INVENTORY OF ON-GOING HIGH TEMPERATURE MATERIALS RESEARCH ACTIVITIES IN EUROPE

SECTION 2: MECHANICAL PROPERTIES

COMMISSION OF THE EUROPEAN COMMUNITIES
Joint Research Centre, Petten Establishment
High Temperature Materials Information Centre

For further information please contact:

Commission of the European Communities
Joint Research Centre, Petten Establishment
High Temperature Materials Programme
Information Centre
P.O. Box 2
1755 ZG Petten (N.H.), The Netherlands

Tel. 31/2246/5235 M. de Groot

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SECTION 2: MECHANICAL PROPERTIES

Coordination: B. Bathe
Scientific Evaluation: J. Bressers
V. Guttmann

EUR 8637 EN

Published by

COMMISSION OF THE EUROPEAN COMMUNITIES
Directorate-General 'Scientific and Technical
Information and Information Management'
Bâtiment Jean Monnet
LUXEMBOURG

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Introduction

In the frame of the High Temperature Materials (HTM) Programme of the Commission of the European Communities, carried out at the JRC, Petten Establishment, an Inventory of HTM research in Europe is being established. Inventories facilitate identification of areas where cooperation should be promoted and additional R & D actions be stimulated.

The present volume contains the second of the Inventory, devoted to Mechanical Properties of HTM's. Further sections are under preparation: Section 3 will deal with Advanced Ceramics.

Section 1: HTM-Corrosion* is already published and is available upon request.

This section comprises information obtained by means of an inquiry carried out in 1982, and by personal communication.
It lists on-going research projects with indication of the performing organisations and the names of the scientists involved in this research.
The list is arranged in alphabetic order per country and organisation. Replies in languages other than English have been translated.
Access to specific research activities is facilitated by indexing per type of materials application/technology, type of material, type of research topic and the involved scientists.

The JRC, Petten Establishment appreciates the willing contribution of all the organisations and scientists who shared in the realisation of this second section and would welcome support for the preparation of future editions.

*) *EUR 6919, revised edition 1981 - Inventory of On-Going High Temperature Materials Research Activities in Europe*
Section 1: Corrosion.
ECSC-EEC-EAEC Brussels-Luxembourg, 1981

Legend

This Inventory presents information on research projects, currently carried out or planned in industrial firms, universities and research organisations in Europe.
The information is arranged in alphabetic order per country and organisation.
Example of Organisation Listing (Entry)

SYSTEM	**EXAMPLE**
Country	DENMARK
Entry Number	14
Name of Organisation	Technical University of Denmark
Name of Dept./Inst.	Department of metallurgy
Address	Anker Engelundsrej 101
City	Ok-2800 Lyngby
Telephone Number	02-884022 [2]
Telex Number	(no indication) [2]
Name(s) of scientist(s)	K. Borggreen (1,2)
Project(s) [1]	14.1 Mechanical and high temperature properties of as - cast Hk 40 after 10.000 operating hours
Technological Application	Sterling Engine [2]
Materials involved	HK 40, IN 519 [2]
	14.2 Residual lifetime study of low allogned steels Power Stations 14 Mo V6 3; 13 Cro Mo 44

[1]) The System Denominations except of [1]) will not be indicated throughout the Inventory
[2]) If indicated

(1) **Oesterreichisches Forschungs-Zentrum Seibersdorf**
Institut für Metallurgie
Lenaugasse 10
A-1082 Wien

H.P. Degischer (2)
H. Konvicka (3,4)
W. Neumann

Project: (1) PNP Materials Testing: Long term creep test and corrosion in process-gas between 800 and 950 °C.

(2) Influence of time and temperature on the structural stability of Alloy 800 type steels.
P.N.P.
Alloy 800

(3) Compatibility of Fe-Cr-Ni base alloys (between 15 and 70% Ni) with dynamic liquid sodium at 730°C with special attention to Ni and Carbon mass transfer.

(4) Compatibility of austenic and ferritic steel and refractory metals with liquid lithium at 400 - 600°C.

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(2) **Montanuniversität Leoben**
Metallkunde - Werkstoffprüfung
A-8700 Leoben

R. Danzer (1-3)
N. Nechtelberger (2)

Project: (1) Life time prediction for components under high temperature fatigue conditions.
Gas Turbines; Fundamental
IN 738LC

(2) Thermoshock behaviour.
Die Cast Metal
X40CrMoV51

(3) Short term creep and creep deformation under cyclic conditions.
Fundamental
X40CrMoV51

---

(3) **Technische Universität Wien**
Insti. fur Allgemeine Physik
Karlsplatz 13
A-1040 Wien

P. Braun (1)
H. Stori (2)

Project: (1) Investigations on the surface composition of carbides under ion-bombardement.
Fusion; Fundamental
WC; TaC; TiC

(2) Surface hardening by physical vapor deposition.
Tools
TiC; TiN, AL_2O_3

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(4) **Universität Wien**
Phys. Chemie - Mat. Wissenschaft
Wahringerstrasse 42
A-1044 Wien

R. Stickler (1,2)
B. Weiss (1,2)

Project: (1) Investigation of HCF behaviour and crack growth in Ni-base superalloys.
Gas Turbines
IN 738; IN 792; U720

(2) Investigation of HCF-behaviour and crack growth in Mo-base alloys.
He-Gas Turbines; Fundamental
Mo; MoW; Mo-TZM

---

(5) **Vereinigte Edelstahlwerke AG**
Mechanische Prüfung-Dauerfestigkeitslabor
Postfach 10
A-8605 Kapfenberg

F. Kreitner (1,2)
N. Mitter (1)
N. Schmid (1)

Project: 1 Investigations of the influence of trace elements and the deformation conditions on hot deformation and recrystallisation behaviour of superalloys.-Gas Turbines NIM. 90; IN 901; Udimet 520

2 Creep tests on fabricated Ni-and Co-base alloys. Tools; Turbineblades; - Discs

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(6) **Vereinigte Edelstahlwerke AG**
Versuchsanstalt und Entwicklung, TQT5
A-2630 Ternitz

H. Aigner (1)
J. Riedl (1)

Project: (1) Investigations related to the development of high temperature materials.
Coal Gasification; HTR-Process Heat
IN 800H; IN 802; Hastelloy X

---

(7) **NV Bekaert SA**
Research Centre
B-8550 Zwevegem

R. DeBruyne (1)
I. Lefever (1)

Project: (1) Mechanical properties of Bekinox (R) metal fibres and fibre products at medium to high temperatures.
High temperature filtration.
AISI 316L; IN 601; Fecralloy.

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(8) **Centre Et. Energie Nucleaire**
Metallurgie (SCK/CEN)
Boeretang 200
B-2400 Mol

F.G. Casteels (1,2)
W. Goossens (2)
F. Moons (3)
M. Snykers (3)
M. Soenen (1,2)
H. Tas (1,2)
W. Vandermeulen (3)

Project: (1) Determination of the influence of dynam. lithium on creep and fatigue characteristics of aust. and ferr. steels, Ni-6V-4Al and TZM. - Fusion Techn. Research.
AISI 316, 316l; EM-12; Ti6Al4V; WN1.4922

(2) Influence of coal gasification environment on mechanical properties of construction materials for coal gasification plants.
Advanced structural materials.

(3) Influence of irradiation and helium on the fatique properties of materials for fusion reactors.
Fusion reactor technology.
AISI 316

---

(9) **C.R.M.**
Rue Ernest Solvay 11
B-4000 Liege

D. Coutsouradis (1-3)
M. Lamberigts (1-3)

Project: (1) Influence of the production route conditions on the creep properties of cast or wrought Nickel-base superalloys.
Gas Turbines.
Nickel Superalloys

(2) Mechanical properties of Nickel-base superalloys produced by powder metallurgy route.
Gas-turbines
Astoloy

(3) Characterisation of high-temperature alloys for advanced energy conversion systems.
Energy conversion
Fe-Ni-Cr-alloys

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(10) **LABORELEC**
Sect. 4, Ind. Phys.-Appl. Mech.
B.P. 11
B-1640 Rhode-St-Genese

M. Wolfs (1)

Project: (1) Calculation of residual life of various components in power plants. Working out of operation rules.
Drums-headers; thick-wall pipes; turbines.

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(11) **LABORELEC**
Sect. 6 Etude des Materiaux
B.P. 11
B-1640 Rhode-St-Genese

N. Stubbe (1)

Project: (1) Remnant life determination in creep.
Steam Turbines (Electricity Generation).
Cr-Mo-V-W-Alloys; Ferritic steels.

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(12) **Universite Libre de Bruxelles**
Metall. Physique, Cpt 19413
Ave. F. Roosevelt 50
B-1050 Bruxelles

J. Charlier (1)
J. Decerf (2)
J. Diltour (2)
J.P. Elinck (3)

Project: (1) Recrystallisation of chromium containing Yttria dispersion hardened ferritic steels.

(2) Dynamic recristallisation.

(3) Dependance of fracture mechanics parameters on the test frequency and temperature in fatique crack growth.

---

(13) **State University of Ghent**
Str. Mat. and Welding Technology
St. Pietersnieuwstraat 41
B-9000 Ghent

A. Dhooge (1,3)
W. Provost (3)
M. Steen (2,4)

Project: (1) Investigation of the hot-cracking susceptibility of different centrifugally cast alloys.
Petrochemical
HK 40; 20Cr 32Ni/Nb

(2) Restlife prediction by slow strain rate tensile tests at high temperatures.
Petrochemical; Fundamental.
20Cr 32Ni/Nb

(3) Data collection on low-cycle fatigue strength of different high temperature materials. (base and as-welded materials)
AISI 304H; Alloy 800H; IN 617

(4) Characterisation and prediction of life under creep-fatigue interaction by the strain-range partitioning method.
Fundamental.
AISI 304H; Alloy 800H; IN 617

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(14) **Techn. University of Denmark**
Dept. of Metallurgy - Bldg 204
Anker Engelundsvej 101
DK-2800 Lyngby

K. Borggreen (1,2)

Project: (1) Mechinical and high temperature properties of as-cast HK 40 after 10.000 operating hours.
Sterling Engine
HK 40; IN 519

(2) Residual lifetime study of low alloyed steels.
Power Stations
14Mo63; 13 CrMo44.

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(15) **Alsthom Atlantique-Belfort**
C.E.R.M.
F-90001 Belfort Cedex

N. Thauvin (1-5)

Project: (1) Effect of the microstructure on the fatique enduration limit of Hastelloy X at 675°C-notch sensitivity.
Gas Turbines
Hastelloy X

(2) Relaxation of steels used for bolts in steam turbines.
Steam Turbines
20CDV5.08

(3) Remnant creep life of steam turbine rotor after 100000 h of service.
Steam Turbines
25CDV5.11

(4) Creep of steam turbines blade steel.
Z20CDVNb11
Steam Turbines
Z20CDVNb11

(5) Creep characteristics of turbines casings after 100000 h of service.
Steam Turbines
18CDV4.10

(16) **C.E.A.-C.E.N.-Grenoble**
Dept. Met. Serv. et Radiometall
85X
F-38041 Grenoble Cedex

J. Gregoire (4)
N. Lopez (3)
N. Mathiot (1-4)
G. Robert (1,2)
G. Saintfort (1-4)

Project: (1) Relation between creep and microstructure.
Fundamental
AISI 316

(2) Creep, fatique and creep-fatique damage in Alloy 800.
Nuclear Energy
Alloy 800

(3) High temperature fatique crack growth in Alloy 800.
Nuclear Energy
Alloy 800

(4) Creep properties in carburising-sulphidising environment.
Coal Conversion.
Austenitic and Ferritic Steels

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(17) **C.E.A.-C.E.N.-Saclay**
DESICP DGI SEPCP SSDP
B.P.2
F-91191 Gif sur Yvette Cedex

J. Charpin (1,2)
N. Schnedecker (2)
M. Yvars (1)

Project: (1) Development of refractory materials having good thermal shock resistance and good high temperature mechanical properties. - 1. Wall of Tokomaks.
Carbons; Graphites; Ceramics

(2) Caculation and development of plasmasprayed single & multilayer coatings; required HT-qualities; good thermal shock resistance; adherence and elasticity.
Surface Prot. - Ceramics; AL_2O_3; TiO_2; Zirc.

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(18) **C.E.A.-C.E.N.-Saclay**
Dept. de Techn. Serv. RMA-GMM

B.P.2
F-91190 Gif sur Yvette

P. Blanchard (9)
M.F. Felsen (1,8,11)
J.P. Gauthier (6)
P. Lemoine (7)
M. Mottot (2,3,4,11)
P. Petrequin (1-11)
P. Soulat (10)
J. Tortel (5)

Project: (1) Creep of metallic materials.
Nuclear Energy.
316-CR-Mo; 9Cr2Mo; Alloy 800

(2) Low cycle fatique and creep-fatique interaction, damage development.
Nuclear Energy
316

(3) Influence of frequency on fatique crack growth.
Nuclear Energy
316 and Weldings

(4) Creep and creep fatique crack growth.
Nuclear Energy

(5) Data collection on 316; Alloy 800; 9Cr2Mo; 21/4Cr1Mo; austenitic weldings.
Nuclear Energy

(6) High cycle fatique of Alloy 800 at high temperatures - Effect of mean stress.
Nuclear Energy
Alloy 800

(7) Thermal fatique behaviour of bimetallic welds.
21/4Cr1Mo - 316

(8) Effects of temperature cycling on creep.
316 - 304

(9) Biaxial fatigue behaviour under tension/torsion condition.
Nuclear Energie
316

(10) Fracture mechanics (J 1C - J Da) of austenitic steels and welds.
Nuclear Energy
316 - Weldings

(11) Description of relaxation curves in creep deformed material.
Nuclear Energy
316 and Weldings

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(19) **C.N.R.S.**
Centre Rech. sur la Physique des Hautes Temperatures
10, Av. de la Rech. Scientifique
F-45045 Orleans Cedex

F. Cabannes (1,2)

Project: (1) High temperature creep.
Oxide Ceramics

(2) Shock and thermal fatigue.
Foundries
Refractories

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(20) **C.N.R.S.**
Lab. de Physique des Materiaux
1, Place Aristide Briand
F-92190 Meudon-Bellevue

J. Cadoz (1-4)
J. Philibert (1-4)

Project: (1) High temperature plastic deformation of single crystals of AL_2O_3 alpha.
Fundamental
AL_2O_3

(2) High temperature deformation and creep cavitation of polycrystalline SiC.
Fundamental; Thermomechanical Applicat.
SiC

(3) In-situ electron microscopic study of the plastic deformation of oxides.
Fundamental
NiO; MgO; AL_2O_3

(4) Mechanisms of the increase in toughness of ceramic composites by means of microcracking.
Fundamental; Thermomechanical Applicat.

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(21) **Creusot-Loire**
Centre de Recherches d'Unieux
B.P. 34
F-42701 Firminy Cedex

C. Pichard (1)
P. Poyet (2,3)

Project: (1) Problem of the deformation at high temperature by creep of large cast pieces made of austenitic-ferritic stainless steel. - Petrochemical
Stainl. Steels with 35/60% of Ferrite

(2) Thermal insulation, at 800°C, of stainless steel exhaust pipes.
Large Diesel Engines
Glass, Refractories; composites

(3) Corrosion of steels in liquid Sn-Pb-Al-Zn environnent.

