Commission of the European Communities

Evaluation of the high-temperature materials programme of the Joint Research Centre (1980-85)

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Evaluation of the high-temperature materials programme of the Joint Research Centre (1980-85)

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SAMMENDRAG

I foråret 1985 udpegede GD XII et udefra kommende panel til at vurdere 1984-1987-programmet for højtemperaturmaterialer (HTM) for FFC Petten under hensyntagen til relevante resultater af det foregående (1980-1983)-program og fremsætte henstillinger om retningslinjerne for det kommende program. Efter tre møder i FFC Petten og et i GD XII, Bruxelles, færdiggjorde panelet sin vurderingsrapport i oktober 1985.

I bilagene til rapporten findes detaljerede kommentarer til de fem projekter, som udgør det nuværende program, idet hovedresultaterne af vurderingen er sammenfattet i selve teksten, efterfulgt af konklusioner og en række henstillinger vedrørende kommende aktiviteter.

Panelet finder, at sagkundskaben og faciliteterne ved FFC Petten, for HTM-program, ti år efter dets oprettelse har ydet og fortsat yder et positivt bidrag til en omkostningseffektiv anvendelse af højtemperaturmaterialer i avancerede teknologier. Arbejdet er i alle henseender af høj kvalitet og afspejler både personalets og administrationens kompetence og sikrer, at FFC Petten i stigende grad spiller en både katalytisk og koordinerende rolle i fællesskabsprogrammer, som omfatter højtemperaturlegeringer, keramiske of sammensatte materialer.

Det er panelets opfattelse, at arbejdet kunne gøres mere effektivt gennem en nærmere tilknytning til industrien og ved gennemførelse af mere grundforskning til støtte for den anvendte forskning. Det henstiller, at FFC Petten fortsætter med at være et overnationalt center for sagkundskab og forsyner Fællesskabet med en videnskabelig tjeneste omfattende målrettet forskning, information og data vedrørende højtemperaturmaterialers egenskaber. De nuværende aktiviteter danner et godt grundlag for opfyldelsen af målsætningerne i 1987-1990 FFC-programmet med hensyn til sikkerhed og standarder.

KAPITEL IV - KONKLUSIONER OG HENSTILLINGER

Konklusioner

1. Ti år efter oprettelsen af HTM-program har FFC Petten nu slået sit navn fast som et overnationalt center for sagkundskab og information vedrørende højtemperaturmaterialer. Panelet finder, at denne rolle fortsat er nødvendig for en fortsættelse af prækonkurrencemæssig forskning under anvendelse af avancerede kostbare faciliteter og for at katalysere og koordinere eksterne forskningsaktiviteter, som vil kunne komme Fællesskabet til gode.

2. Panelet finder, at målsætningerne i HTM-programmet med henblik på at tilskynde udviklingen inden for Fællesskabet af højtemperaturmaterialer, som er nødvendige for avancerede teknologier, er blevet opfyldt i 1980-1983-programmet og sandsynligvis vil blive ofpyldt i 1984-1987-programmet.

3. Man tilslutter sig den strategi, der er anvendt for at opfylde ovennævnte målsætning, og målsætningerne for de projekter, der er medtaget i begge fire-årige programmer. Delmålene for aktiviteterne inden for hvert projekt er veldefinerede, og man værdsætter den praksis med mellemrum at gennemgå de fremskridt, der er gjort med arbejdet i det løbende program. En noget klarere definition af nogle projektmål ville have sat os i stand til mere præcist at vurdere, i hvilken udstrækning målsætningerne er opfyldt. Med henblik på en mere omfattende vurdering af målene for de tre forsøgsprojekter vil det være nødvendigt at indarbejde mere industrielt afgørende parametre i et udvidet program.

4. De fem igangværende projekter danner et sammenhængende HTM-program, som spiller en vigtig rolle på europæisk plan. Forsøgsprojekterne med undersøgelser af metaller og legeringer og af delkomponenter er vel integrerede i samarbejdsprogrammer med omkostningsdeling (COST 501 og 505), og projektet vedrørende teknisk keramik vil om kort tid blive slået sammen med den fælles aktion om samarbejde inden for råstoffer (teknisk keramik). Vi er imponerede af den tjeneste, som ydes af HTM-informationscentret, og håber, at den vil blive udvidet til at omfatte passende amerikansk og

japansk information. Om kort tid vil HTM databanken med indførelsen af on-line brugerservice blive stillet til rådighed for medlemmer inden for Fællesskabet. Vi hilser den øgede anvendelse af sagkundskaben ved Petten fra de forskellige generaldirektoraters side (XII og XIII) med henblik på bidrag til Fællesskabets sektorbestemte målsætninger velkommen.

5. Vi finder, at det nuværende HTM-program bør udvides i et stærkt samarbejde med industrien for at sikre, at dataene er relevante for repræsentative driftsbetingelser i fabriksanlæg, og at den resulterende metodologi til forudsigelse af levetid er acceptabel for anvendelse ved projekteringen af industrianlæg. Arten og omfanget af undersøgelserne vedrørende teknisk keramik er betimelige i relation til Fællesskabets kommende samfundsøkonomiske udvikling. På grund af manglen på fastlagte produktionsveje og specifikationer for avancerede keramiske materialer bør arbejdet med styringen af fabrikationsvariable fortsættes sideløbende med tilvejebringelsen af krybnings- og træthedsdata under kontrollerede korrosionsbetingelser.

6. Panelet er imponeret af den høje kvalitet af arbejdet ved Petten, som kan måle sig med et hvilket som helst nationalt laboratorium, som på tilsvarende måde har til opgave at fastslå pålidelige reproducerbare data og levere en videnskabelig data- og informationsservice. Aktiviteterne i det nuværende HTM-program gælder hovedsagelig anvendt forskning, uden at det er muligt klart at fastslå nogen grundforskning. Vi føler, at en vis grundforskning af nedbrydnings- og fejlmekanismer i HTM bør tilskyndes inden for huset og involvere det faste personale eller være emnet for en doktorgrad eller ske i samarbejde med FFC Ispra eller på kontrakt ved udvalgte universiteter.

7. Ressourcerne for det nuværende (1984-1987) HTM-program synes at vore tilstrækkelige. Selv om arbejdet i stigende grad er tværfagligt, og de personalemæssige begrænsninger endnu ikke har nået et skadeligt omfang, vil der efter vor opfattelse blive brug for øgede ressourcer for at tilvejebringe en mere omfattende databank og sikre, at der sker en forøgelse af bidraget til fællesskabsaktioner. Vi kunne også tænke os at se en mere

omfattende støtteaktivitet vedrørende højtemperatur-legeringers fysik og - til sin tid - keramiske stoffer med henblik på at opnå en dybere forståelse af forringelsen af disse i korroderende miljøer. En mulighed for at gennemføre dette mere omfattende arbejde er at optimere ressourcerne i de pågældende FFC-anlæg inden for relevante materialeområder (se henstilling 4).

8. Panelet finder, at de fremragende miljøforsøgsfaciliteter sammen med de for nyligt udviklede laboratorier til behandling af keramiske materialer og karakteriseringen af keramisk pulver er et trumfkort for Fællesskabet, som der bør gøres grundigt opmærksom på, således at teknikkerne og udstyret kan indføres af fællesskabsmedlemmer og udnyttes af flere forskningsstuderende fra Fællesskabet.

Henstillinger

1. FFC Petten bør fortsætte med at være et center for fagkundskab vedrørende højtemperaturmaterialer og yde en videnskabelig service - målrettet forskning, data og information om egenskaber - til Fællesskabet.

2. På den ene side bør FFC Pettens koordinerende, ledende og rådgivende rolle gradvis øges i takt med, at dets autoritet og kompetence vokser. På den anden side kan sagkundskab kun erhverves og vedligeholdes ved aktiv involvering i eksperimentel videnskab og teknologi, og der bør derfor afsættes tilstrækkelige ressourcer til at opretholde forsøgsaktiviteter af høj kvalitet ved Petten.

3. FFC Pettens rolle som katalysator bør opmuntres, navnlig inden for teknisk keramik. Trods den heldige gennemførelse af COST 50 og det lovende samarbejde inden for COST 501 og 505 bør forskningen i Petten af højtemperaturlegeringers adfærd fortsætte.

4. Tættere og hyppigere forbindelser med industrien er af væsentlig betydning for i højere grad at gøre industrien klar over aktiviteterne i Petten, på ny at bekræfte gyldigheden og prioriteten af F&U-behov og at sikre, at teknologi- og dataoverførsel til Fællesskabets industrier foregår hurtigt.

5. Muligheden af at opnå en vis indtægt fra arbejdet i FFC Petten med hensyn til betaling for afprøvningen af materialer i de enestående FFC Petten-faciliteter bør omhyggeligt overvejes. Dette ville give den foregående henstilling yderligere vægt.

6. Der bør overvejes en tovejsstrategi, som muliggør en korrelation af laboratoriedata og industridata for korrosionsforsøg på metaller og keramiske materialer.

7. Der bør udføres mere strategisk forskning (dvs. grundforskning til støtte for den anvendte forsknings målsætninger) f.eks. af den fysiske fortolkning af forringelse og brud hos metaller, keramiske og sammensatte materialer og med hensyn til metoder til forudsigelse af levetid.

8. De fremtidige retningslinjer for projektet vedrørende teknisk keramik bør omhyggeligt overvejes på grund af dets store potentielle omfang, som omfatter produktionsvariable og vekselvirkninger mellem sammensætning/mikrostruktur/egenskaber hos både keramiske materialer og keramisk-matrix sammensatte stoffer.

9. I vores egenskab af rådgiver for programforvaltningsudvalget for HTM Petten-programmet henstiller vi, at dette regelmæssigt overvåger programmets fremskridt og forvaltning.

10. Personaleressourcerne ved Petten bør gennemgås for at sikre, at der er en passende balance mellem videnskabsmænd, ingeniører, ledende teknikere og administrativt personale og ligeledes en acceptabel aldersfordeling, så man er i stand til at løse opgaverne i forbindelse med det kommende 4-årige program.

11. Kendskabet til FFC Petten-faciliteterne bør udbredes til større kredse, og en effektiv anvendelse af disse faciliteter bør overvejes i forbindelse med en forøget udnyttelse heraf fra videnskabsmænd og ingeniører, som inviteres fra Fællesskabets medlemslande. Der kan være et behov for at offentliggøre forskningsteknikker i sig selv mere i detaljer, måske kollektivt og adskilt fra resultaterne af forskningen.

12. Vi henstiller, at der lægges større vægt på en vurdering af dataene til HTM databanken.

13. Forvaltningen og rådgiverne af FFC Petten bør overveje behovet for både kort- og langsigtede målsætninger, idet de sidstnævnte strækker sig ud over programmernes 4-årige cyklus.

14. Idet vi mærker os det tilfredsstillende samarbejde mellem FFC Petten og FFC Ispra om HTM databanken og vedrørende projekt 2, anbefaler vi et snævrere samarbejde mellem egnede FFC-anlæg med henblik på en optimering af ressourcerne i forbindelse med kommende materialeaktiviteter.

15. Med hensyn til den fremtidige orientering af Petten-programmet anser vi de nuværende aktiviteter for at være et godt grundlag for at løse den foreslåede opgave for FFC for 1987-1990 vedrørende sikkerhed og standarder.

16. Personalet ved FFC Petten bør tilskyndes til at spille en mere vidtskuende og nyskabende rolle med hensyn til forbedringen af materialer til højtemperaturanvendelser.

ZUSAMMENFASSUNG

Im Frühjahr 1985 gab die GD XII einem externen Ausschuß den Auftrag, das Programm Hochtemperaturwerkstoffe 1984-87 der GFS Petten unter Berücksichtigung relevanter Ergebnisse aus dem vorherigen Programm (1980 bis 1983) zu bewerten und Empfehlungen für die Ausrichtung des künftigen Programms auszuarbeiten. Nach drei Sitzungen bei der GFS Petten und einer Sitzung bei der GD XII in Brüssel stellte der Ausschuß seinen Bewertungsbericht im Oktober 1985 fertig.

Detaillierte Bemerkungen zu den fünf Vorhaben des laufenden Programms sind als Anhänge dem Bericht beigefügt. Den wesentlichen Ergebnissen der Bewertung, die im Hauptteil zusammengefaßt sind, folgen Schlußfolgerungen und eine Reihe von Empfehlungen für künftige Tätigkeiten.

Der Ausschuß ist der Auffassung, daß die Sachkenntnis und die Anlagen der GFS Petten, zehn Jahre nach der Aufstellung des Programms Hochtemperaturwerkstoffe, einen positiven Beitrag zur kostenwirksamen Anwendung dieser Werkstoffe in fortgeschrittenen Technologien geleistet haben und leisten. Die Arbeit ist von einheitlich hoher Qualität und spiegelt die Kompetenz sowohl der Mitarbeiter als auch der Leitung wieder und stellt sicher, daß die GFS Petten in zunehmendem Maße eine katalytische und koordinierende Aufgabe im Rahmen der Gemeinschaftsprogramme, die Hochtemperaturlegie- rungen, Keramik und Verbundstoffe betreffen, erfüllt.

Der Ausschuß vertritt die Meinung, daß die Wirksamkeit der Arbeiten durch engere Kontakte mit der Industrie und durch eine verstärkte Grundlagenforschung zur Unterstützung der angewandten Forschungsstudien verbessert werden könnte. Er empfiehlt, daß die GFS Petten auch weiterhin als supranationales Zentrum der Sachkenntnis auftreten und der Gemeinschaft einen wissenschaftlichen Dienst bieten solle, der anwendungsorientierte Forschung, Informationen über Hochtemperaturwerkstoffe und Daten über ihre Eigenschaften umfaßt. Die derzeitigen Tätigkeiten sind eine gute Grundlage, um den Auftrag "Sicherheit und Normen" des GFS-Programms 1987-90 zu erfüllen.

KAPITEL IV - SCHLUSSFOLGERUNGEN UND EMPFEHLUNGEN

Schlußfolgerungen

1. Zehn Jahre nach der Aufstellung des Programms Hochtemperaturwerkstoffe nimmt die GFS Petten heute einen festen Platz als supranationales Zentrum der Sachkenntnis und Information über diese Werkstoffe ein. Der Ausschuß ist der Auffassung, daß diese Rolle für die Durchführung von vorwettbewerblichen Forschungsarbeiten, bei denen technisch aufwendige und kostspielige Anlagen verwendet werden, und die Stimulierung und Koordinierung der externen Forschungstätigkeiten, die der Gemeinschaft zugute kommen, auch weiterhin notwendig sein wird.

2. Der Auscchuß ist der Auffasung, daß das Ziel des Programms Hochtemperaturwerkstoffe, d.h. die Entwicklung von Hochtemperaturwerkstoffen, die für fortgeschrittene Technologien notwendig sind, innerhalb der Gemeinschaft zu fördern, im Rahmen des Programms 1980-83 erreicht wurde und voraussichtlich auch im Programm 1984-1987 erreicht werden wird.

3. Der Ausschuß ist mit der Strategie für die Erreichung des obengenannten Ziels sowie mit den Zielen der in den beiden Vierjahresprogrammen enthaltenen Vorhaben einverstanden. Die Teilziele für die Tätigkeiten innerhalb jedes Vorhabens sind gut definiert. Der Ausschuß bewertet es als positiv, daß Verfahren zur Überprüfung der Etappenziele eingesetzt wurden, um den Fortschritt der Arbeiten im Rahmen des laufenden Programms zu bewerten. Mit einer präziseren Definition einiger Ziele wäre es möglich gewesen, genauer festzustellen, inwieweit die Ziele erreicht wurden. Im Hinblick auf eine weitgehende Erreichung der Ziele der drei Versuchsvorhaben, erweist es sich als notwendig, mehr industriell bedeutsame Parameter in ein umfassenderes Programm aufzunehmen.

4. Die fünf laufenden Vorhaben bilden ein in sich geschlossenes Programm Hochtemperaturwerkstoffe dem auf europäischer Ebene eine wichtige Aufgabe zukommt. Die Versuchsvorhaben betreffend Untersuchungen von Metallen und Legierungen sowie von Teilkomponenten sind in Kooperationsprogramme auf Kostenteilungsbasis (COST 501 und 505) einbezogen. Ein Vorhaben über technische Keramik wird demnächst mit dem gemeinsamen Programm Rohstoffe (technische Keramik) assoziert werden.

Der Ausschuß ist beeindruckt von dem Dienst, den das Informationszentrum für Hochtemperaturwerkstoffe bietet und hofft, daß auch entsprechende amerikanische und japanische Informationen in diesen Dienst aufgenommen werden. Durch den On-line-Benutzerdienst wird die Datenbank für Hochtemperaturwerkstoffe bald auch den Mitgliedstaaten zur Verfügung stehen. Der Ausschuß begrüßt es, daß die Generaldirektionen XII und XIII für Beiträge zu fachbezogenen Gemeinschaftszielen in wachsendem Maße die Sachkenntnis der Forschungsanstalt Petten in Anspruch nehmen.

5. Der Auschuß ist der Auffassung, daß das vorliegende Programm Hochtemperaturwerkstoffe durch eine verstärkte Zusammenarbeit mit der Industrie erweitert werden sollte, um sicherzustellen, daß die Daten repräsentative Betriebsbedingungen von Anlagen wiedergeben und die sich daraus ergebene Methodologie der Lebensdauervorhersage für Konstrukteure von Industrieanlagen anwendbar ist. Die Art und der Themenkreis der Untersuchungen im Bereich der technischen Keramik entsprechen zeitlich der künftigen sozioökonomischen Entwicklung in der Gemeinschaft. Da festgelegte Fertigungsverfahren und Spezifikationen für die fortgeschrittene Keramik fehlen, sollten die Arbeiten über die Kontrolle von Einflußgrößen bei der Fertigung parallel zur Erfassung von Daten über das Kriechen und die Ermüdung unter kontrollierten Korrosionsbedingungen fortgesetzt werden.

