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TITLE

Lessons learned from operational CPF trials

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Notes: Paper #54 contained in Parent Sysnum #516410

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Lessons Learned From Operational CPF Trials

by

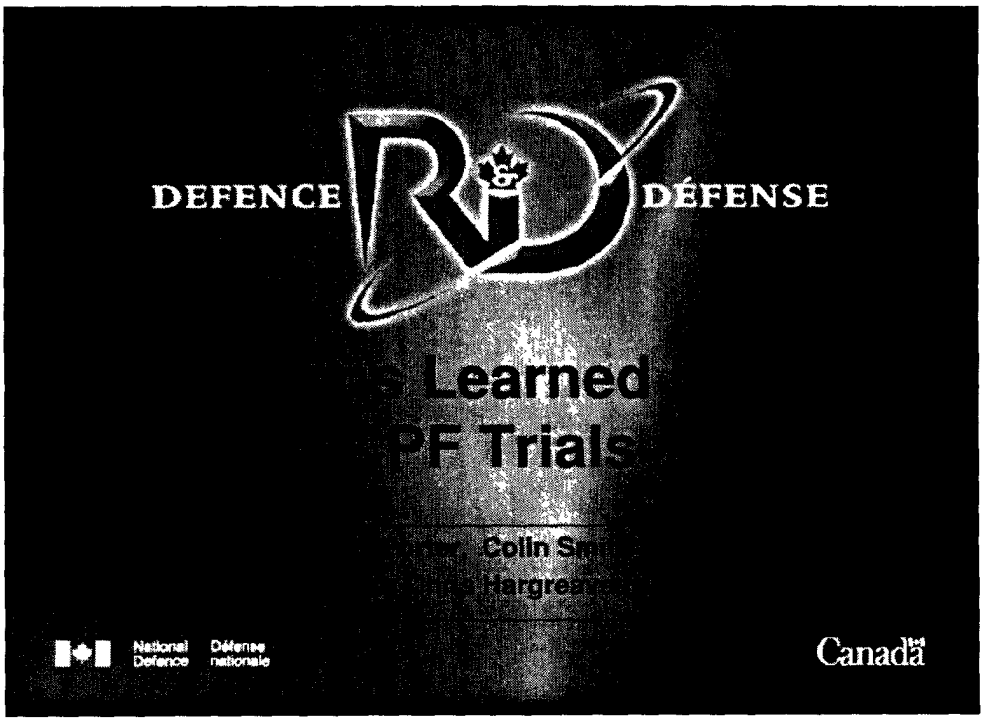
John F. Porter* and Colin Smith** and LCdr. Chris Hargreaves***

* Dockyard Laboratory, DREA, Halifax, N.S.
** NETE, LaSalle, Quebec
*** Directorate of Maritime Ship Support, Hull, Quebec

Abstract

Since shortly after the introduction of the Canadian Patrol Frigate to the Canadian Navy, the Dockyard Laboratory (Atlantic), the Naval Engineering and Test Establishment and the Directorate of Maritime Ship Support have collaborated to undertake numerous experimental trials onboard these platforms. These trials have predominately been in response to operational challenges such as structural and component cracking and have included a wide variety of experimental set-ups, monitoring operational conditions such as temperature, strain, motion, position and environment. While these trials have been instrumental in resolving numerous operational issues, a number of lessons have been learned. These lessons are being employed to conduct more effective experimental evaluations and in the development of advanced sensing systems for marine platforms.

This presentation will review the history of these collaborative trials and a summary of the lessons learned will be provided. A preview of forthcoming trial evaluations, employing recently developed advanced sensing systems will also be discussed.



Canadian Patrol Frigate Sea Trials

Collaborations between DREA, DMSS, and NETE to:

- **Assist in platform investigations**
- **Enhance platform health monitoring capabilities**
- **Define mission and platform strain spectra**
- **Improve understanding of fatigue and fracture processes**

CPF Trials to Date

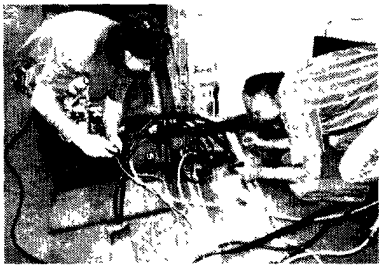
HMCS ST JOHN'S: '96 (2)
HMCS TORONTO: '96-'97 (3)
HMCS MONTREAL: '97 (1)
HMCS FREDERICTON: '97-'98 (2)
HMCS CHARLOTTETOWN: '98-'99 (2)
HMCS VILLE DE QUEBEC: '00-'01 (2)

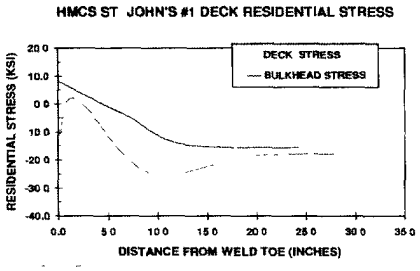
DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

HMCS ST JOHN'S: '96

Objective:
Investigate #1 deck/superstructure cracking. Measure residential strains and wave induced strains.