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(22) **E.N.S. de Ceramique Industrielle**
Lab. des Materieux Ceramiques
47-73 Rue Albert Thomas
F-87065 Limoges Cedex

J.L. Besson (2)
P. Boch (1,4)
P. Lefort (3)

Project: (1) Thermal shock resistance of ceramics used for thermomechanical applications.
Heat Engines
Nitrides; Oxides

(2) Creep studies of nitride ceramics.
Heat Engines
Sialons

(3) Optimisation of the sintering process of carbonitride ceramics.
Heat Engines
Carbides

(4) Development of zirconia-based ceramics with high tenacity.
Heat Engines
Zirconium products and special liners

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(23) **E.N.S. de Chimie de Strasbourg**
Dept. Science des Materiaux
1 Rue Blaise Pascal
F-67000 Strasbourg

A. Clauss (1)

Project: (1) Dynamic strain ageing in alloys.
Fundamental
Niobium alloys

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(24) **E.N.S. de Chemie de Toulouse**
Lab. de Metallurgie Physique
118 Route de Narbonne
F-31077 Toulouse Cedex

F. Dabosi (1-3)
B. Pieraggi (1-3)

Project: (1) Study of the oxidation and of the corrosion of directionally solidified composites.
Gas Turbines
COTAC 744 - Alloy base Ti

(2) Interaction between corrosion and mechanical stress at high temperature.
Gas Turbines
Udimet 500; IN 738

(3) Characterisation of metal-oxide interfaces.
Fundamental
Ti-and alloys; Ni-and alloys

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(25) **E.N.S. de Mines de Paris**
Centre des Materiaux
B.P. 87
F-91003 Evry Cedex

J. Bienvenue (1,2)
D. Broussaud (5-7)
J.P. Henon (12,13)
G. Lesoult (3,4)
A. Pineau (14,15)
G. Pomey (1-15)
L. Remy (4)
J.L. Strudel (8-11)

Project: (1) Mechanical properties of powder metallurgical Nickel-base superalloys in relation to production conditions.
Aerospace
Ni-MP-base superalloys

(2) Protection against sulphur corrosion (liquid and vapour).
Energy Production
Aluminide-coated Inox 321

(3) Study of microporosity formation in precision cast parts. Effect of recycling.
Aerospace
Ni-base superalloys

(4) Effect of solidification structure on the isothermal and thermal fatique properties of cast Nickel-base superalloys.
Aeropace

(5) Study of subcritical fatique cracking of SiC and $Si_3 N_4$
Gas Turbines

(6) Study of rupture characterisation methodology of fiber reinforced ceramic composites.
Fundamental
Ceramics, Ceramic Composites

(7) Wear mechanisms in ceramics.
Car Engines
$AL_2 O_3$, $Zr O_2$, SiC

(8) Creep crack and cavity initiation in powder metallurgical Nickel-base alloys.
Turbine Discs
Ni-PM-base superalloys

(9) Effects of thermal and forging treatment on the mechanical properties of PM Nickel-base superalloys.
Turbine Discs
Ni-base superalloys

(10) Role of composition of Nickel-base superalloys.
Turbine Blades

(11) Creep and relaxation under small loads in 316-type stainless steels.
Nuclear Materials
Austenitic steels

(12) Corrosion of protected superalloys under successively reducing and oxidising conditions.
Aerospace
Ni-base superalloys

(13) Environmental effects on hot cracking.
Aerospace
Ni-base superalloys

(14) Fatique and creep-fatique cracking in forged superalloys.
Aerospace
Ni-base superalloys

(15) Fatique-creep-oxidation interaction.
Nuclear Materials
316

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(26) **E.N.S. des Mines de Saint-Etienne**
Dept. Materiaux et Ingenierie
158 Cours Fauriel
F-42023 Saint Etienne Cedex

N. Driver (1,2)
G. Fantozzi (5)
J. Le Coze (3)
F. Thevenot (4,5)

Project: (1) High temperature low cycle fatique crack initiation mechanisms (T<800 °C).
Fundamental; Nuclear Power Stations Austenitic steels

(2) High temperature low cycle fatigue (T<1000 °C) in controlled atmospheres.
Fundamental; Petrochemical; Coal Gasif.
Refractory alloys

(3) Corrosion under stress:
— Caustic environment 350°C, 150 bar,
— Low strain rate, tensile testing in controlled atmospheres.
— Nuclear; Electrol.
Stainl. steels and Inconels

(4) Improvement of the high-temperature mechanical properties by surface treatments.
Carbon-steels; Cr; Inox

(5) High temperature mechanical properties (<2000 °C) of special, single phase ceramics and of composites.
Nuclear Power Station
SiC

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(27) **Societe Fives-Cail Babcock**
Et. Materiels Thermiques
80 Rue Emile Zola
F-93123 La Courneuve

P. Madamour (1)

Project: (1) Influence on the HT-mech. properties (in part. creep-propert.) of carbide coalescence res. from acc. overheating in heater and superheater tubes.- Steam generation
AFNOB; 10 CD 9-10; 15 2-05; 15 D 3

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(28) **Societé Francaise de Ceramique**
Serv. Refractaire-Analytiques
23 Rue de Cronstadt
F-75015 Paris

H. Le Doussal (1-8)

Project: (1) Study of the stress contributions in refractory constructions.
Metallurgical process; Petrochemical.
Silica-Alumina-; Alumina-based refractor.

(2) Determination of flexure resistance in neutral and/or reducing atmospheres up to 1600 °C.
Metallurgical Process; Gasification; SiC; $Si_3 N_4$; Si-Oxinitrides; Al-Graph.

(3) Influence of microstructure on the properties of insulating ceramics.
Thermal Insulation; Energy Saving
Silica; Alumina-Silica

(4) Study of the tenacity of ceramics.
Fundamental
Alumina

(5) Study of the fracture of multiphase aluminide ceramics.
Metallurgical Process; Gasfication
Alumina; Alumina- Chromia

(6) Hot tensile properties of ceramics.
Glass Manufacture; Metallurgical Process
Alumina-Zirconia

(7) Stress analysis by finite element methods.
Refractories

(8) Effect of temperature on the tenacity of ceramics.
Metallurgical Process; Motors
SiC-Si_3N_4; Alumina

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(29) **Imphy SA**
Acieries d'Imphy
F-58160 Imphy

J.H. Davidson (1)
J. Morlet (1)

Project: (1) Effect of thermomechanical treatment on the high-temperature low-cycle fatique resistance of powder metallurgical superalloys.
Turboreactors; Rene 95

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(30) **I.N.S.A.**
Groupe d'Etudes de Metallurg.
Phys. et de Phys. des Materiaux
20, Ave. Einstein
F-69621 Villerbanne Cedex

G. Fantozzi (1-4)
N. Rouby (1)

Project: (1) Investigation of thermal fatigue of ceramics by acoustic emission and elastic modulus measurement.
Heat Engines
Si_3N_4; SiC; AL_2O_3

(2) Mechanical behaviour of thermomechanical ceramics up to 1500 °C.
Heat Engines
Si_3N_4; Partly stabilized Zirconia

(3) Study of the plastic deformation of W2C up to 2200 °C.
Fundamental
W2C

(4) Study of the mechanical behaviour of WC-Co cermets.
Cutting Tools
WC-Co

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(31) **O.N.E.R.A.**
Dir. Scientifique des Materiaux
29, Ave. de la Division Leclerc
F-92320 Chatillon

N. Duret (1,2)
N. Khan (4)
N. Lasalmonie (5)
N. Marty (6)
R. Pichoir (1-6)
N. Rabinowitch (3)
N. Stohr (6)
N. Walder (6)

Project: (1) Creep properties of aluminized and aged IN 100.
Aero-gas turbines
IN 100

(2) Fatigue properties of single-crystalline aluminized and aged superalloys.
Monocrylline superalloys

(3) Creep and fatique behaviour of Gamma-Gamma prime-NbC solidified composites.
Aero-gas turbines
Gamma-Gamma' NbC Fibres

(4) Tensile, creep and fatigue behaviour of single crystalline superalloys.
Aero-gas turbines
Monocrystalline superalloys

(5) Creep of Al-rich TiAL.
Aero-gas turbines
TiAL

(6) Fatigue and creep behaviour of powder metallurgical superalloys.
Superalloys RSR

(32) **O.N.E.R.A.**
Dir. Struct.-Div. Rupt. Fatigue
29 Ave. de la Division Leclerc
F-92320 Chatillon s.Bagneux

G. Cailletaud (2,6)
Chaboche (1)
M. Chaudonneret (3)
R. Labourdette (1-6)
D. Novailhas (5)
H. Policella (4)

Project: (1) Plastic and viscoplastic behaviour under cyclic loading (tension-compression).
Fundamental
IN 100; IN 718; AISI 316

(2) Creep-fatigue damage and initiation.
Fundamental
IN 100; AISI 316

(3) Stress concentration in high temperature low cycle fatigue.
Fundamental
IN 100; AISI 316

(4) Crack initiation and propagation in non-isothermal creep-fatigue.
Gas Turbine Blades
IN 100

(5) Cycling behaviour under multiaxial (tension-torsion) loading.
Fundamental
IN 100; AISI 316

(6) Crack propagation under non-isothermal cyclic conditions (thermal fatique).
Gas Turbine Blades
IN 100

(33) **Soc. Eur. de Propulsion (S.E.P.)**
Lab. de Chimie Materiaux
B.P. 37
F-33160 St. Medard en Jalles

P. Lamicq (1-16)
N. Mace (1-16)

Project: (1) High temperature torsion.
Method
Carbon/Carbon

(2) High temperature tensile deformation.
Method
Carbon/Carbon

(3) Measurement of modules of elasticity by resonance.
Method
Composites

(4) High temperature thermal expansion.
Method
Composites

(5) Thermal shock resistance.
Method
Composites

(6) High temperature flexure.
Method
Composites

(7) Full characterisation of materials.
Propulsion; Use of ceramics
Carbon/Carbon; Composites

(8) Friction properties.
Brakes
Composites

(9) Rheological properties of materials.
Fundamental
Composites

(10) Fractography.
Fundamental
Composites

(11) Characterisation of fibres.
Method

(12) Shock resistance - Fracture.
Method
Composites

(13) Measurements of thermal diffusivity.
Method
Composites

(14) Behaviour (of composites) in oxidising atmospheres.
Method

(15) Ageing (of composites) in the atmospheres.
Method

(16) Full characterisation of novel materials
(carbon/carbon-composites)
Propulsion; Use of Ceramics

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(34) **Societé Stein Industrie**
1 Ter Rue Jules Guesde
F-5930 Lys-lez-Lannoy

A. Vanderschaeghe (1,2)

Project: (1) Creep fatique properties at high temperatures.
Fluidized Beds; Power Stations
Chromium alloys

(2) Data collection on fatigue crack initiation and crack propagation in the temperature range 500-1000 °C.
Fluid. Beds; Influence of sulphur atmosph.
FeNiCr-alloyed creep resistant steels.

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(35) **Univ. de Techn. de Compiegne**
Div. Materiaux et Sap.
B.P. 233
F-60206 Compiègne

F. Armanet (1,2)
C. Bathias (2,3,4)
G. Beranger (1,2)

Project: (1) Corrosion resistance of superalloys used in electrical resistance applications.
Fundamental and applied
FeNiCr-alloys + Y

(2) Corrosion under mechanical loads in complex environments of alloys with potential application in coal gasification.
Fundamental and applied.
FeNiCr-alloys

(3) Behaviour at high-temperature of blading materials used in helicopter gas turbine
Fundamental and applied.
Udimet 500

(4) Test frequency dependence of the creep-fatique interaction and high-cycle fatigue of two alloys used in the aeronautical industrie.
Gas Turbines
TA 6V-300 °C; U 500-700 °C

(36) **Université de Dijon**
Faculte des Sciences - Mirande
Lab. Rech. Reactivite d. Solides
B.P. 138
F-21004 Dijon Cedex

J.C. Colson (1,5,6)
M. Lambertin (3,4)
J.P. Larpin (3,4)
R. Oltra (1,5)
S. Toesca (2,6)

Project: (1) Stress corrosion of steels in chlorine containing environments.
FeNiCr + Mo; Ti

(2) Stress corrosion in sulpur-bearing environment.
Steel/CuZn

(3) Protection against corrosion in high-temperature sulphur bearing environments by cementation (Al-Si-Cr) and by the growth of protective oxyde scales.
Steel/CuZn

(4) High temperature corrosion of ferritic alloys in sulphur bearing atmospheres.
FeCr; FeCrAl; FeMnAl;FeCrMnAl

(5) Evolution of passive films in chlorine containing environment under plastic deformation - Relationship with crack growth-rate.
FeNiCr; Mo; Ti

(6) High temperature corrosion under deformation.
Fe; FeCrAl; FeNiCrAl

(37) **Université de Limoges**
Centre. Rech. et Etude Ceram.
123 Rue Albert Thomas
F-87060 Limoges Cedex

M. Billy (1,2)
P. Goursat (1,2)
J. Jarrige (1,2)
J. Mexmain (1,2)

Project: (1) Influence of imperfect densification on the mechanical properties. (rupture modulus-creep)
Turbo engines
$AL_3 N_4$; Sialon, SiYON

(2) Influence of the environment on the mechanical properties (rupture-modules-creep).
Turbo engines
$AL_3 N_4$; Sialon;SiYON

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(38) **Université de Franche-Comte**
Lab. Mec. Appl.-Eq. de Rheologie
F-25030 Besancon

P. Delobelle (1-7)
C. Oytana (1-7)

Project: (1) Physical aspects of high temperature creep: Role of atomic order; Role of second phases.
Fundamental
FeCo2V; AlSi; Ag-Hg; CuZn

(2) Constitutive laws. Study of creep under biaxial stress.
Fundamental
316; Beta'CuZn; Al

(3) Creep of stainless steels 316. Study in terms of internal stress.
Nuclear
316

(4) Creep of oriented eutectics.
Fundamental
CuAl; NiAl

(5) Creep and relaxation of plastic composites.
Connections
Glass-Epoxy

(6) Creep-fatigue interaction. Use of the constitutive laws (high temperature)
Nuclear; Fundamental
Inox 316

(7) Creep and fatigue in corrosive atmospheres.
Energy
Steels

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(39) **Université de Paris Sud**
Lab. de Metallurgie Physique
Bâtiment 413
F-91405 Orsay Cedex

R.W. Cahn (2)
A.M. Huntz (1)
R. Penelle (3)
S. Servant (4)

Project: (1) Relation between high-temperature oxidation resistance and oxide growth stresses- Action of external stress.
Electrical Resistance; Fundamental
FeCrAl; NiCr; FeNiCrAl

(2) Study of microcrystalline ferrous alloys.

(3) Low cycle fatique damage in 316 stainless steel between 300 °C and 600 °C.
Nuclear reactors
FeCrNiMo

(4) Hot mechanical properties (tensile, creep fatique) of Ti-and alloys, in particular of Ti 685.
Aerospace
Ti; 685; etc.

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(40) **Université de Rennes I**
Lab. de Chimie Beaulieu
Campus de Beaulieu
F-35042 Rennes Cedex

J. Lang (1)
P. Verdier (1)

Project: (1) Determination of the vitrous regime and measurement of density and viscosity.
Fundamental
Sialon - Systems

(41) **Bergbau Forschung GmbH**
Werkstoffentwicklung PNP WKV
Franz Fischerweg 61
D-4300 Essen 13

H.J. Schröter (1,2)

Project: (1) Creep deformation in air and in WKV-process gas.
Nuclear Process Heat; Coal Gasification
IN 617; HastelloyX; IN 800;
Mannesmann- Alloy (Dr. Weber, Mannesmann)

(2) Mechanical and physical properties of materials.