6. Der Ausschuß ist von der hohen Qualität der Arbeiten in Petten beeindruckt, die voll und ganz der Qualität jedes vergleichbaren einzelstaatlichen Labors entspricht, das sich in ähnlicher Weise bemüht, zuverlässige reproduzierbare Daten zu bestimmen und einen wissenschaftlichen Daten- und Informationdienst anzubieten. Die Arbeiten im laufenden Programm Hochtemperaturwerksotffe beziehen sich im wesentlichen auf die angewandte Forschung, während eine Grundlagenforschung nicht eindeutig zu erkennen ist. Der Ausschuß ist der Auffassung, daß bestimmte Arbeiten im Zusammenhang mit der Grundlagenforschung über Fragen der Verschlechterung und der Versagensmechanismen von Hochtemperaturwerkstoffen gefördert werden sollten. Diese könnten in der Anstalt selbst von den dortigen Mitarbeitern oder Doktoranden/bzw. Jungakademikern oder aber in Zusammenarbeit mit der GFS Ispra. im Rahmen von Verträgen an ausgewählten Universitäten durchgeführt werden.

7. Die Mittel für das laufende Programm Hochtemperaturwerkstoffe (1984-1987) scheinen angemessen zu sein. Obgleich die Arbeit in wachsendem Maße multidisciplinär ausgerichtet ist und sich die personellen Beschränkungen noch nicht nachteilig ausgewirkt haben, ist der Ausschuß der Auffassung, daß mehr Mittel notwendig sein werden, um eine umfassendere Datenbank aufzubauen und sicherzustellen, daß ein wachsende Beitrag zu den Aktionen der Gemeinschaft geleistet wird. Der Ausschuß würde es außerdem begrüßen, wenn die Physik der Hochtemperaturlegierungen und schließlich die Keramik stärker gefördert würden, um ihre Verschlechterung in einer korrosiven Umgebung besser zu verstehen. Um diese zusätzlichen Arbeiten durchführen zu können, könnten z.B. die Mittel der entsprechenden GFS-Anstalten in den einschlägigen Werkstoffbereichen optimiert werden (siehe Empfehlung 4).

8. Der Ausschuß ist der Auffassung, daß die hervorragenden Umwelttestanlagen zusamen mit den neuerstellten Laboratorien für die Verarbeitung von Keramik und die Prüfung der Eigenschaften von Keramikpulvern einen Aktivposten der Gemesinchaft darstellen der besser bekanntgemacht werden sollte, damit die Techniken und die Anlagen von den Gemeinschaftsländern übernommen und von mehr Studenten in der Gemeinschaft verwendet werden können.

Empfehlungen

1. Die GFS Petten sollte auch weiterhin als Zentrum der Sachkenntnis für Hochtemperaturwerkstoffe fungieren und der Gemeinschaft wissenschaftliche Dienste anbieten (anwendungsorientierte Forschung, Informationen und geeinschaftsspezifische Daten).

2. Auf der einen Seite sollten die koordinierenden, leitenden und beratenden Aufgaben der GFS Petten im Rahmen ihrer wachsenden Kapazität und Kompetenz nach und nach zunehmen. Auf der anderen Seite wird Sachkenntnis nur durch eine aktive Beteiligung an der experimentellen Wissenschaft und Technologie erworben und aufrechterhalten. Deshalb sollten ausreichende Mittel darauf verwandt werden, daß in Petten auch weiterhin qualitativ hochwertige Versuche durchgeführt werden.

3. Die katalytische Rolle der GFS Petten sollte insbesondere auf dem Gebiet der technischen Keramik gefördert werden. Trotz des Erfolgs von COST 50 und der vielversprechenden Zusammenarbeit im Rahmen der COST-Aktionen 501 und 505 sollten in Petten auch weiterhin Forschungsarbeiten über das Verhalten von Hochtemperaturlegierungen durchgeführt werden.

4. Engere und häufigere Kontakte mit der Industrie sind wesentlich, damit die Industrie in verstärktem Maße auf die Tätigkeiten in Petten aufmerksam gemacht, die Gültigkeit und Priorität der FuE-Erfordernisse bestätigt und sichergestellt wird, daß der Technologie- und Datentransfer an die Industrien der Gemeinschaft schnell erfolgt.

5. Die Möglichkeit, sich um eine gewisse Vergütung der in der GFS Petten durchgeführten Arbeit zu bemühen, um so die Kosten für die Werkstoffversuche in den einzigartigen Anlagen der GFS Petten decken zu können, sollte sorgfältig geprüft werden. Dies geht in dieselbe Richtung wie die vorausgehende Empfehlung.

6. Eine Doppelstrategie mit der die Korrelation von Daten aus Korrosionsversuchen mit Metallen und Keramik, die im Labor und in der Industrie durchgeführt werden, ermöglicht wird, sollte in Betracht gezogen werden.

7. Es sollten mehr strategische Forschungsarbeiten (d.h. Grundlagenforschung zur Unterstützung der angewandten Forschung), z.B. über die physikalische Deutung der Verschlechterung und des Bruchs von Metallen, Keramik und Verbundwerkstoffen sowie über die Methoden zur Vorhersage der Lebensdauer durchgeführt werden.

8. Die künftige Ausrichtung des Vorhabens Technische Keramik sollte sorgfältig geprüft werden, da die potentielle Tragweite sehr breit ist und Fertigungsvariablen sowie Wechselwirkungen zwischen Zusammensetzung, Mikrogefüge und Eigenschaften sowohl für Keramik als auch für Keramik-Matrix-Verbundwerkstoffe, umfasst.

9. Der Ausschuß nimmt die Rolle des BVKA im Rahmen des Programms Hochtemperaturwerkstoffe von Petten zur Kenntnis und empfiehlt, daß er den Fortschritt der Arbeiten und die Leitung des Programms eng überwachen soll.

10. Der Personalbestand in Petten sollte überprüft werden, um sicherzustellen, daß ein angemessenes Gleichgewicht zwischen Wissenschaftlern, Ingenieuren, Managern, Technikern und Verwaltungspersonal besteht und der Altersaufbau annehmbar ist, um die Aufgaben und Ziele des nächsten Vierjahresprogramms erfüllen zu können.

11. Die Anlagen der GFS Petten sollten besser bekanngemacht werden. Ihre wirksame Verwendung sollte im Zusammenhang mit ihrer stärkeren Nutzung durch externe Wissenschaftler und Ingenieure, die aus den Mitgliedstaaten der Gemeinschaft eingeladen werden, untersucht werden. Dazu könnte es sich als nützlich erweisen, nähere Angaben zu Forschungstechniken an sich, vielleicht zusammengenommen und von den Forschungsergebnissen getrennt, zusammenzustellen und zu veröffentlichen.

12. Der Ausschuß empfiehlt, die Bewertung der Daten für die Datenbank für Hochtemperaturwerkstoffe stärker zu betonen.

13. Die Leitung der GFS Petten sowie ihre Berater sollten prüfen, ob nicht sowohl kurz - als auch langfristige Ziele notwendig sind, wobei die langfristigen Ziele über den Vierjahreszeitraum der Programme hinausgehen sollten.

14. Trotz der zufriedenstellenden Zusammenarbeit zwischen der GFS Petten und der GFS Ispra auf dem Gebiet der Datenbank für Hochtemperaturwerkstoffe und des Vorhabens 2, empfiehlt der Ausschuß eine engere Zusammenarbeit zwischen den entsprechenden GFS-Anstalten im Hinblick auf eine Optimierung der Mittel für künftige Tätigkeiten auf dem Gebiet der Werkstoffe.

15. Angesichts der künftigen Ausrichtung des Programms für Petten betrachtet der Ausschuß die jetzigen Tätigkeiten als eine gute Grundlage für die GFS, um den vorgeschlagenen Auftrag "Sicherheit und Normen" des Programms 1987-90 zu erfüllen.

16. Die Mitarbeiter der GFS Petten sollten ermutigt werden, einen mehr zukunftsweisenden und innovativen Standpunkt im Hinblick auf die Verbesserung der Werkstoffe für Hochtemperaturanwendungen zu übernehmen.

SYNTHESE

Au printemps de l'année 1985, la DG XII a nommé un groupe d'experts extérieurs pour évaluer le programme "Matériaux à Haute Température" (MHT) 1984-1987 du CCR-Petten, compte tenu des réalisations pertinentes du programme précédent (1980-1983), et émettre des recommandations concernant l'orientation du programme futur. Après trois réunions au CCR, à Petten, et une réunion à la DG XII, à Bruxelles, le groupe a achevé son rapport d'évaluation en octobre 1985.

Des commentaires détaillés concernant les cinq projets du programme actuel figurent dans les annexes au rapport, les conclusions principales de l'évaluation étant résumées dans le texte principal qui est suivi des conclusions et d'un certain nombre de recommandations relatives aux activités futures.

Le groupe d'évaluation estime que les compétences et les installations du CCR de Petten, pour le programme MHT, ont apporté et apportent, 10 ans après la création de ce dernier, une contribution importante à l'application rentable des matériaux à haute température dans les technologies de pointe. Grâce aux travaux qui sont tous de niveau qualitatif élevé et reflètent la compétence du personnel et de la gestion, le CCR de Petten joue un rôle croissant de catalyseur et de coordination des programmes communautaires concernant les alliages, les céramiques et les composites destinés à une utilisation à haute température.

Le groupe considère que l'efficacité des travaux pourrait être améliorée grâce à l'établissement de liaisons plus étroites avec l'industrie et au développement des recherches fondamentales venant étayer les études de recherche appliquée. Il recommande que le CCR de Petten poursuive ses activités en tant que centre supranational de compétences fournissant à la Communauté, un service scientifique qui couvre la recherche orientée vers les applications ainsi que les données et informations concernant les propriétés des matériaux à haute température. Les activités actuelles constituent une base solide pour l'accomplissement de la mission "sûreté et normes" du programme CCR 1987-1990.

CHAPITRE IV - CONCLUSIONS ET RECOMMANDATIONS

Conclusions

1. Dix ans après la création du programme MHT, le CCR-Petten est aujourd'hui un centre supranational bien établi de compétence et d'informations relatives aux matériaux à haute température. Le groupe d'évaluation considère que ce rôle reste nécessaire pour la poursuite des recherches précompétitives utilisant des installations perfectionnées et très coûteuses permettant de catalyser et de coordonner des activités de recherche extérieures bénéfiques pour la Communauté.

2. Le groupe estime que, dans le cadre du programme 1980-1983, la réalisation de l'objectif du programme matériaux à haute température, à savoir d'encourager au sein de la Communauté le développement de matériaux à haute température nécessaires pour les technologies de pointe, a progressé dans la bonne voie et que vraisemblablement cet objectif sera pleinement atteint par le programme 1984-1987.

3. Nous approuvons la stratégie adoptée pour atteindre ce but ainsi que les projets inclus dans les deux programmes quadriénnaux. Les sous-objectifs de chaque projet ont été bien définis et nous apprécions le recours à des procédures de révision des étapes importantes pour évaluer l'avancement des travaux du programme actuel. Si la définition de certains objectifs de projets avait été un plus affinée, nous aurions été en mesure d'évaluer avec plus de précision la mesure dans laquelle ces objectifs ont été atteints. En ce qui concerne la pleine réalisation des trois projets expérimentaux, il faudra intégrer dans un programme élargi des paramètres plus significatifs du point de vue industriel.

4. Les cinq projets actuels constituent un programme "Matériaux à Haute Température" (MHT) cohérent qui joue un rôle important au niveau européen. Les projets expérimentaux concernant les études de métaux et d'alliages ainsi que de sous-composants sont bien intégrés dans des programmes de collaboration à frais partagés (COST 501 et COST 505), et le projet concernant les céramiques destinées à des applications en ingéniérie sera sous peu associé à l'action conjointe de collaboration

relative aux matières premières (céramique technique). Le centre d'information MHT nous a particulièrement impressionnés et nous espérons qu'il sera étendu pour inclure les informations américaines et japonaises adéquates. Dans un proche avenir, grâce à la mise en oeuvre d'un service en ligne pour les utilisateurs, la banque de données MHT sera mise à la disposition des membres de la Communauté. Nous soulignons l'intérêt que présente l'utilisation accrue faite par les directions générales (XII et XIII) des compétences disponibles à Petten pour contribuer aux objectifs sectoriels de la Communauté.

5. Nous estimons que le programme MHT actuel devrait être élargi pour y inclure l'apport d'une collaboration intensive avec l'industrie et assurer que les données correspondent aux conditions représentatives d'exploitation des installations et que la méthodologie de prévision de la durée de vie qui en résulte puisse être appliquée par les concepteurs des installations industrielles. La nature et la portée des études sur les céramiques destinées à l'ingéniérie viennent à un moment opportun, eu égard au développement socio-économique future de la Communauté. En raison de l'absence de plans de production et de spécifications bien établies pour les céramiques de pointe, les travaux sur les contrôles des variables de fabrication devraient être poursuivis parallèlement à l'acquisition de données concernant le fluage et la fatigue des matériaux sous conditions de corrosion contrôlées.

6. Le groupe estime que les travaux réalisés à Petten sont d'un très haut niveau qualitatif et soutiennent parfaitement la comparaison avec des activités menées dans des laboratoires nationaux qui se consacren également à la détermination de données fiables et reproductibles et offrent un service de données et d'informations scientifiques. Les activités du programme MHT actuel relèvent essentiellement de la recherche appliquée et ne comportent pas d'éléments de recherche fondamentale clairement identifiables. Nous pensons qu'il faudrait encourager certaines recherches fondamentales relatives aux mécanismes de déterioration et de rupture des matériaux à haute température au sein même du centre en faisant appel à un personnel permanent ou à des étudiants de doctorat/post-graduat, en coopération avec le CCR à Ispra, ou encore dans le cadre de contrats conclus avec des universités sélectionnées.

7. Il semble que les ressources pour le programme MHT actuel (1984-1987) soient adéquates. Bien que les travaux soient de plus en plus multidisciplinaires et que les contraintes en matière de personnel complémentaire n'aient, jusqu'à présent, pas posé de problèmes, nous considérons qu'il faudra disposer de ressources plus importantes pour offrir une banque de données plus complète et assurer une contribution accrue aux actions communautaires. Nous voudrions également qu'un soutien plus important soit apporté aux activités concernant la physique des alliages à haute température et, ultérieurement, des céramiques pour mieux comprendre leur mécanisme de détérioration en environnements corrosifs. Pour permettre la réalisation de ces travaux, on pourrait envisager d'optimiser les ressources des établissements CCR appropriés dans les domaines de matériaux pertinents (voir recommandation 4).

8. Le groupe considère que les installations remarquables d'essais environnementaux, associées aux laboratoires récemment installés pour le traitement des céramiques et la caractérisation des poudres céramiques, constituent pour la Communauté un atout qui devrait être pleinement mis en lumière pour que les techniques et équipements puissent être adoptés par les membres de la Communauté et utilisés davantage par des étudiants du secteur de la recherche communautaire.

Recommandations

1. Le CCR de Petten doit rester un centre de compétence en matière de MHT et continuer à fournir un service scientifique (recherche orientée vers les applications, données et informations concernant les propriétés) à la Communauté.

2. D'autre part, il conviendrait d'accroître progressivement les rôles de coordination, de gestion et de consultation du CCR de Petten au fur et à mesure du développement de son autorité dans ce domaine et de ses compétences. Par ailleurs, seule une participation effective aux activités scientifiques expérimentales et technologiques permet d'acquérir et de maintenir les compétences, il faut donc que des ressources suffisantes soient consacrées au maintien des activités d'expérimentation de haut niveau à Petten.

3. Le rôle de catalyseur du CCR de Petten doit être encouragé, particulièrement dans le domaine des céramiques destinées à l'ingéniérie. Outre le succès du projet COST 50, et les perspectives prometteuses de collaboration dans le cadre de COST 501 et 505, les travaux de recherche de Petten concernant le comportement des alliages à haute température doivent être poursuivis.

4. Il est essentiel d'établir des liaisons plus étroites et plus fréquentes avec l'industrie pour que cette dernière puisse prendre connaissance des activités du centre, pour réaffirmer la validité et la priorité des exigences en matière de R&D et assurer un transfert rapide de technologies et de données aux industries de la Communauté.

5. Il faudrait envisager avec le plus grand soin la possibilité de rentabiliser dans une certaine mesure les travaux du CCR de Petten afin de couvrir les frais entraînés par les essais de matériaux réalisés dans les installations remarquables du CCR. Ceci permettrait de renforcer la recommandation précédente.

6. Il conviendrait également d'envisager une stratégie double permettant d'établir une corrélation entre les données de laboratoire et industrielles concernant les essais de corrosion sur les métaux et céramiques.

7. Il faudrait réaliser des recherches d'un caractère davantage stratégique (c'est-à-dire des recherches fondamentales soutenant des objectifs de recherche appliquée) concernant, par exemple, l'interprétation de la détérioration et de la rupture des métaux, des céramiques et des composites, ainsi qu'en matière de méthodes de prévision de la durée de vie.

8. Il faut également examiner avec attention l'orientation future du projet concernant les céramiques d'ingéniérie en raison de sa portée potentielle considérable couvrant les variables de production et les interactions composition/microstructures/propriétés pour les céramiques et les composites céramiques - matériaux à phases dispersées.

9. En ce qui concerne le rôle consultatif du CGC auprès du programme MHT de Petten, nous recommandons que cet organe suive régulièrement l'état d'avancement et la gestion du programme.

10. Les ressources en personnel à Petten doivent faire l'objet d'un examen afin d'assurer un équilibre adéquat entre les scientifiques, les ingénieurs, les gestionnaires, les techniciens et le personnel administratif, ainsi qu'une structure d'âge acceptable pour la réalisation de la mission et des objectifs du prochain programme quadriennal.

11. Il faut que les installations du CCR à Petten soient mieux connues et utilisées efficacement, notamment par des scientifiques et des ingénieurs des Etats membres de la Communauté qui seraient invités à y travailler. Il conviendrait peut-être de diffuser plus largement et de façon plus détaillée les techniques de recherche proprement dites, éventuellement de façon collective et dissociée des résultats de la recherche.

