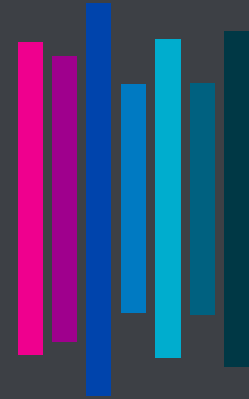




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# **The Story of SOHIC**

**Dr Chris Fowler FIMMM FNACE  
Director Corrosion Exova Group  
President NACE Institute**



# The Story of SOHIC

A 30 year story  
Nearing its final chapter.

## Contents

History of SOHIC

OTI 95 635

Case Histories

The “NEW” Plate test method

The Final Chapter

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# The Story of SOHIC

Definition:-

Stress Orientated Hydrogen Induced Cracking.

Also

Ladder Cracking  
Stacked Array of Cracks

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# The Story of SOHIC

SOHIC



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## The Story of SOHIC

First identified in the early 80's

Research study for Hoesch Steel

Developed Spiral Pipe for Sour Service

Two Papers published

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## The Story of SOHIC

Adjacent to SAW weld in Spiral Pipe

Using early form of the Full Ring Test

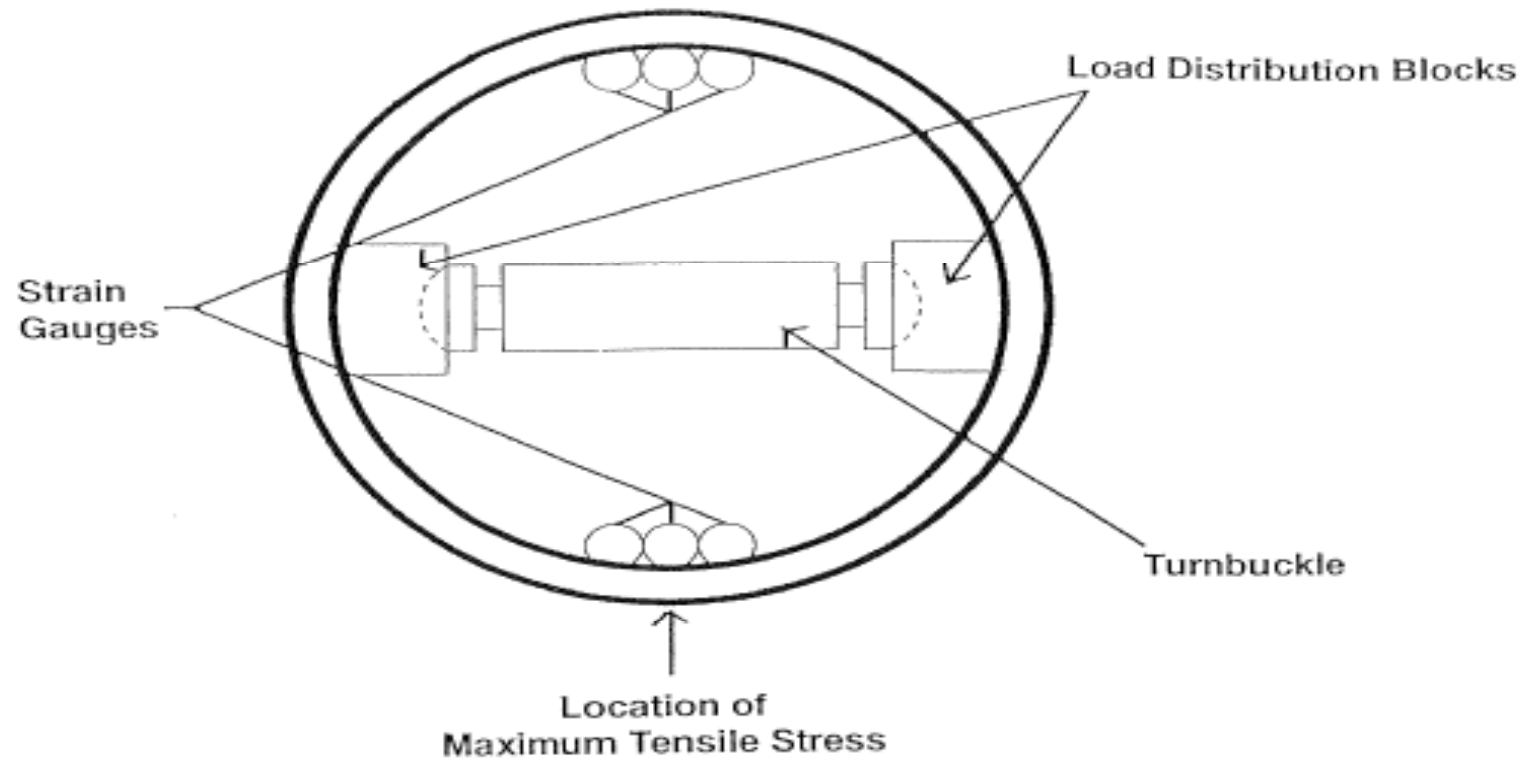
Resulted in thermal treatment of Spiral weld

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## The Story of SOHIC



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## The Story of SOHIC



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# The Story of SOHIC

OTI 95 635  
Development

Joint Industry Project  
Supported by 22 Companies

Method Published by the  
UK Health & Safety Executive.

