machinery is as follows: Disconnect the couplings and check for misalignment. If misalignment is correct the prime mover can then be operated in the normal RPM range and in this manner, either eliminated or identified as the cause of the previously noted vibration, depending upon the results<sup>78</sup>.

Miscellaneous à For all machinery repairs the Repair Superintendent or appointed representative should always witness the following: All rotors balancing, Final installation, condition, alignment and clearances before unit" is closed. After a repair is completed the unit should be checked that it is free for rotation and where feasible rotated by hand assuring same. If a steam turbine or a hot or cold pumped fluid is involved the following coupling misalignment guides can be utilized if the manufacturer does not include same in the instruction: Maximum angular misalignment of coupling faces - .002"-.003" (.05mm-.075mm), Maximum horizontal offset - .003" (.075mm). For a general rule regarding sleeve bearings with no recommended clearances designated by the manufacturer, clearances of (.002-.003") per inch thickness of shaft can normally be used to establish a proper

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<sup>75</sup> Easily noted in centrifugal pumps and forced draft fans.

<sup>76</sup> High speed/high frequency.

<sup>77</sup> Low speed/low frequency.

<sup>78</sup> If excessive vibration was originally noted care should be taken that this procedure does not cause further damage. Damage reduction gears or gear misalignment (noted by poor tooth contact) can also be a cause of vibration. However, this condition generally is identifiable since it normally is accompanied by gear noise.

clearance. Whenever renewing bearings, be sure that the bearing sides are sufficiently relieved by scrapping. Whenever high pressure piping is welded the section should be properly stress relieved and tested.

LNG vessels à If a crack is noted near the horizontal tie corners in way of the scallop hole, the following type repair is recommended: Drill a 50mm hole at the end of the crack and grind away all material from the hole to the bulkhead, but do not remove or touch any material on the bulkhead. The 50mm hole will than appear ovalized and provide a definite "stop gap". If a qualified welder is available the remaining area of crack can be slightly ground out and re-welded. However, this is not necessary and the crack can remain if desired. It is important that the crack is arrested and will not expand. 2. If a pipe bracket is loose and requires re-welding it is sometimes advantageous to relocate the bracket so that further weakening of the bulkhead is eliminated in way of the original location. 3. Cleaning of cargo tanks can be accomplished by a vacuum cleaner. This method has so far proven to be the most reliable.

VLCC vessels à The Dry-docking plans must be closely followed especially on the **Y Malaysia** and **X Norway** companies which contain a centerline cargo duct and no centerline girder. In order to check the clearance on the rudder stock special packing rings must be lowered. According to the manufacturer, the rudder stock must be removed in order to replace these rings since they are continuous and should not be cut. On the main boiler rotary air heaters, the following should be inspected each repair period: Upper and lower radial and circumferential sealing strips. Lower bearing and seal. On main boilers care should be taken that all casing leaks, especially in way of super heater tube penetration through inner walls into headers, are eliminated.

Temporary membrane tube repair (Using Fillet Welded Insert) à When a Class 'A' welder is not available to carry out the butt weld membrane tube insert repair either at sea or in a port, a temporary repair can be made using down hand electric welding to produce fillet welds on sleeves as shown below: *Procedure:* Erect scaffolding when necessary in furnace. Remove Veneer casing where necessary. Mark off the length of damaged tube to be removed. Drill 3/8" die holes in membrane fins at one side of mark at top and bottom of the part of tube being removed {at 'A'}. Then drill 2-3/8" dia. holes 2" above top mark and 1" below bottom mark on both sides of part of tube being removed.

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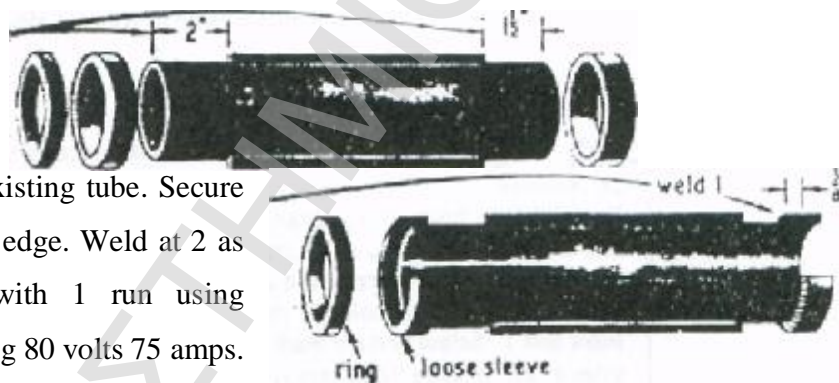


With the reciprocating saw provided and fitted with a narrow blade cut down middle of membrane fins at each side of the tube, care being taken to keep the cut in the centre of the fins.



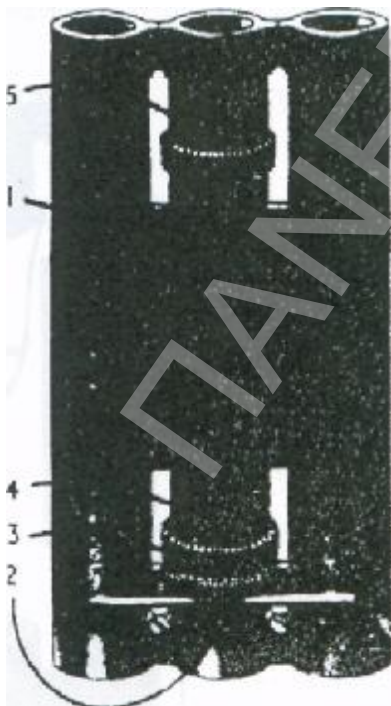
Damaged tube → Saw horizontally through the tube where marked at top and bottom keeping as level as possible. Remove tube with the membrane fin attached. Remove membrane fin from both sides of tube and one side of adjacent fin 2" above cut and 2" below at top and 1" and 1" at the bottom. File exposed ends of tube where the membrane fin was cut off so that it is made flush with the tube. Clean up tube ends with emery cloth until the first 1/8" is bright; measure distance between tube ends.

Temporary membrane tube repair → Using a length of spare finned tube remove fins from either side for 1/2" at one end and 2" at the other file root flush and clean ends with emery cloth. Weld sleeve at 1 with tube 3/8" inside cut insert to just under the dimension obtained above measuring from edge of sleeve. (L).



Slip ring on bottom end of existing tube. Secure for welding 1/2"-9/16" below edge. Weld at 2 as follows: Weld in groove with 1 run using Babcock V type electrode using 80 volts 75 amps.

A striker block should be used to strike initial arc and electrode tip should be warmed on this block.



Put insert in position with loose sleeve on it and secure leaving approximately 1/8" gap top and bottom. Let bottom sleeve rest on weld 2 on ring. Weld at 3 as follows: Weld one run on root of sleeve and ring weld. Complete one further run between ring and sleeve. Weld at 4 with one run as above. Finally weld at 5. Hydraulically test boiler. If necessary cut out weld at any leak, re-weld and re-test.



When satisfactory the membrane fins and Gaps to be made gas tight by applying a Thick coat of Belzoni plastic metal down The length of the butting membrane fins, especially between the edges. Cut 3/8" wide M.S. sealing strip to required length and press strip hard into plastic. Plug weld strip as shown on fig.5, from the casing side, then fill up all the gaps from the furnace side with plastic metal. Allow to air set, then light up boiler slowly to bake out. Replace veneer casing. Sealing Strip. The temporary membrane tube repair described above was devised by Babcock & Wilcox (Operations) Ltd (British Patent Pending).

## CHAPTER 3: OFFICE/VESSEL ADMINISTRATIVE PROCEDURES FOR REPAIRS-

### Preparations for Repairs

Here I outline the administrative requirements necessary to assist in preparing and completing repair specifications, guarantee repairs, expense accounts, etc. This includes: explanation of Ship's Ledger and Classification Record Book; repair forms forwarded from the vessel and procedure of handling same; procurement of spare parts and material and a complete listing of repair codes.

Ship's Ledger - The ledger is a multipurpose record used in conducting all vessel repair business. There is a separate ledger for each vessel consisting of the following: Permanent information, such as specifications, where built, classification, etc. Historical repair information, summarized so that a quick, concise, picture of past repairs is available<sup>79</sup>. Current repair requirements - consist basically of repair requirements submitted by the vessel, plus any recommendations generated by New York personnel. Future repair requirements - consists of items of a deferrable nature that need not be done during the next repair period, but must be accomplished at some future date.

Copy of Superintendent's repair report from the previous shipyard repair. This report also includes possible recommendations for future repairs. Classification society reports accumulated from the previous shipyard period. Open insurance claims (Notes of Protest) and respective insurance numbers.

Classification Record Book - This book contains an updated listing of all classification society survey requirements and expiration dates of the respective survey for each vessel. The Superintendent is to consult this book prior to completing both the repair specifications and undertaking the shipyard repair work in order to stay abreast of all survey requirements and assure their completion before the respective expiration date.

Vessel's repair manual-Section VIII Part 1- C- Monthly Condition Reports - These reports are forwarded from the ship at the end of each month. The report should include all noted deficiencies aboard the vessel with a plan of action indicated. If the deficiency requires shipyard repairs, it

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<sup>79</sup> Details of prior repairs are available in the "Historical Repair File" maintained for each vessel.

should appropriately be indicated by the originator. The Head office is then to review same and if in agreement, extract the required repair item and insert in the vessel's repair ledger. This information is then to be used for preparing repair specifications<sup>80</sup>.

Required Repair Forms - These forms are used to list in detail all items required for shipyard repair. If an item can be completed by the crew it should not be listed but maintained in the Captain's or Chief Engineer's file until the work has been completed. All items should be written in detail including accurate sizes, work required, necessary removals, etc., in order that an effective repair specification item can be written without further investigation. These repair requirements are to be issued in a numerical sequence determined by the individual vessel. A separate repair requirement is to be issued for each item. This would normally constitute a unit, such as a pump, etc.

If parts or material are involved, all available details should be mentioned, such as nameplate data, plans by number and parts number. If the necessary spare parts are not aboard the vessel, then a spare parts requisition should be forwarded to Head office referring to the particular repair requirement. These repair requirements are completed in four copies; the original white and yellow copies remain in the ship's file and the two pink copies are forwarded to the Head office. The pink copies are then reviewed by office personnel and if in agreement both copies are then inserted in the ledger for the Repair Superintendent to use when completing a repair specification. During the repair period one pink copy is given to the Repair Superintendent and the other remains in the ledger. The Superintendent is to indicate on his copy what action was completed in the shipyard and note the extent of completion of the said repair. After the repair period the corresponding pink sheet in the ledger of each completed item should then be removed from the ledger and discarded.

Spare Parts and Material-Whenever writing specifications or issuing work orders which involve spare parts or materials, the Repair Superintendent must decide which of three supply sources is most advantageous. These sources are: - Ship's inventory - Company purchase (procured through the Head office and delivered to the ship or repair site). - Vendor (most often a repair yard, service contractor or ship's chandler).

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<sup>80</sup> Only items required for future shipyard repairs should be extracted and inserted in the ledger. Other items should be handled as required - generally through direct communication with the vessel regarding required action.

First consideration should be given to withdrawals from the ship's inventory. If not in stock the ship should be instructed to requisition from the New York office since experience has proven this is the least expensive method of procurement. If time or conditions do not permit using Company sources, pans and materials must be furnished by the repair yard.

Before making his decision the Repair Superintendent must consider the following: Ship's inventory - would this be depleted to the point where operational risk might be involved, should the ship sail without replenishment of critical inventory items? Company purchase - is there sufficient time to order the requirements through the Head office, or is there a danger of incurring delay time or demurrage because of late delivery? Vendor - can he supply the needs faster than possible through company purchase? If yes, is his markup considered reasonable? Also, is the part of material of a proprietary nature, negating any of the cost advantages possible through supply by company sources?

The company maintains a worldwide inventory of certain critical spare parts which normally require an excessively long lead time to obtain. The Repair Superintendent should familiarize himself with the contents and locations of this stock, and make use of it whenever circumstances permit. This detailed list, itemizing the parts available and their locations can be obtained from the Materials and Purchasing Section. A list of spare parts which are stockpiled for the VLCC class vessels is also available from the Materials and Purchasing Section. These listing will be updated as required.

Prior to the shipyard repair, the Repair Superintendent should obtain a copy of the status of all spare parts ordered by the vessel since the last repair period - especially those spares required to complete necessary repairs in the shipyard.

Accounting- Guarantee Accounts - The Cost and Performance Group will issue a status report on the Builder's Guarantee Account — 185-4, to the ship groups on a quarterly basis for review.

Prior to a ship going to the shipyard (one to one and one-half months) for guarantee repairs a current detailed listing of all items charged to the Guarantee Account will be issued for the use of the Repair Superintendent when settling the shipyard invoice. The Repair Superintendent will make appropriate notations for each item indicating the amount that is for guarantee and/or expense. This will enable



Details-repair reports-Written memorandum form repair reports applicable to both shipyard and voyage repair are to be prepared in the following sequence: - Arrival and departure dates, vessel's movements during the repair period, - Designate total repair time, total diversion time and total out of service time. - Work accomplished. - Analysis of repair days. - Analysis of repair expenditures, - Overall performance of contractor, - General condition of vessel

For work accomplished Repair Superintendent should be specific about unusual technical developments or problems and expensive repair work that were necessary, highlighting cause and effect. Normal survey and repair work need not be specifically mentioned unless consisting of modifications, major proportions or other unusual condition.

Analysis of repair days should examine the time specified in the repair contract in relation to the work accomplished to determine if the contract time should be reduced because of substantial cancellations or the contract time extended because of substantial extra work authorized.

Analysis of repair expenditure should designate the cost breakdown of the final invoice in relationship to the value of extras and credits.

The expenditure breakdown should consist as follows: - Quoted Price - Total credits to original items - Total additional to original items - Total extra items - Total shipyard cost - Total original estimate - Total capital (include breakdown) - Total insurance (include breakdown).

If the total shipyard cost is greater than the original estimate or budget, major expenditures which caused this condition should be included in a breakdown, listing both the reason and final cost of item. Overall performance of contractor should include the organization, working practices, strength and weaknesses of various trades, facilities available and material availability, as applied to the specific vessel repaired.

General condition review should be a resume of the information recorded in the more extensive "Vessel Appraisal Inspection Log"<sup>82</sup>.

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<sup>82</sup> Report should not include every item of repair but should be sufficiently comprehensive to include all items of importance which would be of value to the Repair Superintendent undertaking future repairs.

Supplementary information-When deemed pertinent, whether applicable to shipyard or voyage repairs, advice on the following should be covered in the report: - Status of spare parts inventory - Hull and condenser fouling - Repair cost reduction obtained with assignment of additional day working machinist(s). - Historical/modification data resulting from the said repair (such permanent data should also be entered into the ledger).

Repair information required, for which forms are not provided, and as attachments to the repair report are: - Work performed by ship's crew during the repair period - Material used from ETCO/ETI stockpile - Photos of hull condition, etc. in black and white or color as deemed of value for analysis is left to judgment of Repair Superintendent. Ship's camera is to be used as much as possible. - CO2 inspection certificate as issued by the verifying agency - classification society certificates and reports (copies), if issued prior to leaving the repair site, should be attached to the repair report. Any comments necessary relative to deferments or non-completion of surveys should be included in the body of the principal memorandum form report.

Forms-The following forms principally applicable to the shipyard period are required to be filled in and attached to the repair report. drydocking, painting & completion report Form No. 1. This must accompany all reports for repair yard contracts. boiler cleaning & repair report Form No. 2. This must accompany all reports for repair yard contracts. Inspection, dates & repair requirements report Form No. 3. This must accompany all reports for repair yard contracts. Tank & propeller erosion report Form No. 4. This must accompany all reports for repair yard contracts. Exterior corrosion report Form No. 5. This must accompany all reports for repair yard contracts.