12. Nous recommandons de mettre davantage l'accent sur l'évaluation des données pour la banque de données MHT.

13. Les gestionnaires et les conseillers du CCR de Petten devraient envisager la nécessité de fixer des objectifs à court et à long terme qui, pour ces derniers, iraient au-delà du cycle quadriennal des programmes.

14. Nous constatons qu'il y a une collaboration satisfaisante entre le CCR de Petten et le CCR d'Ispra en ce qui concerne la banque de données MHT et le projet 2, et nous recommandons qu'une collaboration plus étroite soit établie entre les établissements CCR appropriés pour l'optimisation des ressources destinées aux activités futures relatives aux matériaux.

15. En ce qui concerne l'orientation future du programme de Petten, nous estimons que les activités actuelles constituent une base solide pour la réalisation de la mission "sûreté et normes" 1987-1990 proposée pour le CCR.

16. Il faut encourager le personnel du CCR de Petten à adopter une attitude plus visionnaire et novatrice dans le domaine de l'amélioration des matériaux destinés à des applications à haute température.

ΣΥΝΟΨΗ

Την άνοιξη του 1985, η ΓΔ XII ανέθεσε σε μια ομάδα εξωτερικών εμπειρογνωμόνων να αξιολογήσει το πρόγραμμα Υλικών Υψηλής Θερμοκρασίας (ΥΥΘ) (1984-87) του ΚΚΕρ-Petten, λαμβάνοντας υπόψη τα σχετικά επιτεύγματα του προηγούμενου προγράμματος (1980-1983), και να διατυπώσει συστάσεις σχετικά με τους προσανατολισμούς του μελλοντικού προγράμματος. Μετά από τρείς συσκέψεις στο ΚΚΕρ Petten και μία στη ΓΔ XII - Βρυξέλλες, η ομάδα ολοκλήρωσε την έκθεση αξιολογήσεως τον Οκτωβρίο του 1985.

Στα παραρτήματα της έκθεσης περιέχονται λεπτομερή σχόλια για τα πέντε έργα που συνιστούν το τρέχον πρόγραμμα, ενώ στο κυρίως κείμενο συνοψίζονται οι σημαντικότερες διαπιστώσεις από την αξιολόγηση, ακολουθούν δε τα συμπεράσματα και μερικές συστάσεις που αφορούν τις μελλοντικές δραστηριότητες.

Η ομάδα εμπειρογνωμόνων θεωρεί ότι οι ειδικές γνώσεις του προσωπικού και οι εγκαταστάσεις του ΚΚΕρ - Petten για το πρόγραμμα Υλικών Υψηλής Θερμοκρασίας, δέκα έτη μετά τη σύστασή του, έχουν ήδη συμβάλλει και συνεχίζουν να συμβάλλουν θετικά στην αποδοτική- συγκριτικά με το κόστος- χρησιμοποίηση υλικών υψηλής θερμοκρασίας σε εφαρμογές προηγμένων τεχνολογιών. Η εργασία χαρακτηρίζεται ομοιόμορφα από υψηλή ποιότητα, αντικατοπτίζοντας τις ικανότητες τόσο του προσωπικού όσο και της διοίκησης και εξασφαλίζοντας την ολοένα και πληρέστερη ανταπόκριση του ΚΚΕρ - Petten στην αποστολή του ως καταλύτη και συντονιστή των κοινοτικών προγραμμάτων στους τομείς των κραμάτων υψηλής θερμοκρασίας, των κεραμικών και των σύνθετων υλικών.

Η ομάδα πιστεύει ότι η εργασία θα μπορούσε να γίνει πιο αποτελεσματική με την αποκατάσταση στενότερων επαφών με τη βιομηχανία και με την ενσωμάτωση περισσότερης βασικής έρευνας για την υποστήριξη των μελετών εφαρμοσμένης έρευνας. Συνιστά δε το ΚΚΕρ-Petten να συνεχίσει να αποτελεί υπερεθνικό κέντρο ανάπτυξης ειδικών γνώσεων στον τομέα Υλικών Υψηλής Θερμοκρασίας παρέχοντας στην Κοινότητα επιστημονικές υπηρεσίες που περιλαμβάνουν την έρευνα, την πληροφόρηση και τη συλλογή στοιχείων σχετικά με τις ιδιοτήτες των υλικών αυτών. Οι παρούσες δραστηριότητες αποτελούν καλή βάση για να εκπληρωθεί η αποστολή του προγράμματος 1987-90 του ΚΚΕρ σε θέματα ασφάλειας και προτύπων.

ΚΕΦΑΛΑΙΟ IV - ΣΥΜΠΕΡΑΣΜΑΤΑ ΚΑΙ ΣΥΣΤΑΣΕΙΣ

Συμπεράσματα

1. Δέκα έτη μετά τή σύσταση τού Προγράμματος Υλικών Υψηλής θερμοκρασίας, το ΚΚΕρ - Petten, έχει πλέον καθιερωθεί πλήρως ως ένα υπερεθνικό επιστημονικό κέντρο συγκέντρωσης ειδικών γνώσεων και πληροφοριών για τα υλικά υψηλής θερμοκρασίας. Η ομάδα αξιολογήσεως θεωρεί ότι ο ρόλος αυτός εξακολουθεί να είναι αναγκαίος για την συνέχιση προανταγωνιστικής έρευνας στον τομέα, για την οποία απαιτούνται πολύπλοκες και δαπανηρές εγκαταστάσεις, και για την καταλυτική δράση και το συντονισμό ερευνητικών δραστηριοτήτων, εκτός του κέντρου, που είναι χρήσιμες για την Κοινότητα.

2. Η ομάδα θεωρεί ότι ο στόχος του προγράμματος "υλικά υψηλής θερμοκρασίας" (ΥΥΘ), δηλαδή η ενίσχυση, μέσα στην Κοινότητα, της ανάπτυξης υλικών υψηλής θερμοκρασίας που απαιτούνται στις προηγμένες τεχνολογίες, επιτεύχθηκε στο πρόγραμμα 1980-83, και είναι πιθανό να πραγματοποιηθεί επίσης στο πρόγραμμα 1984-87.

3. Συμφωνούμε με την στρατηγική που εφαρμόστηκε για την επίτευξη του παραπάνω στόχου καθώς επίσης και με τους ειδικότερους και γενικότερους στόχους των έργων που περιλαμβάνονταν και στα δύο τετραετή προγράμματα. Οι επιμέρους στόχοι για τις δραστηριότητες στα πλαίσια καθενός έργου ήταν καθορισμένοι σαφώς και αναγνωρίσαμε την αξία της χρήσης διαδικασιών ανασκόπησης με ορόσημα (διάγραμμα EPT) για την εκτίμηση της προόδου των εργασιών στο τρέχον πρόγραμμα. Ένας κάπως ευκρινέστερος καθορισμός των στόχων μερικών έργων θα μας είχε επιτρέψει να εκτιμήσουμε ακριβέστερα το βαθμό στον οποίο εκπληρώθηκαν οι στόχοι αυτοί. Για μια ολοκληρωμένη ανάλυση του βαθμού επίτευξης των στόχων των τριών πειραματικών έργων, απαιτείται η ενσωμάτωση, σε ένα εκτενέστερο πρόγραμμα, σημαντικών βιομηχανικών παραμέτρων.

4. Τα- πέντε τρέχοντα έργα συνιστούν ένα ολοκληρωμένο πρόγραμμα ΥΥΘ του οποίου ο ρόλος σε Ευρωπαϊκό επίπεδο είναι σημαντικός. Τα πειραματικά έργα που αφορούν τις μελέτες μετάλλων και κραμάτων καθώς και επιμέρους συστατικών στοιχείων είναι ενσωματωμένα πλήρως σε κοινά προγράμματα με συμμετοχή στο κόστος (COST 501 και 505), και το έργο που αφορά τα κεραμικά για μηχανολογικές εφαρμογές συντόμως θα συνδιαστεί με το πρόγραμμα κοινής δράσης στον τομέα των πρώτων υλών (κεραμικά για τεχνολογικές εφαρμογές).

Μας εντυπωσίασαν οι υπηρεσίες που προσφέρει ήδη το κέντρο πληροφοριών ΥΥΘ και ελπίζουμε ότι θα επεκταθεί ώστε να περιλάβει τις κατάλληλες πληροφορίες από τις ΗΠΑ και την Ιαπωνία. Σύντομα, με την έναρξη λειτουργίας με συνδεδεμένο τον χρήστη (ON- LINE), η τράπεζα δεδομένων των ΥΥΘ θα είναι διαθέσιμη στα μέλη της Κοινότητας. Καλωσορίζουμε την αύξημένη χρησιμοποίήση των επιστημονικών γνώσεων του Petten από τις Γενικές Διευθύνσεις (XII και XIII) και την συμβολή του κέντρου σε άλλους κοινοτικούς τομεακούς στόχους.

5. Θεωρούμε ότι το παρόν πρόγραμμα ΥΥΘ θα πρέπει να διευρυνθεί με ενεργό ομως συνεργασία της βιομηχανίας για να εξασφαλιστεί ότι τα δεδομένα αναφέρονται σε αντιπροσωπευτικές συνθήκες λειτουργίας των βιομηχανικών εγκαταστάσεων και ότι η προκύπτουσα μεθοδολογία πρόβλεψης του χρόνου ζωής είναι αποδεκτή για να εφαρμοστεί από τους σχεδιαστές των εγκαταστάσεων. Η φύση και το αντικείμενο των μελετών στα κεραμικά για μηχανολογικές εφαρμογές έχουν επίκαιρο χαρακτήρα σε σχέση με τη μελλοντική κοινωνικοοικονομική ανάπτυξη της Κοινότητας. Εξ αιτίας της έλλειψης καθιερωμένων μεθόδων παραγωγής και προδιαγραφών για κεραμικά προηγμένης τεχνολογίας, η εργασία για τον έλεγχο των μεταβλητών παραγωγής των υλικών θα πρέπει να επιδιώκεται παράλληλα με την απόκτηση δεδομένων για τον ερπυσμό και την κόπωση υπό ελεγχόμενες συνθήκες διάβρωσης.

6. Εντύπωση στην ομάδα προξένησε η υψηλή ποιότης της εργασίας στο Petten, η οποία φθάνει το επίπεδο εθνικών εργαστηρίων που έχουν παρόμοια αποστολή δηλαδή τον προσδιορισμό αξιόπιστων αναπαράξιμων δεδομένων και την προσφορά υπηρεσιών παροχής επιστημονικών δεδομένων και πληροφορήσεως. Οι δραστηριότητες του τρέχοντος προγράμματος ΥΥΘ αποτελούν κυρίως εφαρμοσμένη έρευνα χωρίς σαφείς δραστηριότητες βασικής έρευνας. Διαισθανόμαστε ότι ορισμένα στοιχεία βασικής έρευνας, επί της φθοράς και των μηχανισμών εξασθένησης των ΥΥΘ, θα πρέπει να ενισχυθούν αναπτυσσόμενα μέσα στο κέντρο με τη συμμετοχή μόνιμου προσωπικού είτε με σπουδαστές διδακτορικού/μεταδιδακτορικού επιπέδου, ή σε συνεργασία με το KKEp της Ispra, ή μέσω συμβάσεων με επιλεγμένα πανεπιστήμια.

7. Οι πόροι που διατίθενται για το τρέχον πρόγραμμα (1984-1987) ΥΥΘ φαίνεται ότι είναι επαρκείς.

Μολονότι η εργασία απαιτεί ολοένα και περισσότερους επιστημονικούς κλάδους και οι πιεστικές συνθήκες εργασίας δεν έχουν θίξει μέχρι τώρα το σύνολο του προσωπικού, πιστεύουμε ότι θα απαιτηθούν περισσότεροι πόροι για τη δημιουργία μιάς τράπεζας δεδομένων με πληρέστερα στοιχεία και για να εξασφαλιστεί μια πιο δυναμική συμβολή στις άλλες κοινοτικές δράσεις. Θα επιθυμούσαμε επίσης να υπάρξει εντονότερη δραστηριότητα υποστήριξης στη φυσική των κραμάτων υψηλής θερμοκρασίας και, ενδεχομένως, των κεραμικών προκειμένου να κατανοηθεί πληρέστερα η διαδικασία φθοράς τους σε διαβρωτικό περιβάλλον. Υπάρχει πάντως δυνατότητα εκτέλεσης των εκτενέστερων αυτών εργασιών εαν υπάρξει καλύτερη χρησιμοποίηση των πόρων των καταλλήλων εγκαταστασεων του ΚΚΕρ στους συναφείς ερευνητικούς τομείς επί των υλικών (βλέπε σύσταση 4).

8· Η ομάδα αξιολογήσεως θεωρεί ότι οι υψηλής στάθμης εγκαταστάσεις περιβαλλοντικών δοκιμών, συνδιαζόμενες με τα σύγχρονα εργαστήρια επεξεργασίας κεραμικών και χαρακτηρισμού κεραμικών κόνεων, αποτελούν πολύτιμο απόκτημα της Κοινότητας που θα πρέπει να προβληθεί με όλα τα μέσα δημοσιότητας, έτσι ώστε οι τεχνικές μέθοδοι και ο εξοπλισμός να μπορέσουν να υιοθετηθούν από τα μέλη της Κοινότητας και να χρησιμοποιηθούν από περισσότερους σπουδαστές - ερευνητές των Κρατών-μελών.

Συστάσεις

1. Το ΚΚΕρ - **Petten** θα πρέπει να εξακολουθήσει να αποτελεί κέντρο ανάπτυξης ειδικών επιστημονικών γνώσεων για τα υλικά υψηλής θερμοκρασίας και να παρέχει στην Κοινότητα επιστημονικές υπηρεσίες οπως έρευνα προσανατολισμένη στις εφαρμογές, πληροφορίες και δεδομένα για τις ιδιότητες των υλικών αυτών.

2. Κατ'αρχήν, θα πρέπει σταδιακά να επεκταθεί ο συντονιστικός, διευθυντικός και συμβουλευτικός ρόλος του ΚΚΕρ-**Petten** στο μέτρο που αυξάνουν οι αρμοδιότητες του. Αφετέρου, οι ειδικές επιστημονικές γνώσεις γίνονται κτήμα και διατηρούνται μόνο με την ενεργό ανάμειξη στην πειραματική επιστημονική και τεχνολογική δράση και συνεπώς θα πρέπει να διατεθούν επαρκείς πόροι για τη συνέχιση των υψηλής ποιότητας πειραματικών δραστηριοτήτων στο **Petten**.

3. Επίσης θα πρέπει να ενισχυθεί ο καταλυτικός ρόλος του ΚΚΕρ **Petten**, ειδικότερα στον τομέα των κεραμικών για μηχανολογικές εφαρμογές.

Παρά την επιτυχία του COST 50 και την ελπιδοφόρο συνεργασία στο COST 501 και 505, η ερευνητική εργασία του Petten στον τομέα της συμπεριφοράς κραμάτων υψηλής θερμοκρασίας θα πρέπει να συνεχιστεί.

4. Στενότερες και συχνότερες επαφές με τη βιομηχανία είναι απαραίτητες για να ανταποκρίθούν οι δραστηριότητες του Petten στην βιομηχανική πραγματικότητα, να ελεγχθούν για την ορθότητα τους οι E&A προτεραιότητες και να εξασφαλιστεί η ταχεία μεταφορά τεχνολογίας και δεδομένων προς τις Κοινοτικές βιομηχανίες.

5. Θα πρέπει να εξεταστεί προσεκτικά η δυνατότητα κάποιας εξωτερικής χρηματοδότησης των εργασιών του KKEp - Petten οσον αφορά δοκιμές υλικών στις μοναδικές εγκαταστάσεις του κέντρου. Τούτο θα χρησίμευε στην ενίσχυση της προηγούμενης σύστασης.

6. Θα πρέπει να εξεταστεί μια διττή στρατηγική που να δίνει τη δυνατότητα συσχετισμού των δεδομένων από δοκιμές διάβρωσης μετάλλων και κεραμικών που γίνονται στο εργαστήριο και στη βιομηχανία.

7. Στο μέλλον θα πρέπει να διεξαχθεί περισσότερο στρατηγική έρευνα (δηλαδή βασική έρευνα υποστήριξης των στόχων της εφαρμοσμένης έρευνας) π.χ. στη φυσική ερμηνεία της φθοράς και θραύσης μετάλλων, κεραμικών και σύνθετων υλικών, καθώς και σε μεθόδους πρόγνωσης του χρόνου ζωής των υλικών.

8. Θα πρέπει να εξεταστεί προσεκτικά ο μελλοντικός προσανατολισμός του έργου "κεραμικά για μηχανολογικές εφαρμογές" λόγω του ευρέος αντικειμένου του έργου, που καλύπτει τις μεταβλητές παραγωγής και τις αμοιβαίες επιδράσεις σύνθεσης / μικροδομής / ιδιοτήτων τόσο στα κεραμικά όσο και στα σύνθετα υλικά κεραμικής βάσης.

9. Λαμβάνοντας υπό σημείωση το συμβουλευτικό ρόλο της επιτροπής διαχείρησης και συντονισμού (CGC) του προγράμματος ΥΥΘ του Petten, συνιστούμε τη διαρκή παρακολούθηση του προγράμματος απο την επιτροπή αυτή.

10. Το ανθρώπινο δυναμικό του Petten θα πρέπει να αποτελέσει αντικείμενο μελέτης ώστε να εξασφαλιστεί η κατάλληλη ισορροπια σε επιστήμονες ερευνητές, μηχανικούς, προϊσταμένους, τεχνικούς και διοικητικό προσωπικό καθώς και μια αποδεκτή πυραμίδα ηλικιών που να ανταποκρίνεται στην αποστολή

και στους στόχους του επόμενου τετραετούς προγράμματος.

11. Θα πρέπει να προβληθούν ευρύτερα από τα μέσα δημοσιότητας οι εγκαταστάσεις του ΚΚΕρ - **Petten** και η αποτελεσματική χρησιμοποίηση τους θα πρέπει να εξεταστεί σε σχέση με μία ευρύτερη χρήση τους από επιστήμονες και ερευνητές που θα προσκαλούνται από χώρες μέλη της Κοινότητας. Επίσης υπάρχει η ανάγκη να δημοσιεύονται οι τεχνικές μέθοδοι έρευνας λεπτομερέστερα, μόνες τους ή ομαδικά, χωριστά από τα ερευνητικά αποτελέσματα.

