


IN-SITU EMI TESTING OF LARGE NAVAL RADAR SYSTEMS USING A VIBRATING INTRINSIC REVERBERATION CHAMBER (VIRC)

FRANK LEFERINK

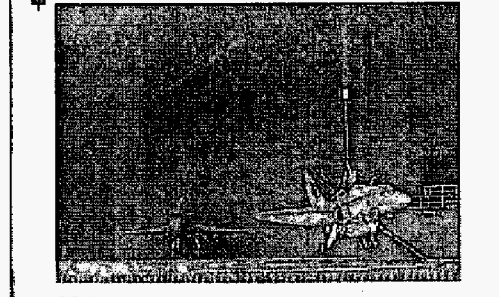
In-situ EMI testing of large naval radar systems using a Vibrating Intrinsic Reverberation Chamber (VIRC)



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Transportable systems under test



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Content

- EMC testing of large systems and installations
- Reverberation Chambers
- Vibrating Intrinsic Reverberation Chamber (VIRC)
- Validation of VIRC
- Testing large systems/installations with a VIRC
- Conclusion

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Installations

- Fixed installation can be tested only in-situ
- Field testing is often replaced by (bulk) current injection or measuring common mode currents
- Moving large systems or 'transportable installations' to large test facilities is often time consuming (dismantle, install) and expensive
- So: why not move the test facility to the equipment under test?
- Before answering this question, let us discuss about reverberation chambers

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EMC and large installations

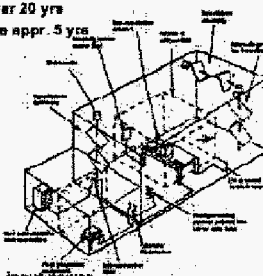
EMC Research/Engineering/Qualification via

- Analyses
 - Difficult due to inferior models, large variation of physical structures etc.
 - Expensive in time and resources
- Often combined with low level testing or scaled model testing
- Testing
 - preferred and often needed
 - but expensive:
 - Measuring equipment: expensive high-power amplifiers, generators and receivers
 - Test facility: expensive large anechoic shielded chambers
 - Equipment Under Test (EUT) and infrastructure has to be moved to the test facility. Expensive facilities, installations

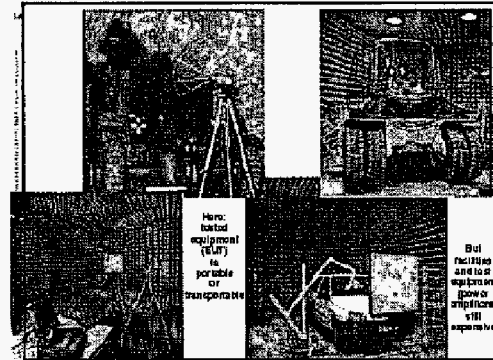
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Modern test technique: Reverberation Chamber, 1

- Used in research for over 20 yrs
- In EMC standards, since appr. 5 yrs
 - MIL-STD 461E (1999)
 - GM-9120P
 - SAE J1413/27
 - RTCA DO-166D
 - EBROCAE WC 14/33
 - IEC (61000-4-21) (2003)
- Operation:
 - Comparable to a microwave oven: reverberate (intensify) and mix the field
- Advantage: high field strength with moderate input power



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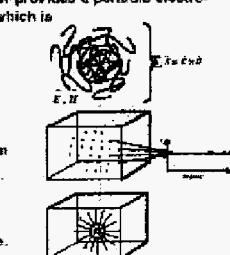
Here: tested equipment (EUT) is portable or transportable

But facilities and test equipment power amplifiers still expensive

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Modern test technique: Reverberation Chamber, 2

- A Reverberation Chamber provides a periodic electromagnetic environment, which is
 - randomly polarised, i.e. the phase between all waves is random
 - spatially uniform, i.e. the energy density in the chamber is uniform everywhere and
 - isotropic, i.e. the energy flow in all directions is the same.