Vessel's repair manual-Section EX -*coating report Form No. 6.* This must accompany all reports for repair yard contracts. Gear tooth conditions report Form No. 7. This must accompany all reports for repair yard contracts. Bulkhead leak report-Not a printed form. This will consist of a sketch or drawing showing all cargo tanks, and the initials of the supervising engineer indicating which bulkheads were tested. Any leakage should be mentioned. Personnel evaluation forms Form No. 8. This form must be completed for all senior officers after observing their performance during the repair period. Vessel's appraisal log - This form is to be completed only if a previous appraisal has not been completed for the said vessel. Breakdown of predicted repair expenditures -This form is to include estimated expenditure for the next Shipyard Repair Period and is to be included with all



repair reports.

Safety/pollutions-Safety: The information here is to be used as a guideline for safety and pollution requirements during the entire repair period. *Good safety and pollution standards* are to be maintained throughout the repair period. The following are safety procedures the Repair Superintendent should assure are followed by both the shipyard and vessel crew members while working aboard the vessel. Any deviations from these procedures should be brought to the attention of the appropriate party.

All personnel should wear an appropriate protective "hard hat" while working aboard the vessel, especially in areas where there is danger of falling objects. All manholes or other openings flush with the deck should be suitably covered or guarded. All areas of "hot work" are to be checked by a chemist at least every 24 hours assuring gas free condition. "Hot work" is not to be conducted unless the area is gas free. Provisions should be established for proper ventilation in closed areas, where completing "hot work", in order to maintain a gas free condition. Areas which are not gas free for "hot work" should be marked accordingly.

Areas which are not considered gas free, such as fuel tanks, should be appropriately marked with warning signs indicating no "hot work" or smoking allowed in the immediate area. Personnel using power tools for removing paint, rust, etc. should have appropriate eye protection. Wires and hoses on deck should be positioned in a manner where there is at least a walkway free of such obstacles. Also no wires or hoses should be located on any ladder whether on deck or in tanks.

All staging should be of proper strength for the designated load and constructed in a sound, safe and secure manner. Any defective components of the staging should be replaced before using. Each staging should also contain appropriate guard rails and all platform planking should be secured. Ladders used for access to all levels must be properly secured and containing protective side or grab rails. On each occasion the Repair Superintendent or any assistant visits an area containing staging, a general inspection of the said staging should be conducted. The Shipyard's Superintendent for the vessel should be immediately advised of any noted defects.

All gratings, catwalks or walkways from which sections of ladders have been removed should be

appropriately barricaded with guardrails. When paints mixed with toxic solvents are sprayed an appropriate respirator should be used. Without toxics at least a filter respirator mask should be used. Good housekeeping condition should be maintained at all times. Aisles, passageways, stairways, walkways, ramps, platforms should be kept clear of tools, materials, debris, etc. All working areas should be kept reasonably free of debris and slippery areas eliminated. All oils, paints, solvents, thinners, rags, waste and other such flammable material should be kept in fire resistant covered containers. All firefighting equipment should be accessible and not blocked by material, equipment or tools.

Infrared heating lamps should be safety wired and a guard placed around the lamp. The area where food waste and rubbish is accumulated and removed each day should be kept reasonably clean. When opening steam lines, adjacent to "live steam" lines, appropriate caution should be maintained. At least two valves separating the two lines should be locked closed and with an appropriate warning sign. All drains should be opened in the line. When removing bolts/studs every other one should be removed first and then the others backed off gradually until all steam pressure has been removed.

LNG Vessels-During oil tank inspection the following precautions should be taken: A minimum of two men should conduct the inspection. When possible all movements within the tank should be conducted within the marked path areas. Where movements are conducted in other areas, extreme caution must be exercised not to step in the various "holes" in way of the horizontal tie. In addition, it is imperative that good lighting be provided. If any work or inspection is undertaken in a cargo tank when another cargo tank has not been inerted or contains gas, all connecting pipes from the dome of the inspected cargo tank should be blanked off.

**à Pollution** -The Repair Superintendent should maintain particular attention to repairs on equipment, such as main pump room sea valves, which could result in potential pollution if not properly repaired. While discharging slops, taking bunkers or transferring bunkers during the repair period, all safety precautions should be taken to avoid overflows, leaks, etc. which could result in pollution. All pumping of bilges should be completed in a manner that eliminates possible pollution. The Repair Superintendent and assistant should maintain a constant watch and immediately correct any noted conditions which could possibly cause pollution by the vessel.

Class certificates & survey requirements - Survey Listings- here I mention all Classification Societies requirements for tanker vessels. It also includes general guidelines and procedures to use when completing various surveys. The following is a list of surveys with the respective time requirements:

Class certificates & survey reports required for Y shipping company international vessels

Certificate/Survey	Requirements
Cargo Ship Equipment Certificate (Safety Certificate)	Every two years
Cargo Ship Radiotelegraphy Certificate (Safety Radiotelegraphy)	Every year
Cargo Ship Safety Construction Certificate	Every five years
International Load Line Certificate	Every five years - after 20 years, required every four years
Annual Load Line Endorsement	Every year except the year in which in International Load Line
	Certificate is renewed.
Equipment Certificates - pertains to items covered by classification requirements (essential to the seaworthy operation of the vessel)	New certificate required if:  -item is replaced  -item is factory reconditioned. This certification may be part of an ABS Survey Report, or a separate certificate
Certificate /Survey	Requirements
Dry-docking Survey	Every two years
Special Survey	Every four years CLASS may allow an additional year of grace".
Boiler Survey	External and internal examination every two years (steam propulsion single boiler vessels must revert to one year inspections after the vessel is eight years old).

Tail shaft Survey	Every three years for wood bushings
	Every three years for white metal oil bearings (both types can be extended to four years with ABS approval which is the company policy. Special considerations are possible for oil bearings extending to five years.)
Intermediate Hull Survey  Annual Classification Survey  *Unprotected Salt Water Ballast Tanks - in cargo space	Every two years after Special Survey No. 3 and after every Special Survey thereafter  Every year - should be carried out simultaneously with Annual Load Line Endorsement  Every two years after construction and two years after each subsequent Special Survey (at least two tanks to be examined internally unless fitted with effective corrosion control).

## CHAPTER 4: REPORTS TO MANAGEMENT

Here I include the reports submitted to Management which involve the Repair Superintendent. These reports include vessel repair budgets and summary shipyard repair expenditures after repairs. In addition, a notation is included regarding availability of computerized reports concerning repair expenditures.

Repair budget-Every year the ship operating groups are responsible for submitting repair budgets for each vessel. This budget consists of a five-year forecast for repair expenditures and out-of-service time. The budget includes: forecasted expenditures for shipyard, voyage and spare parts; and estimated repair days for shipyard, voyage, gas free, deviation, capital and insurance. Although the corresponding ship group manager is directly responsible for budget submittal, the Repair Superintendent generally assist in completing the budgets. He normally will summarize the various known repairs, provide estimated costs for same and further assist the group manager as designated. To properly complete a budget, previous repair reports, required repair forms, certificate file and all vessel ledger items are thoroughly reviewed.

Shipyard repair evaluation form-Upon completion of each vessel repair, a shipyard repair evaluation form is to be partially completed by the Repair Superintendent. This form is then used to complete a summary statement which is submitted with the shipyard invoice prior to final approval for payment<sup>83</sup>. The cost and performance group will partially complete the form prior to forwarding to the Repair Superintendent. The Superintendent is then responsible for completing the entire "actual cost column." Where expenditures are not finalized, such as port charges etc., the Superintendent must designate an estimated value.

Computer reports-Although the Repair Superintendent is not directly involved, monthly, quarterly, semi annual and annual computerized summary reports, designating vessel repair costs<sup>^</sup> are supplied by the Cost Monitoring System. These reports include expenditures for shipyard repairs, voyage repairs, technicians and spare parts.

Technical standards-Welding Guide for Repair Inspectors-This welding guide has been prepared to assist in visual inspection of welds, edge preparations, Gamma-ray and X-ray inspection of welds,

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<sup>83</sup> A copy of this form is noted in attachment No. 2.

"vee" grooving of joints and general welds and weld preparations.

General description-Welding is a fusion process in which heat is essential, and can be described as a small steel making process. This in a sense is the case, in as much as a molten metal is cast in the confines of a mold consisting of the weld groove. A slag coating, the flux, protects this molten metal, and prevents the oxides from combining with the metal, thus preventing oxidation. This is the reason why a coated electrode is employed.

The composition of the base metal, the composition of the weld metal, and the circumstances under which it solidifies has a strong influence on the weld, and how it will form a strong and serviceable joint. In arch welding the composition of the weld bead may be a mixture of filler metal and base metal in varying proportions up to practically all filler metal. It is a known fact that the addition of carbon and other alloying elements such as chromium, which increases the Harden ability, makes steel more difficult to weld. Harden ability is the property which determines the depth and distribution of hardness induced by rapid cooling of steel from an elevated temperature. Low carbon steel is readily weldable because it has low Harden ability and remains relatively soft and ductile even after a drastic cooling.

High quality welded joints can be obtained in nearly all types of steel, provided the proper welding process and procedure are employed. Minimum changes in mechanical properties and the absence of stress across the welded joint should be the goal. However, welding must often be completed under conditions which are difficult to control. These conditions may include adverse temperatures, the thickness of the joint required by design, the position and/or location of the welding imposed by the nature of the structure involved and inclement weather conditions.

The art of welding in itself presents no great difficulty. However, the responsibility resting upon the welder is all important, since he alone often is the only competent judge of his own work until that work is subjected to test and/or service. Therefore, unless welding work and its preceding preparation are thoroughly and competently inspected, the quality of the work is left pretty well to the mercy of the welding operator. Soundness, strength and quality of the work are solely dependent on the welder's ability and desire, to produce a weld of sound and pure quality. This fact alone is sufficient to warrant a thorough and organized inspection when considering the vast number of

welded joints on which human lives, seaworthiness of vessels, cost and successful ship operations are dependent.

Welding quality-To minimize the hazards of welding operations, and the risks of obtaining a poor quality of welded joints, the following can be completed: Inspection of the: Edge-preparation and fit-up; Quality and appearance of weldments; Back-chipping; Air-Arch and/or flame-gouging; Undercutting and overlapping of weldments; Proper welding sequence; Certification of the welding operator; Quality of weldments by X-Ray or Gamma-Ray. In addition, post heating, such as annealing and stress relieving, has long been recognized as a successful means of improving weld properties. It has been quite common to use a thermal stress relieving treatment of welded structure though in some cases such as stem frame repairs, full annealing has been required.

Stress Relieving: A uniform heating of structure to a temperature below the transformation range, and holding this temperature for a sufficient time to relieve residual stress, followed by uniform cooling. In low temperature stress relieving, the material is heated uniformly to 300° F. plus atmospheric temperature. It is then held for a specified time period, and then cooled by a uniform quench. Annealing;

A process, in which the material is heated to a temperature above the transformation range, and after being held there for a proper time at this temperature, is cooled slowly to a temperature below the transformation range. In way of stern frame repairs, the temperature is raised at a rate of 100° F. per hour until a temperature of 1150° F. is reached. This temperature is then retained continuously for a period of six (6) hours, and then lowered at a rate of 100° F. per hour until a temperature of 200° F. has been reached. Material is then allowed to cool normally until atmospheric temperature.

Inspections -Edge Preparation: All edges should be of uniform smooth quality free of burrs and nicks. All root openings of "vee" joints should have 1/16" maximum clearance<sup>84</sup>. Welding: All electrodes are to be covered and of approved classification appropriate for use with the base metal. Welding is to be free of undercutting and/or overlapping. Each weld is to be deposited by the "skip-setback" method-, with the proper sequence of bead deposit. All beads or passes, when peening is to

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<sup>84</sup> If root opening is greater than 3/16" the plate edges are to be built up (using a temporary backing strip as necessary) and are to be completed to the approval of Owner's Representative. All surfaces for welding are to be free of moisture, rust, oil, paint, grease, mill scale and/or other foreign matter.

be done, are to be "penned" while hot except first and last beads.

Never peen a cold weld as this causes internal fractures. Once a weld has been started, and whenever conditions make it possible, continuous progress should be made until the weld is completed while metal is hot. All beads are to be wire brushed to remove slag. At the completion of weld, the weld should be properly completed to eliminate craters at the ending of the weld. In way of "cross" or "tee" joints the weld should be built up and "faired off with the crossing plate edges"<sup>85</sup>.

Tack welding and/or temporary welding for the purpose of erection is to be removed before the final welding is started. In the case of - "vee" grooves, tacks are to be deposited on the face side of plating and not in the "vee" grooves. All tacks are to be effectively removed when back-chipping and/or flame-gouging, before closing or final welding is completed.

When welding in cold weather special care is to be exercised. Production welding can be safely carried out at 32° F. - below that and terminating at 10° F., preheating must be done. Preheating should be completed in such a manner as to maintain at least a 50° F. even metal temperature - for shipbuilding class C-1 or B-1 steel preheating to 100° F. is considered sufficient and tempel-stick checks are to be made to ensure a temperature range of 50° F. to 100° F. during welding operations. When temperature is below 10° F no welding should be carried out except tacking for the purpose of erection. At 0° F. all welding is to cease. Welding to any surface on which the opposite surface is submerged in water should not be carried out at any time.

Welding Sequence: The proper welding sequence is of paramount importance, and should be such as to alleviate structural distortion, panel residual energy and locked-in stresses. Welding should progress symmetrically so as to divide the shrinking stresses throughout the welded structures and thus alleviate the fracture-sensitivity of the welds.

Back-chipping - Arch-air and Flame-gouging: When back-chipping, care should be taken that a "coping" tool is employed rather than a diamond point. The diamond point invariably cuts a very shallow groove and fails to remove any possible impurities in the main weld-bead. The coping tool

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<sup>85</sup> Undercutting - appears as a deep or shallow groove on either side of the weld deposit. Craters - appear as shallow "puddles" at the end of a weld, sometimes 1/4" deep or deeper depending on the dimensions of the weld..



usually cuts a wide and deep groove and, depending on the chipper's ability, is a fairly safe method of removing impurities of the main weld. This enables the welder to obtain proper fusion between main and backing beads.

Flame-gouging is far superior to back-chipping, and is carried out by employing an acetylene torch. Flame-gouging cuts wide and deeply, when done by an experienced operator. It effectively removes all impurities from the main weld bead, ensuring a clean and properly fused weld free of slag inclusions and porosities.

Arch-air is equally as effective as flame-gouging, and in a way preferable in that it requires less heat for effective operation. Arch-air is carried out by a welding torch using a carbon-electrode, with a continuous blast of air, which removes the molten metal and leaves little if any slag.

Magnaflux - X-Ray and/or Gamma-Ray: Magnaflux is a somewhat doubtful means of checking the weld for impurities - in that the magnaflux only penetrates approximately 1/8" to 3/16" below surface, and therefore, does not reveal any internal defects below this level. X-Rays and Gamma-Rays are a very efficient method to employ in checking the welds for all types of impurities, as they reveal slag inclusion, porosities, and thickness of weld, lack of continuity and lack of fusion. Gamma-rays are somewhat slower than X-rays, but produce a clearer picture and require less equipment. The speed of Gamma-rays depends on the thickness of the plates and the mill curies of Cobalt 60. Using a pill of 700 mill curies of Cobalt 60, a penetration rate of 1/10" per minute is obtained. Using Ansco (no screen film) and the above Cobalt pill, exposure time of a 1" plate would be 10 minutes. Impurities in welds have a much defined character and appear in an identical fashion on both X-ray and Gamma-ray film. The appearances are as follows:

*Slag Inclusions*: A series of black spots of varying sizes scattered throughout the weld, sometimes in a line and sometimes confined to a local area. *Porosities*: A series of minute black spots, appearing as pinpoints, scattered throughout the weld and/or grouped together like a group of pock-marks. *Lack of Continuity (Internal Fractures)*: A sharply defined thin black line across and/or parallel with the weld, sometimes appearing in dual sets resembling a "railroad track." *Lack of Fusion*: A thick and sharply defined black line mostly running parallel with the longitudinal plane of the weld, and very clearly defined. All these impurities are of paramount importance and are the chief causes of

weld failures.