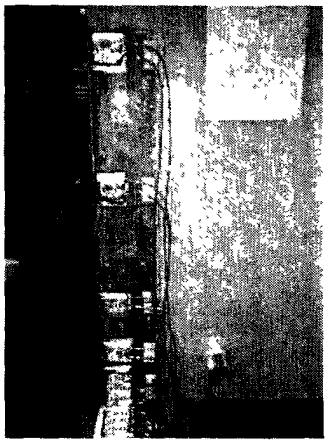
DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

HMCS TORONTO: '96-97

Objective:
Further investigate #1 deck/superstructure cracking. Measured residential strains and wave induced strains.

Findings:
- **Residential strain - primary influence**
- **Redesign not recommended**

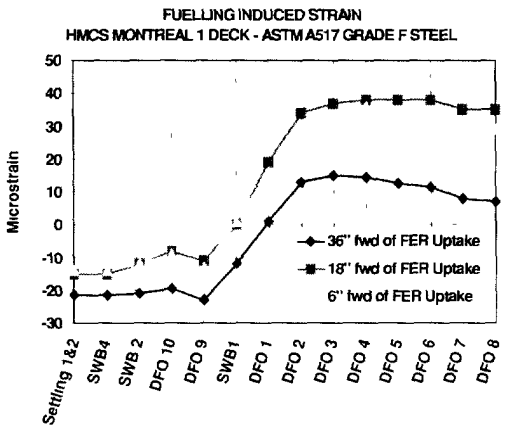


DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

HMCS MONTREAL '97

Objective:
Investigate influence of undocking and liquid cargo status on #1 deck strain states

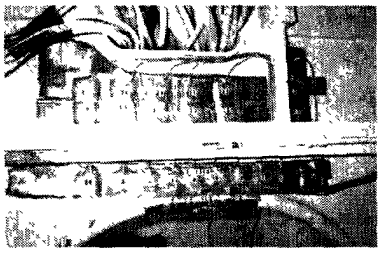


DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

HMCS FREDERICTON: '97-'98

Objectives:
- **Investigate #2 deck longitudinal bulkhead cracking.**
- **Measure residential strains and wave induced strains.**
- **Conduct numerical risk assessment**



Defence Research Establishment Atlantic (DREA)

HMCS FREDERICTON: '97-'98

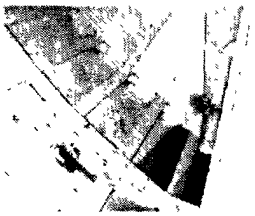
Findings:
- **Modified residential strain fields due to rogue wave encounter.**
- **Crack propagation defined and risk levels assessed**

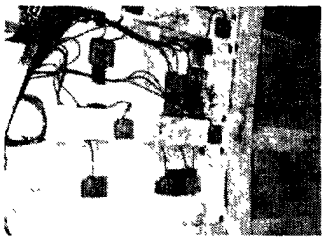
Defence Research Establishment Atlantic (DREA)

HMCS CHARLOTTETOWN: '98-'99

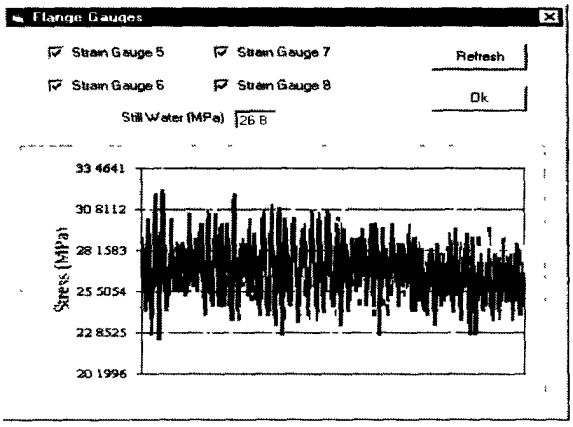
Objectives:
- **Monitor fatigue crack length and local wave induced strains.**
- **Provide onboard real-time defect severity assessment for operational guidance**

