

REPORT

**Photonics Metrology :
April 1998 to March 2001**

**Projects Contracted to The
National Physical Laboratory**

**First Annual Progress Report :
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Dr J M Benson

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Approved on behalf of the Managing Director, NPL
by Mr S Manning, Key Account Director

NATIONAL MEASUREMENT SYSTEM PROGRAMME
PHOTONICS METROLOGY : APRIL 1998 TO MARCH 2001

**PROJECTS CONTRACTED TO THE NATIONAL PHYSICAL
LABORATORY**

Programme Manager: Dr J M Benson

First Annual Progress Report : April 1998 to March 1999

1. INTRODUCTION TO THIS REPORT

The Photonics Metrology Programme covering the period April 1998 - March 2001 contains three technical Themes:

- Optical Fibres and Components
- Test Equipment, Amplifiers, Sources and Detectors
- Optical Properties of Materials

This report provides a summary of the progress achieved during the first year of this programme within each of the Themes.

It summarises the progress achieved within Technology Transfer and Management Themes related to these technical areas

It makes recommendations for the revisions to a few milestones where these are thought necessary or beneficial to the Programme.

It also contains a detailed annex that sets out all the milestones specified for the projects, with information on progress given at milestone level.

2. THEME 1 : OPTICAL FIBRES AND COMPONENTS

2.1 OVERALL OBJECTIVES AND SUMMARY OF PROGRESS

2.1.1 Overall Objectives

The overall objectives of this Theme are:

- To maintain the existing measurement facilities for the characterisation of optical fibres, underpinning the current requirements for accurate traceable measurements arising from UK industry.
- To develop and disseminate new, internationally acceptable measurement capability required to meet emerging needs of industry.
- To verify the validity of both existing and developed new facilities through international comparison.

2.1.2 Summary of progress

Projects in this Theme are overall very slightly behind schedule. All 14 milestones due this year have been completed.

UKAS accreditation for all services has been maintained, and the technical scope of a number of services extended to cover the growing demands of UKAS accredited laboratories in this area. The continued growth in the uptake of fibre measurement services this year reflects the importance the photonics industries place on traceable measurement.

Work on the distributed characterisation of fibre parameters using OTDR techniques has been challenging. A number of important results have been achieved this year, including the identification of the most effective fitting routines for distributed cut-off wavelength using OTDR techniques. The accuracy of the techniques for these distributed measurements is comparable with the reference test methods.

The development of facilities for the characterisation of fibre components has progressed well. In particular, work on the characterisation of fibre gratings has started ahead of schedule and studies of the affects of gratings on polarisation mode dispersion of links identified communication critical effects.

The non-linear competitively tendered project has had a particularly good start with all partners working well to achieve the project goals. The study on four-wave mixing effects has identified a number of metrological applications for this effect. The industry survey of requirements has emphasised the level of both current and future demand for these measurements. The results have confirmed the understanding that industry requires services to characterise n_2/A_{eff} rather than n_2 .

3. REVIEW OF PROGRESS IN THEME 1 PROJECTS

3.1 Project 1.1 Maintenance of fibre optic measurement services

Project Manager: Dr Brian Walker

3.1.1 Project Objectives

The objectives of this project are:-

- to maintain existing standards, measurement capabilities and services.
- to improve measurement capabilities to cater for longer lengths of optical fibre.
- to ensure international acceptance of UK standards through international comparison.

3.1.2 Specified Deliverables

The deliverables of this project are:-

- **maintenance of existing standards, measurement capabilities and services covering:-**

**single and multimode attenuation
single mode attenuation uniformity
cut-off wavelength
dispersion (chromatic and polarisation mode)
mode field diameter/numerical aperture
spectral component facility**

- extension of dynamic range of attenuation measurement facility to enable the measurement of longer fibres (target length 50 km).
- international verification of multimode golden fibre attenuation transfer artefact.
- extension of mode field diameter service to include mfd non-circularity.
- extension of polarisation mode dispersion capability to include second order PMD.
- **extension of optical length calibration service to cover fibre lengths from 0.5 km to 100 km, with an accuracy of 1 part in 10^4 .**
- validation of NPL pmc artefact through intercomparison.

3.1.3 First Year Progress

The project is on schedule. UKAS accreditation has been maintained for all services and uptake of services continues to grow with approximately 100 calibrations performed this year.

The systems used to automate many of the services under this project have been reviewed this year. Many have been operating on older computers and using software packages no longer supported, which increases the risk of failure and increased down-time. A systematic plan to update all automation systems in preparation for the move to the new buildings has been implemented, with a number of services having had software upgrades.

The development work to extend the scope of the length calibration has been successfully completed. Indeed, the accuracy target of 1 part in 10^4 has been exceeded for the longer lengths of fibre. An extension to the formal UKAS scope for this service will be sought at the next surveillance visit.

An additional milestone was added to this project at the six month review. This milestone is to undertake an international comparison of polarisation mode dispersion. Through OFMeC, a wide UK participation in this comparison is planned, and it is expected that this comparison will be completed ahead of schedule (December 1999).

Work on characterising the fibres to be used in the international comparison of the multimode golden fibre attenuation standard has been undertaken at NPL. However it is likely that this milestone will be slightly delayed because of scheduling difficulties amongst participants.

3.1.4 Achievements in First Year

- UKAS accreditation maintained for measurement services.
- Continued growth in uptake of traceable measurement in this area.
- Target uncertainty for length calibration service exceeded.
- Successful move of attenuation and cut-off facilities to improved laboratory accommodation.
- Control software for dispersion and mfd facilities updated, improving service efficiency.

3.1.5 Proposed Changes to Milestones

It is requested that milestone 1.1.6 (International comparison of mm golden fibre attenuation standard complete) be moved to December 99. This is because of scheduling delays among partners.

3.2 Project 1.2 Distributed measurement in fibres

Project Manager: Dr Brian Walker

3.2.1 Project Objectives

The objectives of this project are:-

- to develop measurement techniques allowing the measurement of the variation of fibre parameters along a length of optical fibre.
- to seek international agreement on the techniques for distributed measurements in fibre.