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(42) **Brown Boveri and Cie AG**
Zentr. Lab. fuer Werkstofftechn.
Postfach 351
D-6800 Mannheim 1

R. Bauer (2)
N. Gnirss (1)
K.W. Gruenling (2)
N. Jakobeit (2,4)
N. Pohl (1)
K. Schneider (3)

Project: (1) HTR-Programme:
— HCF behaviour,
— Fracture mechanisms,
— LCF-creep interaction.
Ni-and Mo-base HT-alloys

(2) Interaction of creep deformation and high temperature corrosion of gas turbine materials.
Gas Turbines
IN 738LC; IN 939

(3) HCF-behaviour of gas turbine materials:
Influence of corrosion and coatings.
Gas Turbines
Ni-Basis; UDS-IN 738LC; -IN 939; -IN792-5A

(4) Creep behaviour of gas turbines materials.
Gas Turbines
Ni-and Co-base alloys

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(43) **Dechema Institut**
Abt. Werkstoffe und Korrosion
Theodor Heuss Allee 25
D-6000 Frankfurt/M 97

A. Rahmel (1,2)

Project: (1) Creep behaviour of metals in coal gasification atmospheres.
Coal Gasification
IN 802; IN 802H; Manaurite 36X

(2) Long term tensile tests under constant strain rate conditions.
HT-Materials
IN 800; WN 1.4742; WN 1.4762

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(44) **Deutsche Lufthansa AG**
Mat. and Process Eng. Dept.
Postfach 300
D-2000 Hamburg 63

P. Malik (1)

Project: (1) Performance evaluation of HT-coatings for turbine blades of transport aircraft gas turbines.
HT-corrosion resistance
High strength Ni-base alloys

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(45) **DFVLR**
Inst. fur Werkstoff-Forschung
Linder Höhe
D-5000 Köln 90

W. Bunk (1-3)
N. Wirth (2,3)
N. Ziegler (1)

Project: (1) Thermoshock behaviour of ceramics (SiN; SiC)
Car- Gas Turbines
SN; SiC

(2) Coating procedures for metallic material for high temperature application.
Aircraft- Gas Turbines
SL

(3) Creep behaviour of high temperature materials.
SN; SiC; SL

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(46) **Dornier System GmbH**
Neue Techn. Angewandte Forsch.
Postfach 1360
D-7990 Friedrichshafen

N. Kucera (1,2)
N. Van Rensen (1,2)

Project: (1) GAST-technology programme:
Ceramic-metal-joints; temperature cycling; oxidation behaviour.
Solar Power
SiSiC

(2) Ceramic high temperature heat exchanger.

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(47) **Forsch. Inst. der Cremer Gruppe**
Postfach 1173
D-8633 Rodenthal

E. Gugel (1,2)
H.A. Lindner (1)
H.G. Nitzsche (2)

Project: (1) Characterisation of the mechanical behaviour of ceramics: Bending strength (20-1400 °C), fracture mechanics; life time prediction.
Gas Turbine; Otto/Diesel-Eng.
RBSN; HPSN; SiSiC; SSiC; HPSC

(2) Relationship between structural and mechanical properties.
Gas Turbine; Otto/Diesel-Engines
RBSN; HPSN; SSN; SiSiC; SSiC; HPSC

(48) **Forschungsvereinigung**
Verbrennungskraftmaschinen e.V.
Lyonerstrasse 16
D-6000 Frankfurt/M 71

H. Geisendorf (1-7)

Project: (1) Temperature cycling on axially symmetrical model bodies with circumferential notches.
(Prof. Kussmaul-MPA, Stuttgart)
Turbine Materials
28CrMoNiV49

(2) Influence of fatigue prop., oxidation and multistep exposure on the long term behaviour under strain cycling in the creep region. (Prof. Kussmaul)
Turbine Materials
13CrMo44, 28CrMoNiV49; CS-17CrMoV511

(3) Influence of macroscopic defects in large forgings on crack initiation under tensile stress with low load cycles. (Dr. Schuetz; IABG, Ottobrunn)
Turbine Materials

(4) Long term creep behaviour of high temperature strength gas turbine materials.
(Prof. Kloos; T.H. Darmstadt)
IN 100; IN 713C; Nimcast 739; Udimet 500; FSX 414; Nimonic 101; IN 718

(5) Crack growth in high temperature materials at elasticity exceeding conditions at high temperatures.
(Prof. Kussmaul; MPA, Stuttgart)
Turbine Materials

(6) Influence of structure and environment on the long term strain cycling behaviour .
(Prof. Kussmaul; MPA, Stuttgart)
Turbine Material
28CrMoNiV49; X22CrMoV121

(7) Influence of surface protection on the creep rupture strength of HT Ni-base alloys.
(Prof. Kloos; T.H. Darmstadt)
Turbine Materials
IN 738LC; IN 939; Udimet 520; IN 792

(49) **Fraunhofer Institut für Werkstoffmechanik**
F.G. Metallene Werkstoffe
Rosastrasse 9
D-7800 Freiburg

J.G. Blauel (1)
T. Hollstein (1)

Project: (1) Description of creep crack displacement in steels by means of fracture mechanics.
Power Plants; Turbines
Austenitic and ferritic steels

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(50) **Fraunhofer Institut für Werkstoffmechanik**
F.G. Nichtmetallene Werkstoffe
Rosastrasse 9
D-7800 Freiburg

W. Doll (1-3)

Project: (1) Investigation on the fatigue behaviour of SiC under specific solar conditions.
Solar Tower
SiSiC

(2) Determination of crack propagation parameters as a function of temperature.
Power Plant
SiC; Si_3N_4; AL_2O_3

(3) Investigation of the long term strength properties of ceramic materials containing residual stresses.
Gas Turbines
SiC; Si_3N_4

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(51) **HOBEC mbH**
Zentralabteilung Projekte ZAP
Postfach 110029
D-6450 Hanau

G. Luthardt (1)
D. Schoenfeld (1)

Project: (1) Development and characterisation of scales to prevent hydrogen and tritium permeation.
HTR: PNP
HastelloyX; IN 617; IN 800H

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(52) **Hoechst AG**
Werkst. Techn.-Metall. Werkst.
Postfach 800320
D-6230 Frankfurt/M 80

R. Buchsenschutz (1)

Project: (1) Investigation of the creep behaviour of high temperature alloys for chemical plant.
Petrochemical Industrie; Power Plants
40 various alloys

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(53) **Internat. Atomreaktorbau GmbH**
Abt. Anlagenwerkstoffe OE 9320
Postfach
D-5060 Bergisch-Gladbach 1

N. Breitling (1-5)
N. Leising (1-5)

Project: (1) Mechanical properties after long term service.
Nuclear Process Heat
IN 617; HastelloyX; Nimonic 86; IN 800H

(2) Creep behaviour and creep strength in air and He with defined impurity levels.
Nuclear Process Heat
IN 617; HastelloyX; Nimonic 86; IN 800H

(3) Fatique behaviour under HCF-and LCF-conditions with hold times in air and He with defined impurity levels.
Nuclear Process Heat
IN 617; HastelloyX; Nimonic 86; IN 800H

(4) Investigation of fracture toughness and creep-and fatique crack growth at high temperatures.
Nuclear Process Heat
IN 617; HastelloyX; Nimonic 86; IN 800H

(5) Creep and fatique tests under multiaxial stress conditions at high temperatures.
Nuclear Process Heat
In 617; HastelloyX; Nimonic 86; IN 800H

(54) **K.F.A.-Julich**
Inst. fur Reaktorwerkstoffe
Postfach 1913
D-5170 Jülich

F. Schubert (1,6)
H. Schuster (1-5)

Project: (1) Determination of creep properties under the environmental conditions of a HTR primary circuit.
HTR
IN 800H; HastelloyX; NIM86; IN 617

(2) Determination of creep properties in air (Collaboration with TH Darmstadt)
HTR
IN 800H; HastelloxX; NIM 86; IN 617

(3) LCF-investigations in air and HTR-He.
HTR
IN 800H; IN 617

(4) Hot tensile tests
HTR
Fe-Ni-Base; Ni-Base Alloys

(5) Establishing of a data bank (input of results of the Institute for Reactor Materials at KFA)
HTR
Fe-Ni-Base; Ni-Base Alloys

(6) Tubul. components under intern. pressure with superimp. tensile, compression and torsion deformation: Crack-growth, creep-buckling and -ratchetting at HT
HTR - IN 800H; IN 617

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(55) **Kernforschungszentr. Karlsruhe**
Institut fur Material- und Festkörperforschung I
Postfach 3640
D-7500 Karlsruhe
O. Götzmann (1)

Project: (1) Creep behaviour of metallic materials in corrosive atmospheres (halogens, including oxygen)
Nuclear; Fundamental
Austenitic Steels; Ti-Alloys; Zircaloy

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(56) **Kernforschungszentr. Karlsruhe**
Institut fur Material- und Festkörperforschung II
Postfach 3640
D-7500 Karlsruhe

H.U. Borgstedt (1-5)
S. Leistikow (3,6)

Project: (1) Influence of sodium on growth of welding defects under creep exposure.
FBR
AISI 304; WN 1.4948

(2) Influence of sodium on the fatique behaviour of structural materials.
FBR
WN 1.4958

(3) Determination of mechanical properties of oxid. Zircaloy 4 cladding material at medium and high temperatures under inert and oxidising conditions.
PWR - Zircaloy

(4) Influence of sodium on crack growth under cycling conditions.
FBR
WN 1.4948

(5) Influence of sodium on crack growth under creep conditions.
FBR
WN 1.4948

(6) Determination of the creep behaviour of stainless steel cladding tubes in hot steam at 800-1300°C.
PWR
WN 1.4970; WN 1.4981; WN 1.4988; WN 1.4876

(57) **Kraftwerk Union AG**
Ber. Technik Werkstoffe/TWCC
Postfach 011420
D-4330 Mülheim/Ruhr

F. Schmitz (1)

Project: (1) Hot corrosion and creep rupture properties in air of welds and brazings of superalloys.
Gas Turbines
IN 738LC

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(58) **M.A.N.**
Bereich neue Technologie (NT)
Dachauer Strasse 667
D-8000 München 50

H. Sprenger (1)
N. Zechmeister (2,3)

Project: (1) Investigation of the interaction of creep-fatique-oxidation to improve lifetime prediction methods.
HT-Heat Exchanger
IN 800H; IN 617

(2) Coating, alloying and densification of surfaces with high energy laser.
Engine-and Turbine Components

(3) Investigation of strengh properties under service conditions (up to 1000 °C).
Engine-and Turbine Components

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(59) **Max Planck Institut für Eisenforschung**
Max Planckstrasse 1
D-4000 Düsseldorf

H.J. Grabke (2-4)
K.E. Hagedorn (5)
H. Hougardy (5)
P. Neumann (1)
H. Riedel (1,7)
G. Sauthoff (4,6,7)
H. Vehoff (1)

Project: (1) Inprovement of lifetime prediction for steels subjected to creep-fatigue interaction in different gaseous atmospheres.
Fundamental
Cr-Mo-V-Steel; Austenitic Steel

(2) Influence of Niobium and Cer on creep and corrosion behaviour of high temperature alloys.
Fundamental
Alloy 800 .

(3) Improvement of creep rupture strength of structural materials for protective gas furnaces under carburising conditions and compressive deformation.
Industrial Furnaces; Fe-Cr-Ni-Alloys

(4) Investigations on the oxidation and creep behaviour of Fe-Al and Fe-Ni-Al-Alloys
Fundamental
Fe-Al-and Fe-Ni-Al-Alloys

(5) Influence of coating processes on the structural evolution in heat resistent Ni-base alloy after long time creep exposure.
Turbine Blades
IN 738LC; Udimet 520; IN 792

(6) Creep behaviour of precipitation strengthened ferritic model alloys above 650 °C.
Fundamental
Fe-Cr-NbC-and Fe-Cr-Mo-Ti-Alloys

(7) Recovery of ferritic steels after creep exposure.
Fundamental
13CrMo44; 10CrMo910; 14MoV63

(60) **Max Plank Institut für Metallforschung**
Inst. für Werkstoffwissenschaft
Seestrasse 92
D-7000 Stuttgart 1

V. Gerold (1-5)
R.F. Pabst (1-5)

Project: (1) Plastic deformation at high temperatures.
Fundamental
$AL_2\ O_3$; SiC

(2) Fundamental mechanisms of high temperature fatigue.
Fundamental
$AL_2\ O_3$; SiC

(3) Stress induced transformation and ageing of partially stabilized ZrO_2 at high temperatures.
Fundamental
ZrO_2

(4) Statistical method and subcritical crack growth at high temperatures.
Fundamental
$AL_2\ O_3$; SiC

(5) Fracture mechanics of ceramics at high temperatures.
Fundamental
$AL_2\ O_3$; SiC; ZrO_2

(61) **Max Planck Institut für Metallforschung**
Pulvermetallurgisches Lab.
Heisenbergstrasse 5
D-7000 Stuttgart 80

N. Claussen (3,4)
G. Petzow (1,2)

Project: (1) Optimization of SiC-material properties.
Car Gas Turbines
SiC

(2) Determination of thermodynamical and mechanical properties, and structural characterisation of Si_3N_4-Ceramics.
Car Gas Turbines
Si_3N_4

(3) Transformation induced strengthening of ceramic materials by means of ZrO_2 additions.
Car Engines; Heat Engines
$AL_2\ O_3$; Mullit; Spinell; ZrO_2

(4) Ceramics with small coefficients of thermal expansion.
Heat Engines
Titanates; Glass Ceramics

(62) **Motoren und Turbinen Union**
GWA 1
Dachauerstrasse 665
D-8000 München 50

N. Froschhammer (1)
N. Konig (4)
N. Oswald (3)
J. Wortmann (2)

Project: (1) Mechanical properties of directionally solidified Ni-base alloys (columnar structure and single crystals).
Gas Turbines
IN 100; B-1914; M-200; M-002

(2) Mechanical properties of regenerated Ni-base alloys.
Gas Turbines
NIM 108; IN 100

(3) HCF-properties of repair welds of Ni-base alloys.
Gas Turbines
IN 713LC

(4) Correlation of microstructure and creep-rupture strength of cast Ni-base alloys.
Gas Turbines
IN 100

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(63) **Sigri Elektrographit GmbH**
Forschung/Technikum
Postfach 1160
D-8901 Meitingen

H. Boder (1,2)
H. Gruber (2)
N. Janssen (1)
G. Wilhelmi (1,2)

Project: (1) Development of materials to be used in the pebble-bed type reactor.
Materials development
Nuclear graphite

(2) Development of materials and CFC-tubes testing for hot gas pipes of the PNP-reactor.
Materials development
CFC

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(64) **T.H. Aachen**
Inst. für Eisenhuettenkunde
Templergraben 55
D-5100 Aachen

N. Dahl (1,2)
E. Schmidtmann (1,2)

Project: (1) Investigation of hot crack initiation during welding of IN 800 with filler material of the S-NiCr 19Nb type.
Welding
IN 800; S-NiCr 19Nb

(2) Investigation of hot crack initiation during welding of IN 800 with identical filler materials.
Welding
IN 800; S-NiCr 19Nb

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(65) **Thyssen Edelstahlwerke AG**
Forschunginstitut
Oberschlesienstrasse 16
D-4150 Krefeld 1

B. Huchtemann (3)
G. Lehnert (1,2)

Project: (1) Development of protective coatings for reformer tubes.
Nuclear Process Heat (PNP)
Fe-Ni-Cr-Alloys

(2) Influence of coatings on creep rupture strength.
Nuclear Process Heat (PNP)
Fe-Ni-Cr-Alloys

(3) Alloy development of heat resistant materials to be used for primary circuit compenents in a nuclear process heat plant (strength; toughness; creep propert.).
HTR - Fe-Ni-Cr-Basis; Ni-Basis

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(66) **Thyssen Giesserei AG**
Forschung und Entwicklung
Bessemerstrasse 80
D-4630 Bochum 1

A. Donner (1-3)

Project: (1) Directionally solidified high quality castings of superalloys and steels.
Fundamental
17/4PH; IN 939; C 73

(2) Influence of solidification parameters on segragation and mechanical properties of directionally solidified Ni-Cr-base superalloys.
Fundamental
IN 738C; IN 100

(3) High isostatic pressure for optimisation of mechanical properties of highly stressed components.