12. Συνιστούμε να δοθεί μεγαλύτερη έμφαση στην αξιολόγηση των δεδομένων για την τράπεζα ΥΥθ.

13. Η διοίκηση του ΚΚΕρ **Petten** και οι σύμβουλοί της θα πρέπει να εξετάσουν την ανάγκη καθορισμού μεσοπρόθεσμων και μακροπρόθεσμων - πέρα του τετραετούς κύκλου των προγραμμάτων - στόχων.

14. Λαμβάνοντας υπό σημείωση την ικανοποιητική συνεργασία μεταξύ του ΚΚΕρ - **Petten** και του ΚΚΕρ - **Ispra** αναφορικά με την Τράπεζα δεδομένων ΥΥθ και το έργο 2, συνιστούμε στενότερη συνεργασία μεταξύ σχετικών εγκαταστάσεων του ΚΚΕρ όσον αφορά τη βέλτιστη χρησιμοποίηση των πόρων για μελλοντικές δραστηριότητες επί των υλικών.

15. Όσον αφορά το μελλοντικό προσανατολισμό του προγράμματος του **Petten**, θεωρούμε τις παρούσες δραστηριότητες ως σωστή βάση για την εκπλήρωση της προτεινόμενης για το ΚΚΕρ αποστολής σε θέματα ασφάλειας και προτύπων κατά την περίοδο 1987-90.

16. Το προσωπικό του ΚΚΕρ - **Petten** θα πρέπει να παρακινηθεί να επιδεικνύει μεγαλύτερη διορατικότητα και καινοτόμο πρωτοβουλία αναφορικά με τη βελτίωση υλικών για εφαρμογές υψηλής θερμοκρασίας.

SINTESI

Nella primavera del 1985 la DG XII ha costituito un comitato di esperti esterni con il compito di valutare l'attività 1984-1987 del programma "materiali per alte temperature" dello stabilimento di Petten del CCR, tenendo conto dei risultati del precedente programma (1980-1983), nonchè di formulare raccomandazioni sugli orientamenti per il programma futuro. Dopo tre riunioni presso lo stabilimento di Petten del CCR e una riunione presso la DG XII a Bruxelles, il comitato ha terminato la sua relazione di valutazione nell'ottobre 1985.

Negli allegati di detta relazione vengono fatte diverse osservazioni particolareggiate sui cinque progetti che costituiscono il programma in corso ; la valutazione complessiva viene sintetizzata nella parte principale del testo, seguita dalle relative conclusioni e da diverse raccomandazioni per le attività future.

Il comitato ritiene che, grazie alla sua perizia e alle sue apparecchiature, il programma "materiali per alte temperature" - 10 anni dopo la sua creazione - abbia dato e continui a dare un contributo positivo ai fini di un'utilizzazione efficace dei materiali per alte temperature nelle tecnologie d'avanguardia. I lavori sono generalmente di alta qualità e rispecchiano la competenza del personale tecnico e amministrativo ; lo stabilimento di Petten soddisfa cosi sempre più il suo ruolo di coordinamento e di catalisi dei programmi comunitari di ricerca sulle leghe, le ceramiche e i mateirali compositi per alte temperature.

Il comitato ritiene che si potrebbe ancor più potenziare l'efficacia delle attività rafforzando i collegamenti con l'industria e approfondendo la ricerca fondamentale in appoggio agli studi di ricerca applicata. Il comitato raccomanda che lo stabilimento di Petten continui ad essere un centro di competenza scientifica sopranazionale e a costituire per la Comunità un servizio scientifico che svolge lavori di ricerca applicata sulle caratteristiche e sul comportamento dei materiali per alte temperature. Le attività in corso sono un'ottima base per poter conseguire l'obiettivo del programma del CCR 1987-1990 riguardante la sicurezza e le norme.

CAPITOLO IV - CONCLUSIONI E RACCOMANDAZIONI

Conclusioni

1. Dieci anni dopo la sua costituzione, il programma "materiali per alte temperature" dello stabilimento di Petten del CCR gode oggi di un'ottima reputazione di centro sopranazionale di esperienza e di informazione. Il comitato ritiene che la sua continui ad essere una funzione necessaria per lo svolgimento di ricerche a livello preconcorrenziale utilizzando apparecchiature molto raffinate e costose nonchè favorendo e coordinando attività di ricerca esterne proficue per la Comunità.

2. Il comitato ritiene che l'obiettivo del programme HTM (Materiali per alte temperature) e cioè promuovere nella Communità lo sviluppo dei materiali per alte temperature necessari per le tecnologie d'avanguardia, sia stato conseguito per quanto riguarda il periodo 1980-1983 e probabilmente verrà raggiunto anche per il periodo 1984-1987.

3. Approviamo la strategia adottata per raggiungere il suddetto obiettivo nonchè i singoli scopi ed obiettivi dei progetti inclusi nei due programmi quadriennali. Gli obiettivi delle singole attività in cui si articola ciascun progetto sono ben definiti ed abbiamo apprezzato in particolare la fissazione di procedure di riesame periodico per valutare l'avanzamento dei lavori del programma in corso. Una definizione un po' più precisa degli obiettivi di alcuni progetti ci avrebbero consentito di valutare in modo più esatto il grado di conseguimento degli objettivi stessi. Per conseguire globalmente gli scopi dei tre progetti sperimentali occorrerà inserire in un programma ampliato parametri di maggior rilevanza dal punto di vista dell'industria.

4. I cinque progetti in corso di svolgimento formano un programma coerente HTM che ha un'importante funzione a livello europeo. I progetti sperimentali su metalli e leghe e sui sottocomponenti sono ottimamente inseriti nell'ambito dei programmi di collaborazione e compartecipazione finanziaria (COST 501 e 505); il progetto sulle

ceramiche per l'ingegneria verrà tra breve associato con l'azione con l'azione congiunta in collaborazione sulle materie prime (ceramiche per uso tecnico). Abbiamo apprezzato i servizi offerti dal centro d'informazione HTM di cui auspichiamo l'ampliamento in modo che possa offrire informazioni anche americane e giapponesi sul settore. A breve scadenza, con l'introduzione di un servizio in linea per gli utilizzatori, la banca di dati HTM sarà accessibile agli Stati membri della Comunità. Giudichiamo positivo che le direzioni generali XII e XIII ricorrano sempre più di frequente all'esperienza tecnica dello stabilimento di Petten per contributi al conseguimento degli obiettivi settoriali comunitari.

5. Riteniamo che il programma HTM in corso di svolgimento debba essere ampliato in stretta collaborazione con l'industria in modo da garantire che i risultati riflettano condizioni rappresentative di funzionamento degli impianti e che la conseguente metodologia di previsione della durata media degli impianti sia applicabile e operativa per i progettisti degli impianti e delle apparecchiature industriali. La natura e l'ambito degli studi sulle ceramiche per l'ingegneria sono del tutto opportuni per la futura espansione socio-economica della Comunità. Mancando una definizione precisa delle caratteristiche e dei processi di produzione delle ceramiche d'avanguardia occorre proseguire gli studi sul controllo dei parametri di fabbricazione, parallelamente alla raccolta di dati sullo scorrimento e sulla fatica in condizioni controllate di corrosione.

6. Il comitato è stato favorevolmente colpito dall'alta qualità dei lavori svolti a Petten, molto superiore al livello di altri laboratori nazionali volti al conseguimento di risultati affidabili e riproducibili e alla costituzione di un servizio scientifico d'informazione e di raccolta di dati. Le attività del programme HTM in corso riguardano essenzialmente la ricerca applicata, senza studi di ricerca fondamentale chiaramente identificabili. Pensiamo che occorrerebbe promuovere, all'interno dello stabilimento, alcune ricerche di tipo fondamentale sui meccanismi di deterioramento e di rottura dei materiali per alte temperature con la partecipazione di

personale fisso o di studenti per il dottorato o post-dottorato, oppure in collaborazione con lo stabilimento di Ispra del CCR, oppure tramite ricerche su contratto con università ben selezionate.

7. Le risorse fianziarie per lo svolgimento del programma HTM in corso (1984-1987) ci sembrano adeguate. Pur considerando che le attività assumono sempre più un carattere pluridisciplinare e che le limitazioni sul personale complementare non sono troppo pregiudizievoli, riteniamo che occorrerebbero maggiori risorse per poter costituire una banca di dati più completa e per garantire che vengano apportati contributi sempre maggiori alle azioni della Comunità. Inoltre, auspicheremmo un'intensificazione delle attività di appoggio degli studi di fisica sulle leghe per alte temperature e in fine sulle ceramiche per giungere ad una migliore comprensione dei loro meccanismi di deterioramento in ambiente corrosivo. Per poter svolgere questa maggior mole di lavoro, una possibilità consisterebbe nell'ottimizzazione della distribuzione delle risorse degli stabilimenti del CCR che svolgano ricerche nei settori riguardanti i materiali (cfr. raccomandazione 4).

8. Il comitato ritiene che le notevoli apparechiature di prove ambientali e i laboratori recentemente sviluppati per il trattamento delle ceramiche e la caratterizzazione delle polveri ceramiche costituiscano una preziosa risorsa della Comunità che dovrebbe essere ampiamente pubblicizzata in modo che le relative technice e apparecchiature possano essere adottate dagli Stati membri e utilizzate da un maggior numero di ricercatori della Comunità.

Raccomandazioni

1. Lo stabilimento di Petten (CCR) deve continuare ad essere un centro di competenza sui materiali per alte temperature e costituire un servizio scientifico della Comunità (ricerca orientata alle applicazioni, dati e informazioni sulle caratteristiche).
2. Da un lato, occorrerebbe potenziare, con il crescere del suo prestigio e della sua competenza, i ruoli di coordinamento, di gestione e di consulenza dello stabilimento di Petten del CCR. Dall'altro lato, l'acquisizione e il mantenimento della competenza vengono ottenuti

soltanto con una partecipazione attiva alle ricerche scientifiche e tecnologiche sperimentali. Pertanto, occorre destinare risorse sufficienti per mantenere l'alta qualità delle attività sperimentali dello stabilimento di Petten.

3. Occorre favorire il ruolo catalizzatore dello stabilimento di Petten del CCR, soprattuto per quanto riguarda gli studi sulle ceramiche per l'ingegneria. Nonostante il successo del progetto COST 50 e la promettente collaborazione ai progetti COST 501 e 505, occorre proseguire l'attività di ricerca sul comportamento delle leghe per alte temperature.

4. Più stretti e più frequenti collegamenti con l'industria sono essenziali affinché quest'ultima sia maggiormente al corrente delle attività di Petten, siano riaffermate la validità e la priorità delle esigenze di R & S e sia garantito un rapido trasferimento delle tecnologie e dei dati alle industrie della Comunità.

5. Occore esaminare attentamente la possibilità di certe forme di compenso per i lavori di prova dei materiali con le eccezionali apparecchiature del centro di Petten. Ciò rafforzerebbe l'importanza della precedente raccomandazione.

6. Occorre studiare una duplice strategia che renda possibile la correlazione dei dati delle prove di corrosione, in laboratorio e nell'industria, sui metalli e sulle ceramiche.

7. Occorrerebbe svolgere ricerche maggiormente strategiche (e cioè ricerche fondamentali con orientamenti applicativi), ad esempio sull'interpretazione fisica del deterioramento e della rottura dei metalli, delle ceramiche e dei materiali compositi nonché sui metodi di previsione della loro vita media.

8. Occorre studiare attentamente l'orientamento futuro del progetto sulle ceramiche per l'ingegneria, dato il suo vasto campo di studi possibili che va dai parametri di produzione alle interazioni delle proprietà di composizione/microstruttura, sia per le ceramiche che per i materiali compositi a matrice ceramica.

9. Il CGC del programma HTM dovrebbe controllare periodicamente lo stato di avanzamento dei lavori e la gestione del programma.

10. Occorrerebbe esaminare le risorse di personale del centro di Petten in modo da garantire un adeguato equilibrio tra ricercatori scientifici, tecnici e amministratori, nonché un'opportuna composizione dell'età del personale in modo da poter conseguire gli obiettivi del prossimo programma quadriennale.

11. Le apparecchiature e i servizi del centro di Petten devono essere maggiormente pubblicizzati ; occorre inoltre studiare come utilizzarli in modo più efficace mettendoli maggiormente a disposizione di ricercatori e tecnici esterni degli Stati membri. Potrebbe essere opportuno fare conoscere in modo più approfondito le tecniche di ricerca in sé e per sé, magari in blocco e indipendamente dai risultati delle ricerche.

12. Occorrerebbe dare maggior rilievo alla valutazione delle informazioni della banca di dati HTM.

13. I responsabili della gestione del centro di Petten e i loro consiglieri dovrebbero esaminare l'opportunità di prefiggersi obiettivi sia a breve che a lungo termine (anche al di là del ciclo quadriennale dei programmi).

14. Pur prendendo atto della soddisfacente collaborazione tra lo stabilimento di Petten e lo stabilimento di Ispra del CCR per quanto riguarda la banca di dati HTM e il progetto 2, occorrerebbe rafforzare la cooperazione tra i competenti stabilimenti del CCR al fine di ottimizzare l'utilizzazione delle risorse per le future attività di ricerca sui materiali.

15. Le attuali attività costituiscono un'ottima base per l'orientamento futuro del programma di ricerca dello stabilimento di Petten al fine di conseguire gli obiettivi proposti per il periodo 1987-1990 nel campo della sicurezza e delle norme.

16. Si dovrebbe incentivare il personale del centro di Petten ad essere più immaginativo e più innovativo per il perfezionamento dei materiali per applicazioni ad alte temperature.

SYNOPSIS

In het voorjaar van 1985 heeft DG XII een extern panel belast met een evaluatie van het Hoge-Temperatuurmaterialen (HTM) programma 1984-1987 van het GCO Petten waarbij rekening wordt gehouden met relevante resultaten van het vorige programma (1980-1983) en het doen van aanbevelingen voor de oriëntatie van het toekomstige programma. Na drie vergaderingen in het GCO Petten en één bij DG XII te Brussels heeft het panel in oktober 1985 zijn evaluatierapport voltooid.

De bijlagen bij het rapport bevatten uitvoerige commentaren op de vijf projecten die het lopende programma vormen, terwijl de hoofdtekst een samenvatting van de belangrijkste bevindingen van de evaluatie bevat met conclusies en een aantal aanbevelingen voor toekomstige activiteiten.

Het panel is van mening dat de deskundigheid en faciliteiten van het GCO Petten voor het Hoge-Temperatuurmaterialen programma tien jaar na de oprichting op positieve wijze hebben bijgedragen en nog steeds bijdragen aan een rendabele toepassing van hoge-temperatuurmaterialen in geavanceerde technologieën. De constant hoge kwaliteit van het werk is een afspiegeling van de competentie van personeel en beheer en daardoor vervult het GCO Petten in toenemende mate een katalyserende en coördinerende rol in de programm's van de Gemeenschap die betrekking hebben op hoge-temperatuur-legeringen, keramieken en composietmaterialen.

Het panel is ervan overtuigd dat de doeltreffendheid van de werkzaamheden kan worden verbeterd door nauwer contact met de industrie en door de uitvoering van meer fundamenteel onderzoek ter ondersteuning van het toegepaste onderzoek. Volgens het advies van het panel moet het GCO Petten een supranationaal centrum van deskundigheid blijven en de Gemeenschap wetenschappelijke diensten verlenen op gebieden zoals toepassingsgericht onderzoek, gegevens over materiaaleigenschappen en informatie over hoge-temperatuurmaterialen. De huidige werkzaamheden vormen een goede basis voor het vervullen van de in the GCO-programma 1987-1990 opgelegde taak op het gebied van veiligheid en normen.

HOOFDSTUK IV - CONCLUSIES EN AANBEVELINGEN

CONCLUSIES

1. Tien jaar na de oprichting van het Hoge-Temperatuurmaterialen programma is het GCO Petten thans een gevestigd supranationaal centrum van deskundigheid en informatie op het gebied van hoge-temperatuur-materialen (HTM). Het panel is van mening dat deze rol nog steeds noodzakelijk is voor de uitvoering van precommercieel onderzoek waarbij gebruik wordt gemaakt van geavanceerde kostbare apparatuur en voor het katalyseren en coördineren van externe onderzoekactiviteiten die de Gemeenschap ten goede komen.

2. Het panel is van mening dat het doel van het HTM-programma, nl. het aanmoedigen van de ontwikkeling van de voor geavanceerde technologieën vereiste HTM in de Gemeenschap, met het programma 1980-1983 is bereikt en dat naar alle waarschijnlijkheid ook met het programma 1984-1987 daaraan zal worden voldaan.

3. Wij stemmen in met de strategie die is gekozen om bovengenoemd doel te bereiken en met de doelstellingen van de in beide vierjarenprogramma's opgenomen projecten. De deeldoelstellingen voor de werkzaamheden in het kader van elk project waren duidelijk omschreven en wijstelden de tussentijdse beoordelingen (mijlpalen) op prijs welke werden gebruikt om de vooruitgang te meten die bij de uitvoering van het lopende programma werd geboekt. Een enigszins scherpere afbakening van bepaalde projectdoelstellingen zou ons in staat hebben gesteld nauwkeuriger te bepalen in welke mate het doel werd bereikt. Voor de volledige verwezenlijking van de doelstellingen van de drie experimentele projecten moeten in het verlengde programma meer industrieel significante parameters worden opgenomen.

4. De vijf lopende projecten vormen een samenhangend HTM-programma dat op Europees niveau een belangrijke rol heeft. De experimentele projecten voor studies van metalen en legeringen en van subcomponenten zijn goed geïntegreerd in samenwerkingsprogramma's voor gezamelijke rekening (COST 501 en 505) en het project inzake technische keramieken zal binnenkort worden verenigd met het gemeenschappelijke samenwerkings-project grondstoffen (technische keramieken).