3.2.2 Specified Deliverables

The deliverables of this project are:-

- **measurement facilities developed to enable distributed measurement of cut-off wavelength and mode field diameter.**
- measurement facilities developed to enable the distributed measurement of zero dispersion wavelength (ZDW), polarisation mode dispersion and effective group index.
- recommendation on measurement techniques for distributed measurements to international standards organisations.

3.2.3 First Year Progress

This project is on schedule. OTDR techniques for the distributed measurement of mode field diameter and cut-off wavelength have been investigated and reports on these studies produced. The results of these studies have demonstrated that the techniques employed provide a good estimate of the variation of the parameters along the length of a fibre, provided an accurate determination of the specific parameter at one end of the fibre is available.

A particular study of the fitting routines for the calculating of cut-off wavelength from OTDR traces has been undertaken. This has highlighted the limited applicability of a number of the fitting routines proposed in the literature.

Work on the distributed measurement of polarisation mode dispersion is progressing well. There are a number of particular challenges associated with this aspect of the project. In particular this project requires the development of fast detection electronics and a few nanosecond pulses to provide the spatial resolution and allow characterisation of pmd at a level of approximately 0.1 ps.

Work has commenced on the measurement of distributed zero dispersion wavelength using OTDR techniques.

3.2.4 Achievements in the First Year

- Facilities for distributed mode field diameter developed.
- Facilities for distributed cut-off wavelength developed.
- Accuracies for distributed mode field diameter and cut-off wavelength analysed.
- Fitting routines for distributed cut-off wavelength evaluated.

3.2.5 Proposed Changes to Milestones

No changes are proposed to milestones

3.3 Project 1.3 Single mode and multimode fibre components

Project Manager: Tim Jones

3.3.1 Project Objectives

The objectives of this project are:-

- to provide measurement facilities to meet the measurement requirements for application of wavelength division multiplexing to fibre components.
- to develop techniques to measure chromatic dispersion in components.
- to develop measurement techniques for transmission properties of multimode fibre components.

3.3.2 Specified Deliverables

The deliverables of this project are:-

- **high spectral resolution facility for insertion loss of single mode fibre components.**
- high resolution spectral facility for bandwidth of gratings.
- facility for dispersion measurement in fibre gratings and dispersion compensating devices.
- facility for the characterisation of multimode components.
- software to model modal power transfer in multimode components.

3.3.3 First Year Progress

This project has progressed to schedule during the first year. Discussions with industry have indicated the requirement for the calibration of single mode passive components to be as cost effective as possible. Therefore that part of the project has been focused towards the integration of both phase and amplitude measurements to provide an efficient and cost-effective measurement service for customers.

This is being achieved by the development of the existing facility at NPL for the measurement of fibre dispersion using a tuneable laser based time delay measurement system. The hardware and software have been modified to allow the collection of amplitude data and phase data from fibre components. It is proving technically challenging to achieve the dynamic range for the acquisition of amplitude data and

work is continuing on improving the system performance . Testing of the system for both these parameters and improving the amplitude dynamic range is ongoing.

A design study of source options for multimode component characterisation revealed technical limitations in the ease of manipulating the geometrical properties of laser diode based sources. Therefore a monochromator based source has been adopted as the approach for the measurement of the transmission properties of multimode fibre components. A variable limited phase space geometrical launch system has been designed and constructed to allow any launch condition to be generated for up to 62.5 μm core fibres.

The rapid commercialisation of in-fibre Bragg gratings has produced a strong interest in the provision of traceable measurements for these devices. Therefore, work has commenced ahead of schedule on the characterisation of in-fibre Bragg gratings. Preliminary measurements have been made of the spectral transmission, spectral reflectivity and chromatic dispersion properties of in-fibre Bragg gratings using the modified laser based system. Reproducible spectral structure has been identified in the characteristics of several dispersion compensating devices and this is being investigated.

NPL has discussed with NIST the need to ensure international compatability of grating measurements and both NIST and NPL will take part in a round-robin comparison of fibre grating measurements during the next year. This will provide a useful international link to the planned testing and inter-comparison of the component dispersion measurement facility.

3.3.4 Achievements in the First Year

The achievements during the first year include:

- Automated facility designed and constructed for high resolution spectral scans of passive fibre components.
- Facility for measurement of dispersion in passive fibre components constructed.
- Preliminary measurements made of the spectral transmission and reflectance of in-fibre Bragg gratings, ahead of planned schedule.
- Preliminary measurements made of the chromatic dispersion of dispersion compensating gratings, ahead of planned schedule.
- Variable limited phase space launch facility designed and assembled for the characterisation of multimode components.

3.3.5 Proposed Milestone Changes

There are no proposed milestone changes

3.4 Project 1.4 Study of traceable measurements for fibre coating

Project manager: Andrew Parker

3.4.1 Project Objectives

The objectives of this project are:-

- to identify the requirement for traceable measurements of fibre coatings.
- to identify the validity of measurement techniques for coating geometry.

3.4.2 Specified Deliverables

The deliverables of this project are:-

- a report detailing industrial requirement for traceable measurements of fibre coating thickness and geometry.
- report on the validity of various techniques for the traceable measurement of coating wall thickness and geometry.

3.4.3 Progress in the First Year

This project does not start until September 1999 and therefore there is no progress to report.

3.4.4 Proposed Milestone Changes

There are no milestone changes proposed. However, it is proposed to start this project early to take advantage of the spring OFMeC meeting to develop the consultation exercise.

3.5 Project 1.5 Measurement of Non-linear Properties of Optical Fibre

Project Manager: Dr David Humphreys

3.5.1 Project Objectives

The objectives of this project are:-

- to investigate and verify the industrial need for measurement services and to determine possible metrological applications for four wave mixing in optical fibres.
- to develop measurement services for effective area, the non-linear refractive index n_2 , stimulated Brillouin threshold and Raman Gain coefficient.
- to ensure UK measurements are consistent with those of our trading partners.
- to disseminate the results of this work to UK industry.