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(67) **Technische Universität Berlin**
Inst. Nichtmetall. Werkstoffe
Englischestrasse 20
Berlin

H. Hausner (1-5)

Project: (1) Fracture toughnessu of sintered SiC.
Gas Turbines; Engines; Refract. Industry
SiC

(2) Structural influence on the fracture behaviour of ceramic materials of the $AL_2 O_3$-M90-system.
Fundamental
$AL_2 O_3$

(3) Mechanical properties of SiC at high temperatures.
Refractory Industry
SiC

(4) Mechanical properties of $Si_3 N_4$ at high temperatures.
Gas Turbines; Engines; Refract. Industry
$Si_3 N_4$

(5) Mechanical properties of $Si_3 N_4$ at HT
Turbines; Engines
$Si_3 N_4$

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(68) **Ruhr Universität Bochum**
Inst. Für Werkstoffe I
Postfach 102148
D-4630 Bochum 1

E. Hornbogen (1-3)

Project: (1) Fundamentals of high temperature strength of superalloys.
Fundamental; Gas Turbines

(2) Influence of surface treatments (Shotpressing) on the fatique behaviour at various temperatures.
Fundamental; Gas Turbines

(3) Recrystallization of superalloys and age hardening with special consideration of the surface behaviour.
Fundamental; Gas Turbines

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(69) **Ruhr Universität Bochum**
Inst. für Werkstoffe II
Universitätsstrasse 150
D-4630 Bochum

H. Berns (1)

Project: (1) Toughness improvement of high speed steel.
Energy Research; Steel Programme
WN 1.2349

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(70) **Techn. Univ. Braunschweig**
Schweisstech.-Werkstofftechn.
Langer Kamp 8
D-3300 Branschweig

P. Assmann (1,2,5)
W. Kohler (4)
E. Lachmann (2,3)
TH. Lampe (6)
K.T. Rie (1-6)

Project: (1) High temperature behaviour of welded samples under LCF-conditions and waveform influence.
Power Plants; Containers
Low alloyed-and austenitic steels

(2) Determination of the interaction of fatique, creep and oxidation under LCF-condition at elevated temperatures.
Fundamental
13CrMo44; X8CrNiMoNb

(3) The behaviour of welds and substrate under LCF-conditions at elevated temperature.
Nuclear; Steam Boiler
Low alloyed-and austenitic steels

(4) Influence of a H2-environment on the fatigue behaviour of substrate and welds at room-and elevated temperatures under LCF-condition.
Nuclear; Turbines
Steel; Ni-base alloys

(5) LCF-behaviour of metallic materials under service conditions in corrosive environments at elevated temperatures.
Coal Gasification; Gas Turbines
Ni-and Fe-base alloys

(6) Influence of coatings on life time of high temperature components during hot gas corrosion under LCF-conditions.
Gas-, Steam Turbines
Austenitic steels; Ni-base alloys

(71) **Universität Erlangen-Nürnberg**
Werkstoffwissenschaften I
Martenstrasse 5
D-8520 Erlangen

W. Blum (6)
K. Engel (2,4,8)
B. Ilschner (1-4,8)
B. Reppich (5)
H.G. Sockel (7)

Project: (1) Creep behaviour and structural changes of a Ni-base alloy in a carburising atmosphere.
HTR
IN 617

(2) Strength, crack growth and structure of a Ni-base cast alloy in the range of 800-1000 °C.
Aircraft-Turbines
IN 100

(3) Creep rupture strength and the assesing of life-time of heat resistant ferritic steels under service conditions.
Steam Turbines
13CrMo44

(4) Creep behaviour of tubular tensile specimen under non-uniform temperature distribution.
Heat Exchangers; Cooled Turbine Blades
Ni-Cr-Alloys

(5) Strengthening mechanisms and creep behaviour of two phase Ni-base alloys.
Fundamental
NIM PE 16; NIM 90; IN 100

(6) Creep behaviour under cyclic tensile stresses.
Fundamental
IN 800H

(7) Morphology, kinetics and thermodynamical fundamentals of HT-corrosion in oxidising and carburising atmospheres under creep deformation.
Gas Turbines
HTR Ni-base alloys.

(8) Thermal fatigue at high temperatures in corrosive atmospheres.
Gas Turbines
IN 800H

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(72) **Universität Münster**
Inst. für Metallforschung
Domagkstrasse 75
D-4400 Münster

E. Nembach (1)

Project: (1) Hardening of Ni-base superalloys by Gamma' particles.
Fundamental
Ni-Alloys

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(73) **Universität GHS Siegen**
Inst. für Werkstofftechnik
Paul Bonatzstrasse 9-11
D-5900 Siegen 21

K. Detert (1,2)

Project: (1) Creep ductility of Cu-Ni-alloys.
Fundamental
KUNI 30Fe; CuAlZnFe; CuAl11Ni

(2) Determination of creep crack propagation in austenitic steels.
Steam Turbines
FeNiCr-Alloys

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(74) **Volkswagenwerk AG**
Forschung-Antriebstechnik
Postfach
D-3180 Wolfsburg

P. Rottenkolber (1)

Project: (1) Development of ceramic turbine components for car gas turbines.
Gas Turbines; Fundamental
SiC; $Si_3 N_4$

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(75) **Nat. Inst. for Higher Educat.**
Limerick

J. Bolton (2)
S. Hampshire (1,2)
M. Pomeroy (2)

Project: (1) Fabrication and properties of alpha' Sialon ceramics.
Gas Turbines
Sialons

(2) Corrosion of high-temperature materials, both metals and ceramics.
Energy Conversion Systems

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(76) **University College Dublin**
Merrionstreet
Dublin 2

M. Farmer (2)
S. Timoney (1)

Project: (1) Ceramic materials for diesel engine pistons and liners.
Applied Energy Conversion.
SiC (R.S.S.C.) Si_3N_4 (H.P.S.N.)
Glass Ceramic

(2) Friction properties of ceramic materials Engine Piston Applications SiC (R.S.S.C.); Si_3N_4(H.P.S.N.)
Glass Ceramic

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(77) **AGIP Nucleare SPA**
Laboratori
Via Sabbionara, 611
I-40059 Medicina

M. Boccalari (1-6)

Project: (1) Determination of creep properties under uniaxial and biaxial stress of IMFBR cladding tubes.
Nuclear plants
AISI 316 and its modif.; Zircaloy 2, 4

(2) Correlation between micro-structure (Texture) and mechanical characteristics of LWR cladding tubes.
Nuclear plants
Zircaloy 2, 4

(3) Determination of constitutive laws in the elastic and plastic range of materials for core-components of neclear reactors, their characterisation and qualification.
Nuclear - Austenitic steels

(4) Determination of creep properties of LWR cladding tubes under uniaxial and biaxial stress.
Nuclear plants
Zircaloy 2, 4

(5) Study of the embrittlement and corrosion by chemical agents and of the fracture of LWR cladding tubes.
Nuclear plants
Zircaloy 2, 4

(6) Correlation between chemical composition micro-structure and weldability of steel for core-components of nuclear reactors.
Nuclear plants
AISI 316; Ti

(78) **Instituto Ricerche Breda**
Divisione Resistenza Materiali
Viale Sarca 336
I-20126 Milano

V. Mandorini (1,2)

Project: (1) Effect of the holding times at the max. and minimum limits of the strain range level on the HTLCF damage of a ferritic steel $2^1/_4$ Cr1Mo at HT (CECA-7210-KF-401)
Petrochem.; Energy Generation Plants

(2) Resistance of a $2^1/_4$ Cr 1Mo-steel to fatigue crack propagation at HT.
(Prop. CECA P1088)
Petrochem.; Energy Generation Plants

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(79) **C.N.E.N.-C.S.N. Casaccia**
Div. Scienza Mat. Dip. TIB
S.P. Anguillarese KM 1.300
I-00100 Roma

B. Dalmastri (1,2)

Project: (1) Characterisation of structural materials for fast reactors.
Steam Generators
Alloy 800

(2) Development of HT-materials.
Fundamental
Alloy 800

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(80) **C.N.R. Ist. Technoligia dei Materiali Metallici non Tradizionali**
Via Induno 10
I-20092 Cinisello Balsamo-Mi

F. Grabielli (2)
V. Lupinc (5)
M. Marchionni (1,3)
A. Marucco (4)
D. Ranucci (1)

Project: (1) Interaction of fatigue, creep and environment on the LCF-behaviour of Ni-base alloys at HT.
Gas Turbines
IN 738LC; IN 100

(2) Investigation of creep-fatigue interaction and crack propagation in Ni-base superalloys at HT.
Gas Turbines
IN X-750; IN 100; IN 738LC

(3) Austenitic stainless steels for use in fast reactors.
Nuclear Plants
AISI 316

(4) Structural transformation and kinetics of ordering in Ni-Cr-and Ni-Fe-Cr-alloys.
Fundamental
Ni-Cr; Ni-Fe-Cr

(5) HT-creep, ageing, regeneration and fracture behaviour of superalloys IN 939 and Udimet 720.
Gas Turbines
IN 939; Udimet 720

(81) **C.N.R.**
Ist.di Ricerche Technologiche per la Ceramica
Via Granarolo 6
I-48018 Faenza (Ra)

P. Vincenzini (1,2)

Project: (1) Determination of creep properties at constant temperatures (1300-1400 °C) in air and controlled atmosphere.
Fundamental; Structural applications $Si_3 N_4$-base (various)

(2) Determination of HT-bending resistance (1300-1400 °C) in air and controlled atmosphere.
Fundamental
HPSN; RBSN; SSN; and additives

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(82) **ENEL-CTRN**
Via Rubattino 54
I-20134 Milano

D. D'Angelo (1,2,5)
S. Ghia (7,8)
S. Ragazzoni (3,4,6,)
V. Regis (1-8)

Project: (1) Creep and cyclic creep of ferritic and austenitic steels for power plants;
Residual life studies.

(2) Creep crack growth analysis on welded zones.

(3) Low cycle fatigue and creep fatigue interaction on rotor forgings.

(4) Elasto-plastic fracture mechanics characterisation of nuclear pressure vessel steels.

(5) Mechanical integrity studies of AISI 304.
Nuclear piping.

(6) Environmental fatigue in primary pressure boundary steels.

(7) High temperature in-service strain monitoring.

(8) Residual stress evaluation in AISI 304 weldings.

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(83) **A.F.L. Falck-Ric.e Contr.**
Lab. Prove Meccaniche
Via Mazzini 23
I-20099 Sesto San Giovanni

R. Daglio (1,2)
A. Molaroni (2)
P. Quaroni (2)

Project: (1) Characterisation of the HT-creep resistance of normal production materials.
Heat Exchangers -
ASTM-A199-T11;UNI5462-14CrMo3;UNI 5462-12CrMo9.10; ASTM A199; ASTM A335; DIN17175 15Mo3;UNI 5462 16Mo5

(2) The effect of heat treatments on the HT-creep properties.
Fundamental
UNI 5462-14CrMo3; UNI 5462-12CrMo9.10; ASTM A199; ASTM A335

(84) **Centra Ricerche Fiat SPA**
Udr. Comportamento Materiali
Strada Torino 50
I-10043 Orbassano

L. Bernard (4)
E. Campo (2,5,8)
M. Castagna (1-8)
S. Quaranta (1,3,6)
P.L. Tarditi (7)

Project: (1) HT-creep properties of steels for nuclear applications.
Nuclear plants
Alloy 800

(2) Influence of prior cold work on the creep behaviour of austenitic steels.
Nuclear; Petrochemical
AISI 304,-304L,316,-316L

(3) Creep damage accumulation on Nimocas739 and Udimet 720.(Cost 50)
Gas Turbines
Nimocast 739; UD 720

(4) HTLCF-behaviour of steels for nuclear applications.
Nuclear plants
Alloy 800; 9-Cr-steel

(5) HT-creep properties of austenitic steels for exhaust valves of internal combustion engines.
Internal Combustion Engines
SAE EV 11

(6) Isothermal and non-isothermal LCF behaviour of cast Al-alloys.
Internal Combustion Engines
AlSiCu-Alloys

(7) HT-behaviour of coated Ni-base superalloys.
Gas Turbines
UD 520; UD 720

(8) HT-creep damage accumulation.
Power Stations
AISI 304; 316

(85) **Universita di Genova**
Istituto di Fisica Tecnica e Impianti Termotechnici
Via all'Opera Pia 5-a
I-16145 Genova

C. Pisoni (1)

Project: (1) Determination of the thermal radiation emissivity of materials (in particular steels) at elevated temperatures (1000.K).
Fundamental
AISI 304; AISI 304L

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(86) **Universita di Padova**
Ist. di Chimica Industriale
Via Marzolo 9
I-35100 Padova

M. Magrini (1,2)

Project: (1) Protective coatings for alloys and steels at high temperatures.
Turbines; Internal Combustion Engines
Superalloys, Steels

(2) Structural stability of Ni-base superalloy.
Gas Turbines
IN 100; IN 738

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(87) **D.S.M.**
Central Laboratory
Materials & Corrosion Res. Dept
Postbus 18
NL-6160 ND Geleen

H.G. Orbons (1-4)
C.A.F. Tuijnman (1-4)

Project: (1) Creep properties of cast Cr-Ni-Nb alloys.
Petrochemical

(2) Creep strength of welding material of low C, 20Cr 32 Ni + Nb - alloy.
Petrochemical

(3) Ageing properties of low C 20, Cr 32Ni + Nb alloy.
Petrochemical

(4) Data collecting cast high Cr-Ni alloy for verifying the extrapolated creep strength.
Petrochemical

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(88) **E.C.N. Energieonderzoek**
Centrum Nederland
Postbus 1
NL-1755 ZG Petten

P.W. Bach (2)
R. Blackstone (1,2)
J.H.N. Verheugen (1)

Project: (1) Materials research MHD-channel and heat exchangers.
Advanced fossil fuel conversion (MHD)
Ceramics (ZrO_2; $LaCrO_3$)

(2) Materials research on components of fluidised bed combustion installations.
Advanced fossil fuel conversion (FBC).
Steels and Ni-Alloys

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(89) **Elbar BV**
Research and Development
Industrieterrein Spikweien
NL-5943 AC Lomm

M. Haafkens (3)
G. Marijnissen (2)
J. Mattheij (1)

Project: (1) Diffusion welding of IN738 and U700.
COST 50 NL1.
Gas Turbines
IN 738; U 700; IN 939

(2) Development of thermal barrier coatings for gasturbine blade applications.
COST 50 NL 2.
Gas Turbines.
High Cr, γ'-strenghtened superalloys.