Wij zijn onder de indruk gekomen van de diensten die door het HTM-informatiecentrum zijn verleend en hopen dat daarin ook de desbetreffende informatie uit de VS en Japan zal worden opgenomen. Binnenkort komt er een on-line-dienst voor de gebruiker en dan zal de HTM-databank ter beschikking staan van de Lid-Staten. Wij verheugen ons over het toenemende gebruik dat van de deskundigheid in Petten wordt gemaakt door de directoraten-generaal XII en XIII voor bijdragen aan de sectoriële doelstellingen van de Gemeenschap.

5. Wij zijn van mening dat het huidige HTM-programma met actieve medewerking van de industrie moet worden uitgebreid om ervoor te zorgen dat de gegevens betrekking hebben op representatieve bedrijfsomstandigheden en dat de daaruit voortvloeiende methode ter bepaling van de levensduur zonder meer kan worden toegepast door ontwerpers van industriële installaties. De aard en draafwijdte van de studies betreffende technische keramieken beantwoorden aan de toekomstige sociaal-economische ontwikkeling van de Gemeenschap. Gezien het gebrek aan vaststaande produktieroutes en specificaties voor geavanceerde keramieken, dient verder werk te worden gemaakt van de beheersing van fabricagevariabelen terwijl gegevens over kruip en vermoeiing onder gecontroleerde corrosieomstandigheden worden verzameld.

6. Het panel is onder de indruk van de zeer goede kwaliteit van de werkzaamheden in Petten die zeker op het peil staan van om het even welk vergelijkbaar nationaal laboratorium dat zich eveneens bezighoudt met de bepaling van betrouwbare reproduceerbare gegevens en met het verstrekken van wetenschappelijke gegevens en informatie. In het kader van het lopende HTM-programma wordt vornamelijk toegepast onderzoek uitgevoerd, terwijl er geen duidelijk aanwijsbaar fundamenteel onderzoek is. Naar onze mening moet binnen de instelling enig fundamenteel onderzoek naar beschadigings- en storingsmechanismen van HTM worden aangemoedigd waarbij vast personeel of doctorale/ postdoctorale studenten worden betrokken of dat in samenwerking met het GCO Ispra of op contract in bepaalde universiteiten wordt uitgevoerd.

7. De middelen voor het lopende HTM-programma (1984-1987) lijken toereikend te zijn. Hoewel de werkzaamheden in toenemende mate multidisciplinair zijn en de beperkingen op de personeelsuitbreiding tot dusver geen kwalijke gevolgen hebben gehad, zijn wij van mening dat meer middelen nodig zullen zijn om een uitgebreidere databank tot stand te brengen en ervoor te zorgen dat in toenemende mate aan de communautaire werkzaamheden kan worden bijgedragen.

   We zouden ook meer ondersteunende activiteiten willen zien op het gebied van de fysica van hoge-temperatuurlegeringen en tenslotte keramieken om een vollediger inzicht te verkrijgen in de beschadiging daarvan in corrosieve omgevingen. Eén van de mogelijkheden om deze uitgebreide taak te kunnen vervullen is het optimaliseren van de middelen van de GCO-vestigingen waarvan de werkzaamheden betrekking hebben op deze materialen (zie aanbeveling 14).

8. Het panel is van oordeel dat de uitstekende milieutestfaciliteiten te zamen met de onlangs ontwikkelde laboratoria voor het verwerken van keramieken en de karakterisering van keramiekpoeders een belangrijke aanwinst voor de Gemeenschap vormen waaraan zoveel mogelijk bekendheid moet worden gegeven zodat de technieken en apparatuur door de Lid-Staten kunnen worden overgenomen en door meer studenten uit de Gmeenschap voor onderzoek kunnen worden gebruikt.

Aanbevelingen

1. Het GCO Petten moet een centrum van deskundigheid op het gebied van HTM blijven en verder aan de Gemeenschap wetenschappelijke diensten verlenen zoals toepassingsgericht onderzoek, informatie en gegevens over materiaaleigenschappen.

2. Enerzijds moet de coördinerende, beheers- en adviserende rol van het GCO Petten geleidelijk worden uitgebreid naar mate de autoriteit en competentie toeneemt. Anderzijds wordt deskundigheid alleen verworven en behouden door actieve betrokkenheid bij experimentele wetenschap en technologie en derhalve moeten voldoende middelen worden besteed aan de handhaving van de belangrijke experimentele activiteiten in Petten.

3. De katalyserende rol van het GCO Petten moet worden aangemoedigd, vooral op het gebied van technische keramieken. Ondanks het succes van COST 50 en de veelbelovende samenwerking bij COST 501 en 505 moeten de onderzoekwerkzaamheden te Petten op het gebied van het gedrag van hoge-temperatuurlegeringen worden voortgezet.

4. Nauwere en frequentere contacten met de industrie zijn van essentieel belang om de activiteiten te Petten beter op de behoeften van de industrie af te stemmen, de geldigheid en prioriteit van O&O-behoeften te bevestigen en een snelle overdarcht van technologie en gegevens aan bedrijven in de Gemeenschap te bewerkstellingen.

5. Er moet zorgvuldig worden onderzocht of er geen mogelijkheid bestaat om winst te behalen met de werkzaamheden van het GCO te Petten door een vergoeding te vragen voor de beproeving van materialen in de unieke installaties van het GCO te Petten. Dit zou kracht bijzetten aan de vorige aanbeveling.

6. Er zou een tweeledige strategie in overweging moeten worden genomen waardoor een correlatie tot stand kan worden gebracht tussen in het laboratorium en in het bedrijf verkregen corrosietestgegevens over metalen en keramieken.

7. Er moet meer strategisch onderzoek (d.w.z. fundamenteel onderzoek ter ondersteuning van doelstellingen van toegepast onderzoek worden uitgevoerd, b.v. op het gebied van de fysische interpretatie van beschadiging en breuk van metalen, keramieken en composietmaterialen en met betrekking tot methoden ter bepalingen van de levensduur.

8. Er moet veel zorg worden besteed aan het bepalen van de toekomstige oriëntatie van de projecten inzake technische keramieken gezien de grote potentiële draagwijdte daarvan, waarbij het zowel gaat om produktievariabelen als om de wisselwerkingen tussen compositie, microstructuur en eigenschappen bij keramieken en keramische-matrixcomposieten.

9. Nota nemend van de adviserende rol van het CGC voor het HTM-programma van Petten bevelen wij aan dat het regelmatig toeziet op de voorruitgang en het beheer van het programma.

10. Bij het personeel van Petten moet worden onderzocht of er een passend evenwicht is tussen wetenschappers, ingenieurs, beheerders, technici en administratief personeel en of de leeftijdsstructuur geschikt is voor het vervullen van de taak en doelstellingen van het komende vierjarenprogramma.

11. Aan de faciliteiten van het GCO Petten moet ruimere bekendheid worden gegeven en de doelmatigheid van het gebruik daarvan moet worden beschouwd als functie van de toenemende mate waarin externe wetenschappers en ingenieurs uit de Lid-Staten op uitnodiging daarvan gebruik maken. Het kan nodig zijn meer in detail bekendheid te geven aan onderzoektechnieken als zodanig, misschien in hun geheel en los van de onderzoekresultaten.

12. We bevelen aan dat grotere nadruk wordt gelegd op de evaluatie van gegevens voor de HTM-databank.

13. Het beheer en de adviseurs van het GCO Petten moeten nagaan of er geen behoefte is aan doelstellingen op korte en lange termijn, waarbij deze laatste verder reiken dan de vierjarencyclus van de programma's.

14. Gezien de bevredigende samenwerking tussen GCO Petten en GCO Ispra bij de HTM-databank en project 2, bevelen wij nauwere samenwerking aan tussen de betrokken GCO-vestigingen met het oog op een optimalisering van de middelen voor toekomstige activiteiten op het gebied van materialen.

15. Met betrekking tot de richting van het Petten-programma in de toekomst beschouwen wij de huidige activiteiten als een goede basis voor het vervullen van de voor het GCO voorgestelde taak voor 1987-1990 op het gebied van veiligheid en normen.

16. Het personeel van het GCO Petten wordt aangemoedigd een meer verbeeldingsrijke en innoverende rol te spelen bij het verbeteren van materialen voor hoge-temperatuurtoepassingen.

EVALUATION REPORT

SYNOPSIS

In the spring of 1985, DG XII appointed an external Panel to evaluate the 1984-87 High Temperature Materials programme of JRC Petten, taking into account relevant achievements of the previous (1980-83) programme, and to make recommendations on the orientation of the future programme. After three meetings at JRC Petten and one at DG XII-Brussels, the Panel completed its evaluation report in October 1985.

Detailed comments on the five projects constituting the current programme are contained in annexes to the report, the major findings of the evaluation being summarised in the main text, followed by conclusions and a number of recommendations pertinent to future activities.

The Panel considers that the expertise and facilities of JRC Petten for the High Temperature Materials programme, ten years after its formation, have made and are making a positive contribution to the cost-effective application of high temperature materials in advanced technologies. The work is uniformly of high quality, reflecting the competence of both staff and management and ensuring that JRC Petten increasingly fulfils both a catalytic and a coordinating role in Community programmes involving high temperature alloys, ceramics and composites.

The Panel believes that the effectiveness of the work could be improved by closer liaison with industry and by pursuing more basic research in support of the applied research studies. It recommends that JRC Petten should continue to be a supranational centre of expertise and provide the Community with a scientific service comprising application-oriented research, property data and information on high temperature materials. The present activities are a good basis for fulfilling the Safety and Standards mission of the 1987-90 JRC programme.

CHAPTER I - INTRODUCTION

As part of the Commission's on-going evaluation of Community research programmes Professor Paolo Fasella, Director General of DG XII : Science, Research and Development/Joint Research Centre, appointed a panel of independent experts to perform an evaluation of the High Temperature Materials programme carried out at the Petten establishment of the Joint Research Centre (JRC).

1. Terms of Reference

The Panel's terms of reference were contained in the initial letter of appointment to the members from Prof. Fasella and in more detail in the technical annex to the contract and read as follows :

"Over the last decade the Community has been promoting research in the field of high temperature materials. This research is carried out by means of intramural research in the Joint Research Centre (JRC) and through concerted actions in the framework of COST.

The scope of this contract consists in the evaluation of the JRC programme in the field of high temperature materials which is being performed by the Petten establishment within the framework of the 1984-1987 JRC programme taking into account the achievements of the previous programme (1980-1983) whenever relevant to the present activities.

This task forms part of the efforts undertaken by the Commission to objectively inform the decision-making authorities as well as the scientific community on the value and impact of Community research and development programmes with a view to optimizing the allocation of its R&D resources.

Furthermore, this evaluation is stipulated by article 5 of a relevant Council Decision (O.J. L3, p. 22 dated 5.1.1984) which provides that the present JRC programme (1984-1987) shall be reviewed by external experts during the third year with the view of providing an input for a possible revision or extension of the programme.

The evaluation will be carried out by a Panel of independent external experts.

The Panel is invited to cover the following topics :

- assessment of the scientific and technical achievements of the programmes taking into account the original objectives (quality and practical relevance of the results, and possible spin-offs) ;
- contribution of the programmes to the development of other Community policies and on the social and economic development of the Community in general ;
- assessment of the role played by the JRC in this field at the European level ;
- analysis of the JRC programme implementation methodology ;
- recommendations for future orientation of the programme, improvements in management, exploitation of results, etc.

The findings of the expert Panel, their conclusions and recommendations will be summarized in a final evaluation report.

The contractor agrees to handle with the necessary discretion, all confidential information to which he might have access during the evaluation."

2. Composition of Panel

The Panel consisted of :

Prof. H. BÖHM	Kernforschungszentrum Karlsruhe Karlsruhe, Federal Republic of Germany
Prof. P.J. GELLINGS	Twente University of Technology Enschede, the Netherlands
Dr. R.J.E. GLENNY (Chairman)	Consultant to U.K. Government and Industry formerly Royal Aircraft Establishment Farnborough, Hants, United Kingdom
Prof. P. GOBIN	Institut National des Sciences Appliquées de Lyon Villeurbanne, France
Dr. G. LANZAVECCHIA	ENEA, Rome, Italy
Prof. C. NICHOLAIDES	Theoretical and Physical Chemistry Institute Athens, Greece

The members were thus drawn from Germany, Netherlands, United Kingdom, France, Italy and Greece. None of the members has had any contractual connection with the Commission's High Temperature Materials programme, and their views as reflected in this report do not in any way commit the organisations with which they are affiliated.

Two members of the Evaluation Panel are presently members of the recently established Scientific Committee of the JRC which will be responsible for advising the Commission on a possible revision of the present JRC programme.

3. Method of Evaluation

The Panel met four times between June and October 1985. The first meeting was a preparatory one and served the purpose of

- acquainting the Panel members with the Community's experience with the external postperformance evaluation of its R&D programmes ;
- discussing the evaluation objectives ;
- presenting briefly to Panel members the Community's R&D activities and in more detail those of the JRC ;
- giving an overview of the activities of the Petten establishment and of the programme decision-making procedures.

The second and third meetings were devoted to a visit of the Petten laboratories working for the HTM programme as well as to detailed presentations by project leaders and scientists of project 1 : Studies on Steels and Alloys ; project 2 : Studies on Sub-components ; project 3 : Studies on Engineering Ceramics ; project 4 : HTM Data Bank ; and project 5 : HTM Information Centre. The fourth meeting was devoted to presentations and discussions with Mr. H. Helms, Programmes Director of the JRC and Dr. K. Halpin , formerly Chairman of the HTM Advisory Committee on Programme Management and currently Chairman of the Management and Coordination Advisory Committee (CGC) Industrial Technology, and to revising and finalising the draft evaluation report.

To accomplish its task the panel made use of the following sources of information :

- study of available documents (Annex 1) ;
- presentations and talks with the Director of the Petten Establishment, the HTM programme manager, project leaders and scientists working for the programme ; the Programmes Director of the JRC and the Chairman of the CGC (Annex 2).

4. Acknowledgements

The members of the Panel wish to record their warm appreciation of the cooperation shown by the staff of JRC Petten, particularly the senior staff who made and organised presentations and who ensured that verbal and written requests for information were promptly fulfilled. They wish

to thank Dr. Halpin, Chairman of the CGC Industrial Technology for providing a valuable prospective of the HTM work of JRC Petten. Finally, they are particularly grateful to the Evaluation Service, Directorate-General for Science, Research and Development, for an effective organization of the whole evaluation exercise and, latterly, for gently reminding the Panel that the time available for reporting was shorter than it imagined.

CHAPTER II : DESCRIPTION OF THE PROGRAMME

1. Origin of the Programme

The programme was initiated by an ex-cathedra decision of the Commission, following a breakdown of the Euratom R&D programmes in nuclear technologies, to establish at JRC Petten a materials institute to execute a high temperature materials programme, making use of the existing competences. This decision was supported by a growing awareness of the vulnerability of Europe to conventional fossil fuel supply, and stimulated by successive crises in oil supply up to the year 1973, coupled with an acute scarcity of knowledge of materials employed in high temperature technologies.

The programme, supported by the Council decision of August 1975, was therefore intended to contribute to the Commission's future energy and industrial strategies, both by catalysing research and development in these materials and by direct support to European national and Community actions.

2. Target Areas of the Programme

Initial programme tasks identified those areas of critical industrial constraint to which the most effective benefit would be brought by Community materials programme results.

An extensive review of technological needs, compiled by conducting surveys and enquiries throughout European industry, research institutes and governmental bodies, led to the identification of appropriate targets and programme objectives.

Technological areas covered by this search included conventional industrial (metallurgical, petrochemical, etc.) activities and very advanced developments (MHD, fusion, etc.) involving materials developers, users, designers, universities and research institutes. Information and guidance was obtained from workshops, working parties and experts from all member states.

A comprehensive review of future R&D requirements, published as a result of these investigations (EUR 5623), identified :

- the state-of-the-art in HTM technology ;
- future research needs ;
- the essential requirements of a European HTM research centre.

This centre should, among other things :

- execute materials activities of a supra-national character ;
- conduct high risk research and provide high cost research facilities ;
- catalyse new materials research actions.

The inter-technological areas of outstanding need were identified as :

- increase in thermal efficiency by higher process temperatures,
- use of lower grade, cheaper fuels (corrosivity problems),
- use of less expensive materials (capital costs, raw materials),
- development of more reliable materials to achieve longer component lifetimes, and reduction in maintenance "down time", critical designs (cost factor, raw materials factor),
- safety, safe plant operation, environmental control (emissions, pollution).

Industrial applications at high temperatures (above 600°C) were found to be critically short of materials information and experience. The HTM programme was focussed on this temperature range in order to respond to the indicated need for underlying research, applicable to a well selected range of multipurpose applications and components.

The evolving technology trends in Europe led to an historical development in emphasis for the successive programme periods :

1977/80 - petrochemical processing, gas turbines, fossil fuel conversion, nuclear process heat ;

1980/83 - fossil fuel conversion and utilisation (combustion, gasification) ;

1984/87 - fossil fuel conversion and utilisation (combustion, steam generation), engines for transport.

3. Other Commission Activities in Structural Materials

The wisdom of the initial Commision option for HTM as the primary area of importance for industrial development has been justified "a posteriori" by the subsequent nucleation of several European-wide cooperative actions in the materials field, to which the HTM programme itself has contributed substantially. Principal among these have been :

Activity	HTM contribution
COST* 50 (Gas Turbine Materials) (Rounds II & III)	management functions and collaboration in joint actions
COST 501 (High Temperature Materials for conventional systems of energy generation and conversion using fossil fuels)	management functions and collaboration in joint actions
COST 505 (materials for steam turbines)	management functions and collaboration in joint actions
BRITE*	management functions and collaboration in joint actions, envisaged
RAW MATERIALS (technical ceramics and advanced materials)	collaboration in joint actions, envisaged

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* COST Cooperation in the domain of Scientific and Technical Research
BRITE Basic Research for Industry and Technology in Europe

Community programme on the Development of the Specialised Information Market in Europe	management functions and collaboration in joint actions
FAST*	management functions.