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# The Story of SOHIC

Full Scale Pressure Tests

V

Full Rings

Validation Process

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# The Story of SOHIC

## Essential Features

Correct Loading Direction  
Retention of Residual Stress  
Large Size Sample  
On Line Crack Detection

Parent Material and Associated Welds

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## The Story of SOHIC

### SAFETY

Laboratory must be able to deal with large volumes of Hydrogen Sulphide

Fully Detected and Alarmed systems required  
Proven Deaeration Procedures (1000 litres)

Qualified Strain Gauge Operatives.

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# The Story of SOHIC

FUTURE

An ISO Standard

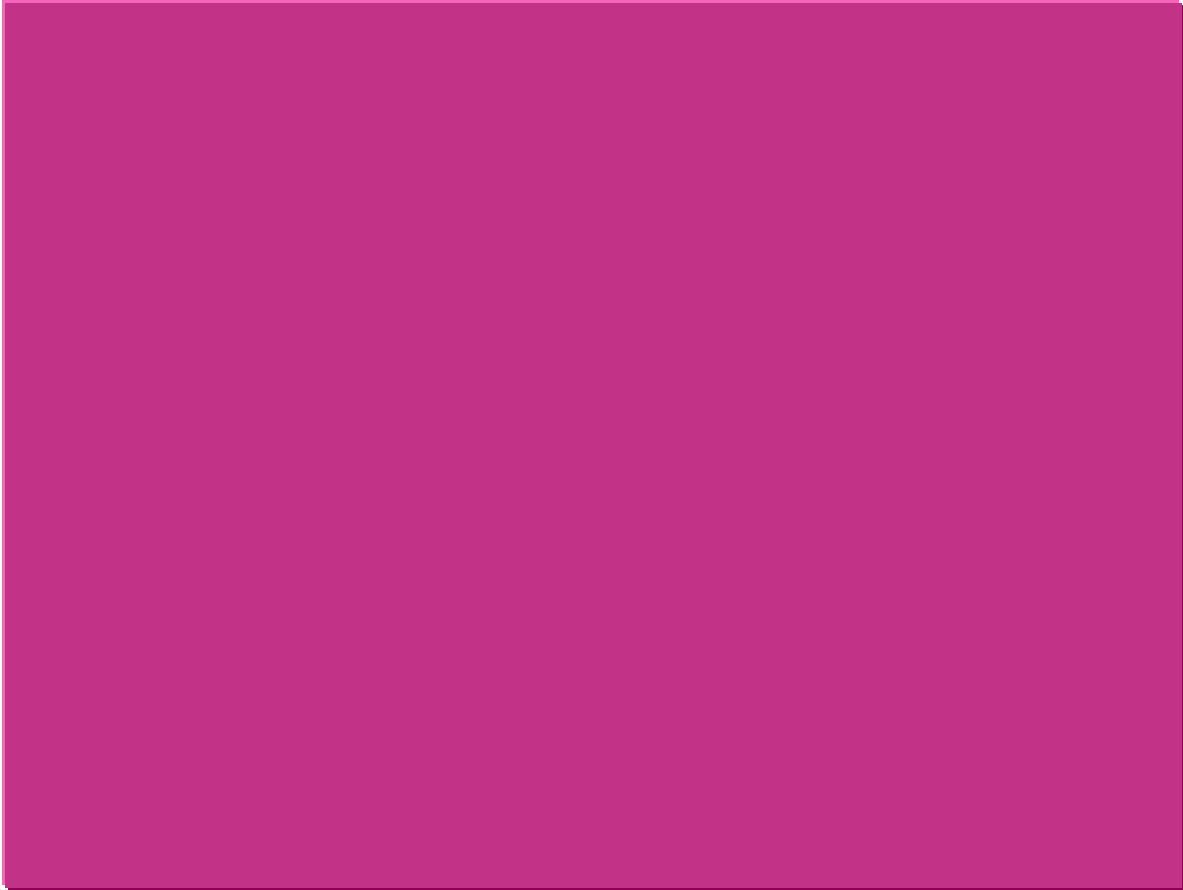
A work group has been proposed.

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## The Story of SOHIC

CRITICAL FACTOR - RESIDUAL STRESS



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**NACE**<sup>™</sup>  
INTERNATIONAL  
**DIAMOND**  
CORPORATE MEMBER

## The Story of SOHIC

Failures?