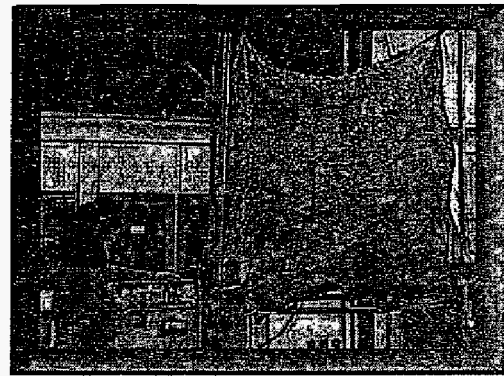


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Modern test technique: Reverberation Chamber, 3

- A mode stirrer is needed to obtain such a 'randomly polarised, spatial uniform and isotropic' field
- A reverberation chamber actually represents the real world in a much better way than the conventional test methods MIL-STD 461E RS103, IEC 61000-4-3 and others

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Vibrating Intrinsic Reverberation Chamber (VIRC)

- A chamber made of flexible material
- By moving the walls the modes (resonant frequencies) are changed (no stirrer needed)
- The mode variation is much faster compared to the conventional mode stirred reverberation chamber
- The change in resonance frequency is much larger compared to the conventional mode stirred reverberation chamber
- The VIRC can therefore be used from a lower frequency than a conventional mode stirred reverberation chamber with comparable size

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VIRC validation

- Stirring Rate (SR)
- Correlation functions (ρ)
- Power Density Function (PDF)
- Cumulative Density Function (CDF)
- Spatial Field Uniformity (SFU)
- Chamber gain (CG)
- Resonance frequency variation (Δf)
- Quality Factor (Q)

Elcoteq
 (Data hereafter obtained with the 3x3x3m VIRC)

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Large installation and the VIRC

- Because the VIRC is flexible, it can be used for in-situ testing and thus move the test equipment instead of equipment under test and associated equipment
- and maintain the advantage of high field strength with moderate input power

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Test setup for SR, PDF, CDF

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Prototype of the VIRC

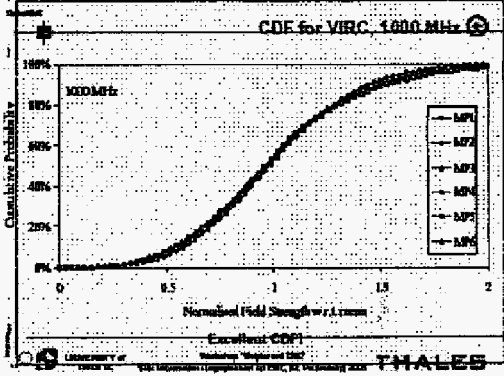
Material:
 flexible woven aluminium

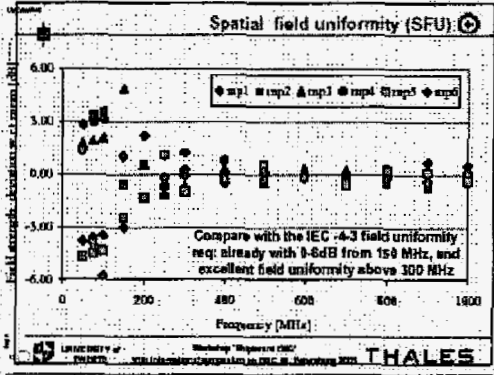
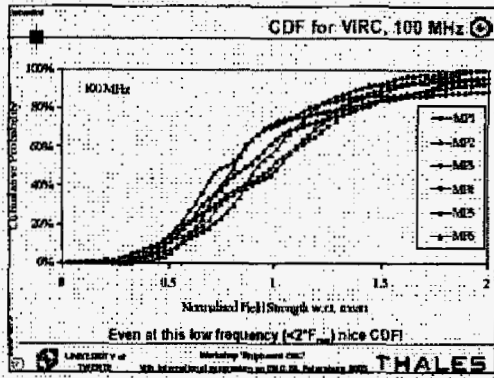
Shielding:
 excellent (>40dB)

