



### 2-days Online Live Training Course

## P91/P92 Steels - Fabrication, Welding, Heat Treatment, Quality Check, Damage Mechanisms, Plant Experience & Integrity/ Life Assessment

P91-P92 COURSE

Acronym: **P91/P92 Course**

**Dates:** 13 – 14 July 2021

**Venue:** Online (from London)



Type IV cracking on the F91 side of a weld between an F91 forged transition bottle and a T91 tube (48mm OD) taken from Ref [2].

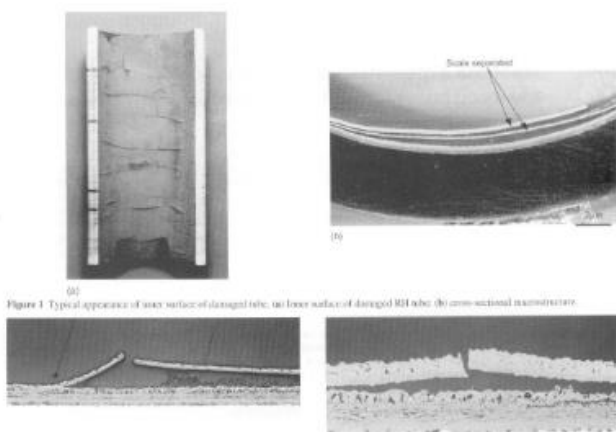
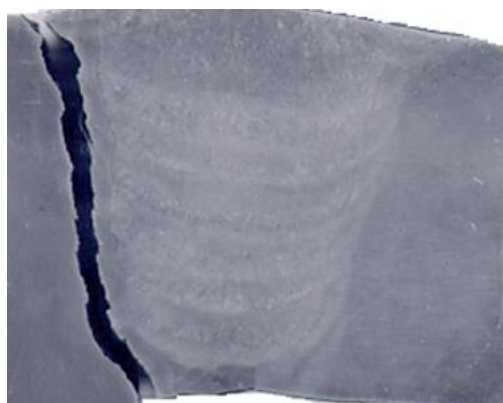
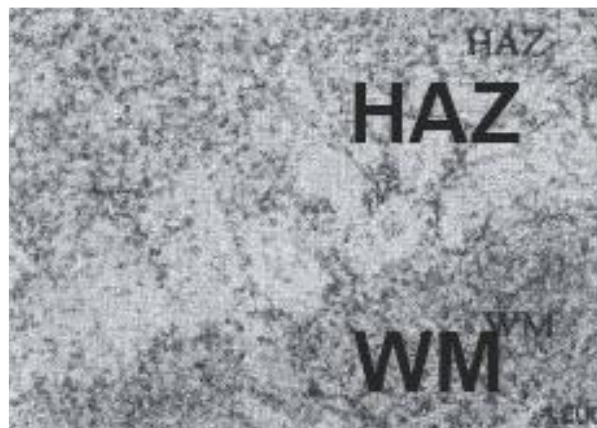
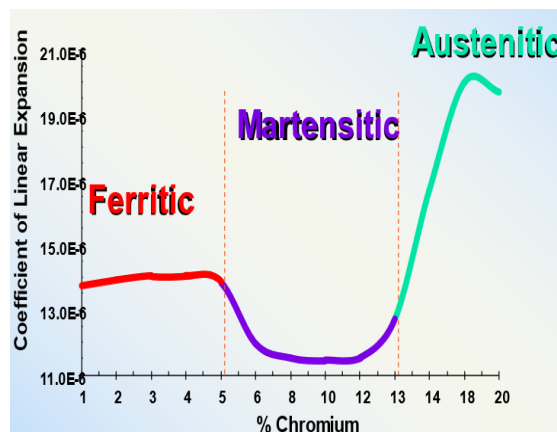


Figure 1 Typical appearance of inner surface of damaged tube, (a) inner surface of damaged RH tube, (b) cross-sectional microstructure.



P91 & P92 Training Course

## ABOUT THE COURSE

ETD has been regularly organising P91 and P92 courses in the UK and many other countries of the world including USA, South Africa, Australia, Europe, South East Asia and the Middle East over the last 20 years. These are well established and popular courses. Indeed, ETD was the first company to draw attention to the importance of the heat treatment, fabrication and quality check of these materials and how to identify problems when they occur and how to rectify these.

Each course is updated with the latest information and the latest industry and research experience. **Day 1** of the course will discuss the material properties and the importance of correct heat treatment. This will be followed by the plant experience worldwide. **Day 2** will focus on the weldment behaviour and how this may affect the vulnerability of the welded components to Type IV cracking and failure. This will be followed by the latest in component inspection and condition/ life assessment methodologies.

## ABOUT THE ORGANISER

**ETD Consulting** is a UK based engineering and consulting company specialising in life assessment/extension, Fitness-for-Service, RBM/RBI, RCM, plant cost analysis and benchmarking, inspection, maintenance, materials and engineering issues in all types of power generating and processing plant. ETD provides these services to plant owners and operators in Europe, Middle East, Asia, Australia and Africa.