Conclusions:
- **Guidance successfully provided.**
- **DSAS envisaged and project commenced**

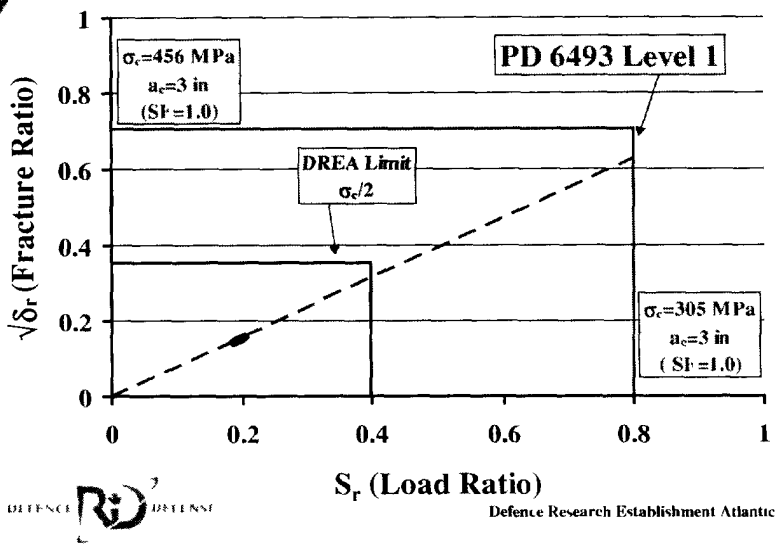




Stress/Strain Spectrum Monitored



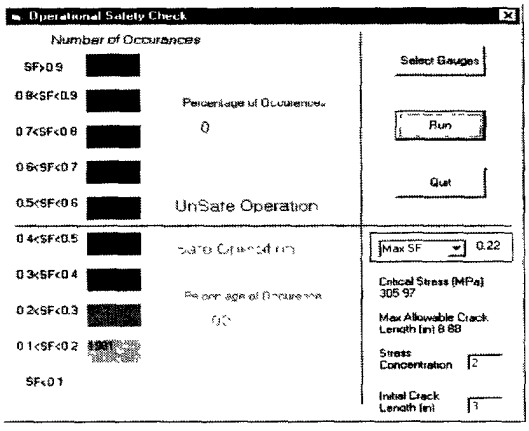
Severity Factor Assessment



DEFENCE R&D DÉFENSE

Defence Research Establishment Atlantic (DREA)

Operator Severity Assessment Display



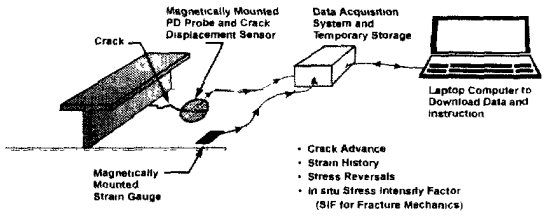
DEFENCE R&D DÉFENSE

Defence Research Establishment Atlantic (DREA)

Defect Severity Assessment System (DSAS) Project

Objective:

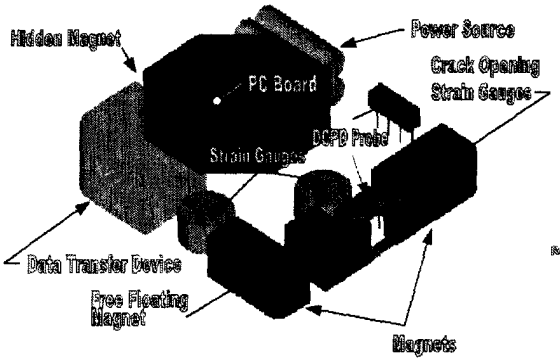
Develop a total system to provide continuous monitoring of crack length, strain and crack opening displacements and advanced real time severity factor assessment for operational guidance

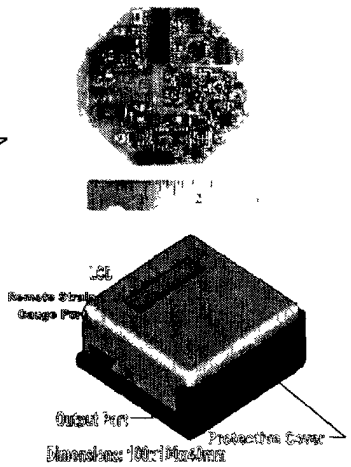


DEFENCE R&D DÉFENSE

Defence Research Establishment Atlantic (DREA)