The general acceptability of welds in which radiographs show impurities is designated by The American Welding Society in the following manner: Welds which show slag inclusions and/or other imperfections shall be unacceptable if: The length of any such imperfection is greater than " $\frac{2}{3} T$ ." - where "T" is the thickness of the thinner plate welded; Several imperfections within the above limitations exist in a line, where the length of each segment of imperfections exceeds  $\frac{1}{4}$ "; When such imperfection exists in a weld or sections of a weld, the affected weld, and/or the entire weld between the two radiographic points is to be removed and re-welded<sup>86</sup>.

#### DIFFICULTIES IN METAL-ARC WELDING

DIFFICULTIES	POSSIBLE CAUSES	POSSIBLE CORRECTIONS
Incomplete Penetration	1. Joint design faulty	1. Check root opening, root face dimension, included angle
	2. Welding speed too rapid	2. Slow down welding speed
	3. Insufficient welding current	3. Increase welding current
	4. Too large an electrode Size.	4. Decrease electrode size
Poor Appearance	1. Current either too high or too low	1. Adjust current values
	2. Improper use of electrode	2. Check welding procedure
	3. Faulty electrode	3. Dry electrode to remove moisture; change electrode.
Undercutting	1. Current too high	1. Use lower current
	2. Arc length too long	2. Shorten the arc length

<sup>86</sup> General weld sizes & electrodes- Plate Thickness & Fillet Weld Size: Not over  $\frac{1}{8}$ ";  $\frac{1}{8}$  to  $\frac{1}{4}$ "  $\frac{1}{4}$  to  $\frac{3}{16}$ ";  $\frac{3}{16}$  to  $\frac{1}{2}$ "  $\frac{1}{2}$  to  $\frac{3}{4}$ "  $\frac{3}{4}$  to  $\frac{1}{2}$ ". General formula for calculating dimensions of double fillet welds:  $T + T = A + \frac{1}{16}$ ", where T = Size of each fillet. A = Thickness of thinnest plate. Electrode sizes-types & applicable currents: Plate Thickness Electrode Type Amps Volts:  $\frac{1}{4}$ " to  $\frac{1}{2}$ "  $\frac{1}{8}$ " to  $\frac{3}{16}$ " E6010-II 100-180 20-38,  $\frac{1}{2}$ " to  $\frac{5}{8}$ "  $\frac{3}{16}$ " as above 180-225 28-30;  $\frac{5}{8}$ " to  $\frac{3}{4}$ "  $\frac{3}{16}$ " as above 225-300 28-30;  $\frac{3}{4}$ " to  $\frac{7}{8}$ "  $\frac{3}{16}$ " to  $\frac{1}{4}$ " as above 300-350 30-32;  $\frac{7}{8}$ " to 1"  $\frac{1}{4}$ " as above 300 to 400 32-35; 1" to 1- $\frac{1}{8}$ "  $\frac{1}{4}$ " to  $\frac{5}{16}$ " as above 300-400 32-35; 1- $\frac{1}{8}$ " to 1- $\frac{1}{4}$ "  $\frac{5}{16}$ " as above 300-400 32-35; 1- $\frac{1}{4}$ " to 1- $\frac{3}{8}$ "  $\frac{5}{16}$ " to  $\frac{3}{8}$ " as above 300-400 32-35; 1- $\frac{3}{8}$ " to 1- $\frac{1}{2}$ "  $\frac{3}{8}$ " to  $\frac{7}{16}$ " as above 300-400 32-35.

	3. Improper manipulation of electrode	3. Change angle of holding electrode so arc force fills undercut.
	4. Welding speed too rapid	4. Slow down the welding Speed.
Excessive Spatter	1. Current too high	1. Use lower current
	2. Arc length too long	2. Shorten arc length
	3. Excessive arc blow	3. See remedies for "arc blow"
	4. Faulty electrode	4. Replace electrode
Arc Blow	1. Magnetic field, created when using d-c, causes the arc to wander	1. Use a-c machine
		2. Counteract blow with angle of electrode
		3. Rearrange or split ground clamp
		4. Replace magnetic work bench
		5. Use brass or copper backup bar
Pinholes	1. Foreign matter in joint	1. Remove rust, scale and other foreign matter from edges
Slag in Weld	1. Joint design: sharp V-shaped recess.	1. Proper preparation of groove before each bead is deposited. Avoid contours that are difficult to penetrate.
	2. High viscosity of molten metal. rapid chilling, too low weld temperature	2. Use preheat and obtain higher heat input per unit
Porus Welds	1. Welding speed too rapid	1. Slow welding speed
	2. Current too low	2. Increase current values
	3. High sulphur or other impurities	3. Use low-hydrogen electrodes
	4. Faulty electrodes	4. Dry electrodes to remove moisture; replace electrodes

Cracked Welds	1. Faulty electrode	1. Use low-hydrogen electrodes.
	2. Rigidity of joint; stressed weld	2. Redesign joint; use pre-heat and post-heat; weave
	3. Shape of bead	3. Use slower travel or faster freezing electrode to give a more conveys bead
	4. Craters	4. Back step to fill craters
	5. Fast cooling rate	5. Preheat and/or post heat
Distortion and Warping	1. Improper design of weld	1. Redesign to allow for expansion and contraction forces.
	2. Overheating	2. Use lower current and more efficient chill bars
	3. Welding speed too slow	3. Increase the speed of arc
	4. Improper welding sequence	4. Improve welding sequence
	5. Faulty clamping	5. Clamp properly to chill bar.
Brittle Welds	1. Incorrect electrode	1. Use low-hydrogen or austenitic electrode
	2. Incorrect heat treatment	2. Use proper preheat and post heat cycles
	3. Air-hardening deposit	3. Use austenitic electrodes
	4. Base metal pick-up	4. Shallow penetration by directing arc on weld puddle

Technical standards-Welding Repair of Piston Crown Lifting Holes and possible Cracks. This instruction comprises the different procedures recommended for welding repair of the lifting holes on a piston crown of S22Mo. It is divided into three sections depending upon the type of repair<sup>87</sup>.

<sup>87</sup> Pertains primarily to B & W type engine.

Filling of threaded holes, when no cracks have been found, but because another lifting arrangement has been introduced. Repair of cracks which are not penetrating to the cooling space. Repair of cracks penetrating to the cooling space. All four threaded holes are drilled to clean material i.e. to a diameter about 3 mm bigger than the outer diameter of the thread; then the edges are chamfered well by a drill about 20% bigger than afore-mentioned drill.

The crown is, when no cracks are found, heated by an oxygen-acetylene burner f. inst. of a size capable for welding of a steel plate 20 to 30 mm thick; heat to about 100 mm's around the hole for about 10-15 minutes avoiding directly heating by the flame on the wear rings in piston ring grooves. Two minutes after preheating has been completed the temperature should still be at least 250°C measured by a color-stick; if not, the preheating to be intensified and when 250°C obtained after two minutes, then immediately start welding, keeping the temperature at this level.

A low hydrogen chromium-molybdenum alloyed welding electrode to be used-ESAB's OK 76.18 (formerly OK VI) or the like corresponding to AWS-ASTM E8018/B2. After welding the surplus weld metal is ground off to smooth surface and the repairs are controlled by magnetic particle test to ensure that no cracks have developed. If non penetrating cracks are found at the lifting holes, first the holes are drilled and chamfered according to. Then the crack(s) should be cut out from outside by pneumatic tools or carbon electrodes forming a welding groove not too wide<sup>88</sup>. If the crown has to be annealed at 650°C after repair, because it has to be welded due to burning of the top surface, the preheating before welding of the cracks should be done as 1.2 above.

If no annealing is completed the whole crown must be heated in an oven to about 300° C before welding, and during the welding process- the temperature should be kept at about 250°C; if at any point above upper piston ring groove the temperature should become lower than 200° C, the whole crown must again be heated in an oven to about 300°. Welding electrode as above to be used. Grinding and magnetic particle test as above. New threaded holes with well rounded, chamfered edges are drilled 45° from the old ones or another arrangement is made for lifting of the crown according to the Owner's specification.

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<sup>88</sup> Magnetic particle test is recommended in order to control that all the fracture has been removed.

The two processes mentioned above, Filling holes by welding and repair of cracks which are not penetrating to the cooling space, have been carried out many times with satisfactory results on S22Mo crowns. As to below-mentioned repair of penetrating cracks we do not know about reliable experience; if it is carried out, we strongly recommend that all details mentioned below are followed. To complete in such a manner, the repair will be rather expensive. Supplement to Instruction Regarding Crowns with Chrome-Plated Piston Ring Grooves In case a piston crown with chrome-plated ring grooves is ordered to be repaired by welding of the lifting holes according to our instruction 1300 D 277 E we advise against heating the crown material near the ring grooves above 400°C, as the chromium-layer hereby will be damaged.

Further as stated in above-mentioned instruction, point as above, direct heating by the flame on the ring grooves always should be avoided and under no circumstances allow forced heating or cooling by water. The temperatures prescribed must be controlled by striking in some points just above the upper ring groove and near to the lifting holes by color sticks or measured in another reliable way. As a safety measure the ring grooves could be covered with a few coils of asbestos cord during the said repair.

The flame should not be kept on for longer time than just necessary to keep the 250°C two minutes after the flames have been taken away; generally this takes less time than the 10-15 minutes which are on the safe side, when no chromium limits the temperature upwards. This also includes that an annealing at 650°C (1300 D 277 E point 2.21 and 3.8) cannot be carried out unless the chromium plating is renewed.

Technical standards and procedures -Gear Tooth Wear Standards-The purpose of presenting information on various types of gear wear is to serve as a guide to marine engineers when examining and reporting observed conditions of gear units. During the early operation of a set of new gears, minor imperfections should smooth out, and the working surfaces will polish up provided the proper requirements of design, material, manufacture, installation, operation, and lubrication have been met. When these requirements are met, gear tooth wear will not be extensive, and the gears under normal conditions of operation will give good service throughout the life of the ship. Conversely, failure to meet one or more of the above requirements may result in abnormal gear wear operating problems

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and eventual gear replacement.

Gear wear or failure has been classified by a committee of the American Gear Manufacturers' Association (AGMA) into four major classifications. These are listed for your convenience as follows: -Wear, -Surface Fatigue, -Plastic Flow, -Breakage.



When any form of abnormal gear wear is observed it is common practice for the ship's engineering staff, owners technical representatives, the manufacturer of the gears, the appropriate classification society and the lubricant supplier to combine their efforts to find the cause and reduce the gear wear. Failure of marine reduction gears in service due

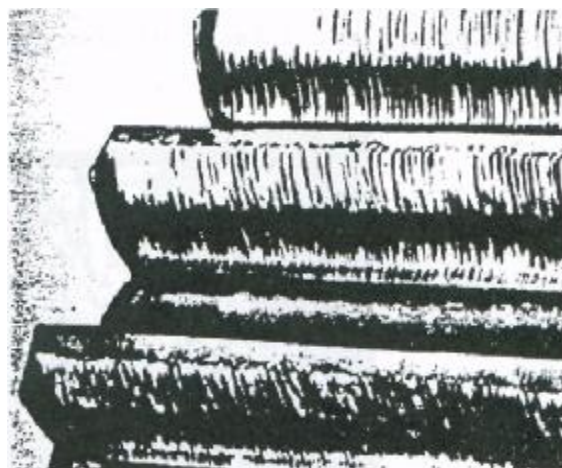
to abnormal wear is a rare occurrence. WEAR-Wear is a general term describing loss of material from the contacting surfaces of gear teeth. Normal Wear or Polishing is the slow loss of metal from the contacting surfaces at a rate that will not affect satisfactory performance within the expected life of the gears.

Moderate Wear is a more rapid loss of metal which may develop on heavily loaded teeth. It is not necessarily destructive but life may be decreased and noise develops.



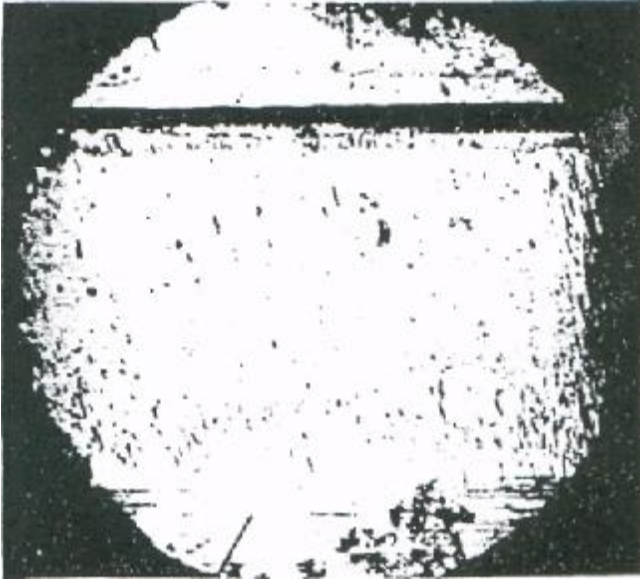
Destructive Wear is surface injury, deterioration, or change in the tooth shape caused by wear to such an extent that the life is appreciably shortened or the smoothness of action is impaired. It may be any, or a combination of any, of the types of wear defined in the following paragraphs.

Abrasive Wear is surface injury caused by fine particles passing through the gear mesh. These particles may be dirt not completely removed, sand or scale from castings, impurities in the oil or from the surrounding atmosphere, surfaces or metal detached from the tooth



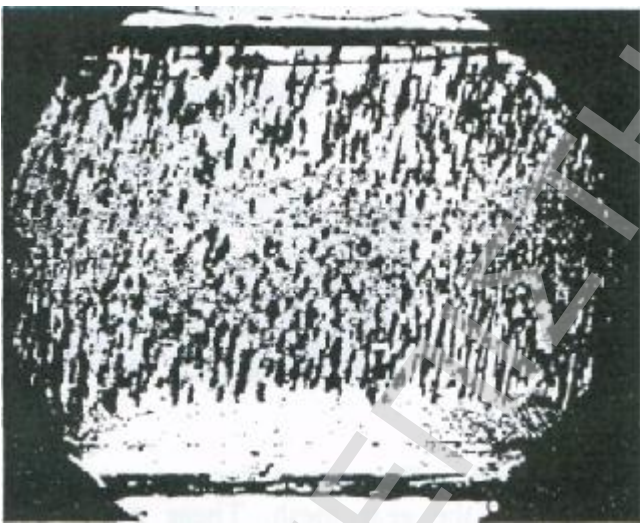
caused by mesh. These removed, impurities in atmosphere, surfaces or

bearings.



Scratching is a severe form of abrasive wear, characterized by short scratch-like lines or marks on the contacting surfaces in the direction of sliding. It may be caused by burrs, projections on the tooth surface material imbedded in the tooth surface, or hard foreign pieces passing through the gear mesh. Scratching should not be confused with scoring because the two effects differ by definition, and scratching damage usually is light and does not

result in progressive destruction provided the cause is removed.



Scoring-The term scoring has been selected as preferable to other terms such as scuffing, seizing, galling, etc. It is the rapid removal of metal from the tooth surfaces caused by the tearing-out of small contacting particles that have welded together as a result of metal-to-metal contact. The scored surface is characterized by a torn or dragged and furrowed appearance with markings in the direction of sliding. Sometimes surface roughness or foreign matter passing through the mesh will cause



localized yielding on the mating profile, without tearing as such, with a similar furrowed appearance as a result of the "plowing" action. It may be localized initially and spread if the cause is not eliminated. Sometimes, particularly in the case of misalignment, the damage may cease and the surface becomes smoother as the contact area spreads and more load-carrying face is brought into contact.