4. Objectives of the Programme

The objective of the programme is to encourage within the Community, the development of high temperature materials required for advanced technologies.

The strategy adopted to achieve this objective is :

- to monitor the status of materials utilisation and future trends in high temperature technologies in order to identify the critical needs in R&D to promote industrial progress ;

- to maintain a centre of materials expertise, by the conduct of medium- and long-term research studies in selected key areas of high temperature materials, in order to provide a basis for expert guidance of Community technological interests and funding institutions ;

- to provide a forum for information exchange and the stimulation of joint research actions in materials research ;

- to act as a nucleus for European cooperative and service activities (i.e. information services, technical data bank facilities, etc.).

5. Staff and Budget

The HTM programme is essentially a small commitment of the CEC, with less than 40 scientific/technical staff in 1980-83, expanding to a little under 50 staff at Petten in 1984-85 by conversion of 10 staff from a programme on organic materials. The programme budget for the years 1984/87 is 28 MECU.

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* FAST Forecasting and Assessment for Science and Technology

Annex 3 gives the authorised partition of resources. It should be noted, however, that during 1984 the actual efforts were 44 my/y at Petten and 2.7 my/y available at Ispra.

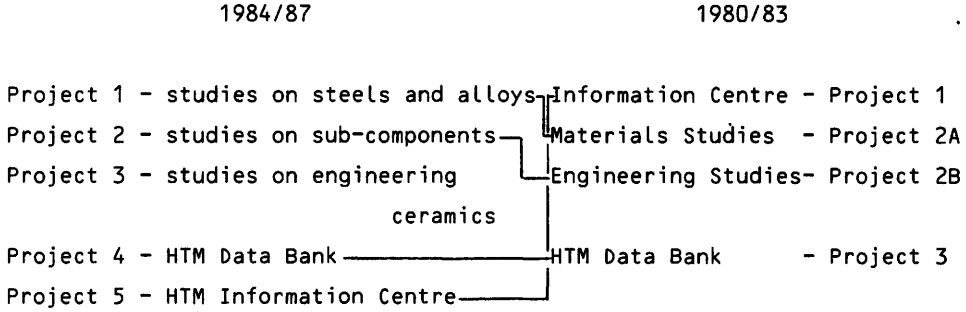
6. Programme Projects

The programme is currently executed in five projects, three involving experimental research into :

- steels and alloys,
- sub-components,
- engineering ceramics,

and the other two projects being concerned with the provision of a factual "HTM Data Bank" and a "HTM Information Centre" respectively.

This strategy has evolved from an earlier (1980/83) programme structure of three projects, related to the present structure as indicated below.



The programme R&D projects have developed with the accumulation of experience, from 1980 to 1985 from studies of simple environmental systems to increasingly complex and realistically simulative research studies. The initial periods considered the behaviour of well-established materials, conventional austenitic steels, gas-turbine alloys and coatings in simple corrosive environments (carburising or oxidising) under uniaxial stress conditions. Subsequent studies progressed to include more advanced steels and protectived claddings, engineering components, and advanced engineering ceramics under the conjoint action of aggressive environments which can include sulphur, oxygen and carbon, with applied stress of a static or dynamic nature, or

of multi-axial nature. Materials evaluation has also progressed from the simpler characterisation to the description of behaviour under complex industrially simulative conditions.

The progress in sophistication of investigative techniques has demanded the establishment of highly advanced testing facilities capable of supplying variable combinations of

- corrosion in accurately controlled and monitored complex gas mixtures,
- temperature : constant, variable, cycling,
- stress : static/dynamic, uni- or multi-axial,

and a wide range of advanced techniques for structural analysis.

Further, while production and processing are not considered for metallic materials, these processes are so fundamental to ceramic properties that they are also included in the framework of that project.

Close collaboration with universities in member countries has resulted in a steady flow of "Fellows" who conduct research on subjects which are integral parts of the multiannual programme. On the basis of their studies, several of these each year obtain a Ph.D. or M.Sc. degree.

The impact of the HTM programme on national materials strategy has led to :

- all E.C. countries, in practice, initiating HTM programmes ; JRC Petten helped to catalyse this development particularly in smaller countries ;
- the making of links between various national research centres, universities and industries.

The standing of the programme is evidenced by its involvement, amongst others, with :

- collaborative research actions,
- preparation of scientific/technical publications,
- frequent visitors and meetings,
- training of research fellows,
- acting as host for European management groups, e.g. COST, Thermodata, EEC advisory bodies, etc.

Future perspectives for the programme are oriented towards the conduct of research on metals, ceramics, and surface and interface engineering in the light of test methodologies, standards, reliability and safety for advanced industrial technologies. The "HTM Data Bank" and "HTM Information Centre" are considered to be vitally important for this European materials activity.

CHAPTER III : EVALUATION

The HTM programme at Petten provides a scientific service concerned with materials information, data handling, and direct research programmes relevant to a range of industrial and energy conversion processes. The research studies have been concerned with evaluating and understanding the high temperature behaviour of selected alloys and ceramics under conditions that typify aggressive industrial environments.

In the 1980-83 programme, the complementary materials and engineering studies were largely devoted to the development of facilities and testing techniques which were employed to generate data for life prediction purposes in Projects 1 and 2 of the 1984-87 programme. The third experimental research study (Project 3) on engineering ceramics is a logical extension of the activity on high temperature alloys and was introduced into the 1984-87 programme. The projects on the HTM Data Bank (Project 4) and HTM Information Centre (Project 5) featured in both programmes and are strongly associated with the study projects. All five projects are well integrated in the current applied research programme directed towards the general field of industrial high temperature processing.

The evaluations of the five individual projects are recorded in Annexes 4 to 8. The main findings are summarised here for those readers who are less concerned with the more specifically technical observations and recommendations.

1. Studies on Steels and Alloys

This project, the largest in the HTM programme, has already made a significant contribution to industrial design philosophy and to an enhanced understanding of material behaviour in corrosive environments but it is too early to say whether improved life prediction can be achieved. It is well planned and executed and we are impressed by the high quality of the work, particularly in the measurement and interpretation of data. Its declared aims and objectives are expressed in broad terms and so only partial

fulfilment can be expected in the time scale of the present programme- parameters such as geometry, gas velocity and erosion are not included. The resources appear adequate although we would expect to see a higher proportion devoted to operating costs and capital investment. We are particularly impressed by the integration of the project work with COST 501 and with other collaborative activities which ensure that the unique Petten environmental test facility is used for the benefit of Community members. Although we agree with the strategy adopted we would like to see more attention paid to the exposure of materials under industrial conditions and to the correlation of industrial and laboratory data, as well as a greater effort on the metal physics aspects of material behaviour.

2. Studies on Sub-Components

The installation and proving of equipment for testing tubular materials under multi-axial loading in corrosive environments was largely accomplished in the 1980-83 programme. Two of the activities in the current project are concerned with acquiring data under these conditions and are progressing well. The third activity involves the design of a thermal gradient rig but does not include testing. We expect to see only limited data resulting from the fourth activity on the creep behaviour of welded tubes.

At this interim stage, it is too early to say whether a useful design methodology will be available at the end of the programme. We are pleased to see the integration of this project into COST 501, particularly as the Petten work serves as a starting point for establishing other plant component parameters e.g. more complex geometries, structural constraints and fluid dynamics aspects. We emphasize the need for establishing a progressively more comprehensive prediction methodology validated by more industrially relevant bench-mark data. We suggest that the proportion of in-house effort to external work devoted to such an extension to the programme is a matter for discussion by JRC Petten and its internal management advisors.

3. Studies on Engineering Ceramics

For a project that started in 1984, the objectives are ambitious. We agree with the selection of one material, silicon nitride, for the programme but, as JRC Petten are well aware, several "alloying" possibilities have been established elsewhere and "unalloyed" silicon nitride may prove to have limited application. We consider that only a restricted examination of compositional effects on processing, and a tentative life prediction methodology will result from the present programme. Nevertheless the Panel believes that this forward-looking project is timely and will contribute to the development of reliable reproducible ceramics. Unlike the first two projects, studies of the production aspects are necessary but we suggest closer integration with the mechanical property and corrosion aspects. We again emphasize the need for closer industrial liaison, involving ceramic component manufacturers as well as plant designers and operators. The Panel is impressed with the expertise and facilities developed in a comparatively short time and considers that JRC Petten will have an authoritative coordinating and catalytic influence on Community programmes and eventually on Community socio-economic developments in engineering ceramics. Because the potential scope of these studies is considerable, the design of critical experiments and the further development of multi-lateral collaboration are important considerations for the project management.

4. HTM Data Bank

The Panel found that the original objectives of this joint Petten/Ispra project have largely been achieved although the real value of the HTM Data Bank can only be assessed when sufficient data are incorporated and user experience has accumulated. We were pleased to learn that the content of data is being continually extended, both with respect to the number of alloys and the range of properties (including corrosion properties), and that the Bank will be available to external users before the end of 1985. As the data base expands, we envisage the need for an increase in resources for this project. The Panel is particularly satisfied with the external contacts so far made and suggests that its contribution to Information Technology, at the invitation of DG XIII, should involve cooperation with a commercial firm in this field. More emphasis should be given to one of the

objectives of this project, namely, the critical assessment of data introduced into the Bank. We endorse the need for users to have access to both selected and typical data.

5. HTM Information Centre

The Panel is satisfied that the objectives and roles of the Information Centre are being fulfilled effectively in a broad range of activities - meetings, R&D assessment and analysis, promotion of cooperation and the maintenance and usage of the HTM Information Base. We found that the timing of the meetings was often particularly appropriate to the development of the other Petten projects. We were pleased to find that the range of high temperature materials covered by the Information Centre is broader than that used in the three experimental projects. The Panel encourages the Centre to be innovative and forward looking with respect to identifying and proposing R&D initiatives as well as R&D requirements. We also wish to recommend that information on U.S. and Japanese activities in HTM is collected and disseminated by the Information Centre.

CHAPTER IV - CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Ten year after the formation of the HTM programme, JRC Petten is now well established as a supra-national centre of expertise and information on high temperature materials. The Panel considers that this role continues to be necessary for the pursuit of pre-competitive research utilising sophisticated high cost facilities and for catalysing and coordinating external research activities beneficial to the Community.

2. The Panel considers that the objective of the HTM programme viz. to encourage within the Community the development of high temperature materials required for advanced technologies has been met in the 1980-83 programme, and is likely to be fulfilled in the 1984-87 programme.

3. We agree with the strategy adopted to achieve the above objective and with the aims and objectives of the projects included in both 4-year programmes. The sub-objectives for the activities within each project were well defined and we appreciated the use of milestone review procedures to assess the progress of the work in the current programme. A somewhat sharper definition of some project objectives would have allowed us to assess more precisely the extent to which the objective was being fulfilled. For comprehensive achievement of the aims of the three experimental projects, more industrially significant parameters will need to be incorporated in an extended programme.

4. The five current projects form a coherent HTM programme which has an important role at European level. The experimental projects on studies of metals and alloys, and of sub-components are well integrated in cost-shared collaborative programmes (COST 501 and 505), and the project on engineering ceramics will shortly be associated with the collaborative Raw Materials (Technical Ceramics)

joint action. We are impressed with the service provided by the HTM Information Centre and hope that it will be extended to include appropriate U.S. and Japanese information. Shortly, with the advent of on-line user service, the HTM Data Bank will be available to Community members. We welcome the increasing use of the expertise at Petten by the Directorates-General (XII and XIII) for contributions to Community sectoral objectives.

5. We consider that the present HTM programme should be extended, with strong collaboration with industry to ensure that the data pertains to representative plant operating conditions and that the resulting life prediction methodology is acceptable for application by industrial plant designers. The nature and scope of the studies on engineering ceramics are timely with respect to the future socio-economic development of the Community. Because of the lack of established production routes and specifications for advanced ceramics, work on the control of fabrication variables should be pursued in parallel with the acquisition of creep and fatigue data under controlled conditions of corrosion.

6. The Panel is impressed with the high quality of the work at Petten which is well up to the standard of any comparable national laboratory similarly dedicated to the determination of reliable reproducible data and to providing a scientific data and information service. The activities of the current HTM programme are essentially applied research with no clearly identifiable basic research. We feel that some elements of basic research on deterioration and failure mechanisms of HTM should be encouraged in-house involving permanent staff or doctoral/post-doctoral students, or in cooperation with JRC Ispra, or under contract at selected universities.

7. The resources for the current (1984-1987) HTM programme appear to be adequate. Although the work is increasingly multi-disciplinary and constraints on staff complement have not so far been detrimental, we consider that greater resources will be required to provide a more comprehensive data bank and to ensure that the increasing contribution to Community actions is fulfilled. Also, we would like

to see a greater support activity on the physics of high temperature alloys and, eventually, ceramics in order to obtain a fuller understanding of their deterioration in corrosive environments. In order to accomplish this increased works one possibility is to optimise the resources of the appropriate JRC establishments in the relevant materials areas (see recommendation 4).

8. The Panel considers that the outstanding environmental test facilities, coupled with the recently-developed laboratories for the processing of ceramics and the characterisation of ceramic powders, are a Community asset which should be thoroughly publicised so that the techniques and equipment can be adopted by Community members and utilised by more research students from the Community.

Recommendations

1. JRC Petten should continue to be a centre of expertise on high temperature materials and to provide a scientific service - application-oriented research, property data and information - to the Community.

2. On the one hand, the coordinating, management and advisory roles of JRC Petten should be progressively increased as its authority and competence grows. On the other hand, expertise is acquired and maintained only by active involvement in experimental science and technology and therefore sufficient resources should be devoted to maintaining the high quality experimental activities at Petten.

3. The catalytic role of JRC Petten should be encouraged, particularly in engineering ceramics. Despite the success of COST 50 and the promising collaboration in COST 501 and 505, the Petten research work on the behaviour of high temperature alloys should continue.

4. Closer and more frequent liaison with industry is essential to increase industrial awareness of the Petten activities, to reaffirm the validity and priority of R&D requirements and to ensure that technology and data transfer to Community industries is rapidly made.

5. The possibility of seeking some return on the work of JRC Petten with respect to repayment for the testing of materials in the unique JRC Petten facilities should be carefully considered. This would serve to reinforce the previous recommendation.

6. Consideration should be given to a dual strategy that enables the correlation of laboratory and industrial corrosion test data on metals and ceramics to be made.

7. More strategic research (i.e. basic research in support of applied research objectives) should be conducted e.g. on the physical interpretation of deterioration and fracture of metals, ceramics and composites, and in respect to lifetime prediction methods.

8. Careful consideration should be given to the future orientation of the engineering ceramics project because of its large potential scope, embracing production variables and compositional/microstructure/property interactions for both ceramics and ceramic-matrix composites.

9. In noting the advisory role of the CGC to the HTM Petten programme, we recommend that it should regularly monitor the progress and management of the programme.

10. The staff resources at Petten should be examined to ensure that there is an appropriate balance of scientists, engineers, managers technicians and administrative staff and also an acceptable age structure for fulfilling the mission and objectives of the next 4-year programme.

11. The JRC Petten facilities should be publicised more widely, and their efficient utilisation should be considered in relation to their greater external usage by scientists and engineers invited from Community member nations. There may be a need to publicise research techniques per se in greater detail, perhaps collectively and divorced from the results of the research.

12. We recommend that greater emphasis should be placed on the assessment of the data for the HTM Data Bank.

13. JRC Petten management and its advisers should consider the need for both short- and long-term objectives, the latter extending beyond the 4-year cycle of programmes.

14. In noting the satisfactory collaboration between JRC Petten and JRC Ispra on the HTM Data Bank and on Project 2, we recommend closer cooperation between appropriate JRC establishments with respect to optimising resources for future materials activities.

15. With respect to the future orientation of the Petten programme, we regard the present activities as a good basis for fulfilling the proposed 1987-90 mission of Safety and Standards for the JRC.

16. JRC Petten staff should be encouraged to adopt a greater visionary and innovative role with respect to the improvement of materials for high temperature applications.

ANNEXES

Annexe 1

LIST OF DOCUMENTS

Community R&D Policy

- A Scientific and Technical Strategy for Europe - Framework Programme - 1984-1987 XII/126/84, Jan. 1984
- Community Research and Development and Demonstration Activities
- Working together - the Institutions of the European Community - ISBN92-825-0571-5 (graphs only)
- Organigramme DG XII + JRC

Evaluation of R&D Programmes

- Council Resolution concerning a Community plan of action on the evaluation of Community R&D programmes (O.J. C213, p.1, dated 3 August 1983)
- Evaluation of the remote sensing programme of the Joint Research Centre (1980-83), Research evaluation - Report n° 11, EUR 9438
- The evaluation of COST Project 50 "Materials for gas turbines" and COST 501 "High temperature materials for conventional systems of energy generation and conversion using fossil fuels", EUR 9603

JRC Programme in the field of High Temperature Materials

- "Research Evaluation of JRC Programmes HTM", analysis of the HTM programme 1980/83, 1984/85, prepared for the Evaluation Panel, May 1985

. Council Decision concerning a multiannual research and development programme of the European Economic Community in the fields of basic technological research and the applications of new technologies (BRITE)(1985 to 1988), O.J. n° L 83, pp. 8-9

. Multiannual Programme of the Joint Research Centre, Technical Description 1984-1987

. Documentation related to programme decision

1. Proposal of the Commission to the Council	)
2. Scientific/technical documentation related to the programme to be evaluated, annexed to the Commission proposal	) 1980/83) and
3. Opinion of the European Parliament	)
4. Opinion of the Economic and Social Committee	) 1984/87
5. Council Decision	)

. Semi-annual Programme Progress Reports (PPR)
PPR 80/I and II, PPR 81/I and II, PPR 82/I and II,
PPR 83/I and II, PPR 84/I and II

. Annual Status Reports 1980, 1981, 1982, 1983

. Mandate for and Composition of Advisory Bodies
- Council Decision
  . ACPMs (1980-1983)
  . CGCs (1984-1987)
- List of Members
  . ACPM-HTM (1980-1983)
  . CGC-Industrial Technology (1984-1987)

. Documentation related to ACPM intervention concerning programme management 1980, 1981, 1980/83

. List of publications (papers, proceedings, ...)