(3) Evaluation of automated T.I.G. welding on superalloys.
COST 50 NL 4.
Gas Turbines; Jet Engines High γ'-strenthened superalloys

(90) **N.V. Kema - Div. of R+D**
Depts. SO/WBM-LMS
Postbus 9035
NL-6800 ET Arnhem

P.J.C. Bloem (3)
W. Huijbrechts (1,2)
N. Van Liere (4)
H. Wolf (1-5)

Project: (1) Stress corrosion cracking in coal gasification atmospheres (in laboratory test facilities).
Coal Gasification
High alloyed materials coatings

(2) High temperature electrochemistry.
Process waters in power plants.
Fe-Cr-Mo steels, duplex.

(3) Slag-refractory interaction in coal gasification-plant.
Coal Gasification
HT-Ceramic materials

(4) Dissimilar joints; determination of creep properties in the H.A.Z.
Boilers in power plants
10CrMo9.10 (2 1/4 Cr1Mo) welded to Sa 213 TP 347H

(5) Creep of welded coextruded tubes.
(Esshete 1250 and SS 310)

(91) **National Aerospace Lab.**
Structures and Materials (N.L.R.)
Voorsterweg 31
NL-8316 PR Marknesse

H.J. Kolkman (4,5,6)
G.A. Kool (3)
A.J.A. Mom (1-3)
R.J.H. Wanhill (7)

Project: (1) Determination of ductility and fatigue strength of high temperature coatings.
Gas turbines.
Aluminides, Noble metal aluminides and overlays on superalloys

(2) Determination of thermal fatigue strength of coated superalloys.
Gas Turbines
Aluminide, Noble metal aluminides and overlays on superalloys

(3) Mechanical properties of high temperature brazed superalloys.
Gas Turbines
IN 718; HS 188; Hastelloy; MAR M509;
Rene 80; L 605

(4) Interaction of creep and fatigue in coated and uncoated superalloys.
Gas Turbines
Rene 80; IN 718

(5) Improvement of creep and fatigue strength by heat-treatment or reheat treatment after service.
Gas Turbines
A 286; IN W

(6) Influence of coatings on fatigue strength.
Gas turbines (Compressors).
AISI 410, 17-4 PH.

(7) Rejuvenation of compressor and turbine disks by hot isostatic pressing.
Gas turbines
Waspalloy Ti-Alloys

(92) **Philips Research Laboratories**
Prof. Holstlaan
NL-5600 MD Eindhoven

G. De With (1)

Project: (1) Mechanical properties of oxide and non-oxide ceramics at high temperature.
Fundamental
Ceramics

(93) **Shell Int. Research My.BV**
RSRH/2
Postbus 162
NL-2501 AN Den Haag

E. Barker (1,2)
J. Green (6)
P.R. Murray (3,4)
A.S. Radcliff (5)
C. Stenger (7)

Project: (1) Residual Creep life studies analysis of literature.
Petrochemical; Oil refining
CrMo-steels; stainless steels

(2) Creep life of carburized furnace tubes - experimental, and analysis of literature.
Petrochemical.
Fe-Ni-Cr alloys.

(3) Design parameters for pressurised components in ceramics, in 600 °C.
Ore production.
AL_2O_3; Si_3N_4; SiC

(4) Design parameters for valves in flyash environment.
Coal Gasification
Metal ceramics

(5) Determination of the creep-rupture life of superheater tubes subjected to fireside corrosion.
Marine Boilers
Low-alloy steels

(6) Determination of the modulus of rupture of magnesia and - based refract. mats.at HT (>1500 °C) as a function of chemical and mineralogical composition.
Refractories; - MgO; MgO-chromite

(7) Determination of the creep resistance of alumino silicates at HT (>1400 °C) as a function of chemical and mineralogical composition. - Refractories
Al-silicates (70% AL_2O_3)

(94) **TNO-IWECO**
Dept. of Structural Mechanics
Postbus 29
NL-2600 AA Delft

C.T.M. Janssen (1,2,8)
J.P. Mast (6)
F. Roode (1,4)
R.J. Schouten (3)
P. Tegelaar (5)
J. Van de Eikhoff (7)

Project: (1) Experimental verification of constitutive equations for plasticity and creep under biaxial, cyclic and non-radial loading conditions.
F.B.R. - WN 1.4948; WN 1.6770

(2) Low-cycle fatigue and creep rupture under biaxial loading conditions.
F.B.R.
WN 1.4948; WN 1.6770

(3) Creep rupture of steam reformer tubes.
Petrochemical
HK40

(4) Investigations of the influence of weldments on the stress analysis of realistic structures.
F.B.R.
WN 1.4948; WN 1.6770

(5) Evaluation of high temperature strain measurement technique.
F.B.R.

(6) Cyclic load and hold time experiments on simplified components in creep range
F.B.R.
WN 1.4948; WN 1.6700

(7) Inelastic analysis, verifications and qualification of finite computer codes.
F.B.R.
WN 1.4948; WN 1.6770

(8) Elasto-plastic fracture mechanics under creep-fatigue conditions.
F.B.R.
WN 1.4948

(95) **Eindhoven University of Techn.**
Dept. of Electrical Engineering
Postbus 513
NL-5600 MB Eindhoven

W.J.M. Balemans (1)
L.H.TH. Rietjens (1)
M.C.M. Smeets (1)

Project: (1) Magnetohydrodynamic (MHD) power generation.
Energy Conversion
BN; Si_3N_4, AL_2O_3; Ta; Mo

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(96) **Eindhoven University of Techn.**
Mech. Eng. Dept. - Group Eng. Mat
P.O. Box 513
NL-5600 MB Eindhoven

M.J.M. Houben (1,2)
J.H. Zaat (1,3)

Project: (1) Research and development on thermal spraying of a thermal barrier coating onto a gasturbine combustion chamber.
Gas Turbines
Cermets; Ni-or Co-base alloys

(2) Determination of mechanical and physical properties of plasma sprayed thermal barrier coatings.
Gas Turbines
Fe-Al-Ni-Cr-Co-Alloys; Cermets

(3) Ceramic and metallic coatings in energy production installations.
Coal Combustion.
Ceramics; Cermets; Metals

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(97) **Centr. Inst. for Ind. Research**
Dept. of H.T.M. and Corrosion
P.O. Box 350
N-Blindern, Oslo 3

I.A. Kvernes (1)
H. Thon (1)

Project: (1) HT creep/thermal shock and corrosion of Ni-superalloys and coatings for gas turbine and diesel applications.
Gas Turbines; Diesel Engines
P/M Astrology; Wasp.; IN 718; NIM 739

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(98) **University of Oslo**
Department of Chemistry
P.O. Box 1033
N-Blindern-Oslo 3

P. Kofstad (1-5)

Project: (1) The reaction of nickel with $SO_2 + O_2$

(2) The reaction of cobalt with $SO_2 + O_2$

(3) The reaction on Ni-20% Co with $SO_2 + O_2$

(4) Sulfate induced corrosion of nickel and nickel alloys in $SO_2 + O_2$ atmospheres.

(5) Hot corrosion of high temperature materials.

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(99) **Forenade Fabriksverken (FFV)**
Maint.Div. - Mat.Labs.
S-58182 Linkoping

S.A. Karlsson (1,2)
G. Lindstrom (2)

Project: (1) Recovery heat treatment of creep damage on turbine blade materials.
Gas (Aero) Turbines
Wrought Ni-base alloys

(2) Influence of fretting-galling on fatigue strength at elevated temperature.
Gas (Aero) Turbines.
Wrought Ni-and Fe-Ni-base alloys.

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(100) **Sandvik AB**
Dept. 45-TR
S-81181 Sandviken

T. Andersson (2-5)
G. Gruenbaum (1-5)
J.O. Nilsson (1,5)

Project: (1) Low-cycle fatigue properties of martensitic CrMo-steels and austenitic stainless steels.
Petrochemical; Power Generation
12Cr1MoWV; AISI 316; IN 800H

(2) Effect of nitrogen pick-up in air at HT on creep properties.
Fundamental.
Ferritic and austenitic steels.

(3) Determination of creep properties and impact strength of martensitic CrMo-steels in the range 450-650°C.
Power Generation
9-12 CrMo steels

(4) Effects of chemical composition, heat treatment, cold work and notches on the HT properties of Alloy 800, 800H
Fundamental.

(5) Creep/fatigue interaction in austenitic stainless steels.
Petochemical; Power Generation
AISI 300-series; IN 800H

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(101) **Studsvik Energitechnik AB**
Dept. Mat. Appl. Technology
S-61182 Nykoping

L. Dahl (1-7)
K. Engman (1)
T. Holm (3,5,6)
P. Tarkpea (2,4,7)

Project: (1) High temperature ceramics.
(partical erosion studies).
Firing of solid fuels; Fluidized beds.
HT Ceramics

(2) Slurry erosion (2 projects).
Firing of coal liquids.
Steels; stainless steels.

(3) Fluidized bed (FB) materials.
Firing and gasification in FB.
Low Cr-steels; 18-8-steels; Ni-Alloys.

(4) Gasification plant materials (erosion-corrosion studies).
Gasification Plants.
Steels; Stainless steels; High Ni-alloys

(5) Erosion vs hardening mechanisms.
Firing or gasification; Fundamental.
Low-alloy steels, HT ferritic and austenitic stainless steels.

(6) Fluidized bed materials (in cooperation with Centralinstitute, Norway)
(Erosion and corrosion studies)
Firing of solid and liquid fuels
AISI 304, 316; NiCrFe-alloys; Coatings

(7) High temperature corrosion in coal or peat fired boilers (includes erosion study).
Boiler steels; Superheated materials

(102) **Swedish Inst. Metals Research**
Dept. of Struct.Metallurgy
Drottning Kristinas Vag 48
S-11428 Stockholm

C. Bengtsson (6)
G. Engberg (1,2,3,5)
H. Grahn (10)
B. Ivarsson (9,11)
R. Sandstrom (4,7,8,)

Project: (1) Low cycle (LCF) and thermomechanical fatigue (TMF) of hotwork tool and austenitic stainless steels. Influence of micro-structure. - Die Casting.
H 13; 253 MA; Alloy 800H.

(2) LCF and TMF of high temperature nickelbase alloys. Influence of hold times and strain-rate. (COST 50 round 3)
Gas Turbines.
IN 738LC; IN 597

(3) Influence of aluminium on the creep rupture properties of a 12% Cr martensite steel.
Steam turbines; Superheater tubes 12% Cr-steels

(4) Crack propagation during LCF and TMF.
Fundamental.
H 13; 253 MA

(5) Creep and LCF in powder metallurgical stainless steel.
12% Cr Steel; TP 316

(6) Residual lifetime during creep of low alloyed Cr-Mo-steels.
Fossile fires power plants.
St.358;12CrMo44;10CrMo910, X20CrMoV121.

(7) Creep and oxidation studies on the REM-alloyed austenitic stainless steel 253 MA.
Heat treatment furnace; FBC

(8) Relations between environment and creep properties.
Simulated combustion and carburizing atmospheres.
Fluidized Bed Combustion.
IN 800H; 2530MA; HastelloyX, HK 40.

(9) Creep in butt-welded tubes subjected to internal pressure.
General HT-Application
SS 2343; 12% Cr-steel; IN 800H; 1CrO.5Mo

(10) Stress relief heat treatment of creep resistant CrMo-steels.
Fossile fiered power plants.
1Cr0.5Mo; 2.25CrMo

(11) Collection and assessment of creep and hot tensile strength data.

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(103) **KB United Stirling (Sweden) AB**
Materials Engineering
P.O. Box 856
S-20180 Malmö

E. Skog (1,2)

Project: (1) Data collection on high cycle and low cycle fatigue strength of Ni-base, Fe-base super alloys.
Sterling engines
NIM PE10; IN 718; CRM-6D; XF 818

(2) Creep test of tubes with internal pressure at high temperature.
Sterling Engines.
IN 625; CG-27; Multimet; Sanicro 32; Sanicro 31H; 12 RN 72

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(104) **Chalmers University of Techn.**
Dept. of Engineering Metals
S-41296 Goteborg

N.G. Ingesten (1)
R. Warren (1-3)

Project: (1) Welding of superalloy compacts produced from REP-powder.
Gas Turbines
P/M Astroloy

(2) High temperature behaviour of refractory alloy wire reinforced superalloys.
Gas Turbines; Fundamental.
W alloy wires in various Ni- and Fe-based alloys

(3) Fracture of cemented carbides up to 1000 °C.
Fundamental (Tool Industry)
WC/Co; WC-TiC/Co alloys

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(105) **Chalmers University of Techn.**
Div. of Solid Mechanics
S-41296 Goteborg

J. Hult (1,2)

Project: (1) Creep and creep rupture in biaxial loading.
Fundamental
AISI 316

(2) Ultrasonic determination of residual life.
Fundamental
AISI 316

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(106) **Brown Boveri and Cie.Schweiz**
Forschungszentrum KLR
CH-5405 Baden Datwill

G.H. Gessinger (1-4)
W. Hoffelner (2,4)
N. Nazmy (1)
N. Singer (3)

Project (1) LCF experiments under service conditions
Gas Turbines
IN 738LC

(2) Life time prediction for high temperature components.
Gas Turbines; Tools
IN 738LC; TZM.

(3) Mechanical properties of ODS alloys.
Gas Turbines
MA 6000

(4) Crack growth at high deformation amplitudes.
Fundamental

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(107) **Ecole Polyt.Fed.de Lausanne**
Lab. de Ceramique
34 Chemin de Bellerive
CH-1007 Lausanne

P. Carry (1,4,6)
A. Mocellin (2,3,5)

Project: (1) Hot working of ceramiques.

(2) Processing and properties of aluminium-silicate ceramiques.

(3) Formation and stability of aluminium-titanate.

(4) Phase transformation microcracking induced in cintered $V_2 O_3$

(5) Quantitative metallography of ceramic polycristals.

(6) Plastic deformation of policristalline oxides.

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(108) **Gebr Sulzer AG**
Material Forschung
Lab. für Metallkunde 1511
CH-8401 Winterthur

P. Huber (3)
B. Walser (1,2)

Project (1) Determination of residual life time on high temperature components.
Energy Production; Gas Turbines
10CrMo910; X20CrMoV121; NIM 105

(2) Investigations on the interaction of creep and LCF.
Energy Production; Gas Turbines
X20CrMoV121; NIM 105

(3) Interaction of high temperature corrosion and creep resistance, and testing of the corrosion resistance of gas turbine alloys and protective coatings.
Gas Turbines - Ni-base Alloys

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(109) **Eidgenössische T.H. Zurich**
Inst. für Metallurgie
ETH Zentrum
CH-8092 Zurich

M.O. Speidel (1-3)

Project: (1) Determination of creep crack growth in high temperature alloys by means of fracture mechanics.
Gas Turbines; Steam Turbines
Ni; Co; Fe-Ni-Cr-Alloys

(2) High temperature fatigue and crack growth.
Fundamental
Steels; Fe-Ni-Cr-Alloys; Superalloys

(3) Life time prediction of rotating components under LCF conditions.
Gas Turbines
Superalloys; Ti-Alloys

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(110) **Admiralty Marine Technology Establishment**
Metallurgy and Ceramics Div.
Holton Heath
BH16 6JU Poole

G.C. Booth (1)
J.F. Conde (1)
D.J. Godfrey (4)
C.M. Heawood (2,3)

Project: (1) Determination of creep/stress-rupture properties in seasalt contaminated sulphur containing combustion environments.
Gas Turbines.
IN 738; IN 792; Experimental Alloys.