Nine reported!



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## The Story of SOHIC

- Not all Spiral Welded Pipe
- One ERW pipe failed in Germany
- SOHIC in Pressure vessel steel also reported by Exxon

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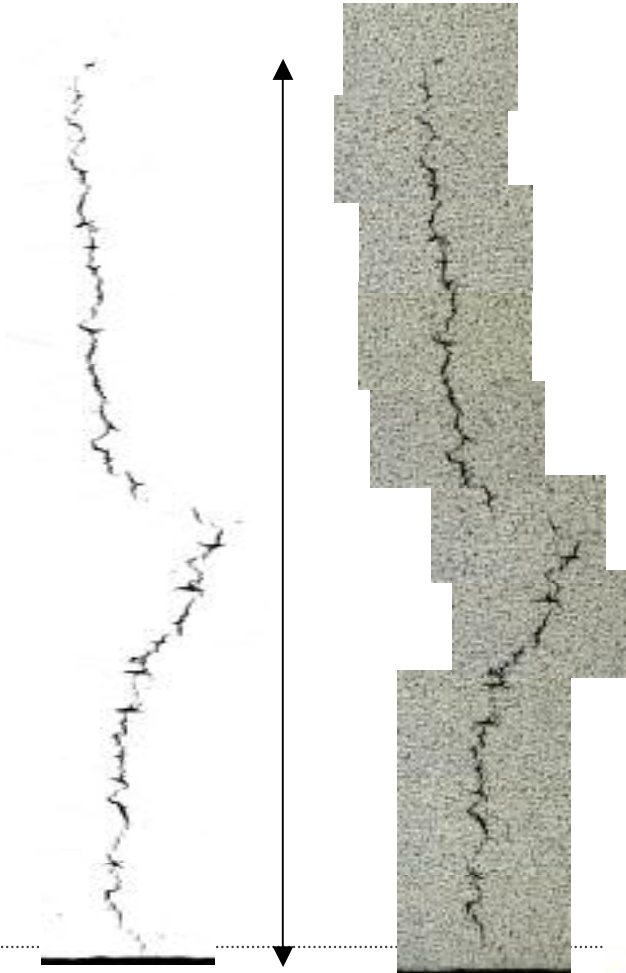
## The Story of SOHIC

- Fittings thought to be immune
  - Three case histories
    - All “soft”
    - Clean
  - Good microstructure
    - Heat treated



# The Story of SOHIC

“T” Piece



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## The Story of SOHIC

Dished End



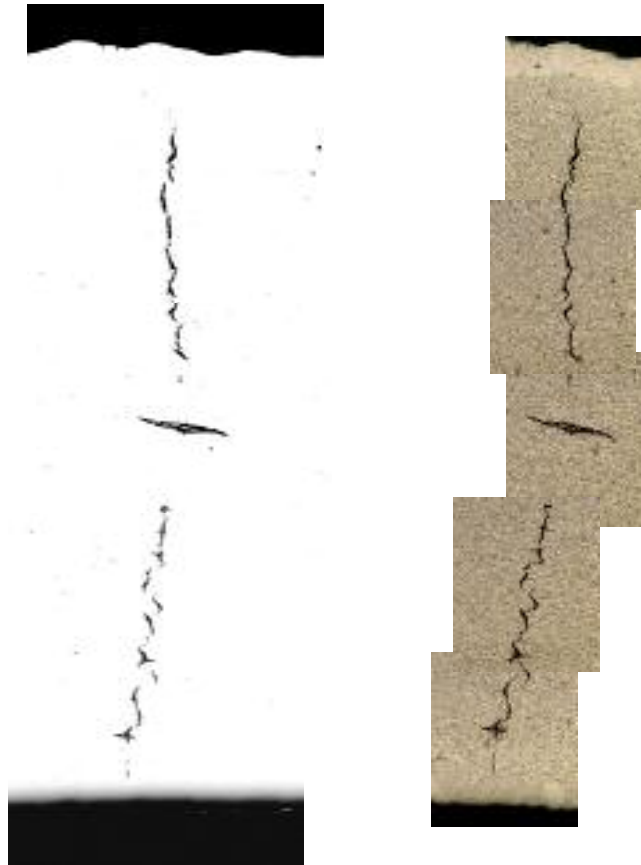
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## The Story of SOHIC

Reducer



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## The History and Development of SOHIC

### The Concern

- The fittings were all tested as HIC coupons with NO applied stress!
  - And for 96 hours
- NACE HIC Test Method now revised to include guidance on how to test fittings and flanges.

# The Story of SOHIC

Test Methods

OTI 95 635 for Line Pipe

NACE TM0103 for Plate (**NOW WITHDRAWN**)

ISO 15156 part 2 cites alternate methods such as Four Point Bends  
and Tensiles?