. List of patents

Annexe 2

PRESENTATIONS AND INTERVIEWS

Present during the meetings

Commission staff

DG XII Mr. Gerold, Director of Means of Action
Evaluation Unit : Mr. Massimo
Mrs. Spachis (Secretariat)

JRC Mr. Helms, Programme Director of JRC
Dr. Hondros, Director of the Petten establishment
Dr. Van de Voorde, Programme Manager
Mr. Lloyd
Project 1 : J.B. Marriott, G. Kemeny, J. Bressers, E. Lang, J.F. Norton
Project 2 : H. Kröckel, R.C. Hurst
Project 3 : M. Van de Voorde, R.J. Fordham, W. Karcher, O. Van der Biest
Project 4 : H. Kröckel
Project 5 : M. Merz

Advisory Committees

ACPM-HTM	Dr. Halpin (Chairman)
CGC-Industrial Technologies	Dr. Halpin (Chairman)

Annexe 3

Table : Overview of resources for the programme "High Temperature Materials" 1980/83, 1984/85 (kECU) + (HR)

A) Repartition of research staff* and specific appropriations" by project

PROJECT 1980/83	PROJECT 1984/85	STAFF*(HR) 1980/83	SPECIFIC APPROPRIATIONS**					STAFF*(HR) 1984/85
			1980	1981	1982	1983	1984	
2A Materials Studies	1. Studies on Steel and Alloys	25	517***	315	530	535	558	25 + 1
2B Engineering Studies	2. Studies on Sub-Components	5	113***	198	158	221	190	4 + 1
	3. Studies on Engineering Ceramics	-	-	-	-	-	704	10
3 Data Bank	4. HTM Data Bank	2 + 1	120	76	76	91	80	3 + 4
1 Information Centre	5. HTM Information Centre	5	51	51	24	52	61	6
	Total	37 + 1	851	640	788	899	1593	48 + 6

* Research Staff : Technical and academic staff directly engaged in projects my/y (HR). First figure is Petten, second is Ispra.

** Specific Appropriations : Funds for running costs, investments, contracts.

*** In 1980 project 2A and 2B had a common budget ; the figures are estimates.

B) Summary of the expenditures (kECU)

	STAFF	SPECIFIC APPROPRIATION			TOTAL	HR
		PROGRAMME	SERVICES + TECH. SUPPORT	SUB-TOTAL		
	1	2	3	2 + 3	1 + 2 + 3	
1980	2120	851	743	1594	3714	38
1981	2245	640	1387	2027	4272	38
1982	2380	788	1226	2014	4394	38
1983	2572	899	1376	2275	4847	38
1984	4171	1593	1381	2974	7145	54*

* In 1984 10 HR were transferred from the JRC Environment Programme (Petten Establishment contribution in the field of organic chemistry) to the HTM programme.

PROJECT 1 : STUDIES ON STEELS AND ALLOYS

Nature and Scope

This project is an extension of the 1980-83 programme project which was aimed at attaining "a deeper knowledge of the influence of different gaseous environments on the high temperature behaviour of selected superalloys ..." The aim of the 1984-87 programme project is to determine the suitability of materials for long-term service in industrial high temperature corrosive environments. The objectives of the studies on steels and alloys are to generate property data in order to quantify reliability and life prediction, and to obtain an understanding of the deterioration of material behaviour in corrosive environments.

Since its inception, this project, the largest in the HTM programme, has involved a virtually constant level of 25 to 26 research staff. In 1984, this represented about one half of the total research staff in Petten, and the project accounted for just over one-third of the total programme costs. It comprises four activities viz. corrosion, protection, creep and fatigue, each with its own objective.

At the date of the examination (mid-1985) by the Evaluation Panel, the work on this topic had been underway for 5 1/2 years. The first four years (1980-83) were largely concerned with establishing an environmental test facility, developing techniques for corrosion and creep testing (in basic carburising, oxidising or sulphidising environments), fatigue testing (in air or in vacuum), and micro-structural analysis, and with obtaining a preliminary data base on selected well-established austenitic steels and nickel-base alloys. During this period, corrosion data were obtained for two major modes of attack, viz. oxidation with carburisation or sulphidation, pertinent to low oxygen industrial environments. Creep behaviour was determined in carburising environments, with and without oxidation. Low cycle fatigue studies showed the dominant effect of oxidation on life. The stability of protective coatings on nickel-base

alloys and their influence on the creep and thermal fatigue behaviour were determined, as also were some of the merits and limitations of clad alloys on heat-resistant steels. The need to explore the effect of thermal cycling, and to determine crack growth behaviour in both creep and fatigue for life prediction purposes was appreciated.

The 1984-87 programme is concerned with expanding the data base, concentrating on the testing in complex sulphidising/oxidising/carburising atmospheres of the more advanced constructional steels and alloys used in fossil fuel conversion and utilisation plant. The programme plan embraces not only the evaluation of selected materials, with and without protective coatings, but also the mechanisms and kinetics of corrosion and the mechanisms of creep and fatigue behaviour in order to establish a methodology for life prediction. The plan also includes the creep and fatigue testing of an oxide dispersion-strengthened nickel-base alloy. Corrosion tests on austenitic steels, currently carried out at 800° C in complex atmospheres with controlled chemical activities of oxygen, carbon and sulphur, simulating industrial processes, are being extended to a wider range of temperatures, and will include the effect of superimposed mechanical stresses on coated steels. The effect of sulphur containing solid deposits on the mechanism and kinetics of corrosion will also be determined. Throughout, the analyses of precipitate and dislocation mechanisms are an essential feature of the project.

Evaluation

(i) a. The extent to which the objectives of the project have been met.

The earlier (1980-83) work was essentially a limited parametric study that nevertheless made, in the opinion of the ACPM, a significant contribution to industrial design philosophy, particularly to the land-based gas turbine industry. The aims and objectives of the present project are sufficiently broad that only partial fulfilment can be expected in the time scale. The research is rightly confined to a small number of selected materials and the laboratory test conditions are chosen to be representative of typical industrial operations. However, other factors

such as component geometry, gas velocity, and erosion by solid particles in gas streams may significantly affect surface, albeit local, deterioration and therefore life prediction.

The objectives of the four activities within the project are defined in general terms and therefore are of limited value in judging the progress and effectiveness of the work. In this respect, the declared sub-objectives for each activity are more precise although all are laboratory-oriented. It would be useful to include one or more sub-objectives concerned with the correlation of laboratory and industrial data. Most of the work targets for the sub-objectives are not scheduled for completion until after 1985 and therefore only limited comment is possible. Apart from temporary delays due to sulphidation corrosion of test equipment, the activities have proceeded according to plan. The fatigue data base on Alloy 800 in air is comprehensive but, unlike the creep studies, tests in complex atmospheres have still to be carried out. The interactive nature of the test and material variables, particularly when complicated by solid state reactions, will make interpretation of behaviour more difficult. The work carried out on microstructural changes (e.g. dislocations, precipitates and their interactions) under static loads was less than we expected. Nevertheless we feel that the results so far obtained indicate that behavioural understanding will be enhanced and, to a degree, better criteria for material selection should be obtained. It is not possible to say at this point in time whether improved life prediction can be achieved.

Although the resources appear to be adequate to meet the project objective, the proportion available for operation and capital investment is somewhat lower than for many national laboratories. It is suggested that this should be increased to allow, for example, the modernisation of surface analysis equipment (ESCA-Auger), and the introduction of equipment that simulates the thermal cycling conditions associated with industrial processes.

(i) b. Role played by JRC at European level.

The objectives, programme definition and direction of this project have benefitted considerably from the involvement of JRC Petten in concerted action programmes, initially in COST 50 (Gas Turbines) and currently in COST 501 (Energy Generation and Conversion using Fossil Fuels) and in COST

505 (Materials for Steam Turbines). Appropriate parts of all four of the project's activities are integrated into COST 501. Collaboration with a wide range of industrial companies, research institutes and laboratories ensures that the JRC Petten expertise and its unique environmental test facility are used for the benefit of Community members. Outside the COST activity, cooperation with European users and producers of high temperature steels and alloys ensures that the results of this project are discussed and made available for application.

The educational role of JRC Petten, particularly in post-graduate research training, has been enhanced by this project. The JRC can now exercise a stronger coordinating role in any corrosion-dominated European R&D programme.

(ii) Appraise scientific and technical contributions of the programme in relation to its objectives, including the quality of the work and the relevance of the results obtained.

The Panel agrees with the approaches that have been taken to fulfil the declared aims and objectives of the project. We agree with the early decision to concentrate the research work on a study of the combined effects of chemical corrosion and creep or fatigue stresses, using a small number of representative austenitic steels.

The need for a well characterised and controlled environment has been appreciated and largely fulfilled in the test facility designed and constructed by JRC Petten staff. The Panel agrees with the choice of a "matrix" approach based on exposure over a range of temperatures to typical atmospheres characterised by partial pressures of sulphur and oxygen rather than the more usual approach based on the simulation of specific processes. It feels that the gas composition, determined from computerised thermodynamic calculations at the temperature and pressure of the experiment, should be checked to determine whether equilibrium under the reaction conditions is attained, even though the residence time of the gas before reaching the specimens may be sufficiently long.

Considerable progress has been made towards elucidating the interactive effects of stress, temperature, environment and compositional variables. Within a few years, JRC Petten has achieved an international reputation from their studies in this field. The quality of the work is high and reflects well on both the high technical standard of the staff and the excellence of the facilities. In particular we are impressed with the quality and standard of scientific interpretation of the results which we consider are and will be relevant to industrial processes.

The Panel recommends that more attention should be paid to the exposure of specimens in industrial conditions not only to ensure closer liaison with industry and the reality of its problems but also to obtain "calibration" points for the matrix approach. Perhaps a dual programme strategy should be adopted to correlate laboratory and industrial corrosion test performance.

In assessing laboratory thermal fatigue behaviour, the Panel suggests that the range of heating and cooling rates experienced in industrial situations should be simulated. The high rates obtained by the fluidised bed technique have limited relevance to fossil fuel conversion processes.

We approve the activity concerned with evaluating and understanding the behaviour of protective coatings supplied from outside sources. As it appears likely that those components experiencing the most severe corrosion in service will be protectively coated, consideration should be given to increasing the effort on this topic, perhaps concurrently with the planned work on sulphur-containing solid deposits.

Thermal and mechanical stress cycling are rightly an essential feature of the investigations. We suggest that the significance of corrosion cycling e.g. oscillating partial pressures of oxygen which can occur in fluidised bed coal combustion should be examined.

It appears to the Panel that the effort devoted to basic research into mechanisms and the metal physics of behaviour is limited compared to that on phenomenological studies. We suggest that more effort be devoted to such aspects before the final year of the 1984-87 programme.

(iii) Determine the practical contribution of the results of the programme to Community objectives and to the socio-economic development of the Community.

This project is making a growing contribution to Community objectives, particularly those concerned with better standards of measurement, greater reliability and improved safety. The broad cooperation with industry and high temperature materials R&D interests, particularly through the COST programmes, ensures that the national industries derive on-going benefit from the project. Duplication of activity is avoided and cost-shared R&D results in national cost savings which also accrues from the greater certainty in material selection. The knowledge arising from the data established under controlled conditions will enhance the reliability and safety of industrial plant, particularly through improved material selection and design codes.

We recommend that even closer liaison with industry should be pursued in order to maintain an early awareness of new problems and consequently the need for a change in emphasis or direction of the programme, and also to ensure earlier exploitation of the results and of research techniques.

It is also particularly important that the controlled environmental testing in the laboratory reflects all the significant parameters of industrial processes.

(iv) Evaluate the programme implementation methodology.

We consider that the programme is adequately planned and we agree with the proposed sequence of activities and the milestone review procedures. We presume that in the light of any changes in industrial priorities, revision of the plan can be quickly accomplished. The Panel is conscious of the complex nature of the industrial problems and the difficulty of addressing "typical" process-conditions, particularly when desulphurisation is incorporated. While we endorse in principle the need for more sophisticated laboratory tests that are closer to simulating industrial practice we would seek assurance that interpretation of the data is not so inexact that the tests have only an ad hoc significance.

(v) Recommendations on ways of exploiting research results, on improvement of management and on the future orientation of the programme.

The exploitation of results is facilitated in several ways, notably through the half-yearly progress reports, JRC Petten research reports, regular meetings with members of COST programmes, lectures, conferences, visits to and from cooperating bodies, and dissemination of information via the HTM data bank and the Petten Information Centre. The half-yearly progress report has been modified and refined over the past five years and pays due regard to collaborative activities. We approve the recent inclusion of activity plans and milestone reviews, and suggest that "the state of the art" should be described in each report, which should also indicate more clearly the extent to which the planned objective for the project has been fulfilled.

The future orientation of the project depends on the outcome of the present plan and on changes in industrial priorities which may necessitate the introduction of new or modified alloys. The most severe industrial conditions may well be localised and require more resistant materials and, more likely, improved coatings. We consider that greater attention should be paid to the design of the composite i.e. substrate plus coating, and its selection should be related to specific rather than typical processes.

PROJECT 2 - STUDIES ON SUB-COMPONENTS

Nature and scope

The general objective of this engineering-related project is "to make the mechanistic understanding and property data generated by materials research applicable to design and analysis of plant components". Although plant components in high temperature service frequently experience creep under multi-axial stresses and environmental corrosion, design criteria are largely based upon empirical extrapolation of much simpler test data. In order to convert simplified test data (e.g. on uniaxial creep and simulated environmental corrosion) to the design parameters applicable to the more complex service conditions experienced by critical sub-components such as pipes, bends, intersections and welded tubes, a versatile mathematical methodology is needed. Validation of the methodology must be supported by verification (bench-mark) tests. The project is concerned with studies that will predict the creep behaviour of tubular components under four "constraints", viz multi-axial loading, gaseous corrosion, thermally induced loads and welded discontinuities, examined singly and, in selected cases, superimposed. As shown in Annex 3, its resources are small compared to the other two study projects.

The work has been in progress since 1980. During the 1980-83 period, it concentrated on building up and consolidating advanced testing facilities, for example, for internal pressure testing and exposure to chemically aggressive gases, and the development of techniques for high sensitivity axial and diametral creep measurement.

The 1984-87 programme is concerned with the execution of an experimental programme using these facilities and with comparing the multi-axial creep performance of tubular specimens with uniaxial creep behaviour determined both in the first project (Studies on Steels and Alloys) and by external sources. It comprises four activities corresponding to the above four "constraints", each with its own objective. The first is concerned with the correlation of the uniaxial creep behaviour of tubular specimens with that

of conventional test specimens, and its extension to multi-axial loading behaviour of tubes subjected to internal gas pressure and to combined axial loading and internal pressure, followed by analysis of the creep constitutive equations. The second activity involves assessing the influence of gaseous corrosion (carbon/oxygen/sulphur) on the correlation of uniaxial and multi-axial creep behavour. Both these activities are on-going and employ the same material, Alloy 800H. The third activity is an investigation of the effect of thermal loading on the creep behaviour of a tubular sub-component, the objective being the design and construction of a special thermal gradient test rig. The design feasibility study, conducted jointly with JRC Ispra, commenced in 1985. The fourth activity is concerned with predicting the creep behaviour of welded tubular sub-components using hypothetical data and the analytical methods developed in the first activity, with some selected verification testing. This work has not yet begun.

Evaluation

(i) a. The extent to which the objectives of the project have been met.

At the conclusion of the 1980-83 programme, two of the required four test cells were operational and the other two awaited delivery of parts. Sufficient creep measurements had been made on alloy 800H to show that the extensometry systems were sensitive enough to measure creep rates down to 10^{-9} per sec, and to indicate that variable creep rates resulted from geometrical differences in the test-pieces (tubes and miniature specimens taken from the tube walls) subjected to axial loading in air at 900° and 1,000°C.

The objective of the 1984-87 programme has not yet been fulfilled because only interim data have been obtained for the first two activities, and special analytical techniques and experimental equipment have yet to be developed for the third and fourth activities. However, in the first activity, uniaxial creep testing in air and correlation studies for tube and bar specimens have been completed, and creep curve analyses for the mathematical correlation of these data have been made. Geometry dependence has been confirmed, although the major contributing factor (e.g. oxidation or ductility) has not yet been elucidated. Unexpectedly, the creep

performance of tubes was considerably superior to that of bar ; re-heat treatment of the tubes to remove dislocation networks and produce similar creep properties to bar will be necessary. The parallel study of multi-axial testing by internal pressurisation, with and without axial loading, of tube specimens in air is well underway and on target for achieving the comparison of bench-mark data with analytical predictions. In the second activity, corresponding multi-axial tests to determine the influence of corrosion superimposed on mechanical stress have commenced using pre-carburised tubes. The beneficial effect of carburisation on creep ductility, and its temperature dependence has been demonstrated. Further work is needed to obtain a better mechanistic understanding of carburisation on deformation and fracture. Work has not yet started on the influence of simulated industrial environments (C-O-S) on uniaxial or multi-axial creep behaviour of tubes but is scheduled for 1986 and 1987.

The resources for the project appear to be adequate to meet the objectives of the four activities and the generalised objective of the project viz. to provide a methodology for design/analysis. Such a methodology applies to a simple component, namely a tube. The outcome of the work is not necessarily relevant to the solution of industrial plant problems. Component failures are invariably associated with more complex geometries (bends, bottlenecks, convergences, junctions), structural constraints (restrained thermal expansion, thermal stresses arising from differences in thermal expansion of adjacent materials, including weldments), fluid dynamics (recycling, vortices) as well as steady and transient temperature variations within the component. A programme that would significantly reduce the incidence of industrial plant failures would involve a thorough analysis of specific cases and a simulation of the conditions in an engineering circuit in which the relevant components are installed and the events leading up to failure closely monitored. In our view, the present project provides a generalised response to the problems of industry, i.e., a starting point for establishing correlations with other more specific parameters of plant components.