3.5.2 Specified Deliverables

The deliverables of this project are:-

- **report to NMSPU on the results of initial theoretical investigations of four wave mixing with recommendations of best approaches for experimental investigations.**
- **a report to NMSPU giving the results of the survey of users and developers of optical fibre systems.**
- a report or presentation to NMSPU recommending a preferred approach to realise the measurement service for effective area.
- a report or presentation to NMSPU recommending a preferred approach to realise the measurement service for non-linear refractive index.
- a report on experimental investigations into four-wave mixing effects in optical fibre, presented to NMSPU and disseminated to industry
- report to NMSPU on the results of experimental investigations with a description of the developed technique in the form of an interim progress report
- report to NMSPU on the results of experimental investigations with a description of the developed technique in the form of an interim progress report.
- the availability to customers of a validated calibration service method for non-linear refractive index and a short progress report presented to NMSPU.
- the availability to customers of a validated calibration service method for non-linear refractive index and a short progress report presented to NMSPU
- a Report presentation to NMSPU on the investigations, system validation and the measurement facility
- a validated measurement facility for measuring stimulated Raman scattering threshold and gain profile in optical fibre, to a specification agreed by NMSPU
- a Report presentation to NMSPU on the investigations, system validation and the measurement facility

- an electronic media User Guide outlining the issues involved with non-linear measurements and describing the NPL measurement facilities. Supporting publications and reports will also be available.

3.5.3 First Year Progress

All milestones to date have been achieved and reports have been presented to NMSPU on the Four wave mixing paper study and the survey of the UK fibre optic industry. An overview of the project was presented at the OFMeC meeting on 4 November 1998 with presentations from NPL, Imperial College, PK Technology and Nortel.

The four-wave mixing study identified that crosstalk and parametric gain will be the most serious implications for wavelength division multiplexed long-haul telecommunications systems. The impact of these effects can be reduced by careful system design. NPL will contribute to this by providing accurate measurements of the non-linear parameters n_2 and A_{eff} in addition to measurements of the zero-dispersion wavelength and dispersion slope.

A conclusion of the report was that the area of distributed measurements using methods based on four-wave mixing looks particularly promising as a metrological tool. Distributed, non-destructive, measurement of factors such as dispersion and non-linear coefficient will be of more use than measurements of the average value along the entire fibre. The possibility of distributed measurements of external mechanical quantities such as temperature and stress over lengths of up to 25 km or more should also be considered.

The survey of the UK fibre optic industry aims were to identify the need and accuracy for traceable measurement for non-linear parameters of optical fibre and the priorities for each measurement over the next five years. 84 questionnaires were sent out and a response rate of 15% was achieved. The importance of optical fibre non-linearity will increase over the next five years. All of the respondents who expressed an opinion believed that non-linear effects in optical fibre will be either important or very important to their business within 3 years.

The current milestone scheduling is fully consistent with the projected needs of the industry. Effective area was identified as the parameter that most urgently requires a traceable measurement infrastructure. Additionally, an immediate need has been identified for a traceable measurement of non-linear coefficient. The infrastructure for scattering-related parameters is not an immediate requirement but will become so in 3 to 5 years' time.

Most of the respondents believed that a measurement service for the second order refractive index would not be necessary if services for the A_{eff} and the n_2/A_{eff} were available at NPL. The market for n_2/A_{eff} measurements is predicted to exceed that of n_2 within 5 years. It is recommended that the agreement to provide a measurement service for n_2 be altered to a service for n_2/A_{eff} to be commercially available in December 2000.

3.5.4 Achievements in First Year

- The theoretical study of four-wave mixing applications has been completed and reported to NMSPU.
- The survey of users and developers of fibre optic systems has been completed and the results reported to NMSPU.
- An overview of the project was presented to the OFMeC club on 4 November 1998.
- A presentation on non-linear effects in optical fibres was made as part of the Measurements in Optical Fibres course run by NPL.

3.5.5 Proposed Milestone Changes

All milestones are proceeding to plan. As a consequence of the customer survey undertaken as part of this project, changes are requested to the definitions of milestones 1.5.08, 1.5.14 and 1.5.16. Details are given in Section 10 of this report.

4. THEME 2 : TEST EQUIPMENT, AMPLIFIERS, SOURCES AND DETECTORS

4.1 OVERALL OBJECTIVES AND SUMMARY OF PROGRESS

4.1.1 Overall Objectives

The overall objectives of this Theme are:

- to maintain the existing measurement facilities for the calibration of fibre optic test equipment, sources and detectors, underpinning the current requirements for accurate traceable measurements arising from UK industry.
- to develop and disseminate new, internationally acceptable measurement capability required to meet emerging needs of industry.
- to verify the validity of both existing and developed new facilities through international comparison.

4.1.2 Summary of Progress

The projects in this Theme are running to schedule with all 13 milestones due this year completed.

The UKAS accreditation of all services has been maintained, and where appropriate the scope of the services extended to meet the developing requirements of industry. In addition the facility for calibration of optical spectrum analysers achieved accreditation from UKAS. There has been particular demand for the calibration optical fibre power meters, with the number of new customers for the service particularly notable this year. In addition, the demand for high power calibration of power meters is growing, reflecting the timeliness of the milestone to develop this capability later in the programme.

The development of the ITU frequency grid artefact has proceeded to plan, after an initial re-scheduling of milestones to accommodate the demands of the maintenance schedule and to bring some of the artefact development activities in-house.

Project 2.2 on fibre amplifiers is linked with an EC SM&T project (FAME). Much of the work in project 2.2 this year has supported the successful conclusion of this EC project. In particular the facilities for gain and noise figure have been used in an international comparison of these parameters, which have identified particular weakness across Europe in high power measurements. This can be attributed to poor high power characterisation of power meters and components used in measurement.

5. REVIEW OF PROGRESS IN THEME 2 PROJECTS

5.1 Project 2.1 Maintenance of equipment, source and detector services

Project Manager: Dr David Humphreys

5.1.1 Project Objectives

The objectives of this project are:-

- to maintain measurement standards and facilities for the calibration of fibre optic power meters, OTDRs, fibre optic spectrum analyzers and fast photonic devices, including frequency response.
- to ensure UK measurements are consistent with those of our trading partners.
- to ensure the accuracy with which fibre optic test equipment, sources and detectors can be calibrated, is in line with industrial requirements.