Scoring is usually caused by rupture of the oil film resulting from load concentration at localized contact areas. Excessive unit loading or an unsuitable lubricant has the same effect. Sometimes scoring can be arrested by smoothing the roughened area by filing or

stoning, or by use of a different type or grade of lubricant.

Interference Wear occurs when improper or premature contact concentrates the entire load at the point of engagement of the driving flank with the mating tip, or at disengagement on the driven flank and mating tip. It may range from a light line of wear or pitting of no serious consequence other than noisy operation, to a more severe damage in which the flank is gouged out and the tip of the mate heavily rolled over, usually resulting in complete failure of the pair.



Corrosive Wear (not illustrated) is surface deterioration from the chemical action of acid, moisture, or contamination of the lubricant. It may occur under several different circumstances. If the lubricant becomes contaminated with foreign acid, the teeth may become lightly pitted. The wiping action during

contact may continually remove all evidence of this, but the rate of wear is excessive. Rusting as a result of contamination with water from condensation, excessive humidity, etc., will produce similar results. If corrosion or rusting is taking place, evidence should also appear on other surfaces besides the active tooth faces. Under heavy loads EP oils may react with the metal, permitting operation without scoring but with a uniform and low rate of wear under load conditions that could not

otherwise be tolerated. Gear teeth that are wearing as a result of EP activity usually have a smooth appearance. If the oil temperature becomes excessive, more active reaction of the EP materials with the metal can take place, resulting in accelerated high-temperature corrosive wear.

*Flaking* is a form of wear in which material is removed from the surface in the form of small and very thin wafers, characterized initially at least, by a dull and slightly rough appearance. Sometimes it can be detected only by the presence of an excessive quantity of the flaked material in the oil. While flaking may be a form of surface fatigue in some cases, it is more probably the result of tensile yielding under the action of combined rolling and sliding. It is more commonly associated with the softer steels and some gear bronzes, but may result from a decarburized skin on hardened or case-hardened steel. Flaking is related to the cold-work characteristics of the material and ordinarily it is not serious.

*Burning* can result in severe wear and surface deterioration of the previously described types due to loss of hardness from high temperatures. The fatigue life also may be adversely affected—depending on the degree and location of the burn. It is characterized by temperature discoloration of the contacting and/or adjacent surfaces and is the result of excessive temperature, either from external sources or the excessive friction from overload, over speed, or inadequate lubrication. On gears that have not been put into service the same discoloration would indicate improper grinding, but generally grinding burns can be detected only by etching. *Discoloration* may also occur on adjacent surfaces from deterioration of the lubricant from temperatures not high enough to cause loss of hardness in the tooth surfaces and therefore is not burning as defined or necessarily injurious.

*Surface Fatigue* is the failure of the material as a result of repeated surface or subsurface stresses that are beyond the endurance limit of the material. It is characterized by the removal of metal and the formation of cavities. These cavities may be small and remain quite small; they may be small initially and then combine or increase in size by continued fatigue; or they may be of considerable size at the start.

*Initial Pitting* is the type of surface fatigue which may occur at the beginning of operation and continue only until the overstressed local high areas of the surface have been reduced, thus obtaining sufficient area of contact to carry the load without further impairment. It usually occurs in a narrow



band just below or at the pitch line. Such pitting is not serious since it is corrective and non-progressive.

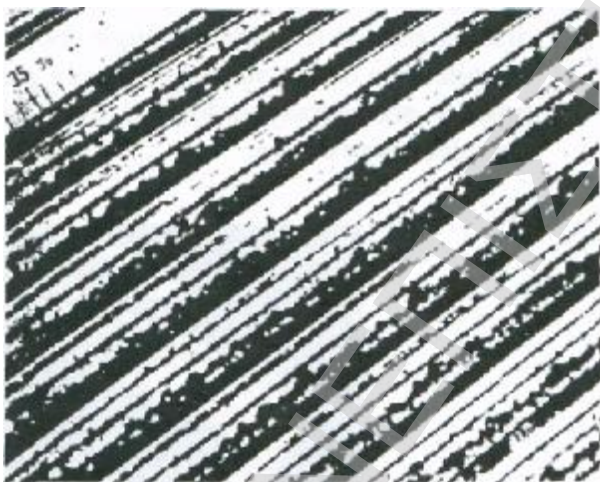
Severe Pitting is a form of surface fatigue that may be caused by slight misalignment and/or undulation of tooth surfaces in gear cutting. It can be either progressive or non-progressive, depending on the many variables. EP types of

turbine oils have proven beneficial in arresting severe pitting.

Destructive Pitting is a form usually starting pitch line, progressively increasing size and pits. The gear noise level may increase. The surface fails in a similar manner, and finally the is destroyed. The pits constitute stress raisers lead to failure by fatigue breakage. Large pits the joining of smaller adjacent pits are due to the material between them and constitute a form



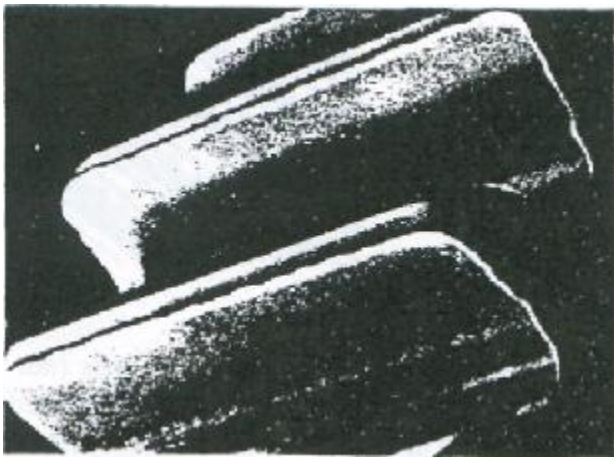
below the number of remaining tooth shape which may formed by failure of of spalling.



Spalling of the more usual type (not illustrated) is a sporadic fatigue failure, occurring only in fully hardened or, more usually, case-hardened steel, originating with a surface or subsurface defect or from excessive internal stresses due to heat treatment. It is characterized by large particles or chips which spall or flake out the tooth surfaces, usually along the top edges or ends. The cavities

are larger, deeper, and of a cleaner break than pits, although the distinction is primarily one of degree. Frequently it is not a fatigue failure of the usual variety since it occurs after a relatively few cycles as a result of excessive internal stresses. The joining of several smaller pits by failure of the metal between them is a form of spalling.

Plastic Flow is the surface deformation resulting from the yielding of the surface metal under heavy loads. It is usually associated with the softer metals, but may occur in through-hardened and case-hardened steels. Rolling and Peening almost always occur together as the result of the sliding action under excessive loads and the impact loading from improper tooth action. They are characterized by fins at the top edges or ends of the teeth (not to be confused with burrs from cutting or shaving), by badly rounded tooth tips, or by a depression in the surface of the driving gear at the start of single-tooth contact, with a raised ridge near the pitch line of the mating or driven gear. The remaining portions of the profiles are usually deformed to a considerable degree long prior to complete destruction.



Rippling (not illustrated) is a wave-like formation on the surface at right angles to the direction of sliding. It is characterized by a fish-scale appearance, occurs mostly on case-hardened hypoid pinions and does not constitute failure unless allowed to progress. It may be caused by surface yielding due to "slip stick" friction resulting from inadequate lubrication, heavy loads, or vibration.

Ridging is a particular form of plastic flow occurring on the tooth surfaces of case-hardened hypoid pinions and bronze worm-gears. It usually appears as diagonal lines or ridges across the tooth surface, but may be characterized by a herringbone or fishtail pattern, both occurring in the direction of sliding. Ridging is generally associated with excessive loads or inadequate lubrication, and usually complete failure results unless the material has a great capacity for work hardening.

Breakage is the fracture of an entire tooth or substantial portion of a tooth. Fatigue Breakage is the most common type of failure by breakage. It results from repeated bending stresses that are above, the endurance limit of the material. Such stresses can result from poor design, overload, misalignment, or from inadvertent stress raisers such as notches, surface or subsurface defects, etc. It originates as a crack on the loaded side usually in the fillet at the edge of the face, and progresses to complete failure either along the root or diagonally upward across the tooth. Fatigue fractures are usually characterized by a series of contour lines and a focal point in an area that is smooth by

comparison. In the case of a sub- surface point of origin, the eye (focal point) at the bottom of the cavity is highly polished.



Breakage from Heavy Wear is a secondary type since it is a result of another kind of failure or wear. For instance, severe pitting, spalling, or heavy abrasive wear can remove enough metal to reduce the strength of the tooth below the breaking point.

Overload Breakage is a rather uncommon type of failure resulting from sudden shock overload and does not show progression of the crack as in fatigue. The fracture will have a silky appearance in the harder and more brittle materials and a fibrous and torn appearance without a definite pattern in the more ductile metals. Misalignment which concentrates the load at one end of the face is usually the cause, but overload breakage may also be caused by wedging of the teeth due to bearing



failure, bent shafts or large pieces of foreign matter entering the mesh.

*Quenching Cracks* result from excessive internal stresses developed by heat treatment and can be originating points for fatigue breakage. Usually they are visible hairline cracks. They may run across the top land, or be radial in direction in the fillet region, or be at random direction at the ends of the teeth. If large, the cracks may result in a failure similar to overload breakage after relatively few cycles. In either

case the initial portion of a break will be discolored from rusting or oxidation.

*Grinding Cracks* are fine surface cracks developed in grinding, usually in a definite pattern or network, caused by improper grinding technique or heat treatment or both. Sometimes they do not appear until the surface has been subjected to load. Such cracks can be originating points for fatigue breakage, although sometimes the failure may be of the surface alone with large areas spalling out.

Marine reduction gear inspection-A practical method of recording gear tooth surface condition when making gear inspections is illustrated by the chart in Section IX, Form G. The standard terms for tooth conditions as shown in the preceding section should be recorded. The use of this chart at each gear inspection will establish a valuable record of gear wear. Use the key at the bottom of the chart to mark the teeth shown. When precise measurements are needed on the progression of heavy undercutting or pitting of gears a record may be maintained of the wear rate and surface condition by making a plastic casting reproducing the gear tooth surface in negative form. Two of three specific gear teeth are marked for this purpose.

### ΣΥΜΠΕΡΑΣΜΑΤΑ

Ένα από τα μεγαλύτερα τραύματα της παγκόσμιας ναυτιλίας ήταν, είναι και θα είναι τα ατυχήματα, η ρύπανση του περιβάλλοντος, καθώς και οι απώλειες σε ανθρώπινο δυναμικό και τεχνικό εξοπλισμό. Παρόλο το σύνολο των βελτιώσεων σε όλους τους διαχειριστικούς τομείς μιας ναυτιλιακής εταιρείας και μολονότι γίνονται συνεχώς προσπάθειες μέσα από ένα ευρύτερο σύνολο κανόνων να μειώνεται το ποσοστό του ανθρώπινου παράγοντα και κατ' επέκταση του λάθους, δυστυχώς, όλα αυτά δεν είναι αρκετά. Βέβαια, από την πλευρά τους οι εταιρείες, αλλά και οι διεθνείς φορείς, καταβάλουν κάθε προσπάθεια για βελτιστοποίηση και συνεχή αναβάθμισης της ποιότητας θεσμών, κανόνων, δυναμικού. Στα πλαίσια αυτά εντάσσεται και η εξέλιξη των διαδικασιών, αναφορικά με το δεξαμενισμό των πλοίων. Μία ποιοτικότερη, πιο αξιόπιστη προσέγγιση, κρίνεται επιτακτική ανάγκη προκειμένου να διασφαλιστεί περισσότερο ένα ασφαλέστερο περιβάλλον στον τεχνικό τομέα υλοποίησης συνθηκών ποιοτικής διαχείρισης κινδύνων, διασφαλίζοντας παράλληλα επικοινωνιακότερη χρήση των πόρων μιας ναυτιλιακής εταιρείας. Προς αυτή τη κατεύθυνση και με αυτό το σκοπό εκπονήθηκε η παρούσα εργασία, ευελπιστώντας μελλοντικά να χρησιμοποιηθεί αποτελεσματικά και με πρακτική εφαρμογή από στελέχη ναυτιλιακών επιχειρήσεων, προσθέτοντας έτσι ένα λιθαράκι στον αγώνα και την προσπάθεια για μείωση όχι τόσο των ίδιων των κινδύνων αλλά της αποτροπής του ενδεχομένου αυτών.

## REFERENCES

1. Γουλιέλμος Α Μ –Γκιζιάκης Κων., (2005), Έλεγχος ποιότητας στην ναυτιλιακή επιχείρηση και στο πλοίο, Τόμος Α, Εκδόσεις Αθ. Σταμούλης, Αθήνα – Πειραιάς.
2. Anderson Phil Dr, (2005), ISM Code: a practical guide to the legal and insurance implications, 2<sup>nd</sup> edition, Lloyd's practical shipping guides.
3. Material from Avin international SA-repair manual.

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΑ

Appendix I.

L.O.A. DEPTH MLD. BEAM MLD. THE /S \_\_\_\_\_ OF  
\_\_\_\_\_Gross Registered Tons

This AGREEMENT AND SPECIFICATIONS attached hereto are for repairs, renewals and/or alterations to be effected to the above-named vessel, and are to cover the furnishing of all necessary labor, machinery, materials, equipment, and spare parts required for the CONTRACTOR to complete the items of work outlined herein (except those items of machinery, materials, equipment and spare parts specified to be furnished by the OWNER) in accordance with this AGREEMENT AND SPECIFICATIONS.

All general language embodied in the SPECIFICATIONS and/or on the GUIDANCE PLANS is intended to amplify, explain and implement the requirements of this AGREEMENT. However, in the event that any language or requirements so embodied permits of an interpretation inconsistent with any provisions of this agreement, it is to hold in each and every such event that the applicable provisions of this AGREEMENT control. The SPECIFICATIONS and GUIDANCE PLANS are also intended to explain each other, and anything stipulated in the SPECIFICATIONS and not shown on the GUIDANCE PLANS, or shown on the GUIDANCE PLANS and not stipulated in the SPECIFICATIONS, shall be deemed and considered as if embodied in both. In the event of conflict between the SPECIFICATIONS and GUIDANCE PLANS, the SPECIFICATIONS shall govern.

Any structural parts specified to be renewed which can be restored to their original condition by fairing, et-cetera, also any parts specified to be removed for fairing which can be faired in place to the satisfaction of the Classification Surveyors, governmental agents and the Owner's Representative will be accepted; on the other hand, any parts found broken or which are broken in removal or fairing, are to be renewed by the Contractor at his own expense.

All repairs, alterations and/or betterments specified herein are to be carried out and completed by the CONTRACTOR to meet the requirements and prescriptions of the Classification Society and governmental authorities that may have jurisdiction. All workmanship and/or material is to be of the best quality; and any dispute or differences of opinion as to the interpretation of these specifications or any part thereof regarding the quality of material and/or workmanship shall be left to the decision of the Owner or its accredited representative, whose decision shall be final and binding on both parties.



The Owner reserves the right to correct errors or omissions in, or to make deductions from or additions to, the SPECIFICATIONS, however, in such event, the increased or decreased cost, if any, and time of completion of the work specified herein shall be adjusted accordingly. The CONTRACTOR shall not depart from the requirements of the SPECIFICATIONS and/or GUIDANCE PLANS unless such departure is satisfactory to, and is made with the written consent of the OWNER.

Any particulars of the work involved, specified herein are given only for the guidance of the CONTRACTOR, who will be held responsible for the securing of all necessary dimensions and details, the intent of these specifications being to restore the vessel to first class condition.