(i) b. Role played by JRC at European level.

This project is well integrated into the COST 501 project on multi-axial creep in corrosive environments and uses the common COST 501 material (Alloy 800H) and agreed test temperatures. Collaboration with five participating countries is strong. Contribution to the BRITE programme will be made. A significant part of the work contributes to two doctoral theses at JRC Petten.

The Panel considers that, in Europe, JRC Petten is conducting pioneering research in multi-axial creep/ corrosion interactions. Their work embraces not only the provision of valid material data on sub-components but also, through the development of complex computations, serves to enhance existing codes of practice for the design of plant components and thereby improve plant reliability. Further reduction in the incidence of plant failures would require a more comprehensive programme that is a closer approximation to reality.

(ii) Appraise scientific and technical contributions of the programme in relation to its objectives, including the quality of the work and the relevance of the results obtained.

The Panel agrees with the strategy adopted for fulfilling the objectives of the activities in this project and with the decision to employ a single alloy in one form (i.e. tubular). The high quality of the work is reflected not only in the sophisticated test equipment and the high accuracy of creep measurement (which proved necessary for the small changes of diametral strain incurred at low stresses), but also in the analysis of creep curves and of temperature dependent effects.

The early results are already relevant to industry - the importance of geometry and the beneficial effects of carburisation have been demonstrated. We expect that the major contribution of the work will be in reducing the ad hoc nature of design by improving design codes of practice as a consequence of the fresh insight into geometry- and temperature-dependent effects of creep behaviour under complex loads and simulated industrial environments.

(iii) Determine the practical contribution of the work to Community objectives and to the socio-economic; development of the Community.

The techniques of measurement and the predictive methodology arising from this project will contribute to better standards of measurement, and, through improved design codes, to more efficient, reliable and safer equipment in industry. As in the case of Project 1, we again recommend closer liaison with industry to ensure that any revisions in industrial practice and operating conditions are quickly incorporated in the project and that EC industry is made aware as early as possible of relevant findings.

(iv) Evaluate the programme implementation methodology.

We agree with the planning of the programme and the sequence of activities that progressively involves a simulation of the more important features of the industrial environment.

(v) Recommendations on ways of exploiting research results, on improvement of management and on the future orientation of the programme.

Since this project is complementary to Project 1, the same comments on exploitation of the results apply. In due course consideration should be given to presenting the findings to an invited audience of plant designers, manufacturers and operators, perhaps under the auspices of COST 501.

The four-activity programme is ambitious and no doubt further bench-mark testing will be required for the third and fourth activity, and perhaps also for the second activity if tests with intermediate values of bi-axial loading prove necessary. The future orientation of the work will depend on the outcome of the predictive methodology. If this is of significant but limited value, it may be undesirable for JRC Petten to pursue researches that are incraesingly phenomenological, for example, exploring the effects of stress and strain concentrations, residual stresses (equivalent to those induced by cold or warm working during fabrication), large local temperature variations (hot spots). Extension of the fourth activity would

require careful consideration, bearing in mind factors such as weld quality, heat affected zones, anisotropy of microstructure and its relation to loading direction, stress relieving heat treatments.

We recommend that JRC Petten considers an extension of the project to include other sub-components and therefore the probable involvement of other aspects of a geometric, structural or fluid dynamic nature.

PROJECT 3 - STUDIES ON ENGINEERING CERAMICS

Nature and Scope

The declared objectives of this project are :

- to develop the lifetime prediction methodology of ceramic components in severe environments (high temperature, corrosive and under mechanical load), and
- to develop guidelines for the processing of more reliable materials.

The project, established after a careful review of the R&D needs of the Community and with due regard to the JRC resources and capabilities, was integrated into the Petten 1984-87 programme. Its objectives will be achieved by a determination of the mechanical and corrosion resistant properties of engineering ceramics and ceramic composites, and by studying the processing parameters that determine the microstructure and also the mechanisms that govern high temperature behaviour in aggressive environments.

The project is divided into three subactivities :

- Production Research,
- Corrosion Evaluation,
- Mechanical Properties.

For the first phase of the project silicon nitride has been selected as the main ceramic type material to be investigated.

The project expenditure on capital and running costs and contracts was 704 kECUs in 1984 (i.e. about half the total HT programme costs). A total of 10 research staff ($\sim$ 20% of the total HT effort) were engaged in the project during 1984-85.

Evaluation

At the date of examination (summer of 1985) by the Evaluation Panel, this project has been underway for some 18 months during which time the facilities for silicon nitride sample production have been designed and established, first samples from other producers have been tested and most of the environmental equipment has been acquired. Several testing techniques have been developed, sometimes after adapting and extending existing facilities. Consequently, only limited experimental data are as yet available. It is therefore too early to make definitive statements on the project, using all the suggested criteria for evaluation.

(i) a. Extent to which the objectives of the project have been met

The objectives being claimed for the project are great and probably too ambitious. Within the resources available and within the time scale of the project, it is likely that only a tentative methodology can be proposed for the life-time prediction of ceramic components. For example, the effects of specimen geometry, surface condition and cyclic loading will require an extension of the project. Only a limited examination of compositional variables will be possible in the processing studies.

In this respect one also has to keep in mind that among the various ceramic research laboratories (some of these with quite an experience in the field of silicon nitride) the JRC Petten is a newcomer and in the cooperation with those laboratories up to now is still a "junior partner" whose qualification has to be proven. The Panel believes that within some years JRC Petten may achieve a position among the leading institutes in the field of engineering ceramics, but close cooperation with research institutes and industries is needed. In these respects the development of the project should be carefully considered during the next few years.

The Panel agrees with the approaches taken to fulfil the project's objectives. Preliminary data have been obtained on the effects of controlled environments in the absence of stress, and on the strength and creep behaviour in air and in vacuum respectively. The panel agrees that it is necessary to determine the effects of individual environments in both the presence and the absence of stress in order to elucidate the mechanisms

of corrosion as well as to provide meaningful data. Such elucidation is of limited value unless the material is well characterized and also well controlled in its preparation. We approve the collaboration with a research institute in order to determine the effect of processing variables on microstructure and properties.

(i) b. Role played by JRC at European level

The JRC role in this activity can be both direct and catalytic. We expect its coordinating role will be strengthened with increase in its authority as a Community source of knowledge and expertise on the behaviour of ceramics in aggressive environments.

(ii) Appraise scientific and technical contributions of the programme in relation to its objectives, the quality of the work and the relevance of the results achieved

We consider that the existing and proposed facilities, when taken in conjunction with the bilateral and multi-lateral collaborative actions so far taken, will be adequate for carrying out the experimental R&D programme and will be a good basis for the achievement of the objectives, albeit on an extended time-scale. We are impressed with the quality of the research so far conducted - for example, the development of reproducible strength-measuring techniques that are essential for the provision of meaningful data on the strength distribution of brittle materials. The emphasis on the importance of microstructure and associated techniques of examination, and on the mechanisms of environmental attack under stress ensures that there is a good balance between basic and applied research in the programme.

(iii) Determine the practical contribution of the results of the programme to Community objectives and to socio-economic development of the Community

Although it is too early to comment on the practical contribution of the results to Community objectives, it is highly probable that the national industries will benefit from the increased knowledge that will give added value to national programmes. This increased knowledge of materials under stress in corrosive conditions will help to increase the reliability and safety of industrial plants. Improved techniques of measuring mechanical

properties will lead to better standards of measurement. The output from this project may also have an important influence on material selection - the wrong choice of material can easily negate potential savings in energy and material costs, particularly if the weakness of the material is not revealed until the operational stage of the plant.

Under DG XII, JRC Petten is associated with the multi-collaborative programme on Raw Materials (Technical Ceramics) and has contributed to the evaluation of proposals on engineering ceramics for BRITE. More recently, proposals on collaborative schemes for the Stimulation of European Cooperation and Scientific and Technical Interchange have been made. Thus, although the project is in an interim stage, the knowledge and expertise of Petten staff are already being sought, and approaches have been made to use the facilities.

The links with national programmes are promising but need to be reinforced, particularly through cost-shared programmes such as BRITE where the catalytic role of Petten could be beneficial and ensure quicker industrial exploitation of the results. We would like to see stronger industrial liaison in order to increase industrial awareness of the project and to ensure that plant environments are characterised and truly simulated in the Petten laboratories.

(iv) Evaluate the programme implementation methodology

The programme appears to be adequately planned. Three activities viz. production technology, corrosion properties and mechanical properties are being conducted in parallel. While the last two are clearly inter-related, integration with the production technology aspect is not apparent in the plan.

(v) Recommendations on ways of exploiting research results, on improvement of management and on the future orientation of the programme

It is premature to comment on exploitation of results. Closer links with manufacturing and user industries during the project will ensure early exploitation. There is a need to pursue contacts with industries initially

reluctant to cooperate - there may be a change of heart when such industries appreciate the value of the knowledge and expertise acquired progressively during the project.

Careful consideration needs to be given to the future orientation of the project because of its potentially large scope, for example (a) its extension to the evaluation of static and dynamic fatigue under both mechanical and thermal loading, (b) the evaluation of more complex silicon nitrides (such as Si-Al-O-N compounds) and of composites, (c) the processing variables involved in the fabrication of composites, (d) crack propagation characteristics of ceramics, especially composites. As JRC Petten becomes more involved in multi-lateral collaboration, we would hope that its role will include the design of critical experiments for evaluating materials and thereby reduce the cost of comprehensive assessments.

PROJECT 4 - HTM DATA BANK

Nature and scope

This project is a follow-up of the development of a pilot data bank of mechanical properties which has been implemented by the HTM-group of the Petten establishment, in cooperation with the Ispra computing centre.

As stated in the Technical Description of the Multiannual Programme of the Joint Research Centre the second phase of this project has as main objectives :

- the utilisation of the data base for the dissemination of material data by intermediate (off-line) and interactive (on-line) routes ;
- the extension of the data base to other materials and to other properties ;
- the evaluation, critical assessment and standardisation of materials properties data obtained from various industrial and scientific sources, Community programmes such as the HTM programme itself and from COST concerted actions.

In the first phase of the project only raw data, without assessment or evaluation have been taken up in the bank. One of the reasons for this decision was that real assessment, selection and evaluation are only possible when sufficient data have been collected. Also the criteria for selecting particular data are not easily available or generally accepted.

Evaluation

At the beginning it should be noted that the real value of a data bank can only be assessed when it is more or less complete and when a user's interface is available. As on the other hand such a data bank can only be built up piece by piece this means that a complete evaluation is not yet possible.

The original objectives of this project have in a large measure been met : it has been demonstrated that both entering and retrieving data in various forms is possible, and on-line interaction has been realized. The content is continually being extended and the Panel noted with satisfaction that both the number of alloys on which data are available in the bank and the number of properties have been increased during the last year. In particular the introduction of corrosion properties in the Data Bank is of great importance.

The extension of the scope of the Data Bank to other types of materials is being studied at present by evaluating the possibility of including ceramic materials. This would mean more than just an extension : certain parts of the set up and of the software have to be revised in that case. The Panel notes that this study is of great importance as the value of the Data Bank would increase enormously if the scope could be widened to other groups of materials, albeit less comprehensively than for alloy 800H.

Another point which was noted with satisfaction by the Panel is that there is extensive contact with the participants of the COST 501 concerted action. This interaction both results in more data becoming available and in the use of the data by these participants. Application programmes for lifetime prediction calculations in the framework of the COST 50 and 501 concerted actions are being developed and further work on these and on evaluation programmes certainly must be continued.

This also points to the necessity of intensifying the efforts to obtain a good user interface. The Panel has noted that by the end of 1985 it will become possible for external users to work with the Data Bank. Only after their experiences have become available is a real evaluation possible. The resources at Petten and Ispra for this project have been adequate since 1984 but they need to be increased as the data base expands to include a wider range of materials and assessment of raw data.

The role played by the Petten establishment at the European level is certainly satisfactory. This project is perhaps the most supranational of all activities conducted at Petten and is as such a typical Community type of activity. It certainly fits in the framework of the activities conducted

by DG XIII directed at a joint European materials data system with which a cooperation has already started. In this regard , the well prepared and well received symposium held at Petten in November 1984 was very timely.

The scientific and technical contribution of the Data Bank project in relation to its objectives, including the quality of the work and the relevance of the results obtained can at the moment, for reasons already given above, only partly be assessed. The quality of the work as such is certainly very good when one compares the results obtained so far in relation to the very limited man-power which has been available. Because the original objective of setting-up a pilot project to show the feasibility of the ideas put forward in the programme proposal has been reached the Panel concludes that this project has made a positive contribution in this field with probably very relevant results for the users of this system.

The practical contribution to Community objectives and to the socio-economic development of the Community is still limited. As the scope of the Data Bank is increased and as the user interface is developed there is no doubt that this project will give a substantial contribution to industrial activities in the High Temperature Materials field. It is to be expected that many, and in particular the smaller industries who are not able to collect sufficient data themselves, will make use of the possibilities of this Data Bank.

The implementation methodology of this part of the programme is certainly satisfactory. Not only has the Data Bank been set up and is operative now, the participants have also contributed to the literature in this field and have organized an important symposium. The latter has already resulted in the above-mentioned activity of DG XIII in the field of a European materials data system.

The Panel likes to give some recommendations concerning ways to further exploit the results and the future orientation of the programme. As noted several times above the real value of the Data Bank can only be realized after the following conditions have been met :

- the content has to be increased by incorporating data on more alloys and more different properties of these ;

- the scope of the content has to be increased by extension to other types of materials ;
- an efficient and good working user interface with appropriate application programmes must be realized as quickly as possible ;
- the evaluation programmes must be developed to critically evaluate the data present in the Data Bank in order to make it possible for users to obtain selected and typical data.

In order to make it possible to achieve these objectives the man-power available for this part of the programme should be increased, e.g. by a contribution from the DG XIII activity.

Because of the high commercial value of this activity to industry another possibility would be to obtain the interest and cooperation of a commercial firm working in the field of Information Technology (such as firms which are now dealing with bibliographical Data Banks or other types of factual Data Banks).

PROJECT 5 - HTM INFORMATION CENTRE

The objectives of the information centre, originally conceived in 1975, are to provide an information service to the European High Temperature Materials Community, to identify and evaluate technological trends and R&D requirements, and to promote R&D cooperation in materials associated with HTM technologies. The strategy is expressed in four activities viz. meetings (conferences, symposia, workshops and expert discussion groups) ; R&D assessment and analysis (preparation of topical reviews on the state-of-the-art of materials used in conventional and advanced high temperature technologies, identification of problem areas and the evolution of R&D requirements) ; promotion of cooperation (establishment of weighting factors concerning research priorities, definition of programmes, preparation and initiation of collaborative schemes), and the HTM information base (collection, storage and dissemination of HT relevant information concerning R&D programmes, organisations, experts and materials).

During the 1980-83 programme, a total of 11 meetings were held, involving some 200 presentations and 700 participants, the proceedings of most of which were published commercially. This commitment was well maintained in the present programme. The experimental activities in Petten were reflected in the subject matter of the meetings, the workshop on silicon nitride based materials being particularly timely. Fourteen R&D studies of materials for advanced industrial processes and state-of-the-art surveys on specific materials have been prepared under external contract, and have mostly appeared in open publications which have been well received.

A survey on "Requirements for High Temperature Materials R&D for Industry and Energy - and Future Prospectives" will shortly be published. The computerised information service has made information available to a progressively wider range of users of HTM and is in constant use as a reference source on corrosion, mechanical properties, alloy production and processing, and ceramics.

In the present programme, there is greater emphasis on the promotion of cooperation on behalf of the Commission. The Centre has coordinated managerial and technical assistance to the shared-cost actions BRITE (DG XII-C) and Raw Materials-Technical Ceramics (DG XII-G).

The Panel considers that the objectives of the project are being met and that the roles of the Information Centre in providing reliable information and data, in proposing R&D requirements, in catalysing cooperative actions and in coordinating research actions for the Commission are being seriously fulfilled. We are particularly pleased with the activity on the integration of Commission programmes with relevant external national bodies- producers, users, R&D institutes, universities and other educational establishments and technical societies pertinent to the HTM field.

We consider the quality and relevance of the output to be very good, and its practical contribution to Community objectives and to the socio-economic development of the Community is positive. We have no doubt about the importance of the Information Centre with respect to both the internal JRC programme and external collaborative programmes, and about its benefit to smaller industries and to the newer members of the EEC. Its resources appear to be adequate, although they may be stretched as commitments to the growing number of collaborative materials-oriented EEC projects increases. Assuming that a staff age structure problem exists or manifests itself in Petten, we suggest to management that older experienced scientists should be transferred to information technology duties. We have no constructive or critical comment to make regarding the implementation methodology of the Information Centre or on the exploitation of results which we consider admirable.

We are pleased to see that, in the context of high temperature applications, materials are being broadly interpreted. It appears to us that productivity in this activity could be increased by intensifying the efforts related to the main goals and by expanding the targets to include - in an intelligent and useful way - additional HTM information produced in the U.S. and Japan.

ABBREVIATIONS

HT	High Temperature
HTM	High Temperature Materials
COST	Cooperation in the Domain of Scientific and Technical Research
COST 50	Gas Turbine Materials
COST 501	High Temperature Materials for Conventional Systems of Energy Generation and Conversion using Fossil Fuels
COST 505	Materials for Steam Turbines
BRITE	Basic Research for Industry and Technology in Europe
ACPM	Advisory Committee for Programme Management
R&D	Research and Development
EEC	European Economic Community
DG XII	Directorate-General XII - Science,Research and Development
DG XIII	Directorate-General XIII - Information Market and Innovation
FAST	Forecasting and Assessment for Science and Technology
CGC	Comité Consultatif en matière de Gestion et de Coordination "Technologies industrielles"

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EUR 10593 — Evaluation of the high-temperature materials programme of the Joint Research Centre (1980-85)

R. J. E. Glenny, H. Böhm, P. J. Gellings, P. Gobin, G. Lanzavecchia, C. Nicholaides

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The evaluation covers the quality and relevance of the research, the usefulness of the results and the role played by the JRC in this field at the European level.

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