5.1.2 Specified Deliverables

The deliverables of this project are:-

- **maintenance of measurement facilities and standards for fibre optic power calibration, OTDR calibration, temporal and frequency response of fast photonic devices.**
- **maintenance of optical frequency standards for fibre optics and telecommunications applications.**
- **maintenance of calibration facility for optical spectrum analysers and wavemeters.**
- reduction in uncertainty with which fibre optic power meters can be calibrated (target 0.5%).
- extension of attenuation uniformity capability to include multimode fibres.
- **develop accurate representation of ITU frequency grid at 193.1 THz with 100 GHz spacing.**
- report on international comparison of OSA wavelength calibration artefact.
- reports on international comparisons of temporal and frequency response of fast optoelectronic devices.

5.1.3 First Year Progress

This project has run to schedule this year with all first year milestones achieved. The majority of the milestones relate to the maintenance of traceability and auditing of the measurement services. Uptake of traceable calibrations for fibre optic test equipment has been particularly buoyant, with over 70 calibrations having been performed over the period of this report. In particular, there has been strong demand for the calibration of fibre optic power meters. In addition, a number of requests for high power calibration of power meters and OTDRs is indicative of the likely demand for this service when introduced later in the programme.

UKAS accreditation has been maintained for all services. In addition, the optical spectrum analyser calibration service achieved accreditation from UKAS for single wavelength calibrations, providing a service with an accuracy of ± 34 pm over a spectral range of 600 nm - 1800 nm.

The number of participants in the Optical Spectrum Analyser intercomparison was increased by the addition of DFM. A total of four different measurement standards have been characterised and circulated to Denmark and the USA. Initial results from the comparison show good agreement between laboratories.

The power meter facility has been moved to a new laboratory in Building 95 and the working standards re-calibrated. The power meter measurement service passed the annual UKAS surveillance inspection. The milestone to reduce uncertainties in fibre optic power meter calibration to a 0.5% target is progressing satisfactorily. A detailed study of the systematic uncertainties associated with integrating sphere standards is on-going. This has highlighted problems associated with inter-reflections between fibre end and sphere wall when using barium sulphate. We have identified the areas where improvement is required from the uncertainty budget. Arrangements have been made to renew the power meter linearity measurements traceability for OFMET - Switzerland as part of the EUROMET agreement.

The ITU Grid Artefact milestone was rescheduled with agreement from NMSPU because of difficulties subcontracting the electronic assembly. However, this milestone has now been achieved, providing an artefact giving direct wavelength traceability for the ITU grid.

5.1.4 Achievements in First Year

- All milestones have been achieved.
- The OSA measurement service has achieved UKAS accreditation.
- All other facilities have maintained accreditation.
- Increase in the uptake of traceable calibrations.
- An Etalon calibrator, spaced at the ITU Grid and containing an absolute reference has been built.
- UKAS accreditation has been maintained on all existing services.

- Presentations have been made to individual companies and as part of the Optical Fibre Measurements course run at NPL.
- An intercomparison of OSA calibration artefacts between NPL, NIST and DFM is underway and all the NPL measurements have been completed.
- The laboratory move of the power meter services to building 95 has been completed successfully and UKAS re-assessment taken place.

5.1.5 Proposed Changes to Milestones

This project is running to schedule. No milestone changes are proposed.

5.2 Project 2.2 CHARACTERISATION OF FIBRE OPTIC AMPLIFIERS

Project Manager: Martin Wicks

5.2.1 Project Objectives

The objectives of this project are:-

- to develop facilities for the measurement of gain, noise and gain slope of optical fibre amplifiers.
- to provide facilities for measurement of non-linear and multi-wavelength behaviour of optical fibre amplifiers.
- to ensure UK measurements on fibre optic amplifiers are consistent with those measured in other countries.

5.2.2 Specified Deliverables

The deliverables of this project are:-

- **results of inter-comparison carried out with partners in FAME project analysed and reported.**
- measurement services for the characterisation of gain, noise and gain slope of optical fibre amplifiers.
- a report on the measurement requirements and best measurement techniques for amplifiers in non-linear and multi-wavelength systems.
- measurement facilities for the relevant amplifier parameters with emphasis on non-linear parameters and multi-wavelength behaviour.

5.2.3 First Year Progress

The project has progressed according to schedule. Systems for the measurement of amplifier gain and noise figure have been assembled and continue to be evaluated. Techniques based on the use of both optical and electrical spectrum analysis have been evaluated. The electrical technique has the potential to provide more representative values for the noise figure of an amplifier, particularly if it is to be used in analogue applications. However the realisation of the electrical method has been shown to be more difficult than the optical spectrum analysis method which may provide adequate information for digital applications.

A major part of the work on the project has been associated with the European SM&T FAME project. This project involved an inter-comparison of measurements on two commercial amplifiers which were circulated amongst the five participants (from France, Germany, Italy, The Netherlands and the UK). The amplifiers were first

characterised at NPL and were re-measured at NPL after circulation amongst the other participants.

The agreement between participants for gain was consistent with the uncertainties estimated by participants except at the lowest and higher input powers. At low input powers there was evidence of instability in the unsaturated amplifiers which would explain the increase in variation. At higher powers additional uncertainties included both the reproducibility of input powers and the accurate measurement of high optical output powers.

Noise figure measurements showed a greater than expected variation at shorter wavelengths where the intensity of the ASE spectrum varies rapidly with wavelength. The interpolation techniques used by participants yielded significantly different results for noise figure measurements in this spectral region. This is likely to be due to the detail difference in the interpolation techniques and extra uncertainties in the calibration of Optical Spectrum Analysers when measuring signals of rapidly varying intensity with wavelength.

The intercomparison has shown that in the 1550 nm spectral region gain variation was below 0.5 dB and noise figure below 1.0 dB. The intercomparison also highlighted the difficulty with some amplifiers of reproducing equivalent measurement conditions as the performance of one amplifier was shown to be significantly changed by the ambient environment in different laboratories.

5.2.4 Achievements in the First Year

- Establishment of systems for gain and noise figure measurement by optical and electrical spectrum analysis.
- Characterisation of amplifiers prior to international measurement inter-comparison.
- Successful completion of international measurement intercomparison co-ordinated by NPL.
- Completion of report analysing results of the FAME intercomparison.

5.2.5 Proposed Changes to Milestones

All milestones are proceeding to plan. No changes are expected in the next year.