In case any of the vessel's machinery, equipment, or fittings are used by the CONTRACTOR for any purpose whatsoever he shall be held responsible for their reconditioning, if necessary, and shall make good any damage resulting from such use.

All scrap and salvage material caused by the making of the repairs and alterations herein called for, shall become the property of the CONTRACTOR, unless otherwise specified.

The CONTRACTOR'S liability as stipulated in this contract is to commence at the time the vessel is delivered to the CONTRACTOR'S yard or pier, and said liability shall only cease after all work specified herein has been completed to the satisfaction of the OWNER or its accredited representative, and when all the CONTRACTOR'S equipment, tools, et-cetera, and all rubbish and debris have been removed from the vessel, including cleaning of such rubbish and debris from tanks, holds and other areas where work has been accomplished.

It is mutually agreed that if the work contracted for herein is not completed within the time stipulated by the CONTRACTOR, then the CONTRACTOR shall pay to the OWNER for every whole day or fraction thereof the vessel is delayed beyond the stipulated time, as liquidated damages, not as a penalty, per the following schedule:

\$\_\_\_\_\_per day for the first two (2) days late on completion of contract;

\$\_\_\_\_\_per day for the third and subsequent days late on Completion of contract; In the event liquidated damages are due, such amounts are to be deducted from the CONTRACT PRICE.

It is understood and agreed that the time stipulated by the CONTRACTOR for the completion of the work herein provided for shall commence to be counted at the time the vessel is delivered to the CONTRACTOR'S yard or pier; and the total time actually employed in the completion of the work shall cease only when all work specified herein has been completed to the satisfaction of the OWNER or its accredited representative, and when all the CONTRACTOR'S equipment, tools, et-

cetera, and all rubbish have been removed from the vessel. It is further understood and agreed that if the CONTRACTOR should complete the work herein provided for before the time stipulated by the CONTRACTOR, then in such event OWNER shall not be liable to CONTRACTOR for any premium or special bonus payment.

All of the workmanship and material required for, and performance under, this agreement, shall be inspected promptly by the authorized representative of the OWNER, shall be accepted promptly if in accordance with this AGREEMENT and the SPECIFICATIONS and/or GUIDANCE PLANS, and rejected promptly if not in accordance therewith, provided, however, that in the event any of the materials specified in the SPECIFICATIONS and/or GUIDANCE PLANS are unprocurable, the CONTRACTOR shall apprise the OWNER or authorized representative as to such condition, and under permission as granted by the OWNER or its authorized representative dealing with each specific appraisal the CONTRACTOR shall thereupon provide equivalently-suitable material of the best procurable alternatives.

In consideration of making this agreement it is mutually agreed, and is hereby stipulated and agreed that the undertaking of the CONTRACTOR to perform work on and dry-dock vessels, and provide berth, wharfage, towage and other service and facilities, is made only upon condition that it shall not be liable in respect to any one vessel, directly or indirectly in contract, tort or otherwise, to its Owners, Demise Charterers or underwriters for any injury to such vessel, its equipment or movable stores, or to cargo owned by said ship-owners or Demise Charterers, or for any consequence thereof, unless such injury is caused by the negligence of the CONTRACTOR or its employees, and in no event shall the aggregate liability of said CONTRACTOR to all such parties in interest for such aforesaid damages sustained by them, as a result of such injury, exceed the sum of \$300,000.

In further consideration of the making of this AGREEMENT, the CONTRACTOR stipulates and agrees that the CONTRACTOR will insure and keep insured during the period of the AGREEMENT, the CONTRACTOR'S liability under the preceding clause to the ship-owner and/or Demise Charterer and/or hull insurer, for loss of/or damage to the vessel, its equipment or movable stores, and/of cargo owned by said ship-owner and/or Demise Charterer, or for any consequence thereof, in the sum of not less than \$300,000, under a policy or policies of insurance payable to the CONTRACTOR and satisfactory to the ship-owner.

The CONTRACTOR shall also take out adequate and proper insurance covering any Workmen's Compensation Act applicable (or in lieu thereof shall secure the payment of the compensation provided for by any such acts in some other manner approved by the terms of such acts), .it being

expressly understood that all workmen engaged upon the work hereunder shall at all times be employees of the CONTRACTOR or its sub-CONTRACTOR and not employees of the OWNER.

The CONTRACTOR shall indemnify the OWNER against and hold said OWNER harmless from all claims and damages arising from injuries to any person or persons (except employees of the OWNER, unless said employees are injured through carelessness or negligence of the CONTRACTOR) or from damage to property in or about or connected with the repairs, renewals, alterations, conversion, dry-docking, equipment and operation of the vessel until completion of this contract as set forth in paragraphs 9 and 10 of this AGREEMENT.

Safety and Health Standards of the highest degree are to be maintained in the shipyard by the CONTRACTOR. This should be in full accordance to the local Rules and Regulations, which OWNERS would assume to be equivalent to the highest industry standards in the CONTRACTOR'S country.

CONTRACTOR agrees to use its best efforts to keep confidential and to require its employees and representatives to keep confidential: f 1) the nature and purpose of the work under this Agreement, and (2) any technical information disclosed to CONTRACTOR by OWNER as long as, and to the extent that, said technical information remains unpublished or is not otherwise in the public domain and not to disclose said technical information to others, except to the extent necessary to carry out the work hereunder, without first obtaining OWNER'S written authorization.

CONTRACTOR agrees that it will not, without the written permission of OWNER, use the confidential technical information disclosed to it hereunder by OWNER or its Affiliates for any purpose other than the work to be performed by CONTRACTOR hereunder for OWNER. The same should apply for any publicity release about OWNER or vessel.

If any of CONTRACTOR'S representatives or employees make any inventions or improvements during the life of this Agreement and six months thereafter based upon confidential technical information disclosed to the CONTRACTOR by OWNER, CONTRACTOR agrees to disclose the same promptly to OWNER and CONTRACTOR agrees to grant and hereby grants to OWNER nonexclusive, irrevocable, royalty-free license and the irrevocable right to grant nonexclusive licenses without accounting therefore to CONTRACTOR, under CONTRACTOR'S rights to such improvements and inventions.

The OWNER reserves the right to reject any and all bids.

Tenders must specify the time required by the CONTRACTOR, in continuous running days, to complete the repairs, renewals, alterations and/or conversion set forth in the SPECIFICATIONS

attached hereto, and itemized fixed rates for insurance premiums and all services required to be furnished by the VESSEL by the CONTRACTOR, as specified under SERVICES TO BE FURNISHED BY THE CONTRACTOR in the SPECIFICATIONS. Tenders are to be addressed and delivered to Y INTERNATIONAL, TANKER - OPERATIONS, and are to be drawn in the following form:

I, or we, hereby agree to faithfully carry out and complete all the repairs, renewals, alterations, replacements, and/or conversion to the \_\_\_\_\_ as set forth in this AGREEMENT and SPECIFICATIONS under date of \_\_\_\_\_ and to abide by all the conditions expressed or implied therein for the sum of \$\_\_\_\_\_ and to complete same in \_\_\_\_\_ running days.

At its option and expense, the OWNER or its representatives shall have the right of access to whatever records are necessary to audit account in order to verify and evaluate that the amounts charged to OWNER is in accordance with this AGREEMENT.

To accommodate our accounting procedures please arrange your final invoices as follows:

One item of work to one sheet of paper. If a specification has one hundred (100) items, we would expect an invoice of 100 sheets.

The repair specification (include complete repair number) as issued to the CONTRACTOR is to be shown completely written up as the first part of the invoice, together with individual prices.

Any extra, credit or cancellation applicable to an item of the original SPECIFICATION is to be shown with price, or credit, immediately after each item of the SPECIFICATION. A separate number is not required for these extras, credits or cancellations. Please also show the net amount due of each item on each sheet.

All extras that cannot be added to items of the original SPECIFICATION are to be shown as the second part of the invoice with appropriate serial and code numbers to be supplied by OWNER'S representative, as well as price.

A recapitulation is required on the last sheet showing original contract, cancellations, credits, extras and net total.

Itemized prices to be shown in U.S.A. dollars or local currency. If local currency, please also show conversion to U.S. dollars with current rate of exchange used.

Original invoice and two (2) copies only are required.

UNLESS OTHERWISE SPECIFICALLY DIRECTED, THE SUCCESSFUL CONTRACTOR SHALL FURNISH THE NECESSARY LABOR, MATERIAL AND/OR EQUIPMENT TO COMPLETE THE FOLLOWING ITEMS OF WORK: 1R/100 SERVICES TO BE FURNISHED

BY CONTRACTOR. Tenders must quote applicable fixed unit prices or rates, i.e., hourly, daily, etc., for each of the following services furnished by the Contractor as required while the Contractor's time and liability is in effect as set forth in paragraphs 9 and 10 of the Preamble AGREEMENT viz: Liability insurance premium in accordance with paragraphs 12 and 13 of the Preamble AGREEMENT<sup>89</sup>. Fire watchmen, including connecting and disconnecting fire hoses from dock to vessel fire line. Electric power for power and lighting while vessel's plant is shut down. Tugs for shifting vessel while in shipyard custody. Daily garbage removal from vessel.

Shore steam including connecting and disconnecting steam hoses as required for cooking, heating and raising steam on boilers. Supplying circulating water to vessel's refrigeration plant, including connecting and disconnecting hose. h. Supplying fresh water as required while vessel is undergoing repairs, renewals and/or alterations, including connecting and disconnecting hoses. i. Supplying of compressed air and/or steam, including connecting and disconnecting hoses as required for docking and undocking the vessel and to weigh anchor. j. Supplying labor of Shipyard's riggers and mooring men to assist vessel's crew in handling lines when shifting and securing vessel. k. Install telephone onboard and remove after repairs<sup>90</sup>. l. Provide wharfage (Berth) as necessary to accomplish work. (Most shipyards do not have a separate price for this item as it is included in their overhead.)

N.B.: Provide lump-sum price for above services covering contract days, in addition to unit prices. (Do not show a charge for any above services which are covered in Contractor's overhead.)

2R/130 GASFREE- Cost of obtaining gas free certificates are to be included in this item. The owner will steam, clean and gas free, or cause to be steamed, cleaned and gas freed all cargo tanks, cofferdams, pump rooms, compartments, and pipelines other than those containing bunker or boiler fuel and such other tanks, cofferdams, compartments, etc. as are specifically exempted by the Contractor's Certificated Chemist. The Contractor shall not assume, however, that the vessel and/or its compartments and/or its pumps and or its piping is or are free from explosive or dangerous gas or gases or oil, but shall at his own expense have such tanks, compartments. pumps, piping, etc. tested by a Certificated Chemist engaged by the Contractor who shall furnish the owner and/or his representative with a Certificate showing that such compartments and/or pumps and/or piping, etc. have been so tested and found to be free from explosive and/or dangerous gases or oil. Said Contractor shall keep all such cargo tanks, cofferdams pump rooms, compartments and pipelines

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<sup>89</sup> Insurance premium is not to be shown as a separate price but should be absorbed in Contractors overhead.

<sup>90</sup> Most shipyards do for their own convenience without charge for this service, just charges for calls made.

free from explosive and/or dangerous gas or gases or oil during the period of repairs and/or alterations. Delivery of such aforementioned Certificate and receipt thereof by' the owner or his representative shall in no way relieve and/or discharge the Contractor from his obligations to keep these places free from explosive and/or dangerous gas or gases or oil during the performance of this contract or any related additional work. Should, during the course of repairs or alterations, the Contractor's Chemist report the presence of dangerous and/or explosive gases or oil, the Contractor shall immediately stop all work and shall not resume work until such places, etc. are again certified free from explosive and/or dangerous gas or gases or oil.

Burning or other hot work shall not be done by the Contractor on any part of the cargo piping system, gas vent lines or other piping lines which may have contained oil, gas or other inflammable products, unless permission to do so is specifically granted by the Contractor's Certificated Chemist. Anodes installed in cargo tanks generate hydrogen gas when water, or oil containing additives to activate anodes, come in contact therewith.

Burning or other hot work shall not be done by the Contractor in or adjacent to the tanks in which anodes are installed which may have come in contact with such water or oil, nor shall men enter into these tanks until the tanks have been tested by the Certificated Chemist or the Contractor (engaged by and at the expense of the Contractor) who shall furnish the master of the vessel and owner's representative with a Certificate showing that these tanks have been so tested and are free of explosive and/or dangerous gases.

Tanks in which anodes are installed shall be adequately ventilated with spark-proof mechanical blowers at all times and there shall be no burning or welding at any time on or around these anodes without the permission of the Contractor's Certificated Chemist<sup>91</sup>.

Although a space and/or tanks have been declared "safe for men - safe for fire" on the Gas free Certificate, just prior to starting hot work the exact area where the work is to be done is to be rechecked for issuing a new Gas free Certificate by the Contractor's chemist to be sure no sediment, sludge and/or oil is present, especially where it might be lying in horizontal structures such as

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<sup>91</sup> This has been added to original item and is effective January 2. 1973.

bulkhead stiffeners and shell longitudinal. If additional cleaning is required, the Contractor should request the Owner's Representative to issue extra work orders to accomplish same. Periodically these spaces and/or tanks must be rechecked and a new Gas free Certificate issued as long as work continues. This should be done as deemed necessary by the conditions found, but in all cases at least every 24 hours.

Tanks in which anodes are installed shall be adequately ventilated with spark-proof mechanical blowers at all times and there shall be no burning or welding at any time on or around these anodes without the permission of the Contractor's Certificated Chemist.

Cost of obtaining Gas free Certificates is to be included in this item.

Please Note: There are no anodes installed in this vessel.

**ΠΡΟΔΙΑΓΡΑΦΕΣ ΕΠΙΣΚΕΥΗΣ ΚΑΙ ΔΙΑΤΑΓΕΣ ΕΡΓΑΣΙΑΣ** -Διαδικασία προετοιμασίας των προδιαγραφών επισκευής -Οι πληροφορίες σε αυτό το τμήμα πρόκειται να χρησιμοποιηθούν ως οδηγός για τον επιθεωρητή επισκευής κατά την προετοιμασία των προδιαγραφών και της έκδοσης ή την ακύρωση των στοιχείων επισκευής. Περιλαμβάνονται οι συγκεκριμένες διαδικασίες που πρέπει να εφαρμοστούν προκειμένου να ολοκληρωθούν κατάλληλα οι προδιαγραφές. Υπάρχει επίσης μια λίστα των διαδικασιών που χρησιμοποιούνται για την έκδοση των εντολών εργασίας και για την πρόσθετη εργασία και για τις ακυρώσεις κατά τη διάρκεια των "επιτόπιων" επισκευών.

**ΠΡΟΔΙΑΓΡΑΦΕΣ** -Οι προδιαγραφές πρέπει να γραφτούν κατά τρόπο σαφή, συνοπτικό, και αρκετά λεπτομερή έτσι ώστε να είναι ρητές ως προς τις επισκευές που απαιτούνται. Εκτός αν οι περιστάσεις το απαιτούν οι υπερβολικές λεπτομέρειες πρέπει να αποφευχθούν, δεδομένου ότι μπορούν να δώσουν την εντύπωση ότι η εργασία είναι περισσότερο εκτενής από όσο είναι απαραίτητο. Εντούτοις, ικανοποιητικές πληροφορίες πρέπει να περιληφθούν έτσι ώστε οι δαπάνες να μπορούν να υπολογιστούν με ακρίβεια από το ναυπηγείο.

Οι "τυποποιημένες προδιαγραφές" πρέπει να χρησιμοποιούνται όποτε είναι δυνατόν και να είναι διαθέσιμες για τις διάφορες κατηγορίες πλοίων. Τα πλεονεκτήματα των τυποποιημένων προδιαγραφών είναι: (α) ενεργούν ως άτυπος κατάλογος ελέγχου, (β) αποφεύγονται οι παραλείψεις, (γ) ο επιθεωρητής επισκευής κερδίζει χρόνο στη σύνταξη των προδιαγραφών, και, (δ) η σαφήνεια

(που ποικίλλει από επιθεωρητή σε επιθεωρητή) διατηρείται.