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# The Story of SOHIC

Test Method Development

Joint Industry Project

Bodycote (now EXOVA)

TWI

Force Institute.

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## The Story of SOHIC

Sponsors

UK H&SE

Chevron

Saudi Aramco

Rockwater

Dalmine

Shell

Hydrogen Ion Science

BEB (Exxon MOBILE)

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## The Story of SOHIC

Followed by:-

Two Internships from Aalen University

Two Research Students from Industry

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# The Story of SOHIC

## Test Method Development

Aims

Go/No Go test

Short Duration

Simple Interpretation

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# The Story of SOHIC

Rig Design Requirements

Controlled Twist

Controlled Tensile Load

Reproducible!

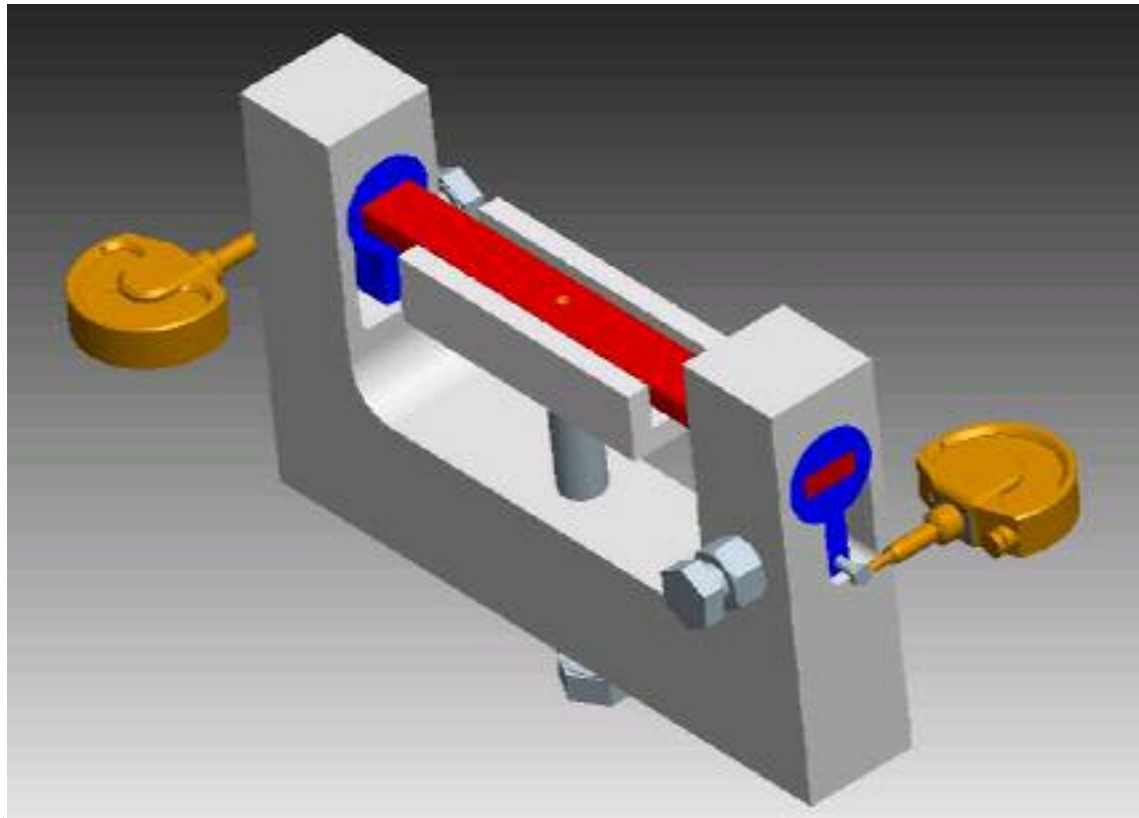
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## The Story of SOHIC

New SOHIC Test Rig



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# The Story of SOHIC

Results

Control 2deg and 5deg twist



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# The Story of SOHIC

## Results

Application of between 2 and 5 degrees of twist  
Combined with Four Point Bend loading of 50% SMYS

Stimulates SOHIC in susceptible material.

First Commercial Tests Undertaken

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# The Story of SOHIC

## The Future

Validate Test Method – on-going

Produce written procedure Complete

Consider JIP to study the SOHIC mechanism now that a true test method is available.

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# The Story of SOHIC

JIP

Variables to consider:-

**HARDNESS**

- Microstructure
  - Chemistry
- Weld and HAZ properties
- Level of Hydrogen charging

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# The Story of SOHIC

## Conclusions

History of SOHIC described

Case Histories presented

New Test Method Outlined

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**Thank You**

**Any Questions**

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