(2) Creep and stress-rupture properties in air.
Gas Turbines; Boilers; Heat Engines.
Superalloys; Coated Superalloys; Low Alloy Steels

(3) Relaxation behaviour of bolting materials.
Heat Engines
Low Alloy Steel

(4) Creep and stress-rupture of ceramics; fatigue of ceramics.
HT Engines
Si_3N_4; Sialons; SiC; etc.

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(111) **Admiralty Underwater Weapons Establishment**
Propulsion Division
Southwell
Portland

J. Bainbridge (1)

Project: (1) Short term creep rupture life of stainless steel tubes.
Heat Exchanger Development
AISI 316; 321

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(112) **AVP Paramount**
Manor Royal
RH10 2QD Crawley

R.F. Atkinson (1-4)
J.J. Jones (1-3)
D. Poole (4)

Project: (1) Creep data on Paralloy H39W
(25Cr/35Ni/1Nb)
Petrochemical
0.4C 25Cr/35Ni/1Nb

(2) Creep data of high temperature materials containing Nb rad Ti additions
Petrochemical
HK40+Ti+Nb

(3) Carburisation resistance of alloys
(Paralloys Cr39W) and mechanisms.
Petrochemical
0.1C 25Cr/35Ni+1Nb - HK40

(4) Effect of deoxidants in S/R properties; the role of calcium.
Petrochemical
0.4C 25Cr/35Ni/1Nb

(113) **British Ceramics Research Ass.**
Refract. and Ind. Cer. Div.
Queens Road
Penkhull
ST4 7LQ Stoke on Trent

W.R. Davis (12)
J.B. Everill (14)
P.T.A. Hodson (3,5,8,9)
M. Lester (6,7,11)
D.E. Lloyd (4,10,13,15)
G.C. Padgett (1-15)
F.T. Palin (1-2)

Project: (1) Engineering of refractory-lined structures to minimise degradation due to thermo-mechanical stress.
Structural Engineering Design Refractories

(2) The use of acoustic emission to assess degradation of refractory linings due to thermo-mechanical stress.
Structural Engineering Design Refractories

(3) Fracture mechanics and microstructure of refractories.
Fundamental
Refractories

(4) High temperature strength vs. composition and texture.
Engineering Ceramic Application
Si_3N_4

(5) Mechanical & thermal properties of semi-insulating refractories.
Energy Saving
Refractories

(6) Test methods for the assessment of monolithic refractories.
Standard Specification
Monolithic Refractories

(7) Development of thermal shock test method
Test Procedure
Refractories

(8) High temperature kiln furniture.
Improved Performence
Alumina; Aluminium Sillicate

(9) Effect of oxidation on silicon carbide performance.
HT Applications
SiC

(10) Improvement of strength of materials for HT batteries.
Batteries
MgO; FeS; (Li/K)Cl

(11) Effect of heat on devitrification of ceramic fibres.
Fundamental
Alumina Silicates

(12) Non-destructive testing of refractories.
Quality Control
Refractories

(13) Fabrication of complex shapes.
Productivity
All Non-plastic Ceramics

(14) Specifications for refractories.
Standards; Quality Control
Refractories

(15) High temperature properties of V.C.D.-deposided mirrors.
Synchotron Mirrors
SiC

(114) **British Gas Corporation**
Midlands Research Station
Wharf Lane
BG1 2JW Solihull

R.G. Cockerham (1-3)
P. Knowles (3)
F. Starr (1,2)
T. Taylor (2)
N.J. Wood (1)

Project: (1) Determination of creep propert. of alumina forming ferritic steels and Co-alloys in sulphiding atmospheres of low oxygen potential. - Fossil Fuel Gasific.
Ferritic stainless steels; Co-alloys

(2) Monitoring of life of plant components.
Petrochemical; Gasification; Electric-Power Generation
Carbon and stainless steels, etc.

(3) Monitoring of the mechanical performance of gasification plant components.
Fossil Fuel Gasification; Petrochemical.
Stainless steels; Refractories

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(115) **British Steel Corp.**
Swinden Labs.Phys.Met.Dept.
Moorgate
S60 3AR Rotherham

N.G. Needham (1)

Project: (1) Cavitation and fracture in creep resisting steels.
Electrical Power Generation; Fundamental
BS 1501-621; BS 1501-622

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(116) **British Steel Corp.**
Teesside Labs. Rails and Sect.
P.O. Box 74
T58 9EC Middlesbrough

B.R. Kirby (1-4)

Project: (1) Studies of the elevated temperature strength of structural section (steels).
Fire Protection of Structural Steelwork
BS 4360

(2) Conventional tensile tests at constant nominal strain rates.
Mild-and Microalloyed structural steels

(3) Anisothermal creep tests on structural steels.
Mild-and Microalloyed structural steels

(4) Constant load-measuring strain as a function of temperature.
Mild-and Microalloyed structural steels

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(117) **Centr. Electr. Generating Board**
Berkeley Nuclear Laboratories Fuel and Core Division
Mech. Prop. Section
GL13 9PB Berkeley

B.D. Clay (4)
A.T. Donaldson (5,9)
H.E. Evans (1-3,6,8)
T. Healey (5,9)
R.B. Jones (4)
G. Knowles (3,7)
R.C. Lobb (8)

Project: (1) Influence of prior oxidation on creep properties of stainless steels.
CAGR Fuel (Nuclear Power)
20Cr/25Ni/Nb; 20Cr/25Ni/TiN

(2) Determination of unelastic creep behaviour of particle-strengthened alloys.
CAGR Fuel (Nuclear Power)
20Cr/25Ni/TiN

(3) Determination of dislocation densities and distribution in creep of particle-strengthened alloys.
Fundamental
20Cr/25Ni/Ti; 20Cr/25Ni/TiN

(4) Influence of neutron irradiation on the uniaxial and biaxial creep properties and structure of alloys.
CAGR Fuel (Nuclear Power)
20Cr/25Ni steels; NIM PE16

(5) Determination of creep properties of Zircaloy in α, (α + β) and β-phase regimes.
PWR Fuel (Nuclear Power)
Zircaloy-4

(6) Measurements and modelling of creep threshold stresses in particle-strengthened alloys.
CAGR Fuel (Nuclear Power)
20Cr/25Ni/TiN

(7) Evaluation of creep properties at constant stress under both uniaxial and biaxial conditions.
CAGR Fuel (Nuclear Power)
20Cr/25Ni/Nb; 20Cr/25Ni/TiN

(8) Effect of prior oxidation at elevated temperatures on subsequent creep properties.
CAGR Fuel (Nuclear Power)
20Cr/25Ni/TiN

(9) Determination of high-temperature tensile behaviour of Zircaloy for code evaluation.
PWR Fuel (Nuclear Power)
Zircaloy-4

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(118) **Centr. Electr. Generating Board**
Berkeley Nuclear Laboratories Struct. and Mechanisms Div.
Basic. Struct. Research Section
GL13 9PB Berkeley

I.W. Goodall (1-6)

Project: (1) Multiaxial deformation and failure of materials.
AGR/Conventional Power Plant
316 SS; CrMoV

(2) Influence of ductility on rupture around stress concentrations.
Conventional Power Plant
CrMoV 2 $^{1}/_{4}$ Cr

(3) Constitutive equations.
AGR/Fast Reactor
316 SS

(4) Assessment of creep fatigue damage.
AGR/Fast Reactor/Convent. Power Plant
316 SS

(5) Effect of sodium on creep embrittlement.
Fast Reactor
316 SS

(6) Effect of ageing on fatigue creep.
AGR
316 SS

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(119) **Centr. Electr. Generating Board**
Berkeley Nuclear Laboratories Struct. and Mechanisms Div.
Corr. & Comp. Integrity Section
GL13 9PB Berkeley

I.R. McLauchlin (1-4)
M.R. Wootton (3)

Project: (1) Determination of creep properties of bolting steels.
Electrical Power Plant
En3; En16; Durehete 900

(2) Effects of carburisation on creep properties of steel.
Electrical Power Plant
9Cr-1Mo

(3) Determination of the effects and distribution of strain in bolted joints.
Electrical Power Plant
Common bolting material

(4) Determination of the effects of corrosion on the strength of welded and dowelled joints.
Electrical Power Plant
Struct. steels and a select. of weld metal

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(120) **Centr. Electr. Generating Board**
Centr. Electr. Research Labs.
Chemistry Division
KT22 7SE Leatherhead

A.J.B. Cutler (1)

Project: (1) Electrochemical studies of corrosion in molten sulphates.
Coal fired Boilers; Gas Turbines
Fe-Ni-and Co-Alloys, and Coatings

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(121) **Centr. Electr. Generating Board**
Marchwood Engineering Labs.
Welding Section
S04 4ZB Marchwood

R.D. Nicholson (1-2)

Project: (1) Structure and mechanical properties of austenitic-ferritic dissimilar metal welds.
Nuclear and Conventional Power Plant
2 1/4 CrMo; AISI 316; IN 182; 82; etc.

(2) Structure and mechanical properties of austenitic weld metals.
Nuclear and Conventional Power Plant
AISI 316; Esshete 1250

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(122) **Centr. Electr. Generating Board**
Midlands Region
Scientific Services Dept.
Material Technology Section
NG11 OEE Ratcliffe-on-Soar

H.G. Mellor (2)
G.J. Neate (1)
J.D. Stott (2)
H.D. Williams (1,2))

Project: (1) Crack growth under load-and displacement controlled static and cyclic loading conditions at elevated temperatures.
Power Generation.
Wrought & cast 1/2Cr-1/2Mo-1/4V-Steels

(2) Investigation of the factors governing the life of high temperature bolts.
Power Generation.
Wrought 1%Cr1%Mo3/4%V steel, Nimonic 80A.

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(123) **Daniel Doncaster and Sons Ltd.**
Materials Development
Birley House
Wadsley Bridge
Sheffield

F. Thompson (1-5)

Project: (1) Thermomechanical processing of Inconel alloy MA 754 for gas turbine vane applications.
Gas Turbines
Inconel Alloy MA 754

(2) Structure/property relationship in forged Inconel alloy MA 754.
Gas Turbines
Inconel Alloy MA 754

(3) Thermomechanical processing of Incoloy alloy MA 956.
HT Boilers; Heat Exchangers
Incoloy Alloy MA 956

(4) Structure/property relationship in Inconel alloy MA 6000.
Gas Turbines
Inconel Alloy MA 6000

(5) Thermomechanical processing of Inconel alloy MA 6000 for gas turbine blade applications.
Gas Turbines
Inconel Alloy MA 6000

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(124) **Era Technology Limited**
Eng. Mat. and Metallurgy Div.
Cleeve Road
KT22 7SA Leatherhead

M.P.E. Desvaux (1,2)
A. Wickens (1,2)

Project: (1) Creep of steel.
Power generation; Petrochemical.
Low CrMoV through 800 -20 variants.

(2) Assessment of residual life estimating techniques.
Power generation; Petrochemical.
2 ½ Cr-Mo,CrMoV.

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(125) **Flight Refuelling Ltd.**
High Temp. Mat.Progr.
Brook Road
BH21 2BJ Wimborne

K.G.E. Brenner (5)
R.H. Cook (1,2,3,5)
L.W. Graham (1-7)
M.R. Warren (4-7)

Project: (1) Determination of uniaxial creep properties of high temperature alloy weldments in helium and air.
Process Heat HT Reactors.
IN 617; IN 800; Hastelloy X, NIM 86.

(2) Determination of uniaxial creep properties of samples from heat exchanger tubes in helium and air.
Process Heat HT Reactors.
IN 617; NIM 86.

(3) Determination of effects of grain size on creep and rupture properties.
Process Heat HT Reactors.
IN 617.

(4) Determination of RT tensile, bend and impact properties of materials after prolonged exposure to HTR helium and air.
Process Heat HT Reactors.
Alloy 800H; IN 617; NIM 86,

(5) Data collection and extrapolation techniques as applied to Inconel 617.
Process Heat HT Reactors
IN 617

(6) Determination of tensile behaviour at the exposure temperature after prolonged exposure to HTR helium and air.
Process Heat HT Reactors
Alloy 800H; IN 617; NIM 86; HastelloyX

(7) Determination of RT and HT tensile behaviour of weldments after prolonged exposure to HTR helium and air
Process Heat HT Reactors.
Alloy 800H; IN 617; NIM 86.

(126) **GEC Gas Turbines Ltd.**
Central Metallurgical Labs.
Cambridge Road
Whetstone
LE8 3LH Leicester

A.L. Baker (1-4)
P. Greenfield (1-4)
S.R. Holdsworth (1-4)
A. Strang (1-4)

Project: (1) Thermal fatigue of blading materials.
Gas Turbines
IN 738; IN 939

(2) Creep crack growth in IN 939.
Gas Turbines
IN 939

(3) Evaluation of repair welds on blades.
Gas Turbines
IN 738; IN 939

(4) Mechanical evaluation of a IN 901 disc.
Gas Turbines
IN 901

(127) **GEC Power Engineering Ltd.**
Mech. Eng. Lab.-Str. Analysis Gr.
Cambridge Road
Whetstone
LE8 3LH Leicester

N.R. Otter (1-4)

Project: (1) Relevance of short cut inelastic design methods with respect to qualitative material properties.
Nuclear industry.
SS 316/304 Cr-Mo steels.

(2) Assessment of constitutive equations for use in inelastic analysis and their correlation with materials data.
Nuclear industry.
SS 316/304.

(3) Review of propensity of materials to undergo shakedown/ratchetting in high temperature structures.
Nuclear industry.
SS 316/304.

(4) Data collection on high strain fatigue properties.
Gas/Steam turbines.
Cr-Mo-Cr MoV steels.

(128) **Inco Alloy Products Ltd.**
Technology Centre
Wigginstreet
B16 OAJ Birmingham

J. Buchan (4,9)
M.J. Fleetwood (1-9)P.I. Fontaine (7)
S.W.K. Shaw (1,2,3,5,8)
D.M. Ward (6)

Project: (1) Influence of heat treatment on properties of cast superalloy IN-939.
Gas Turbines.
IN-939.

(2) Development of directionally solidified cast superalloy on high creep strength and corrosion resistance.
Gas Turbines.
Ni-Cr

(3) High-strength cast blade alloy for marine and industrial gas turbines.
Gas Turbines
Ni-Cr

(4) Stress-rupture properties of Alloy 800H
Nuclear
Alloy 800H

(5) Dependence of stress rupture properties on grain size.
Gas Turbines
IN 939

(6) Properties of microduplex superplastic stainless steels.
Fe-Ni-Cr.

(7) Mechanical properties of alloy for autoturbocharger casing.
Automotive.
Ni-resist type D5S.

(8) Properties of atomised powder superalloys.
Gas Turbines
Ni-Cr

(9) Combined creep/LCF properties of high-temperature alloys.
Fe-Ni-Cr; Ni-Cr.

(129) **National Engineering Lab.**
East Kilbrige
Glasgow

J. Henderson (1-5)

Project: (1) Multi-axial creep and creep rupture relationships.
Power Plant; Chemical processing;
Energy producing industries
Relevant metals.

(2) Development and validation of elevanted temperature engineering design methods.
Power Plant; Chemical processing;
Energy producing industries.
Relevant metals.