Όλες οι σημαντικές προδιαγραφές επισκευής πρέπει να αρχίζουν με έναν τυποποιημένο πρόλογο που καλύπτει στοιχεία γενικής φύσης, συνήθως εφαρμόσιμα σε όλες τις επισκευές ναυπηγείων. Αυτήν την περίοδο, ο πρόλογος που χρησιμοποιείται, τιτλοφορείται " συμφωνία προδιαγραφών ή /και σχέδια καθοδήγησης για τις επισκευές, τις ανανεώσεις και τις αλλαγές<sup>92</sup>». Επιπλέον, συμπεριλαμβάνονται και τα δύο πρώτα στοιχεία των προδιαγραφών. Οι υπηρεσίες και το αδρανές αέριο. Όλοι οι επιθεωρητές επισκευής θα πρέπει να φέρουν τα αντίγραφα αυτών των σελίδων σε όλα τα ταξίδια, καθόσον μπορεί να χρειαστούν για να προετοιμάσουν και να υποβάλουν μια προδιαγραφή έκτακτης ανάγκης για ένα προβληματικό πλοίο.

Οι προδιαγραφές πρέπει να καθοδηγούν τους αναδόχους επισκευών ώστε να υποβάλουν τις προσφορές ή τις εκτιμήσεις τους, με κάθε στοιχείο στην προδιαγραφή με τιμή. Αυτό επιτρέπει στη διαχείριση να κάνει καλύτερες αξιολογήσεις και να συμβαδίζει με τους παγκόσμιους όρους τιμολόγησης, καθώς επίσης και να εξοικειώνεται με την ιδιοσυγκρασία των μεμονωμένων ναυπηγείων.

Κατά τη χρήση των "τυποποιημένων" προδιαγραφών, προσοχή πρέπει να επιδεικνύεται προκειμένου αυτές να είναι προσαρμοσμένες στις πραγματικές περιπτώσεις που θα λάβουν χώρα. Δεν θα πρέπει να αντιγράφονται κατά λέξη, εκτός εάν πραγματικά απαιτείται. Σε περίπτωση που υπάρξει τέτοια ανάγκη, οι προσθήκες και οι ακυρώσεις μπορούν να περιλαμβάνονται στο τέλος της τυποποιημένης προδιαγραφής προκειμένου να καθίστανται αυτές πιο συγκεκριμένες.

"Με βάση την επιλογή και τα έξοδα, η εταιρεία ή οι αντιπρόσωποί της έχουν το δικαίωμα της πρόσβασης σε οποιαδήποτε αρχεία που είναι απαραίτητα να ελεγχθούν, προκειμένου να αξιολογήσουν ότι τα ποσά που χρεώνονται είναι σύμφωνα με αυτήν την σύμβαση."

Η κατά προσέγγιση ποσότητα υλικών επισκευής πρέπει να περιγράφεται σαφώς για κάθε στοιχείο, όπως επίσης, πρέπει να προσδιορίζεται και ο προμηθευτής.

Σημείωση: α. Οι επιθεωρητές επισκευής θα πρέπει να ελέγχουν τα αιτήματα επισκευής του πλοίου

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<sup>92</sup> Ένα αντίγραφο δειγμάτων του προλόγου συμπεριλαμβάνεται στο τέλος αυτού του τμήματος.



για τα εφεδρικά υλικά και εξαρτήματα και να καθορίζουν το πώς πρέπει αυτά να αποκτούνται.

β. Εάν το υλικό και τα εφεδρικά αντικείμενα πρόκειται να παρασχεθούν από την επιχείρηση, ο επιθεωρητής της επισκευής καθορίζει εάν υπάρχουν στις αποθήκες της εταιρείας ή εάν θα πρέπει να ακολουθήσει τη διαδικασία παραγγελίας μέσω των κεντρικών γραφείων.

8. Όταν είναι εφικτό, ο πλοίαρχος και ο πρώτος μηχανικός θα πρέπει να εξετάζουν τις προδιαγραφές για την πληρότητα και την ακρίβεια πριν από την τελική έκδοσή τους, προκειμένου να παραδοθούν στο ναυπηγείο και να ξεκινήσουν οι εργασίες.

9. οι προδιαγραφές, δεν θα πρέπει να γράφονται με τον ακόλουθο τρόπο: "Ανοίξτε, επιθεωρήστε, επισκευάστε εάν είναι απαραίτητο, και κλείστε". Πρέπει να αναφερθεί ότι η περιγραφή που απαιτείται για μια μονάδα για την οποία υπάρχει η υποψία της ανάγκης για επισκευή, ίσως να πρέπει να είναι πολύ πιο λεπτομερής από όσο απαιτείται για να περιγράψει κανείς μια γνωστή απαίτηση επισκευής. Η προτιμητέα μέθοδος είναι να περιγραφούν περισσότερες επισκευές από όσες μπορεί να απαιτηθούν, και να εκδοθεί μια ακύρωση για εκείνο το μέρος που η πραγματική επιθεώρηση αποκαλύπτει ως μη απαραίτητη. Αυτή η τεχνική είναι πολύτιμη βοηθώντας να μειωθεί ο αριθμός συμπληρωμάτων που εκδίδονται. Είναι επιθυμητό το να αποφεύγονται τα συμπληρώματα, δεδομένου ότι διατιμώνται κάτω από μη ανταγωνιστικούς όρους και μπορούν να είναι ακριβότερα από τις τιμές που θα ίσχυαν σε περιπτώσεις κατοχύρωσής τους με άλλο τρόπο.

10. Αναγγελίες των πιθανών ακυρώσεων πρέπει να αποφεύγονται όποτε είναι δυνατό. Κι αυτό, διότι αποκλείει τους αναδόχους επισκευών από το να υποβάλουν εικονικά χαμηλές τιμές, αναμένοντας ότι μόνο οι δευτερεύουσες πιστώσεις θα υλοποιηθούν στην τελική τιμολόγηση.

11. Πριν από τη σύνταξη των προδιαγραφών επισκευής, ο επιθεωρητής επισκευής πρέπει να ανατρέχει στο "καθολικό του πλοίου" και στο «βιβλίο αρχείου πιστοποιητικών» που διατηρείται στο γραφείο. Αυτά περιέχουν τις πληροφορίες για:

- (α) τον εξοπλισμό που θα απαιτεί σίγουρα επισκευή, ανανέωση ή αντικατάσταση κατά τη διάρκεια της επόμενης σχεδιασμένης επισκευής.
- (β) τον εξοπλισμό που πρέπει να εξεταστεί ή να ανοιχτεί για την επιθεώρηση και την πιθανή επισκευή λόγω προβληματικής λειτουργίας.
- (γ) τα ατυχήματα ή άλλες περιστάσεις που μπορεί να είχαν προκαλέσει κάποια ζημία στις περιοχές του πλοίου που είναι δύσκολο να επιβλέπονται.
- (δ) τις προτάσεις για μελλοντικές επισκευές που περιλήφθηκαν στην τελευταία έκθεση που συντάχθηκε από έναν επιθεωρητή επισκευής.
- (ε) τις ιστορικές πληροφορίες σχετικά με το πλοίο.

(στ) την ενημέρωση των προγενέστερων προτάσεων επισκευής.

(ζ) την κατάσταση των επιθεωρήσεων της που σχετίζονται με την κλάση του πλοίου.

12. Το τμήμα δεξαμενόπλοιων δημοσιεύει έναν κατάλογο "Συνιστώμενων κατασκευαστών μηχανημάτων για νέες κατασκευές". Όποτε αν ένα κομμάτι του εξοπλισμού πρέπει να αντικατασταθεί, πρέπει να καταβληθεί κάθε προσπάθεια προκειμένου η αντικατάσταση να γίνει από έναν από τους κατασκευαστές στον κατάλογο αυτό σύστασης.

13. Η προδιαγραφή επισκευής στην τελική της μορφή, θα πρέπει να εξετασθεί από το διευθυντή ομάδας πριν από την έγκρισή της.

ΠΡΟΔΙΑΓΡΑΦΕΣ ΕΠΙΣΚΕΥΗΣ ΚΑΙ ΔΙΑΤΑΓΕΣ ΕΡΓΑΣΙΑΣ-Τρόπος έγκρισης των εντολών για πρόσθετες εργασίες και ακυρώσεις-ΔΙΑΤΑΓΕΣ ΕΡΓΑΣΙΑΣ.

1. Κάθε πρόσθετη εργασία ή ακύρωση πρέπει να εγκριθεί γραπτώς έτσι ώστε να αποφεύγονται οι διπλές δαπάνες. (Πρότυπο προς χρήση: «Πεδίο εντολών για την εργασία και το υλικό. Κάθε διαταγή συμπληρώνεται σε τρία αντίτυπα: το λευκό αντίγραφο πρέπει να δοθεί στο ναυπηγείο (**χωρίς την εκτιμώμενη τιμή ή τον εκτιμώμενο χρόνο**), το κίτρινο αντίγραφο διαβιβάζεται στο γραφείο κάθε εβδομάδα με τις μεταβολές του επιθεωρητή επισκευής κατ' εκτίμηση των τιμών και του χρόνου, και το μπλε αντίγραφο κρατείται από τον επιθεωρητή επισκευής και συμπεριλαμβάνεται στην τελική έκθεση επισκευής.

Σημείωση: Αυτή η φόρμα θα πρέπει επίσης να χρησιμοποιείται και κατά την έγκριση των εντολών εργασίας κατά τη διάρκεια των επισκευών ταξιδιού (εν πλω).

2. Όταν είναι εφικτό, οι πρόσθετες εργασίες και οι ακυρώσεις πρέπει να διέπονται από τρεις σημειώσεις σχετικά με το χρηματικό ποσό που εμπεριέχεται. Αυτές οι σημειώσεις, αναφέρονται κατωτέρω, κατά σειρά προτίμησή τους:

- Μια σταθερή τιμή, ή - Μια μέγιστη τιμή, ή - Μια κατ' εκτίμηση τιμή (η οποία ΔΕΝ παρουσιάζεται στις διαταγές εργασίας που παραδίδονται στον ανάδοχο).

3. Είναι επιθυμητό να αποφεύγονται τα πρόσθετα όποτε είναι δυνατόν, δεδομένου ότι οι δαπάνες τους μπορεί να είναι υψηλότερες σε σχέση με αυτές που είναι δυνατό να επιτευχθούν υπό ανταγωνιστικούς όρους. Ο ευκολότερος τρόπος για να αποφεύγονται τα πρόσθετα είναι το να

περιλαμβάνονται όλα τα γνωστά στοιχεία που χρίζουν επισκευής, στις αρχικές προδιαγραφές αυτής. Η αποτελεσματικότητα αυτής της αρχής, εξαρτάται έντονα από την ομαλή λειτουργία του συστήματος πληροφοριών μεταξύ των πλοίων και του γραφείου. Εάν υπάρχει κάποια ερώτηση σχετικά με μια απαίτηση επισκευής, είναι προτιμότερο να περιληφθεί η επισκευή στις αρχικές προδιαγραφές και ν' ακυρωθεί έπειτα εάν η εργασία είναι περιττή, όπως αυτή την αναφέραμε.

4. Προτού ο επιθεωρητής επισκευής εγκρίνει κάτι το πρόσθετο, πρέπει να προσπαθήσει, εάν αυτό είναι πρακτικά εφικτό, να «κλείσει» μια σταθερή τιμή με τον ανάδοχο επισκευών. Διαφορετικά, πρέπει να ερευνήσει τις δυνατότητες για κατοχύρωση μιας μέγιστης τιμής που δεν πρόκειται να ξεπεραστεί, εκτός αν οι προδιαγραφές αλλάξουν.

5. Τα πρόσθετα θα πρέπει να γράφονται όσο το δυνατόν πιο ρητά έτσι ώστε να αποφεύγονται οι παρανοήσεις και έτσι ώστε οι δαπάνες να μπορούν να αξιολογηθούν με ακρίβεια.

6. Η περιγραφή κάθε ακύρωσης πρέπει να εμπεριέχει μια αναφορά στον αριθμό των αρχικών προδιαγραφών ή στον αριθμό διαταγής εργασίας στην οποία πρωτοεμφανίστηκε.

7. Κάθε ακύρωση, και ειδικά μερικές από αυτές, πρέπει να περιγράφεται με σαφήνεια έτσι ώστε οι πιστώσεις να μπορούν να υπολογιστούν με ακρίβεια και να αξιολογηθούν.

*Attachment 1* is a copy of Section 45 "Survey after Construction" extracted from the CLASS Rules for Steel Vessels. This attachment is to be used as a guideline for completion of all surveys. Presently all diesel vessels are on a five-year continuous machinery survey. With this system Special Survey requirements are completed in a regular rotation of which all must be completed within a five-year period. Each vessel has a survey record which a class representative will "sign off (credit) items he has witnessed or accepts from the Chief Engineer's maintenance records within the five-year period. A second copy of the record is kept in the Avin International office and a third in the New York class office. This system allows the survey to be completed throughout the five-year period rather than undertaking all inspections and granting credit within the last two years as with the normal Periodical Special Survey. The survey requirements listed in Item 1 still apply for those vessels using the Continuous Survey system. If a vessel is using this system care must be taken that all appropriate inspections or work has been properly credited toward the Special Survey

requirements<sup>93</sup>.

Special Periodical Survey (Machinery) is completed and dated when the main engines have been examined and approved. Special Periodical Survey (Hull) is completed and dated when the majority of cargo tanks have been examined and approved.

Class certificates & survey requirements -Guidelines for Completing Surveys. The following are guidelines and procedures used to assist in completing surveys: When completing a Special Survey, prior to the vessel's arrival in the shipyard, the Superintendent should consult with the class Surveyor regarding requirements of equipment inspections, procedures for tank testing, etc. Although all equipment is required to be inspected, the following methods of inspection can be used as a guideline resulting in a considerable cost savings:

While the plant is in service closely observe the operation of all running machinery with class surveyor determining the extent of proper operation. For example, if condensate pump, feed pump, sanitary pump, fuel oil pump, lube oil pump, forced draft fans, etc. are operating properly and the Chief Engineer advises of no known problems, the running machinery could be credited without opening, resulting in the necessity of opening only one pump of each type.

All reciprocating machinery such as emergency fuel oil service pump; general service pump, bilge pump, fuel oil transfer pumps and forward bilge ballast and fire pump can be operated and if operating properly credited without further inspection. If there is any doubt most class surveyors are willing to open one side of the reciprocating machinery (one steam cylinder and one liquid end piston plus the valves). If they are found in good condition, the other side of a duplex pump will not require inspection.

The main generators can also be handled in the same manner as noted in (a) and (b) - especially when one of the units was completely overhauled within the last two years. d. Main steering gear equipment interval inspection can often be eliminated by the surveyor witnessing a test of both units and also testing of the relief valves. e. Total inspection of main reduction gear bearings may not be required. A random selection of bearings is generally acceptable unless a deficiency

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<sup>93</sup> Prior to writing the Repair Specifications the Superintendent should always consult the Continuous Survey Record Book.

of any nature is discovered at which time all bearings should then be inspected (age of vessel often determines the bearings required). Generally one set of pinion bearings, one intermediate set, etc. are sufficient.

Fuel oil heaters and evaporators can also be handled as noted in (a) and (b). Generally, if there are no signs of oil in the feed water system and no operation problems the class will not require a thorough inspection of the fuel oil heaters. g. Anchor windlass can be handled the same as mentioned in (b). Generally, the surveyor will agree to a random sample of bearing inspections and one steam cylinder. If any problems are noted then additional bearings and the other cylinder should be opened. It is generally recommended to always inspect the throttle/reversing valve assembly<sup>94</sup>.