In addition to its *main business of technical consulting, plant inspection and their condition/ life assessment*, ETD regularly organises training courses in power, petrochemical, oil, gas and other industrial sectors as a part of its programme on *technology transfer to industry worldwide*.

In the recent past ETD has organised various international workshops/ courses/ conferences in the UK, a number of other European countries (Germany, France, Portugal, Italy), Middle East, Far East, South Asia, Canada and the USA. The issues involved in these courses covered conventional and CCGT power plant component life assessment and failure analysis; boiler and HRSG design, maintenance and inspection; high temperature plant materials behaviour; plant component safety and durability; performance of in-service welds and weld repairs; power plant cycling - technical and cost issues; boiler and turbine maintenance; petrochemical and refining plant issues; and, power plant bench marking for performance, O&M costs and risk based maintenance and inspection (RBMI).

ETD's *consulting services* are backed-up by the ETD's *technology development programmes* in which ETD has been leading and co-ordinating a number of large leading edge international industry initiatives (supported by industry from North America, Japan, Europe and elsewhere, or by funding agencies such as the European Commission and the UK government). These have covered issues related to the assessment and improvement of high temperature plant performance, materials, plant design, and plant maintenance, repair, inspection and monitoring strategies. The company has also carried out or participated in leading edge projects on P91 weld repairs, crack assessment, plant integrity issues and has only recently carried out and concluded reviews of T/P23, T/P24 and P/T91 performance in power plants worldwide.

ETD has also prepared a number of guidelines and software packages for power plant boiler, HRSG and turbines operations, inspection, monitoring, assessment of cracks and component life in general. It has also produced guidelines for its clients on power plant condensers.

For further information, please visit our website:

[www.etd-consulting.com](http://www.etd-consulting.com) Or, write to: [enquiries@etd-consulting.com](mailto:enquiries@etd-consulting.com)

## Day 1

# Understanding Material Properties, Microstructure, Heat Treatment, Material Quality Checks, Codes/Standards and Plant Experience

P91-P92  
COURSE

**0745-1400h** (all times are UK, please make sure to join at the right time from your time zone).

**Join Zoom meeting at: 0745h (UK time)**

**Introduction to the course and the proceedings of the day** (0745-0800h)

### Module 1: MATERIAL PROPERTIES AND HEAT TREATMENT

0800 – 1030 h (with 15 min. break)

*Presenter: **Dr D Robertson***

#### **Objective**

To develop a better understanding of the underlying concepts and basis of P91 development, its properties, the effect of heat treatment, chemical composition etc.

#### **Specific topics will include:**

- The effect of heat treatment (austenitising/ normalising and tempering) on microstructure.
- The effect of heat treatment on material strength, creep strength, hardness and ductility.
- The effect of chemical composition details and what to look for.
- P91/ P92 materials specifications - European, ASME, other codes, practices, recommendations, standards & their differences, and best available practices.
- Quality control and checks required when receiving material. Acceptance tests of components, hardness, microstructure etc.
- Potential sources of materials data.

**Major Break: 1030 – 1115h** (45 mins.)

Presenter: **Dr David Allen**

**Objectives**

To provide an overview of experience with P91 / P92 in power plant, including “Type IV” weld HAZ creep cracking and failures in service, the identification and elimination of “aberrant” mis-heat-treated P91/ P92 material, and recommendations for the purchase, design, installation, management, repair and replacement of P91/ P92 plant components.

**Specific topics will include:**

- What can go wrong?
  - Premature “Type IV” cracking at welds
  - “Aberrant” soft, weak parent materials
- What can we learn from worldwide plant experience with P91/P92?
- How can we write purchase specifications which will avoid buying sub-standard material?
- How can we monitor manufacture and installation to eliminate “aberrant” material?
- How should we inspect and monitor P91/P92 components during their service life, and will flexible operation bring new problems?
- When we find soft material or cracking in service, what can we do to maintain safety without excessive outage or repair costs?
- When we need to replace components prematurely, can we improve material selection and/or design, so that the problems do not simply recur again?

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**Discussion / Questions/ Answers 1330 – 1400h**

## Day 2

### **Understanding Material Welding, Welded Component Behaviour, Component Inspection & Integrity / Life Assessment**

**0745-1400h** (all times are UK, please make sure to join at the right time from your time zone).

**Join Zoom meeting at: 0745h (UK time)**

**Introduction to the course and the proceedings of the day** (0745-0800h)

#### Module 3: Welding and Welded Component Behaviour

*0800 – 1030 h (with 15 min. break)*

*Presenter: Dr D Robertson, ETD Consulting, UK*

#### **Objective**

To create an understanding of the welding and pre- and post-weld heat treatment requirements and the criticality of the precise control required for this steel. These issues will refer to industrial experience to date.