Integrated Crack Monitoring Module





DEFENCE R&D DÉFENSE

Defence Research Establishment Atlantic (DREA)

DSAS Severity Factor Forecasting

Speed (kts)	Sea State 1	2	3	4	5	6	7	8	>8
0 - 4									
4 - 8									
8 - 12									
12 - 16									
16 - 20									
20+									

HMCS VILLE DE QUEBEC: '00-'01

Objectives:

- **Monitor exterior structural temperatures**
- **Examine new sensor systems**
- **Explore global to local transfer function consistency**
- **Explore environmental factor characterization routines for platform health monitoring**
- **Further define #2 deck longitudinal bulkhead strain spectra**

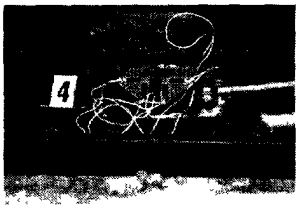
Exterior Plate Temperatures

Findings:
Exterior plate temperatures closely follow ambient – no or little heating provided from interior spaces.

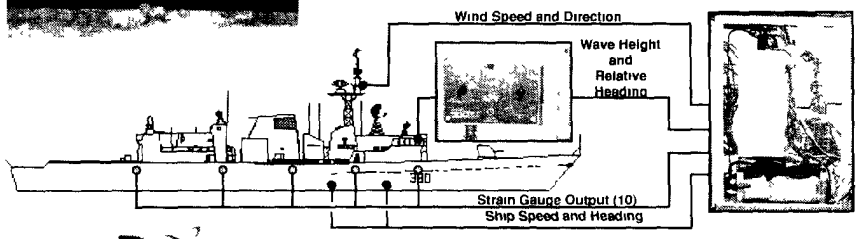
DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

Long Term Strain Monitoring



- **Monitoring 10 strain locations, ship speed and heading, wind speed and direction**
- **Manual input of wave height and heading relative to ship**

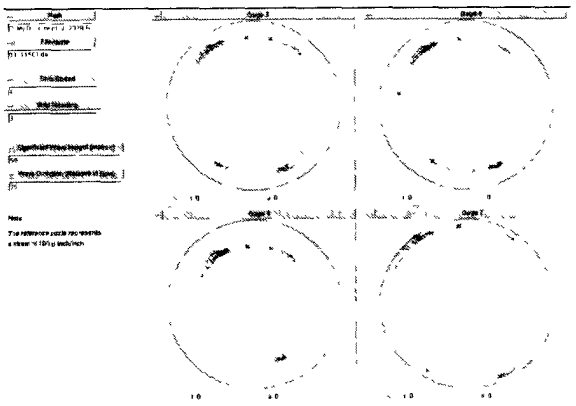


DEFENCE R&D DEFENSE

Defence Research Establishment Atlantic (DREA)

Global and Local Strain Consistency

Findings to date:
Apparent independence on environmental factors for transfer functions between local and global strains



5-6 meter waves

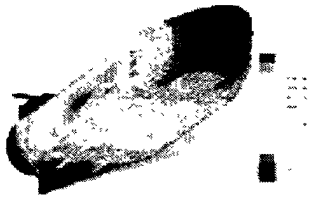
Defence Research Establishment Atlantic (DREA)

Platform Health Monitoring (PHM) Development Project

Application of lessons learned and emerging technologies to create continuous monitoring system for naval platforms

PHM Project Activities

Emerging technology applications;
- **Non-traditional sensors**
- **Large area sensors**
- **Rigid body dynamics derived stresses**
- **Differential GPS**
- **Wireless communications**
- **Integration of numerical and experimental capabilities**
- **Integration of remote sensor data**
- **Enhanced environment description**



Some Lessons Learned

Technical Lessons:

- **All ships crack, however not all cracks are of serious concern. The ability to distinguish between the serious and nuisance cracking is an essential capability**
- **Real-time defect risk assessment for the operator is a proven capability**
- **Weldable gages remain the most effective, reliable sensors available**
- **Data acquisition should be "stand-alone"**
- **Manual data input (Bridge log) is an invaluable backup to automated or semi-automated data collection systems**

Some Lessons Learned (cont.)

Not-So Technical Lessons:

- **Teamwork between DREA, DMSS, NETE and the Fleet has proven an extremely effective means of addressing short and long term operational issues.**

- **A half hour in the CO's cabin is worth more than 3 months of trial request paperwork.**

- **"Smith's Law" – The ideal gage location is always the most awkward.**

- **"Finagles Law" – The most obviously correct data, beyond all need of verification, is erroneous.**