Construction:

- no walls parallel
- at most one wall placed perpendicular to another
- dimensions not being a multiple
- natural corrugation of surface

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Applications, 1, Testing APAR, 1

- EMC testing of APAR (2000/2001)
 - Active Phase Array Radar (APAR) is the multifunctional radar (MFR) of German and Dutch Frigates
 - The electromagnetic environment is hostile
 - due to other systems onboard
 - due to systems operating at nearby platforms (ships), in a background of drifting electromagnetic
 - due to enemy actions
- EMC testing necessary

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APAR movie

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Applications, 1, Testing APAR, 2

- EMC testing of APAR (2000/2001)
 - Full-scale conventional EMC testing (in an anechoic chamber) difficult
 - high power amplifiers needed,
 - due to the high field strength risk of fire,
 - changes of existing chamber etc.
 - Full-scale conventional EMC testing expensive
 - investment in high power amplifiers and associated equipment
 - Upgrade existing anechoic chamber
 - Moving the complete APAR system and infrastructure to the EMC test site, make it operational and after EMC testing dismantle
- Better: use the VIRC

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Applications, 1, Testing APAR, 3

Material:

- metallised (copper) fabric

 Production VIRC:

- regular tent manufacturer

 Shielding:

- good (>60dB)

 Dimension:

- 5 x 3 x 5 m ($F_{min} = 50$ MHz)

 Connection with EUT:

- overlapping flaps,
- electrically connected with EUT

 Vibration:

- wiper motors with eccentric

 Cost:

- <math><25</math> kEuro

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Applications, 1, Testing APAR, 4

Emission and susceptibility:

- 10 MHz - 10 GHz

 Emission noise level:

- >20dB below receiver noise!

 Susceptibility (with only 100W RF power):

- 1000W/m average!
- 10,000W/m peak!

 All levels with the existing test apparatus

Savings: > 700k Euro

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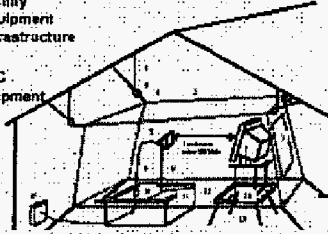
VIRC movie

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Applications, 2, System XX and system YY, 1

Thales France

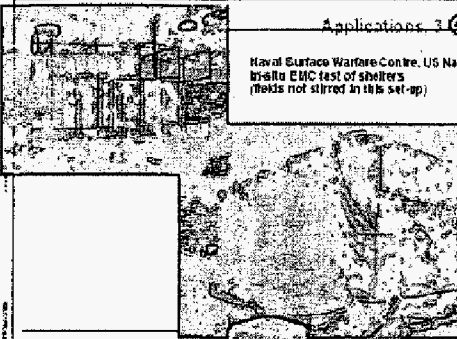
- Conventional
 - 250kEuro facility
 - 300kEuro equipment
 - 300kEuro infrastructure
- With VIRC:
 - 10kEuro VIRC
 - 20kEuro equipment



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Applications, 3

Naval Surface Warfare Centre, US Navy
In-situ EMC test of shelters
(fields not stirred in this set-up)



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Applications, 2, System XX and system YY, 2



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Conclusion

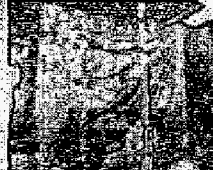
- Conventional EMC testing of large systems or installations is very expensive
- VIRC gives:
 - High field strength with moderate input power (major cost saver)
 - Enables in-situ testing (no infrastructure movements: large cost savings)
- Technique applied:
 - APAR EMC (and HIRF/HPM) testing
 - Various EMC tests within Thales Netherlands
 - System XX and YY tested within Thales France
 - Various labs, research institutes and universities are using the technique

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Applications, 2, System XX and system YY, 2

Test of a shield enclosure

Des capacités nouvelles



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Further reading

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