#### **Specific topics will include:**

- Suitable welding procedures, pre-and post-weld heat treatment, weldment microstructures and properties; the Type IV zone
- Type IV cracking; weld strength/ life reduction factors.
- Weld repair issues.
- Dissimilar metal weld issues (P91/ P92 to low CrMoV steel welding, P91/ P92 to austenitic stainless steel welding), the effect of cycling and lessons from plant experience.

**Major Break: 1030 – 1115h**

**Module 4: P91/ P92 Component Inspection & Integrity/ Life Assessment**

*1115 – 1330 hrs (with 15 minutes break)*

*Presenters: Dr Ahmed Shibli, Dr David Robertson*

**Objectives**

To understand how P91/ P92 component integrity can be assessed. What are the available techniques and the advantages that they may offer. This includes a better understanding of the basic principles of oxidation in steam and its effect on tube over-heating and cracking/ failure.

**Specific topics will include:**

- Late cavitation development due to creep.
- Ductility and hardness issue.
- Type IV failures and their early detection.
- NDE techniques and their use for life assessment.
- Potential of the use of new NDE type techniques.
- Developments in Europe and Japan for life assessment of P91/ P92 component integrity/ life assessment.

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**Discussion / Questions/ Answers    1330 – 1400h**



**Dr David Robertson**, Lead Metallurgist, ETD Consulting, UK



**Experience**

Dr Robertson has over twenty years experience of materials used in the power, petrochemical and other industries. Since 2004, Dr Robertson has been working for ETD Consulting on projects related to high-temperature plant integrity and life assessment, materials and welding issues, and root cause failure analysis. Through his work, Dr Robertson has gained extensive experience of the materials used and damage/failure mechanisms in high-temperature plant. He also has considerable experience in examination and interpretation of metallographic replicas in order to assess metallurgical damage and degradation (creep cavitation, spheroidisation, etc). Dr. Robertson has been co-ordinating the ‘International P91 Users Group’ since it was formed by ETD in 2006 to better inform international industry about the issues related to use of grade 91 steel. Over the last 20 years or so Dr Robertson has prepared a number of Guidelines on P91 and P92 use in industry.

**Education:** Dr. Robertson gained his qualifications in metallurgy and materials at Imperial College, London.

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**Dr David Allen**, Principal Engineer, ETD Consulting, UK



Dr David Allen spent over 20 years at E.On working on high temperature materials and welding research and power plant applications, and has now joined ETD. David was the Chairman of the European Creep Collaborative Committee (ECCC) until recently and has managed several ECCC projects. David’s main interests have been in high temperature performance of power plant alloys, creep failure of high temperature weldments, development of novel materials for advanced high temperature applications, and leading collaborative R&D projects within the UK and Europe.

**Achievements include:**

- Development of a predictive equation to estimate the safe creep life of mis-manufactured P91 components from simple in-situ hardness data.
- Development of novel design approach to avoid premature weld cracking in power plant.
- R&D projects on advanced MARBN steels and on novel electromagnetic inspection technology

**Education:** David Allen obtained a Honours Degree in Metallurgy and Science of Materials and a D.Phil postgraduate qualification from the University of Oxford.

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**Dr Ahmed Shibli**, Director, ETD Consulting, UK



Dr Ahmed Shibli is the Director of European Technology Development and is a practising metallurgist. He has led and co-ordinated a number of European and International Industry projects especially on P91 and P92 steels and their behaviour for the past 20 years and has written a number of reviews and conducted training courses on these steels in Europe, USA, Asia and elsewhere. His P91 and P92 large Group Sponsored Projects (GSPs) include one on inspection, life and integrity of in-service P91 and P92 steels and the other on P91 of ‘aberrant’ or ‘abnormal’ heat treated steels. Thus he has an excellent and well recognised expertise in P91 research and industry experience and new developments in this area.

**REGISTRATION FORM**

(Please complete and email back)

**P91-P92 Training Course**

*Date: 13 - 14 July 2021*

*Venue: Online from London*

**Registration Fee:** Covers delivery of the course & provision of presentations in pdf format (Fees shown are in GB Pounds).

Please put 'x' in the relevant box and show the total payment.

	<b>Reduced Fee</b> (Until 14 June 2021)		<b>Full Fee</b> (From 15 June 2021)	
Registration Fee	£350		£400	
Please show here (no. of attendees x £ ): _____			<b>Total Amount Payable = £</b> _____	

**How to Pay:** When paying please quote reference 'P91-P92 Course' and the ETD invoice number (if this was issued):

1) **By bank to bank transfer** to: European Technology Development Ltd.

(ETD bank account details will be provided on request)

2) **Credit Cards:** Payment information will be provided on request.

*When registering, please state below how you paid or intend to pay:*

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All Registration & Payment enquiries to: [enquiries@etd-consulting.com](mailto:enquiries@etd-consulting.com)

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**Attendee(s) Details**

Your **title** and **name:**

Company:

Job Title (optional):

Address:

Phone:

E-mail:

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**Address for Registration:**

Please email the required information/ completed form to: [enquiries@etd-consulting.com](mailto:enquiries@etd-consulting.com)