6. THEME 3 - OPTICAL PROPERTIES OF MATERIALS

6.1 OVERALL OBJECTIVES AND SUMMARY OF PROGRESS

6.1.1 Overall Objectives

The overall objectives of this Theme are:

- to maintain the existing measurement facilities for the calibration of visual displays and bulk refractive index of materials, underpinning the current requirements for accurate traceable measurements arising from UK industry.
- to develop and disseminate new, internationally acceptable measurement capability required to meet emerging needs of industry.
- to verify the validity of both existing and developed new facilities through international comparison.
- to identify developing measurement requirements for UK industry in the area of photonic devices.

6.1.2 Summary of Progress

The projects in this Theme are running to schedule with all milestones due this year completed.

The project in this Theme addressing the maintenance and development of standards for refractometry does not start until September 1999, when it transfers from the Length programme. Work has therefore concentrated on the characterisation of visual displays. The study on industrial requirement for measurement of displays has highlighted a broad requirement across industry for the standardisation of measurements used to specify displays. There is a particular need to raise awareness of what is available under the NMS in this field. The aim of the work in this Theme has been to address the technical issues raised by the survey. This has been coupled with a significant effort under the Technology Transfer Theme to address the knowledge transfer issues.

6.1 Project 3.1 Measurement requirements for display technologies

Project Manager: Dr Julie Taylor

6.1.1 Project Objectives

- to identify the metrological requirement for display, including flat panel technology.
- to develop and appraise measurement techniques for displays.

6.1.2 Specified Deliverables

The deliverables for this project are:

- maintenance of existing services for the colorimetry of displays.
- a new transfer standard suitable for colorimetric calibrations of all display types.
- new measurement facilities for the measurement of miniature displays.
- new transfer standards for the calibration of miniature displays.

6.1.3 First Year Progress

The work within this project has proceeded well this year with a number of specific achievements. The study on industrial requirements for standards for new display technologies identified a major problem in terms of measurement agreement and traceability within the displays industry. Many companies included in the survey were unaware of display measurement protocols and traceable standards that were currently available. One of the main recommendations from the study was that NPL should develop a closer relationship with the UK displays industry to enhance knowledge transfer and ensure that metrology is considered at an early stage of new technological development. Since the study the DTA consortia has been approached with a view of using this forum for knowledge exchange and dissemination particularly on metrological issues.

There are currently two instruments used at NPL for the calibration of displays. During their annual calibrations earlier in the year, large wavelength errors were identified. In order to correct for these errors, the measurement technical procedures and control software were modified. Since then quarterly checks on both instrument wavelength scales have been carried out and the results have confirmed the accuracy of the scales.

In addition the diode array instrument measurement procedure has been developed in order that off-site calibrations can be offered to industry. Since then one off site calibration has been performed successfully. The current diode array instrument however has a very restricted measurement range and can only be used for

measurements of displays with luminance levels of greater than 1 cd/m². Many displays require measurements to be made for off and on states of black or dark where the luminance level is approximately 0.1cd/m². Additional portable facilities may need to be considered in the future.

6.1.4 Achievements in the First Year

- Completed study on industrial requirements for standards for both old and new display technologies.
- Developed dialogue with DTA and EPSRC and obtained agreement to use DTA forum as a direct link to the displays industry on metrology issues.
- Presented 5 papers/lectures on industrial based display technology courses throughout the UK.
- Maintained current measurement instrumentation and standards for colorimetry of displays and further developed on and off site calibration facilities.
- Carried out one full off site displays calibration using the portable spectroradiometer system.

6.1.5 Proposed Changes to Milestones

This project is currently running to schedule. There are no proposed changes to the milestones for the next year.

6.2 Project 3.2 Metrology for passive, active and non-linear photonic materials - Refractometry

6.2.1 Project Objectives

The objectives of this project are:-

- to determine the key measurement parameters limiting the industrial uptake of photonic technology.
- to develop traceable measurement techniques to characterise the most important parameters of photonic materials.

6.2.2 Specified Deliverables

The deliverables of this project are:-

- a facility to measure the refractive index of photonic materials, building on existing facilities.

6.2.3 First Year Progress

This project does not start until September 1999, when it transfers from the Length Programme to Photonics Metrology. There is, therefore, no progress to report for this year.

6.2.4 Proposed Changes to Milestones

No changes are proposed to the milestones of this project.

7. THEME 4 - TECHNOLOGY TRANSFER

7.1 OVERALL OBJECTIVES AND SUMMARY OF PROGRESS

7.1.1 Overall Objectives

The overall objectives of this Theme are:

- the promotion of and training in best measurement practice.
- the promotion and provision of measurement services developed and maintained under technical projects.
- the provision of advice on measurement techniques.
- the provision of technical advice on behalf of UK industry to national and international standardisation and metrological committees, e.g. ITU, IEC, BSI, EUROMET, COST.
- the support for training and education courses in fibre measurement techniques.

7.1.2 Summary of Progress

Good progress has been made on the projects within this Theme. All milestones for the year have been completed, a number exceeding the contracted scope.

A particular effort has been made to raise industrial awareness of the display measurement capability provided by the programme. In particular, contacts have been fostered between the NPL Displays Group and the Displays Technology Alliance, EPSRC and the Scottish Optoelectronic Association. An informal agreement has been formulated which provides NPL with the role of liaising between these groups to ensure coordination of measurement activities.

Work in both national and international standards committees has continued throughout the year. This year has seen the successful conclusion of a number of activities including the finalising of documents for fibre geometry, OTDR return loss and dispersion.

The successful series of fibre measurement courses has continued this year, in addition to that which is contracted for next year. Although usually run bi-annually, its success in previous years led significant demand for it to be run this year.

The quality of science undertaken under this programme is reflected in the number of papers and presentations made this year. This far exceeds the scope of the milestones associated with these activities.

8. REVIEW OF PROGRESS ON THEME 4 PROJECTS

8.1 Project 4.1 Programme-wide technology transfer

Project Manager: Dr Jerry Benson

8.1.1 Project Objectives

The objectives of this project are:-

- to ensure the maximum level of dissemination of measurement related technology across all industrial sectors identified in the Measurement Mapping exercise.
- to facilitate greater take-up of traceability for measurements across broad spectrum of industries using photonics.
- to improve the take-up of best measurement practice in measurements for photonics.
- to publicise widely, and maintain access routes to measurement services for UK industry.
- to promote UK interests through active participation in high level metrology and standardisation committees such as EUROMET, COST, BSI, CEN and IEC.