(3) Ultra-high sensitivity creep data collection.
Power Plant; Chemical processing;
Energy producing industries.
Relevant metals.

(4) Finite-element and approximate methods of creep design- and assessment.
Power Plant; Chemical processing,
Energy producing industries.
Relevant metals.

(5) Multi-axial creep under changing stress conditions.
Power Plant; Chemical processing;
Energy producing industries.
Relevant metals.

(130) **National Gasturbine Establ.**
Materials Department
Pyestock
GU14 OLS Farnborough

M.G. Cockcroft (1-5)
J.E. Northwood (1)
J.E. Restall (2)
M.J. Weaver (3-5)

Project: (1) Properties of advanced superalloy single crystals.
Gas Turbines
Ni-base

(2) Effect of coatings on the properties of superalloys.
Gas Turbines
Ni-base

(3) Creep-fatigue behaviour of unidirectionally solidified superalloys.
Gas turbines.
Mar-M002 etc.

(4) Effects of processing on the structure and properties of disc materials.
Gas turbines.
API etc.

(5) Fracture mechanics of disc materials.
Gas Turbines.
API etc.

(131) **National Physical Laboratory**
Div. of Materials Applications
Sect. Mech. Prop. of HT-Material
TW11 OLW Teddington

B.F. Dyson (2,6)
T.B. Gibbons (1)
N.S. Loveday (5)
M. McLean (1-6)
P.N. Quested (3)
G.B. Thomas (1)

Project: (1) Effects of trace impurities on the creep behaviour of cast superalloys.
Gas Turbines
IN 939

(2) Prediction of materials behaviour in service condition; effects of complex and cylic stress.
Process plant; Gas Turbines.

(3) Effects of processing conditions on the high temperature mechanical behaviour of directionally solidified nickel-base alloys (superalloys and in. situ composites).
Gas Turbines. - IN 738; IN 939.

(4) Materials rejuvenation by heat treatment and hot-isostatic pressing.
Gas turbines.
IN 738.

(5) Advanced testing standardisation of high temperatures.
General

(6) Effects of environment on the mechanical behaviour of materials at HT.
Petrochemical; Coal Gasification; Gas Turbines.

(132) **Sheffield City Polytechnic**
Dept. of Metallurgy
Pondstreet
S1 1WB Sheffield

A.H. Bott (2)
J. Cawley (3)
F.B. Pickering (1-3)

Project: (1) High temperature creep and tensile properties of Fe-Ni-Cr alloys.
Fast Nuclear ractors.
PE 16 type alloys.

(2) Recrystallisation of austenitic stainless steels.
Core components of nuclear reactors.
316, 347 and 321 types.

(3) High temperature constitution and void swelling in Fe-Cr-Ni-X alloys.
Fundamental; Nuclear reactor application.
Fe-Cr-Ni base alloys.

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(133) **The Polytechnic**
Physical Science Dept.
Wulfrunastreet
WV1 1LY Wolverhampton

R.J. Bishop (1)

Project: (1) High temperature corrosion of alloys and characterisation of ash deposits in coalfired fluidized beds.
Coal Combustion
Fe-and Ni-base Alloys

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(134) **Rolls-Royce Ltd.**
Materials Research
P.O. Box 31
DE2 8BJ Derby

G.W. Meetham (1-3)

Project: (1) Mechanical properties evaluation steels:
Strain contolled low cycle fatigue and fracture toughness.
Gas Turbines.
FV 535; FV 448

(2) Disc applications: LCF (load and strain controlled), creep fatigue interaction on plain sections and stress concentration features crack propag., fracture toughn.
Waspaloy, N109; Astroloy (powder); IN718

(3) Turbine blades: load controlled HCF and LCF, strain fatigue, creep, crack propag. fract. toughness, properts. of coated substrates to establ. interactions.-MarM002; IN100; IN713LC; IN738; DS/Single Cryst.All.

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(135) **Sandvik Ltd.**
Hard Materials Research Centre
Torrinton Avenue
CV4 9AD Conventry

D.H. Jack (1)
V. Thompson (1)

Project: (1) High temperature strength of cemented carbide and other cutting tool materials Cutting tools.
Cemented carbides and ceramics.

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(136) **UKAEA-AERE**
Materials Development Div.
Harwell
OX11 ORA Didcot

M.J. Bennet (10)
D.R. Harries (1-7)
J.A. Hudson (8,9)
R.S. Nelson (1-11)
J.B. Price (10)
P.M. Scott (11)
B.C. Tofield (11)

Project: (1) Post-irradiated tensile and creep-rupture properties.
Fast Reactor
Ferritic/Martensitic, Austenitic steels and Nickel-base Alloys

(2) In-reactor creep.
Fast Reactor
Austenitic steel

(3) Influence of helium on high temperature intergranular fracture.
Basic research.
Austenitic steels and alloys.

(4) Simulation irradiation creep studies.
Basic Research; Fast-/Fusion Reactor.
Austenitic steels and Nickel alloys.

(5) Effects of irradiation on DBTT and ductile fracture of pressure vessel steels.
Basic research.
Low alloy steels.

(6) Fracture toughness of irradiated alloys.
Fast reactor.
Austenitic, ferritie steels and NIM PE 16

(7) Creep and rupture of 12% Cr steels.
Fast/fusion reactor.
FI, FV 607 and FV 448.

(8) Low strain rate creep of austenitic stainless steels.
Basic Research
316

(9) Creep/fatigue interactions in stainless steels.
Fast reactor.
316.

(10) Effect on strain of simult. stress and oxidation in CO_2-based environments and the role of surface modif., includ.ceram. coatings.- Nuclear Reactor - 20Cr/25Ni/Nb & 20/25TiN Aust. SS; Ceria&Silica coatings

(11) Influence of PWR primary circuit water on fatigue crack growth in pressure vessel steels.
PWR pressure vessel safety.
A533B, A508-III & Weldments.

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(137) **UKAEA-AERE Harwell**
Metallurgy Division
Harwell
OX11 ORA Didcot

D.R. Harries (1)
E.A. Little (1-3)

Project: (1) Determination of elasto-plastic fracture mechanics parameters of fast reactor irradiated austenitic stainless steel at elevated temperatures. - Fast Reactor.
Type 321 stainless, Nimonic PE16.

(2) Radiation hardening and embrittlement of PWR pressure vessel steels (up to 300 °C)
Fundamental.
A533B low alloy steel.

(3) Elevated temperature mechanical properties of unirradiated and irradiated 12% Cr martensitic stainless steels.
Fast Reactor.
FI;FV 607; FV 448 steels

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(138) **UKAEA - Risley Nuclear Labs.**
Sect. Mech. Properties
Risley
PR4 ORR Warrington

D.S. Wood (1)

Project: (1) Mechanical properties of fast reactor structural steels.
Design application Ferritic, Austenitic steels

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(139) **University College Cardiff**
Metallurgy - Mat. Science
Newport Road
CF2 1TA Cardiff

R.D. Jones (1)

Project: (1) Investigation of thermal fatigue phenomena in aluminised low carbon steel in the temperature range 450-600°C.
Domestic Heating Systems

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(140) **University College of Swansea**
Dept. of Mech. Engineering
Singleton Park
SA2 8PP Swansea

J.M. Alexander (1)

Project: (1) Mechanical properties of components produced by deposition forming.
Gas turbines.
Ni-Ti, stainless steels.

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(141) **University College of Swansea**
Metall. -Mat. Techn. Dept.
Singleton Park
SA2 8PP Swansea

R.W. Evans (6-10)
D.H. Isaac (2)
G.M. Jenkins (2)
D.R.J. Owen (3)
B. Wilshire (1-10)

Project: (1) High temperature creep and fracture of refractories.
Extraction/Refining Processes.
Magnesia/Lime Doloma

(2) Pitch-Bearing magnesia refractories.
Extraction/Refining Processes.
Magnesia.

(3) Creep life assessment.
Electricity Generation Plant
$^1/_2$ Cr $^1/_2$ Mo steel; 20/25 Austenitic

(4) High temperature deformation at dissimilar metal interfaces.
Electricity Generation Plant.
2.$^1/_4$ Cr 1Mo steel/Weld metal.

(5) Creep life prediction of conventionally cast and directionally solified Mar M002 turbine blades.
Aero engine turbines.
Mar M002.

(6) Creep data monitoring and analysis systems.
General.

(7) Remnant life assessment of Mar M002 turbine blades.
Aero-engine turbines.
Mar M002.

(8) Isothermal forging of superalloys.
Aero-engine turbines.
Wrought and powder superalloys

(9) HT deformation and fracture of welds.
Electricity Generation; Chemical Plant
2 $^1/_2$ Cr 1 Mo/Welds

(10) High temperature deformation and fracture of welds.
Electr. Generation/Chem. Plant
2 ½ Cr 1 Mo/Welds

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142 **University of Aston**
Metallurgy-Mat. Eng. Dept.
Birmingham

J.T. Barnby (1,2)

Project: (1) Determination of creep properties at HT.
Aircraft engines.
Single crystal Ni alloys.

(2) Determination of mechanisms and mechanics of creep crack growth.
Aircraft engines.
Stainless steels, Ni-Cr-Mo-V steels.

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143 **University of Bath**
School of Materials Science
Claverton Down
BA2 7AY Bath

B. McEnaney (1-3)
V.D. Scott (1,2)

Project: (1) The effect of ion implantation on the oxidation of metals and alloys at high temperatures.
Coatings/fundamental.
Iron and chromium.

(2) Development of a high temperature, solid state, electrochemical cell based on zirconia for the measurement of oxidation rates of metals and alloys.
Fundamental.

(3) The corrosion of stainless steels in molten alkali metal fluorides at high temperatures.
Fundamental.
AISI 316, 20Cr/25Ni stainless steel.

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(144) **University of Bristol**
Dept. of Mech. Engineering
Queen's Building
University Walk
BS8 1TR Bristol

E.G. Ellison (1,2,3,7)
W.J. Plumbridge (2,4-7)

Project: (1) Combined thermal & strain cycling in the fatigue-creep regime.
Nuclear; Gas Turbine.
1Cr-Mo-V 316 SS.

(2) Prediction of materials behaviour at elevated temperature. Strain stress control with dwell periods, creep fatigue condition. - Nuclear; Gas Turbine.
1 Cr Mo V 316 SS.

(3) Creep Crack growth and rupture.
Nuclear; Gas Turbine.
1Cr-Mo V.

(4) Mechanisms of fatigue-creep interactions
Power generation.
1 Cr-Mo-V AISI 316.

(5) Effects of ageing on mechanical properties.
Power generation.
AISI 316.

(6) Fatigue-creep interaction in Ti 829
Aero space. Ti 829.

(7) Life prediction in cast nickel alloys.
Jet engines.
Mar M 002

(145) **University of Bristol**
H.H. Wills Physics Laboratory
Tyndall Ave.
BS8 1TR Bristol

D.J. Dingley (1,2)

Project: (1) Investigation of the effects of segregation to grain boundaries in superalloys.
Turbines.
Ni-Al-Ti.

(2) Grain misorientations in creep resistant steels.
Power Generation.
SS 316.

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(146) **University of Cambridge**
Engineering Department
Trumpingtonstreet
CB2 1PZ Cambridge

M.F. Ashby (1,2)

Project: (1) Creep fatigue by void growth.

(2) Modelling of creep crack growth.

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(147) **University of Cambridge**
Metallurgy and Mat. Science
Pembrokestreet
CB2 3QZ Cambridge

G.T. Burstein (4)
J.A. Charles (5,6)
G. Dearnalay (10)
R.W.K. Honeycomb (1-12)
N.W. Jepps (9)
J.F. Knott (7)
T.F. Page (3, 8-10,12)
B. Ralph (11)

Project: (1) Structural and creep studies in cast stainless steels.
Fundamental; Petrochemical
HK 40; IN 519 and related alloys

(2) High temperature deformation and structural studies on single crystal turbine blade alloys.
Fundamental; Gas Turbines
Ni-base alloys

(3) High temperatur mechanical properties of porous ceramics.
Fundamental; Gas Turbines
MgO; $CaZnO_2$; stabilised ZrO_2

(4) Stress corrosion cracking of turbine steels.
Fundamental; Steam Turbines.
Ni-Cr-Mo-V steels.

(5) Prior particle boundaries in powderformed Nickel superalloys.
Fundamental; Gas Turbines.
APK 1.

(6) Surface charactaristics of superalloy powders.
Fundamental; Gas Turbines
Ni-base superalloys

(7) Fracture mechanisms in nickel-base high temperature alloys.
Fundamental; Fast Breeder Reactor.
PE 16.

(8) Micro-hardness, friction and wear of SiC and $Si_3 N_4$ materials as a function of Bearings; Seals; Wear resist. applicat.
Var. Forms of SiC; $Si_3 N_4$; Sialons; Silicon

(9) HREM investigation of the nature and role of grain boundaries and interfaces in high-performance materials.
High-perf. Ceramics; Intermet. Compounds SiC; Si_3N_4; Sialons; Alumina; Si; etc.

(10) Controlling near-surface deformation by ion implantation.
Wear resistance

(11) Deformation mechanisms in duplex titanium alloys.
Fundamental (Turbines)
1 M 1318 (811)

(12) High temperature mechanical properties of highly porous ceramics.
Casting cores; etc.
various materials

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(148) **University of Exeter**
Dept. of Chem. Engineering
Northcote House
The Queens Drive
Exeter

T.W. Davies (1)

Project: (1) Density changes of alumino-silicate powders during flash calcination.
Fundamental
Kaolinite and Pearlite

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(149) **University of Leeds**
Dept. of Ceramics
LS2 9JT Leeds

A.J. Moulson (1)

Project: (1) Creep-resistant reaction-bonded $Si_3 N_4$
High temperature engineering ceramics $Si_3 N_4$

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(150) **University of Leeds**
Dept. of Metallurgy
LS2 9JT Leeds

A.J. Baker (1)
C. Hammond (2,3,8)
T.A. Hughes (2)
J. Nutting (1-7)
J.C. Scully (5)

Project: (1) Structure/property relationships in Fe-Mn-Al alloys.
Coal gasification.
New alloys.

(2) Mechanical properties and creep behaviour of dispersion strengthened Fe-Cr alloys.
Aircraft engine applications
MA 956 E

(3) In situ observations of high temperature deformation mechanisms in b.c.c. alloys.
Fundamental. Studies in relation to superplasticity
Ti-Alloys

(4) Structure/properties of high nitrogen stainless steels.
Nitrided AISI 304, 316 and 321.

(5) High temperature sulphidation.
Alloy development programme.
Coal and Oil Gasification.

(6) Structure/Property relationships in $2^{1}/_{4}$ C_4-Mo steels.
Nuclear application.
Steels

(7) Grain growth characteristics of steels at HT.
Electric power generation.
Steels.

(8) Mechanical properties and oxidation behaviour of 1 MA 956 E.
Gas Turbines
Ferrous Alloy

(151) **University of Leicester**
Dept. of Engineering
University Road
LE1 7RU Leicester

D.R. Hayhurst (3,4)
A.R.S. Ponter (1,2,5)

Project: (1) Behaviour of structures at high temperatures subjected to fluctuating thermal and mechanical loads.
F.B.R.
AISI316

(2) Behaviour of 316SS under simultaniously fluctuating temperature and load.
F.B.R.
AISI316

(3) Creep crack propagation.
F.B.R.
AISI316

(4) Creep rupture under transient stress.