The same techniques as mentioned above can be used regarding boiler surveys. Although the boiler survey requires inspection of all boiler valves and fittings the surveyor will generally agree to open only one of each type valve rather than all valves. Of course, the Chief Engineer should be consulted as to any known problems prior to deciding what valves to open. In addition, a random amount of handhold plates can be opened rather than all handhold plates. Boiler safety valves should be tested immediately upon the vessel's arrival in the shipyard. Only those valves found leaking or defective should then be sent ashore for repairs.

The following major equipment does not require a class inspection: Main cargo pumps. Main cargo stripping pumps. Deck winches. Air compressors (Ships Service). Refrigeration/air condition machinery. Bilge keels except hull attachments. Spare anchors are no longer required on tanker vessels. As a result if the present spare anchor is used, a replacement is not required. Ultrasonic gauging for Special Surveys of tanker vessels is required on the third Special Survey and thereafter.

While underwriters refer to a vessel's age when outlining the extent of required gauging, class refers to the Special Survey number. In actual practice, this has not caused any problems since the two are obviously related. As the class Rules do not provide specific gauging requirements, outlined below are the minimum requirements for the various surveys: Special Survey No. 3

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<sup>94</sup> The object of the techniques noted in Item 1 is to eliminate opening pumps and other equipment which do not require repairs. However, one must be cautioned not to eliminate a piece of equipment which should be repaired. Generally the class surveyor is in agreement with these techniques but he should be thoroughly consulted prior to making the necessary inspection, work cancellations, etc. which will result from above. Often the vessel's age general condition and previous repairs designate the extent of utilizing the noted methods in Item 1.

Two girth belts of representative gauging within the amidships half length in different cargo tanks. Areas considered suspect by the Surveyor. Special Survey No. 4. Three girth belts of representative gauging within the amidships half length avoiding those areas previously gauged. Two wind and water strakes for amidships half length. Areas considered suspect by the Surveyor. Special Survey No. 5. Representative gauging of amidships half length. Extensive gauging of internals. Exposed main deck as well as poop and forecastle for full length of vessel. Two wind and water strakes for full length of vessel. Bottom and flat keel plating as considered necessary by the Surveyor.

Areas considered suspect by the Surveyor<sup>95</sup>. Fully coated vessels gauged and approved prior to coating are given special consideration. Vessels Classed for Salt Water and Fresh Water Service (Great Lakes and Ocean) are treated as Ocean Vessels. As the class has no records on existing vessels entering the Class, more extensive gauging than those normally asked for will be required. The requirements will be outlined by the Head office for specific vessels. When and if there are any departures from the requirements outlined, such as recently renewed plates, etc., the Surveyor must insure that the reason for departure is clearly indicated in transmission and review letters.

In all instances where gauging results are marginal, and more than one reading per plate is submitted, the representative reading is to be indicated and any locally wasted area dealt with to the attending Surveyor's satisfaction. When the existing conditions allow repairs to be deferred, both the report and submittal letter should clearly indicate when repairs are to be carried out.

The retained end(s) of vessels with new mid-bodies are to be gauged in two wind and water strakes, exposed poop and forecastle, all keel plates, extensive bottom plating and in girth belt(s) at the junction of the new mid-body. The new section is to be treated as a regular vessel of corresponding age.

Where gauging is required item of a Special Survey, it will be necessary to gauge all areas required by the pending Special Survey that are accessible, including as applicable, areas subject to excessive

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<sup>95</sup> Gauging for a Special Survey should be completed as soon as possible when the vessel enters the shipyard in order to obtain the results soonest so as not to delay the vessel for completion of work designated by the gauging.

corrosion such as deck and wind and water strakes, as a part of the Year of Grace survey which is to be carried out about the due date of the Special Survey. The results of the gauging should be submitted for review by the attending Surveyor to the area Reviewing Office in order that any critical wastage indicated by the gauging together with that revealed by visual examination can be dealt with immediately before granting the Year of Grace. Less serious wastage and other gauging required as part of the Hull Special Survey may be deferred until the end of the grace period but must be completed before the Special Survey can be credited.

#### Class 1973-SECTION 45-Surveys after Construction-Part I: Vessels in Salt-water Service-45.1

General Conditions-45.1.1 Notification-The Surveyors are to have access to classed vessels at all reasonable times. Owners or their representatives are to notify the Surveyors on all occasions when a vessel can be examined in dry dock or on a slipway. If at any visit a Surveyor should find occasion to recommend repairs or further examination, intimation is to be made immediately to the Owners or their representatives in order that appropriate action may be taken.

45.1.2 Damage-Damage to hull, machinery or equipment, which affects or may affect seaworthiness or classification, is to be submitted by the owners or their representatives for examination by the Surveyors. All repairs found necessary by the Surveyors are to be carried out to their satisfaction.

45.1.3 Availability for Survey-The Surveyors are to undertake all surveys on classed vessels at the request of the Owners or their representatives and are to report thereon to the Committee. They are to avail themselves of every convenient opportunity for carrying out periodical surveys in conjunction with damage and repair surveys in order to avoid unnecessary duplication of work.

45.1.4 Annual Surveys-Annual Surveys are to be made during each year of service.

45.1.5 Special Periodical Surveys-For vessels built under Classification Survey, the first Special Periodical Survey becomes due four years after the date of build. For other vessels, a Special Periodical Survey becomes due four years from the date of the Special Survey for Classification. Subsequent Special Periodical Surveys are due four years after the crediting date of the previous Special Survey. The interval between Special Surveys may be reduced by the Committee. If a Special Survey is not completed at one time, it will be credited as of the end of that period during which the greatest part of the survey has been carried out. Special consideration may be given to Special Periodical Survey requirements in the case of vessels of unusual design.

45.1.6 Continuous Surveys-At the request of the Owner, and upon approval of the proposed arrangements, a system of Continuous Surveys may be undertaken whereby the Special Survey

requirements are carried out in regular rotation to complete all the requirements of the particular Special Survey within a five-year period. For Continuous Surveys, a suitable notation will be entered in the Record and the date of completion of the cycle published. If any defects are found during the survey, they are to be examined and dealt with to the satisfaction of the Surveyor.

45.1.7 Year of Grace-To be eligible for the year of grace to complete the Special Survey within one year after the due date, the vessel is to be presented for survey at about the due date of the Special Survey. The requirements for surveys to qualify for a period of grace are to be specially considered in each case and may include dry-docking or gauging or both. If the survey is satisfactory, the completion of the Special Survey may be deferred for a period not exceeding twelve months, provided the whole Special Survey is satisfactorily completed within five years from date of build or from the date recorded for the previous Special Survey.

45.1.8 Reactivation Surveys-In the case of vessels which have been laid up for an extended period the requirements for surveys on reactivation are to be specially considered in each case, due regard being given to the status of surveys at the time of the commencement of the lay-up period, the length of the period and the conditions under which the vessel had been maintained during that period.

45.1.9 Incomplete Surveys-When a survey is not completed, the Surveyors are to report immediately upon the work done in order that Owners and the Committee may be advised of the parts still to be surveyed.

45.1.10 Premature Commencement—Special Survey-When circumstances cause a Special Survey to be commenced before it is due, the entire survey is to be completed within a period of twelve months if such work is to be credited to the Special Survey.

45.1.11 Alterations-No structural alterations which affect or may affect seaworthiness, classification or the assignment of load lines are to be made to the hull or machinery of a classed vessel unless plans of the proposed alterations are submitted and approved by the Committee before the work of alterations is commenced and such work, when approved, is carried out under the supervision of the Surveyors to the Bureau.

45.1.12 Special Materials-Welding is not to be performed on higher-strength steels of the hull structure nor repairs or renewals commenced on such plating or adjacent to such plating without thorough and careful reference to the recommendations contained in 3.1 with respect to higher-strength steels. Substitution of higher-strength steels differing from those originally installed is not to be undertaken without approval.

45.1.13 Dry-docking Survey -a. Interval. An examination of each classed vessel is to be made in dry



dock at intervals not exceeding two years. For vessels operating in salt water for less than six months each year, the maximum interval is not to exceed three years. Proposals for alternate means for providing underwater inspection equivalent to Dry-docking Survey will be considered for vessels of unusual design or in special service, having special protective coatings or impressed current protection. Consideration may be given to any special circumstances justifying an extension of the interval.

**Parts to be Examined** The vessel is to be placed in dry dock or upon a slipway and the keel, stem, stern frame or stern post, rudder and outside plating are to be cleaned and examined together with appurtenances, the propeller, sea chests, strainers and their fastenings. Stern bearing clearance is to be ascertained.

**45.3 Annual Surveys—Hull-45.3.1 Parts to be examined**-At each Annual Survey between Special Surveys the following parts are to be examined, placed in good condition and reported upon:

All parts of the steering arrangements, including the gear, quadrants, tillers, blocks, rods, chains, tele-motor or other transmission gear and brakes, b. Sluice valves, watertight doors in bulkheads and vessel's sides, closing appliances in superstructure bulkheads and for air and sounding pipes, c. Comings of ventilators to spaces below the freeboard deck and below decks of superstructures which are intact or closed by closing appliances; hatchway comings, tarpaulins, hatch covers and all their supports.

All parts particularly liable to rapid deterioration. e. Machinery casings, guard rails and all other means of protection provided for openings and for access to crew's quarters. f. Freeing port doors in bulwarks of enclosed wells in freeboard and superstructure decks are to be examined and their hinges put in good order; fittings for securing shutters are not to prevent the shutters from opening in the event of a substantial amount of water coming aboard. g. The holds and tween decks of vessels engaged in the dry bulk-cargo trade, at each Annual Survey after Special Survey No. 3.

**45.3.2 Special Load Lines**-Where vessels have timber, tanker or special load lines, an examination is to be made of the structural arrangements, fittings and appliances upon which such load lines are conditional. **45.3.3 Position of Load Lines**-The Surveyors are to satisfy themselves at each Annual Survey that no material alteration has been made in the hull, superstructures or means of closing openings in superstructures which affects the position of load lines.

**45.5 Intermediate Surveys-45.5.1 Older Ships**-At a survey approximately two years after the Special Survey No. 3 and each subsequent Special Survey has been credited for a tanker, and the Special Survey No. 4 and each subsequent Special Survey has been credited for a dry-cargo vessel, in

addition to the parts outlined in 45.3.1, the following are to be examined, placed in good condition and reported upon: For Tankers Some of the cargo tanks (internally). For Dry-cargo Vessels à some of the holds (internally). For Both Types of Vessels. The Surveyors are to examine as they deem necessary any parts of the structure in addition to subjects above to damage or wastage.

45.5.2 Unprotected Salt Water Ballast Tanks-At a survey approximately two years after entering service and after each subsequent Special Survey, at least two tanks within the length of the cargo space used primarily for salt water ballast, unless fitted with a suitable effective corrosion control system, are to be examined internally. Conditions found are to be considered as representative of all such tanks.

45.7 Special Periodical Surveys-Hull-45.7,1 Special Periodical Survey No. 1-Special Periodical Survey No. 1 is to include compliance with all Annual Survey requirements, and the Surveyors are to satisfy themselves, by examination in position, that all means of protection to openings are in good condition and are readily accessible. Effect also is to be given to the following requirements:

The vessel is to be placed in dry dock or upon a slipway and all items of 45.1.13b are to be examined. The rudder is to be examined and lifted when required and the gudgeons re-bushed. The condition of carrier and steadiment bearings and the effectiveness of stuffing boxes are to be ascertained when the rudder is lifted. c. Particular attention is to be given to overboard discharges, ash chutes and all other openings in the shell, casings being removed so that a proper examination can be made. d. The holds, tween decks, deep tanks, peaks, bilges and drain wells, engine and boiler spaces and coal bunkers are to be cleaned out and the surfaces of the framing and plating are to be cleaned and examined. e All watertight bulkheads are to be examined.

Close ceiling in holds and coal bunkers of single-bottom vessels is to be lifted to the extent of at least two strakes on each side (one strake being at the bilge) and all portable hatches in holds and the flooring plates in machinery spaces are to be removed for internal examination of the bottom framing and plating. g. The cement or other composition on the inner surface of the bottom plating is to be carefully examined and sounded to ascertain if it is adhering satisfactorily to the plating. h. Where a double bottom is fitted, the tanks and cofferdams are to be thoroughly cleaned out and examined internally; sufficient ceiling is to be lifted from the double bottom to enable the Surveyors to satisfy themselves as to the condition of the tank-top plating, and if necessary all ceiling is to be removed for cleaning and coating the top plating. All ballast tanks are to be cleaned and examined internally. Requirements for tanks which are used exclusively for permanent ballast, and are fitted

with an effective means for corrosion control, are to be specially considered.

Where double-bottom and other tanks are used primarily for heavy oil fuel or exclusively for light oils, the gas freeing and internal cleaning and examination may be waived, except for the fore-and-after peak tanks, provided that, upon a general external examination of the tanks, the Surveyors find their condition to be satisfactory.

Double-bottom, deep, ballast, peak and other tanks are to be tested with a head of liquid to the highest point that liquid will rise under service conditions. The testing of double bottoms - and other spaces not designed for the carriage of liquids maybe omitted provided an internal examination is carried out together with an examination of the tank top and, in the opinion of the Surveyor, testing may be waived. For deep tanks designed and used for the carriage of liquid cargoes, an alternate means of testing may be approved, provided the Surveyors are satisfied with the internal and external condition of the tanks and associated structure.

The Surveyors are to see that a thick steel plate is securely fixed below each sounding pipe for the rod to strike upon, in all dry places and in those tanks which are accessible for internal examination. The decks are to be examined and deck compositions are to be examined and sounded, but need not be disturbed if found to be adhering satisfactorily to the plating. The hawse pipes are to be examined. Anchors and chain cables are to be examined if they are ranged and the required complement and condition verified. The efficiency of hand pumps is to be tested. In insulated cargo spaces all limbers and hatches are to be removed and the plating examined. Steel cargo hatch covers not fitted with tarpaulins are to be hose tested or otherwise proven tight. Load line marks are to be checked and re-cut or painted as required.

45.7.2 Cleaning of Tanks and Their Testing in Tank Vessels-In vessels intended for the carriage of oil in bulk, the tanks are to be thoroughly cleared of gas and cleaned before inspection, and every precaution is to be taken to insure safety during inspection. Where fitted, anodes and their attachments are to be examined. The bulkheads at the ends of cargo-tank spaces are to be tested with a head of liquid up to the top of the expansion trunk or, if specifically approved, by an alternate method. The Surveyor is to be satisfied as to the tightness of the remaining cargo-tank bulkheads.

45.7.3 Special Periodical Survey No. 2-Special Periodical Survey No. 2 is to include compliance

with all requirements for Special Periodical Survey No. 1 and with those which follow: a Close ceiling in vessels with a single bottom is to be Lifted to an extent which permits all material below the ceiling to be properly examined; in vessels with double-bottom tanks sufficient ceiling and flooring is to be lifted to enable the Surveyors to satisfy themselves as to the condition of the material in tank tops, bulkheads, tunnels, side framing and piping.

All double-bottom and other tanks and cofferdams are to be thoroughly cleaned out and examined internally. In cases where the double-bottom tanks are used primarily for heavy oil fuel or exclusively for light oils, a forward double-bottom tank is to be gas freed, thoroughly cleaned out and examined internally and, if found satisfactory, the gas freeing and cleaning of the remaining double-bottom oil tanks may be waived, provided that, upon a general external examination of the tanks, the Surveyors find their condition satisfactory. Likewise the gas freeing, cleaning and internal examination of other tanks (excluding the peak tanks) used for oil fuel may be waived if, after a general examination, the Surveyors find their condition satisfactory.

In the case of vessels which have been built to reduced scantlings, owing to the adoption of special protective coatings as a means of corrosion control, a thorough examination is to be made of the deck, shell and other main scantlings in order to determine the condition of the structure; and the thicknesses of these members are to be determined to the extent deemed necessary by the Surveyors to provide satisfactory evidence of continued protection.