8.1.2 Specified Deliverables

- continued operation of OFMeC with a target to double membership by the end of the programme.
- at least 1 training course.
- at least 1 best practice guide.
- at least 2 articles or adverts per year in trade journals and other appropriate publications.
- high level representation on international committees such as COST, IEC, CEN and BSI.
- provision of a technical advice service.
- provision of calibration services.
- annual report on the effectiveness of technology transfer activities.

- a new brochure to promote the Photonics metrology Programme.

8.1.3 First Year Progress

This project continues to make good progress, with all milestones running to schedule.

The uptake of calibration services continues to grow. Further work has been done this year to improve access to these services. A programme of updating calibration service literature has been started, providing a common format for all NPL services which have been brought together under this programme. Two exhibitions were attended this year, each of which generated approximately 50 enquiries with regard to the measurement capabilities of the Photonics Metrology programme. Work has started on the development of a Photonics Metrology website and a power point presentation of the capabilities of the group has been developed and is available on CD ROM.

The Optical Fibre Measurement Club continues to run successfully with a 16% increase in membership over the last twelve months. One particular initiative of the club has been the development and maintenance of a "current status" document for all fibre and test equipment parameters. This gives details accuracy requirements for measurements and existing capabilities, as well as the status of intercomparisons for given parameters. It also provides a summary of industry's view of whether further work is required in a given area. The linkage between OFMeC and the EC funded FOTON Thematic Network will provide increased UK influence in the area of fibre optic measurement.

The fibre optic measurement course was run this year, and will be run again next year. This course continues to attract delegates from both the UK and overseas. The satisfaction rating scores for this year showed a 4% improvement over the previous year's rating.

A particular effort has been made to develop contacts with other organisations associated with photonics. In particular, activities under this project have included discussions with EPSRC concerning their Photonics Review, Discussions with the Scottish Optoelectronic Association with regard to future measurement requirements and interaction with DTI's Photonic Link programme, with particular emphasis on the Display's Technology Alliance, developed under this Link programme.

This year has seen the successful conclusion of the COST 241 initiative. The support provided by the NMS has enabled the direct participation of 11 UK organisations in the projects undertaken under COST 241, and the wide dissemination of the results of the research projects through OFMeC.

8.1.4 First Year Achievements

- Completion of OTDR best practice guide.
- Over 190 calibrations undertaken.
- Successful completion of fibre optic training course with improved satisfaction scores
- New web site for Photonics Metrology under development
- Over 150 enquiries answered

- New promotional material for services under development
- Two successful exhibitions attended
- Development of close links between programme and EPSRC, LINK and SOA

8.1.5 Proposed Changes to Milestones

The project remains on schedule. No milestone changes are proposed for next year.

8.2 Project 4.2 Project specific technology transfer

Project Manager: Dr Jerry Benson

8.2.1 Project Objectives

The objectives of this project are:-

- to provide technical input to, and representation of UK interests on national and international standardisation and metrological committees.
- to maintain the reputation for technical excellence of the UK NMS through the presentation of technical results of NMS projects at national and international conferences.
- to co-ordinate the UK technical input to international activities.

8.2.2 Specified Deliverables

The key deliverables of this project are:-

- attendance at national and international metrology and standardisation committees.
- at least 4 papers or presentations per year.

8.2.3 First Year Progress

Work on national and international standards committees has continued to provide an effective voice for UK industry. The co-ordination of UK input to international bodies has been a cause for concern over the last few years, with conflicting views being put forward by BSI as the UK response on a number of occasions. Through the activities of this programme, a rationalisation of the UK response mechanism has now taken place which should provide for improved UK submissions.

The work on return-loss calibration of OTDRs being sponsored by IEC is nearing completion. This document has been primarily written by NPL and strongly echoes the needs of the UK industry in this area. The procedure on fibre geometry has been published as IEC 61745 and the procedure on optical spectrum analyser calibration has been submitted for voting.

Three papers were presented at the Boulder Symposium on Optical Fibre Measurement, one of which was an invited contribution on the measurement of PMD in gratings, which was particularly well received

8.2.4 Achievements in the First Year

- Continued UK representation on national and international standards committees.
- Completion of work on the IEC standard for dispersion.
- Calibration procedure for fibre geometry published - IEC 61745.
- Authorship of IEC document on return loss calibration of OTDRs.
- Dissemination of standardisation activities through OFMeC.
- Presentation of 3 papers at BSOFM 98.
- Presentation of photonics capabilities at a range of companies and courses.

8.2.5 Proposed Changes to Milestones

This project continues to run to schedule. No milestone changes are proposed for the next twelve months.

9. REVIEW OF PROGRESS IN PROGRAMME MANAGEMENT

9.1 Project 5.1 Programme management

Project Manager: Dr Jerry Benson

9.1.1 Project Objectives

The objectives of this project are:-

- to deliver to time and budget the Photonics Metrology programme.
- to ensure efficient coordination of contractors.

9.1.2 Specified deliverables

The deliverables of this project are:-

- **delivery of the Photonics Metrology programme.**
- **quarterly invoices and annual reports.**
- **quarterly project reviews.**
- **six-monthly review and annual reviews to MAC/NMSPU.**

9.1.3 First Year Progress

This project is running broadly to schedule.

Quarterly project management and programme review meetings have been held during the year to monitor the progress of the programme and ensure projects are delivered to schedule and to specification.

A satisfactory six month review of the programme was completed by NMSPU

The RIN and Chirp maintenance aspects of project 2.2, delivered by DERA have been monitored for NMSPU through the year. Two formal monitoring visits have been carried out by the Programme Manager to discuss progress with the contractor.

9.1.4 Achievements in the First Year

- Four quarterly monitoring returns provided to NMSPU
- Successful six month review
- Project monitoring of RIN and Chirp undertaken
- All staff levels and facilities maintained and managed
- Delivery of the programme to schedule

9.1.5 Proposed Changes to Milestones

No changes to milestones are proposed.