(5) Theoretical studies of thermal shakedown and ratchetting of structures.
General pressure vessel

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(152) **University of London**
Imperial College
Dept. of Metall. and Mat.Science
SW7 2BP London

M.G. Hocking (1,2)

Project: (1) Cermets, Ni & Co based: Their applicat. by electrodeposition on ferrous & Ni&Co based superalloys. - Coatings.
Ni&Co with oxides, carbides, silicides, nitrides, etc. of Al, Cr, Ti, Zr, Hf, Y, etc.

(2) Fe- & Mn- containing Ni-Cr based super-alloys.
Gas turbines; Coal Gasification.
Ni-Cr & Fe-Cr, Co-Cr alloys.

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(153) **University of Loughborough**
Dept. of Mat. Eng. and Design
LE11 3TY Loughborough

T.E. Chung (9,11)
R.G. Faulkner (1-11)
D.R. Gabe (11)
P.J. James (5)
I.A. Menzies (6)

Project: (1) Long term metallurgical stability of aero engine alloys.
Gas Turbines
Mar M 002

(2) Post irradiation ductility in ferritic + austenitic steels.
Nuclear.
316 AISI; Fe-9-Cr; Fe-12 Cr

(3) Heat treatment of Nimonic 80A.
Gas Turbines
Nimonic 80A

(4) Grain boundary precipitation.
Nuclear
Alloy 800

(5) Heat treatment of gas turbine and turbocharger materials.
Gas Turbines
Nimonics

(6) Aluminide coatings on nickel base alloys
Gas Turbines
Nimonics

(7) Partitioning in single crystal aero-engine alloys.
Gas turbines.
SR99.

(8) Critical Cr levels for boiler tube materials.
Coal fired power plant
304; 316; 25/20; 347; 310; Fe-25Cr

(9) Creep fatigue in fusion reactors.
Fusion
316

(10) Non equilibrium grain boundary segregation.
Gas Turbine; Power; Nuclear.
304, 316, Fa-9 Cr.

(11) Corrosion-fatigue crack growth studies of a titanium alloy.
Gas Turbines
Ti

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(154) **University of Manchester**
Dept. of Metallurgy
Metallurgy Building
Grosvenorstreet
M1 7HS Manchester

T.J. Davies (4,9,10)
J.B. Hawkyard (5)
R. Pilkington (1-4,8)
N. Ridley (5,6)
R. Rolls (7)

Project: (1) The creep fracture of 1%Cr/Mo steel.
Electrical power generation.
Fe-Cr-Mo steel.

(2) Creep crack growth/notch rupture of stainless steel.
Nuclear power plant.
AISI 316.

(3) Creep and creep/fatigue of stainless steel.
Nuclear power plant.
20/25Nb.

(4) Creep deformation of IN 100.
Gas Turbines.
IN 100

(5) Superplastic flow and superplastic bulge forming.
Aero Space.
Ti-6Al-4V; Microduplex alpha/gamma SS, e.g.3RE60
FALC 223; Al-alloys e.g. 7475, 7010

(6) Effects of phosphorus and titanium additions on the creep behaviour of 21% Cr-1% Mo steels of varying molybdenum to carbon ratios. - Power Generation.
$2^1/_4$ Cr-1 Mo

(7) Effect of steel making route on fatigue crack growth rates at relevated temperatures. - Fundamental.
Low alloy Ni-Cr-Mo-V steels.

(8) Determination of high temperature creep behaviour in atmospheres of low and high oxidizing potential.
Fundamental.
Fe-Al and Fe-Cr alloys.

(9) Notch rupture behaviour of 1% Cr/$^1/_2$ Mo steel.
Electrical Power Generation

(10) Superplastic creep behaviour of Mullite.
Fundamental
Mullite

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(155) **University of Newcastle u.Tyne**
Dept. of Metallurgy & Eng. Materials
Haymarket Lane
NR1 7RY Newcastle upon Tyne

J. Congleton (1-3)

Project: (1) Stress corrosion of stainless steel in high temperature water.
Power Generation/Fundamental.
316 SS

(2) Corrosion fatigue of A533B steel in high temperature water.
Power Generation/Fundamental.
A533B Steel

(3) The initiation of corrosion fatigue in condensing steam.
Power Generation/Turbines/Fundamental.
13% Cr Steel

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(156) **University of Nottingham**
Dept. of Mechanical Engineering
University Park
BG7 2 RD Nottingham

T.H. Hyde (1)

Project: (1) Investigation of plasticity/creep interactions in 316 stainless steel at elevated temperature.
Power Plant
316 SS

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(157) **University of Oxford**
Metallurgy and Science of Mat.
Parks Road
OX1 3PH Oxford

G.W. Groves (6)
Sir P. Hirsch (1-6)
J.W. Martin (1-3)
G.D.W. Smith (4)
G. Taylor (5)

Project: (1) Micromechanisms of fatigue crack propagation at elevated temperatures in superalloys.
Gas Turbines
Mar M 002

(2) Structure-property relations in superalloy single crystals.
Gas Turbines
SRR 99

(3) Recrystallization of single crystals.
Fundamental.
SRR 99; Cu

(4) High temperature creep properties of Nickel superalloys.
Gas Turbines
IN 739; IN 939; Mar M 002 and experimental alloys

(5) Deformation of bcc metals and alloys.
Fusion/Fundamental.
Nb; Mo; Ta

(6) The effects of elevated temperature on the strength of ceramics.
Engineering Ceramics.
Glasses; Glass-Ceramics; Alumina; Ceramics

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(158) **University of Sheffield**
Dept. of Mech. Engineering
Mappinstreet
S1 3JD Sheffield

M.W. Brown (1-13)
A.P. Kfouri (1-13)
K.J. Miller (1-13)
E.D.L. Rios (1-13)

Project: (1) Multiaxial, in-phase, fatigue plus creep at 400 °C and 565 °C.
Nuclear Plant

(2) Mixed-mode fatigue crack growth at notches; 550 °C; air.
Steam turbines.
1Cr.MoV.

(3) Biaxial fatigue crack growth at low stresses (LEFM); 565 °C; air.
Nuclear plant.
RR 58; AISI 316.

(4) Biaxial fatigue crack growth at high stresses (elastic-plastic fracture mechanics).
Fundamental.
AISI 316.

(5) Biaxial fatigue crack initiation and propagation at various notch profiles.
Nuclear Plant.
AISI 316.

(6) Crack propagation under thermal shock conditions.
Gas Turbines/Nuclear
Mar M 002; AISI 316

(7) Elastic-plastic finite element analysis, uniaxial and biaxial fields.
Fundamental.

(8) Metallography and fractography of uniaxial, biaxial and multiaxial fatigue and fatigue plus creep specimens.
Nuclear Plant.
All materials in use

(9) Multiaxial, out-of phase, fatigue plus creep.
Nuclear

(10) Crack initiation at elevated temperature.
Fundamental.

(11) Biaxial creep-crack growth.
Nuclear

(12) Biaxial creep-crack growth at notches.
Nuclear.

(13) Effects of anisotropy on deformation and fracture under multiaxial stress-strain conditions.
Fundamental

(159) **University of Sheffield**
Dept. of Metallurgy
Mappinstreet
S1 3JD Sheffield

G.J. Davies (1-5)
G.W. Greenwood (3-5)
H. Jones (3)
C.M. Sellars (1,2)

Project: (1) High strain rate, high temperature deformation of stainless steels.
Hot Formability.
AISI 316

(2) Hot working and microstructural changes in nickel-based superalloys.
Hot Formability.
Waspalloy, Nimonic 80A; Nimonic 90

(3) Creep of austenitic stainless steels at low stresses.
Power generation.
AISI 304, 316.

(4) The evaluation of creep damage and its relationship to creep life.
Power Generation.
Ferrous and non-ferrous alloys

(5) Creep damage at welds.
Power Generation.
Ferritic steels

(160) **University of Sheffield**
Dept. of Chem. Engineering
Newcastlestreet
S1 3JD Sheffield

C.G. McCreath (1-3)
J. Whitton (2)

Project: (1) Salt particle evaporation in a Tyne combustion chamber.
Gas Turbines
Various materials

(2) Salt particle trajecting evaluation through rotating and static blading.
Gas Turbines.
Various materials

(3) Erosion/corrosion potential of particulate salt material as a function of its impact characteristics.
Gas turbines.
Various materials.

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(161) **University of Strathclyde**
Dept. of Mechanics of Materials
James Watt Building
Montrosestreet
G1 1XJ Glasgow

J. Spence (1)

Project: (1) Determination of high temperature creep properties.
Fast reactor pipework
316 SS.

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(162) **University of Surrey**
Metallurgy and Mat. Technology
GU2 5XH Guildford

M.B. Waldron (1)

Project: (1) Wetting of high temperature materials by braze alloys.
Fundamental/Gas turbines.
Jethette and Au/Ni alloy.

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(163) **Wiggin Alloys Ltd.**
Technical Department
Metallurgical Services
Holmer Road
HR4 9SL Hereford

G.B. Stubbs (2)
C.H. White (1)

Project: (1) Characterisation of large Nimonic alloy 901 forgings for disc purposes.
Gas turbines.
Nimonic 901.

(2) Collection of creep and mechanical property data of Inconel 625 for pressure vessels.
Petrochemical.
Inconel 625.

(164) **J.C.R. Petten Est.**
Postbus 2
NL-1755 ZG Petten

J. Bressers (4-7)
E. Bullock (8-10)
V. Guttmann (1-3)
E. Lang (8-10)
J.B. Marriott (1-5)

Project: (1) The influence of carburisation on creep properties.
Coal Convers.; Petrochem.; Gas Turbines
HK 40; HP 40 Nb; Alloy 800H

(2) The influence of the combined attack of carburising/oxidising atmospheres on creep behaviour.
Coal Convers.; Petrochem.; Gas Turbines
HK 40; HP 40 Nb; Alloy 800H

(3) The influence of the combined attack of sulphidising/oxidising/carburising gases on creep properties.
Coal Convers.; Petrochem.; Gas Turbines
HK 40; HP 40 Nb; Alooy 800H

(4) HTLCF data generation in corrosive environments.
Coal Convers.; Petrochem.; Gas Turbines
Alloy 800H

(5) Deformation and fracture mechanisms in HTLCF in corrosive environments.
Coal Convers.; Petrochem.; Gas Turbines
Alloy 800H

(6) Effect of creep-fatigue interaction on the life of nickel-base superalloys (ends 1981).
Coal Convers.; Petrochem.; Gas Turbines
Waspaloy; Astroloy

(7) Crack initiation in HTLCF.
Coal Convers.; Petrochem.; Gas Turbines
Waspaloy; Astroloy

(8) Mechanical behaviour of protective coatings on austenitic steels.
Coal Convers.; Petrochem.; Gas Turbines
HP 40 Nb, Alloy 800H + overlay and aluminide coatings

(9) The effect of coatings on the high temperature mechanical properties of some nickel-base alloys.
Coal Convers.; Petrochem.; Gas Turbines
IN738LC, IN100, aluminide & overlay coatgs.

(10) Grain boundary segregation in a nickel-base alloy (ends 1981).
Coal Convers.; Petrochem.; Gas Turbines
IN738LC, IN100, aluminide & overlay coatgs

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(165) **Dg XII - COST 50**
200 Rue de la Loi
B-1049 Bruxelles

O. Morocutti (1-27)

Project: (1) Verenigte Edelstahlwerke, Kapfenberg, Austria. Study of the effects of trace elements and of deformation conditions on the hot deformation and recristallisation behaviour of superalloys.

(2) Montanuniversitaet, Leoben, Austria.
Lifetime prediction in the case of HT-fatigue and its application to components.

(3) Departement E&R, IMPHY, France.
Armines, Evry Cedex, France.
Influence of thermomechanical treatment on the HT low cycle fatigue resistance of PM superalloys.

(4) Institut de Soudure, Paris, Cedex, France.
Fatigue behaviour of electronic welding induced microcracks in alloys for gas-turbines.

(5) Armines, Paris Cedex, France.
Snecma, Paris, France.
Application of isothermal fatigue to thermal fatigue studies.

(6) Dechema, Frankfurt, Germany.
Interactions between corrosion and creep of uncoated and coated superalloys in sulphate melts.

(7) Thyssen, Bochum, Germany.
Effect of solidification parameters on the mechanical properties of directionally solidified Ni-Cr superalloys with special regard to segregation effects.

(8) Motoren-Turbinen-Union, München, Germany.
Increase in service life of hot gas leading parts under stress.

(9) Motoren-Turbinen-Union, München, Germany.
Possibilities for more accurate life prediction of components.

(10) Kraftwerk Union, Mülheim-Ruhr, Germany.
Hot corrosion and Air Creep Rupture Properties of Superalloy Welding and Brazings.

(11) C.R.Fiat, Orbassano (Torino), Italy.
Creep Damage Accumulation on UD 720 and Nimocast 739.

(12) BBC Brown Boveri, Baden, Switzerland.
Crack initiation and propagation of a forged Nickel base-alloy under high mechanical and thermal loading.

(13) BBC Brown Boveri, Baden, Switzerland.
Life-Time prediction of HT-components (turbine blades).

(14) Gebr. Sulzer, Winterthur, Switzerland.
Cycle Creep or creep/fatigue interaction.

(15) FFV. Linkoeping, Sweden.
Development of structural damage under combined testing modes in turbine blade materials.

(16) Institute for Metals, Stockholm, Sweden.
Thermomechanical and Low Cycle Fatigue of Advanced Nickel base Alloys.

(17) CEGB, Leatherhead, U.K.
The Effect of Environment and Temperature on the Low Cycle Fatigue Behaviour of Advanced Nickel Based Superalloys.

(18) GEC. Gas Turbines, Leicester.
Fatigue in Gas Turbines Blading.

(19) GEC. Gas Metallurgical Lab., Leicester, U.K.
The effects of Stress and Temperature Fluctuations on the Creep Crack Growth Resistance of Nimocast 739.

(20) Nat. Phys. Lab., Middelsex, U.K.
The effect of trace elements on the properties at high temperature of a Ni-Cr-base alloy at two levels of creep ductility.

(21) Nat. Phys. Lab. Middelsex, U.K.
Applicability of lab. assesssments of property regeneration techniques and life prediction procedures to service components of wrought and cast Ni-Cr alloys.

(22) Nat. Phys. Lab., Middelsex, U.K.
Evaluation of a modified fractional damage and life law predicting LCF in Ni-Cr base alloys.

(23) Henry Wiggin, Hereford, U.K.
Characterisation of large Nimonic 901 forgings for disc purposes.

(24) GEC. Gas Turbines, Leicester, U.K.
An investigation of the properties of large Nimonic 901 disc forgings.

25 Ministry of Devense, Dorset, U.K.
Effect of Marine Environment on High Temperature Creep of Superalloys.

(26) CEC JRC., Petten, The Netherlands.
Crack initiation in high temperature low cycle fatigue.

(27) CEC JRC., Petten, The Netherlands.
Grain boundary segregation in IN738LC.

Index of Materials Applications/Technologies

Index to Type of Material

Non Metals

Index to Type Research

Chemical Properties/Environmental Corrosion.

Design and Control

Index of Scientists

INVENTORY OF ON-GOING HTM RESEARCH ACTIVITIES IN EUROPE SECTION 2: Mechanical Properties

Abstract

The inventory contains 648 research projects arranged per country and performing organisation (166).
The presented information resulted from a questionnaire-inquiry carried out in 1982.
Indexing is provided per type of materials application/technology, type of material, type of research topic and involved scientists (438).

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