Plating, in way of airports especially, is to be examined. In this and any other part of the structure where wastage is evident, the Surveyors may require holes to be drilled in order to obtain the actual thickness of material. e. The chain cables are to be ranged and examined together with anchors, chain locker and cable holdfasts. Cables are to be renewed in cases where it is found that the links have been so far worn that their sectional area is 25% below the requirements or their diameter reduced below the Rule diameter by the amount given in the following table:

Metric Units

1.59 mm reduction in cables 12.7 mm and under 19.0 mm diameter
3.18 mm reduction in cables 19.0 mm and under 31.8 mm diameter
4.76 mm reduction in cables 31.8 mm and under 44.4 mm diameter
6.35 mm reduction in cables 44.4 mm and under 50.8 mm diameter

7.94 mm reduction in cables 50.8 mm and under 63.5 mm diameter
9.52 mm reduction in cables 63.5 mm and under 76.2 mm diameter
11.11 mm reduction in cables 76.2 mm and under 88.9 mm diameter

Inch/Pound Units

1/16 in. reduction in cables of 8/16 in. and under 12/16 in. diameter
2/16 in. reduction in cables of 12/16 in. and under 1 4/16 in. diameter
3/16 in. reduction in cables of 1 4/16 in. and under 1 12/16 in. diameter
4/16 in. reduction in cables of 1 12/16 in. and under 2 in. diameter
5/16 in. reduction in cables of 2 in. and under 2 8/16 in. diameter
6/16 in. reduction in cables of 2 8/16 in. and under 3 in. diameter
7/16 in. reduction in cables of 3 in. and under 3 8/16 in. diameter

Where structural alterations to the vessel have had the effect of so increasing the equipment numeral as to bring the vessel into a higher grade, the original cables may be used until they have been reduced 25% below the area of the larger cable required by the higher grade.

45.7.4 Special Periodical Survey No. 3-Special Periodical Survey No. 3 is to include compliance with all requirements for Special Periodical Survey No, 2 and with those which follow: a. Close ceiling, spar ceiling and wood lining is to be removed in sufficient quantity to enable the Surveyors to satisfy themselves as to the condition of the structure underneath such ceiling and lining. Casings in the holds and platform plates in the machinery spaces are to be removed as required by the Surveyors. The vessel is to be made sufficiently free from rust inside and out in order to expose for examination the framing and plating, together with discharge, scupper, air and sounding pipes.

When the vessel is thus prepared, the outer and inner surface of the shell plating and the framing, floors, brackets, reverse bars, keelsons, girders, tank-top plating, engine and boiler seating, shaft tunnels, thrust and shaft stools, beams, watertight bulkheads, rivets, stringers and decks are to be examined and found or placed in good condition.

If it be considered necessary by the Surveyors, the thicknesses of the shell and deck plating and such other parts of the vessel as are liable to excessive corrosion are to be determined; where a material reduction from the required scantlings is found to have taken place, the defective parts are to be removed and replaced with new materials of the required scantlings and quality.

In the case of vessels carrying oil in bulk, the thicknesses of the shell, deck and other main scantlings

are to be determined. In cases where the deterioration of scantlings is widespread, a detailed preliminary report with a sketch is to be made and immediately forwarded by the Surveyors to the Committee for consideration.

All double bottoms, cofferdams and other tanks are to be thoroughly cleaned, gas freed where oil is carried and examined internally. In the case where double-bottom tanks are used primarily for heavy oil fuel or exclusively for light oils, one double-bottom tank forward, one in vicinity of amidships, and one aft is to be gas freed, thoroughly cleaned out and examined internally and, if found satisfactory, the gas freeing and cleaning of the remaining fuel-oil double-bottom tanks may be waived, provided that, upon a general external examination of the tanks, the Surveyors find their condition satisfactory. Likewise, the gas freeing, cleaning and internal examination of other tanks (excluding the peak tanks) used for oil fuel may be waived if, after a general examination, the Surveyors find their condition satisfactory.

Where sidelights are fitted, the condition of the plating in way of same is to be ascertained and, in way of cabin accommodations the lining may, in the first instance, be removed so that the Surveyors may judge as to the condition of the hull at those parts and, if upon such examination it be considered necessary, additional lining is to be removed.

When spaces are insulated in connection with refrigeration, the limbers and hatches are to be lifted and enough lining is to be removed from all spaces to enable the Surveyors to satisfy themselves as to the general condition of the plating and framing in way of the insulation.

45.7.5 Special Periodical Surveys Nos. 4 and 5-These surveys are to be at least as comprehensive as Special Periodical Survey No. 2 with special attention being given to the condition and thickness of material liable to corrosion. The thicknesses of the shell, deck and other members which have not previously been ascertained are to be determined, having regard to the degree of wastage previously indicated by a review of the records of the vessel.

45.7.6 Special Periodical Survey No. 6-This survey is to be at least as comprehensive as Special Periodical Survey No. 3 and in addition at least one double-bottom tank in way of each cargo hold is to be thoroughly cleaned, gas freed where oil is carried and examined internally. The actual scantlings of the vessel are to be ascertained by the Surveyor and reported in detail to the Committee.

45.7.7 Special Periodical Surveys Subsequent to No. 6-These surveys are to be at least as comprehensive as Special Periodical Survey No. 6. The requirements for gauging of the scantlings are to be specially considered after a review of the record of the previous gauging.

45.9 Annual Surveys—Machinery—A general inspection of engines, boilers, steering machinery, windlass and fire-extinguishing apparatus required for Classification as outlined in Section 39, is to be made, if practicable, during each year of service.

45.11 Special Periodical Surveys—Machinery—45.11.1 Correlation with Hull Special Surveys—Main and auxiliary engines of all types are to undergo Special Periodical Survey at intervals similar to those for Special Surveys on the hull, in order that both may be recorded at approximately the same time. In cases where damage has involved extensive repairs and examination, the survey thereon may, where approved by the Committee, be accepted as equivalent to a Special Periodical Survey.

45.11.2 Parts to be examined—At each Special Periodical Survey effect is to be given to the following requirements: a. All openings to the sea, including sanitary and other overboard discharges, together with the cocks and valves connected therewith, are to be examined internally and externally while the vessel is in dry dock; and the fastenings to the shell plating are to be renewed when considered necessary by the Surveyor.

Pumps and pumping "arrangements, including valves, cocks, pipes and strainers, are to be examined. Nonmetallic flexible expansion pieces in the main saltwater circulating system are to be examined internally and externally. The Surveyor is to be satisfied with the operation of the bilge system, including an internal examination of the emergency bilge suction valve. Other systems are to be tested as considered necessary.

Shafts (except the propeller shaft), thrust bearings and line shaft bearings are to be opened for examination. The foundations of main and auxiliary machinery are to be examined.

Evaporators are to be opened for examination and relief valves of unfired pressure vessels intended for working pressure above 3.5 kg/ cm<sup>2</sup> (50 psi) necessary to the vessel's operation are to be proven operable. f. Examination of the steering machinery is to be carried out, including an operational test and checking of relief-valve settings, and the machinery may be required to be opened for further examination as considered necessary by the Surveyors. g. Reduction gears are to be opened as considered necessary by the Surveyors in order to permit the examination of the gears, gear teeth, spiders, pinions, shafts and bearings.

An examination of the fire extinguishing apparatus required for Classification as outlined in Section 39 is to be made in order that the Surveyors may satisfy themselves as to its efficient state.

45.11.3 Engines and Turbines- In addition to the foregoing requirements, turbine blading and rotors, cylinders, pistons, valves, condensers and such other parts of main and auxiliary machinery as may be considered necessary, are to be opened up for examination. At Special Periodical No. 1 only, for vessels having more than one main propulsion ahead turbine with emergency steam crossover arrangements, the turbine casings need not be opened provided vibration indicators and rotor position indicators are fitted and that the operating records are considered satisfactory by the Surveyor. An operational test of the turbines may be required if considered necessary by the Surveyor.

Exhaust steam turbines, gears and clutches are to be opened and examined together with the shaft tapers in way of internal couplings of driving shafts. Main steam piping is to be examined and where considered necessary by the Surveyors, sections may be required to be removed for examination. Alternatively for installations operating at temperatures not exceeding 427C (800 F) hydrostatic tests to 1 1/4 times the working pressure maybe accepted. Copper pipes are to be annealed before the test. Where considered desirable by the Surveyors, the thickness is to be ascertained to determine the future working pressure.

45.11.4 Internal-combustion Engines-a. In addition to the foregoing applicable requirements, cylinders, cylinder heads, valves and valve gear, fuel pumps, scavenging pumps, and superchargers, pistons, crossheads, connecting rods, crankshafts, clutch, reversing gear, air compressors, intercoolers, and such other parts of the main and auxiliary machinery as are considered necessary are to be opened out for examination. Parts which have been examined within twelve months need not be again examined except in special circumstances.

Oil tanks and air reservoirs are to be examined and, if considered necessary, tested under the water pressure required for new construction. If air reservoirs cannot be examined internally they are to be hydro-statically tested.

45.11.5 Examination during Overhaul-On all occasions of overhaul or adjustment, facilities are to be provided for Surveyors to examine the parts opened; in the event of defects being discovered, such other parts as may be considered necessary are to be opened and examined.

45.11.6 Examination at Shorter Intervals-If it be found desirable, upon inspection, that any part of the machinery should be examined at shorter intervals than specified above, it will be necessary for Owners to comply with the Committee's requirements in this respect.

45.13 Propeller Shaft Surveys-45.13.1 Propeller Shaft Surveys -Propeller shafts fitted with continuous liners or with glands which effectively prevent sea water from contacting the steel shaft



are to be drawn at least once every three years for single-screw vessels and four years for vessels fitted with multiple screws. All other shafts are to be drawn every two years or more frequently if considered necessary by the Surveyors. In the case of single-screw vessels fitted with tail shafts having continuous liners or with effective seals, the interval between examinations may be extended to four years when requested by the Owners, provided that, in addition to the propeller hub details given in Section 37 of the Rules, the design includes other features which would further reduce stress concentrations in the propeller assembly and that, during each survey, the shaft is examined by an effective crack-detection method from the after edge of the liner for one-third of the length of the cone from the large end. Consideration may be given to any special circumstances which might modify the requirements in particular cases.

45.13.2 Allowable Wear down-Where machinery is located amidships, the after bearing is to be re-bushed when it has worn down to 6.4 mm (1/4 in.) clearance in the case of shafts 229 mm (9 in.) or less in diameter, 7.95 mm (5/16 in.) clearance where the diameter is above 229 mm (9 in.), but not more than 305 mm (12 in.), and 9.53 mm (3/8 in.) clearance where the shaft exceeds 305 mm (12 in.) in diameter. In cases where machinery is located aft the maximum clearance is to be one grade less than the foregoing.

45.13-3 Flanged Propeller Shaft Surveys-a Applicable Arrangements For shafting arrangements where the propeller is fitted to a coupling flange at the after end of the shaft, and the shaft is fitted with an approved oil gland at the forward and after ends of the stern tube, and new oil seals may be fitted without removal of the propeller, the modified survey detailed in b and c may be accepted.

b Modified Survey Details The modified survey consists of dismantling the forward coupling and oil glands, drawing the shaft outboard to expose all of the aft bearing surface of the shaft, examining the forward bearing and all accessible parts of the shaft, including the flange and propeller coupling bolts, performing a non-destructive examination by an approved crack detection method, of the after part of the shaft.

c. Survey Interval These modified surveys are accepted at alternate 4 year surveys and provided the clearances of the forward and aft bearing are found in order, and the oil, and oil glands, is in good condition. No postponement of surveys is normally permitted. Special consideration will be given to circumstances of any particular case upon application by the Owners.

45.15 Boiler Surveys-45.15.1 Survey Interval-a. Water-tube Boilers for Propulsion-1. For vessels fitted with more than one boiler the interval between surveys shall not exceed two years.

2. For vessels fitted with one boiler, the interval between surveys shall not exceed two years for the

first eight years; thereafter the boiler shall be surveyed annually.

b. Fire-tube Boilers for Propulsion Boilers are to be surveyed when four years old and when six years old; thereafter boilers shall be surveyed annually.

c. Auxiliary Boilers Waste-heat or fired auxiliary boilers, normally used for the operation of the vessel at sea, are to be surveyed at the same interval as a or b above.

#### 45.15.2 Parts to be examined

a. At each survey the boilers, super heaters, and economizers are to be examined internally (water-steam side) and externally (fire side).

b. Boiler mountings and safety valves are to be examined at each survey and opened as considered necessary by the Surveyor.

c. The proper operation of the safety valves is to be confirmed at each survey.

d. All studs fastening mountings directly to boiler shells or heads are to be examined at least once every eight years.

e. When considered necessary by the Surveyor, the boilers and super heaters are to be subjected to hydrostatic pressure test.

#### 45.17 Electrical Equipment

##### 45.17.1 Timing of Survey

The entire installation, including auxiliary and emergency equipment, is to undergo Special Periodical Survey every four years at the same time as the Special Survey on the machinery

The following are to be carried out at each Special Periodical Survey:

##### 45.17.2 Auxiliary Apparatus

a. Fittings and connections on main switchboards and distribution panels are to be examined, and care is to be taken to see that no circuits are over fused.

b. Cables are to be examined as far as practicable without undue disturbance of fixtures.

c All generators are to be run under load, either separately or in parallel; switches and circuit breakers are to be tested.

d All equipment and circuits are to be inspected for possible development of physical changes or deterioration. The insulation resistance of the circuits is to be measured between conductors and between conductors and ground and these values compared with those previously measured. Any large and abrupt decrease in insulation resistance is to be further investigated and either restored to normal or renewed as indicated by the conditions found.

e. Where electrical auxiliaries are used for vital purposes, the generators and motors are to be

examined and their prime movers opened for inspection. The insulation resistance of each generator and motor is to be measured with all circuits of different voltages above ground being tested separately. This test is to be made at a direct-current potential of 500 volts, if practicable, and the insulation resistance in mega ohms is to be at least equal to:

$$\frac{\text{Rated voltage of the machine}}{\frac{\text{Rating in kva}}{100} + 1000}$$

The minimum insulation resistance of the fields of machines separately excited with voltage less than the rated voltage of the machine is to be of the order of one-half to one mega ohm.

45.17.3 Main Propulsion Apparatus-a. The windings of generators and motors are to be thoroughly examined and found or made dry and clean; particular attention is to be paid to the ends of all windings of stators and rotors. After the windings have been cleaned and found dry, they are to be varnished, if necessary, with a standard insulating varnish applied preferably by spraying.

b. All air ducts in stator coils and the ventilating holes in rotors and retaining rings of alternators are to be carefully examined and found or made clear and clean.

c. All cable runs are to be examined and found or placed in good condition as to supports, etc., and the ground connections of protective coverings or sheath found substantial and effective. Particular attention is also to be paid to high-potential bus insulators, which are to be free from dust or oil in order to prevent creepage to ground.

d. The insulation resistance of each propulsion unit is to be measured and found equal to the requirements noted above for auxiliary generators and motors. In order to further evaluate these insulation-resistance readings, it is recommended that a separate log be kept of insulation-resistance measurements taken frequently at regularly scheduled intervals. Humidity, ambient temperature and condition of the machine are also to be noted. Any large and abrupt decrease in insulation resistance, when compared with those recorded in the log, is to be further investigated and either restored to normal or renewed as indicated by the conditions found.

e. When a log is not available for the comparison of measured insulation-resistance values with those previously taken at regularly scheduled intervals, the cables and windings except d-c fields of propulsion generators and motors are to be subjected to a dielectric strain test for one minute by application of a potential of 125% of the maximum operating voltage of the circuits to which it is applied. The d-c fields of generators and motors