9.2 Project 5.2 Programme formulation

9.2.1 Project Objectives

The objectives of this project are:

- to identify, through a wide ranging consultation process, work required to meet the future needs of UK private and public business in the field of photonics metrology and to prioritise that work according to the criteria and mechanisms set out by DTI
- to organise the identified work into a logically structured and documented programme with specific objectives
- to provide assistance in the identification of potential contractors to carry out the specified work

9.2.2 Specified Deliverables

- a draft programme document for Photonics Metrology, including activities broken down by themes and projects, description and rationale for activities, a guide price for each project, milestones, recommendations on competitive tendering and potential tenderers and objective economic impact parameters.

9.2.3 First Year Progress

This project has yet to formally start, although some informal approaches to organisations with an interest in photonics have been made.

9.2.4 Proposed Changes to Milestones

No changes to the milestones are proposed.

10. SUMMARY OF PROPOSED REVISIONS TO MILESTONES

Project 1.1 Maintenance of fibre optic measurement services

	Milestone	Description	Cost	Due Date
Baseline	1.1.6	International comparison of mm golden fibre attenuation standard complete	£14.0k	Jun 99
Proposed Revision	1.1.6	International comparison of mm golden fibre attenuation standard complete	£14.0k	Dec 99
Comment	Comparison delayed by participating partners			

Project 1.5 Measurement of Non-linear Properties of Optical Fibre

	Milestone	Description	Cost	Due Date
Baseline	1.5.8	n_2 system available at NPL	£35.6k	Dec 99
Proposed Revision	1.5.8	n_2/A_{eff} system available at NPL	£35.6k	Dec 99
Comment	Result of customer survey			

	Milestone	Description	Cost	Due Date
Baseline	1.5.14	n_2 and A_{eff} systems ready for UKAS accreditation	£15.7k	Oct 00
Proposed Revision	1.5.14	n_2/A_{eff} and A_{eff} systems ready for UKAS accreditation	£15.7k	Oct 00
Comment	Result of customer survey			

	Milestone	Description	Cost	Due Date
Baseline	1.5.16	n_2 and A_{eff} services available for customers	£10.8k	Dec 00
Proposed Revision	1.5.16	n_2/A_{eff} and A_{eff} services available for customers	£10.8k	Dec 00
Comment	Result of customer survey			

Project 2.1 Maintenance of equipment, source and detector services

	Milestone	Description	Cost	Due Date
Baseline	2.1.9	Accurate representation of ITU grid; artefact evaluated	£20.2k	Sep 98
Proposed Revision	2.1.9	Accurate representation of ITU grid; artefact evaluated	£20.2k	Mar 99
Comment	Out-sourcing difficulties in manufacture of electronics			

	Milestone	Description	Cost	Due Date
Baseline	2.1.11	OSA service audited	£15.4k	Dec 98
Proposed Revision	2.1.11	OSA service audited	£15.4k	Oct 98
Comment	Brought forward to improve linkage with UKAS surveillance visits			

	Milestone	Description	Cost	Due Date
Baseline	2.1.12	Wavemeter traceability maintained and service audited	15.4	Mar 99
Proposed Revision	2.1.12	Wavemeter traceability maintained and service audited	15.4	Feb 99
Comment	Brought forward to improve linkage with UKAS surveillance visits			

*The changes to this project were approved by NMSPU at the six month programme review.

NATIONAL PHYSICAL LABORATORY

CONTRACT ANNUAL REPORT:

March 1999

PHOTONICS METROLOGY PROGRAMME

Customer Contract Reference: MPU 8/52

Contract start date: 01-Apr-98 Contract end: 31-Mar-01

Contract type: D T I SINGLE TENDER GUARANTEED

Contract value: £2,372,400

NPL reference: QP98/S01

NPL manager: J M BENSON

Milestone statistics:

Total number:	173	
Total complete:	46	27%
Total due by: 31-Mar-1999	46	27%
Total due by: 31-Mar-2000	105	61%
Total active:	51	29%
Total not started:	76	44%

Milestone statistics:

Total number:	28	
Total complete:	5	18%
Total due by: 31-Mar-1999	5	18%
Total due by: 31-Mar-2000	19	68%
Total active:	8	29%
Total not started:	15	54%

**** 1.1.01 Audit of mfd system complete**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Jun-98
100 % complete	Revised/Actual Finish:	Jun-98

All equipment associated with the mfd facility re-calibrated. UKAS accreditation maintained. 21 calibrations have been performed on this facility this year.

**** 1.1.02 Audit of pmd system complete**

Current Status:	Planned Start:	Jul-98
Completed on Schedule	Planned Finish:	Sep-98
100 % complete	Revised/Actual Finish:	Sep-98

All equipment associated with this facility has been calibrated. The pmd calibration artefact has been evaluated against different pmd measurement methods.

**** 1.1.03 Improved single mode length calibration to 1 in 104 for lengths form 0.5 to 100 km**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Nov-98
100 % complete	Revised/Actual Finish:	Nov-98

The target calibration uncertainty has been exceeded for long lengths of fibre and achieved for the shorter lengths. Measurements can be done at both 1300 nm and 1550 nm.

**** 1.1.04 Audit of fibre characterisation facilities complete**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

All equipment associated with this service has been calibrated. UKAS accreditation has been maintained. The facility has been moved to new, more appropriate laboratory accommodation.

** 1.1.05 Audit of chromatic dispersion facility complete

Current Status:	Planned Start:	Jan-99
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

All equipment associated with this milestone has been calibrated and UKAS accreditation maintained. 39 calibrations have been performed on this facility.

* 1.1.06 International comparison of mm golden fibre attenuation standard complete

Current Status:	Planned Start:	Apr-98
Active or due to start in next 3 months	Planned Finish:	Jun-99
80 % complete	Revised/Actual Finish:	Jun-99

All characterisation of the fibres to be used in the comparison have been completed at NPL. However, a delay is likely in this milestone because of scheduling problems with participants. A new milestone date of December 99 is sought.

* 1.1.07 Audit of mfd facility complete

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Jun-99
0 % complete	Revised/Actual Finish:	Jun-99

* 1.1.08 MFD service extended to include mfd non-circularity

Current Status:	Planned Start:	Oct-98
Active or due to start in next 3 months	Planned Finish:	Jul-99
50 % complete	Revised/Actual Finish:	Jul-99

This milestone is running to schedule. Software to fit experimental data to mode field diameters has been commissioned. It is expected this software will be delivered in May 99, providing eight weeks for testing.

1.1.09 Audit of pmd system complete

Current Status:	Planned Start:	Jul-99
Not Started	Planned Finish:	Sep-99
0 % complete	Revised/Actual Finish:	Sep-99

* 1.1.10 Second order pmd system operational

Current Status:	Planned Start:	Jan-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
25 % complete	Revised/Actual Finish:	Dec-99

On schedule. Equipment has been purchased to allow the measurement of second order pmd. A number of techniques are being assessed to identify the best technique to be employed for this measurement

* 1.1.11 Single mode attenuation measurements extended to 50km lengths

Current Status:	Planned Start:	Sep-98
Active or due to start in next 3 months	Planned Finish:	Mar-00
37 % complete	Revised/Actual Finish:	Mar-00
On Schedule. A number of approaches are being assessed to identify the best technique, including monochromator based and laser based measurement systems.		

* 1.1.12 Maintenance of fibre refractive index facility complete

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 1.1.13 Audit of fibre characterisation facilities complete

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.14 Audit of chromatic dispersion facility complete

Current Status:	Planned Start:	Jan-00
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.15 Audit of coating geometry facilities complete

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.16 Audit of integrated optic mode field profiler complete

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.17 Audit of distributed stress measurement facility complete

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.18 Audit of fibre geometry facilities complete

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.1.19 Audit mfd system complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

1.1.20 Audit pmd system complete

Current Status:	Planned Start:	Jul-00
Not Started	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

1.1.21 Maintenance of fibre refractive index facility complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.22 Audit of fibre characterisation facilities complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.23 Audit of chromatic dispersion facility complete

Current Status:	Planned Start:	Jan-01
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.24 Audit of coating geometry facilities complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.25 Audit of integrated optic mode field profiler complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.26 Audit of distributed stress measurement facility complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.1.27 Audit of fibre geometry facilities complete

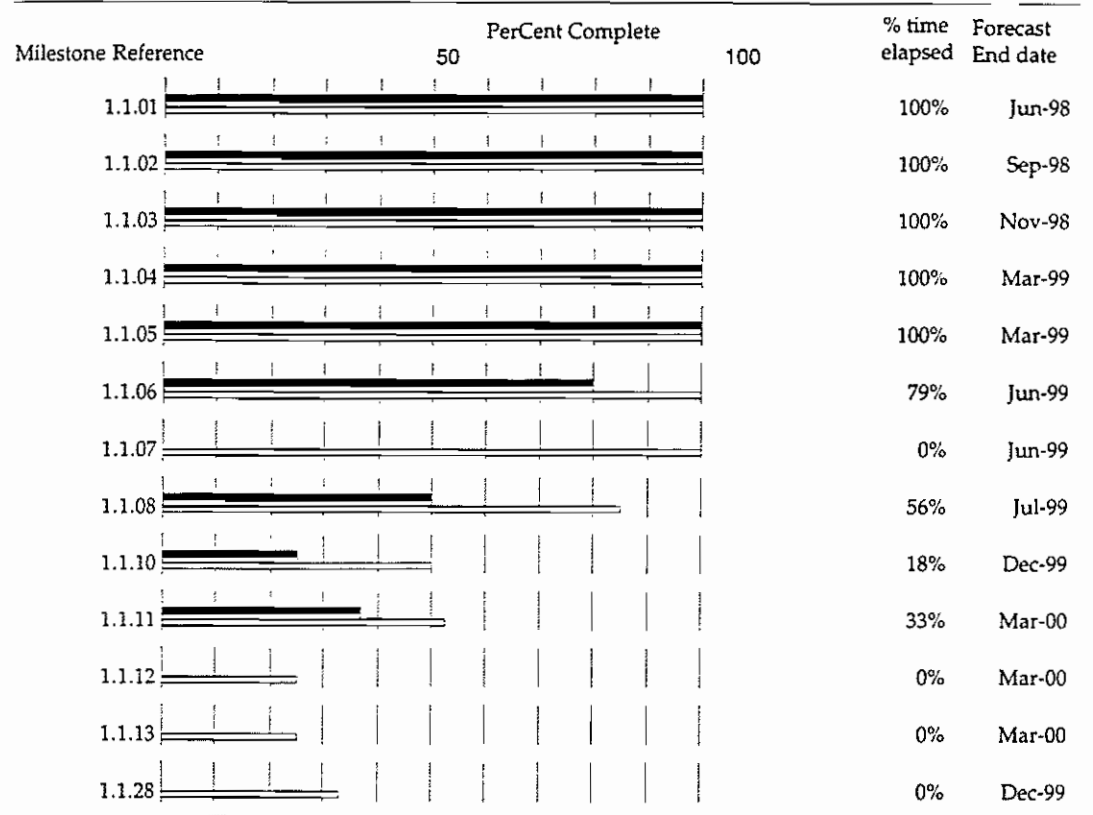
Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

* 1.1.28 Complete comparison of pmd artefact

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
0 % complete	Revised/Actual Finish:	Dec-99

Active and Recently Completed Milestones

Project: QP9811 MAINTENANCE OF FIBRE OPTICS ME



NPL Reference: QP98/S01

Graphs: Page 1 / 12

Actual % complete
 Previous forecast % complete
 Forecast % complete in 3 months time

12-Apr-99

Milestone statistics:

Total number:	9	
Total complete:	3	33%
Total due by: 31-Mar-1999	3	33%
Total due by: 31-Mar-2000	6	67%
Total active:	2	22%
Total not started:	4	44%

** 1.2.1 Survey of distributed ZDW measurement techniques complete and approach iden.

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	May-98
100 % complete	Revised/Actual Finish:	May-98

Three techniques for the measurement of distributed zero dispersion wavelength were identified, which will be investigated under later milestones. These are an mfd based technique, an OTDR gain technique and a four wave mixing technique.

** 1.2.2 Accuracy of techniques for distributed mfd measurement evaluated; report

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Aug-98
100 % complete	Revised/Actual Finish:	Aug-98

A detailed study of distributed measurement of mode field diameter was undertaken. There was good correlation between measurements obtained from OTDR traces and those from far field scan data measured from samples taken along the length of a fibre.

** 1.2.3 Accuracy of techniques for distributed cut-off measurements evaluated; report

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Nov-98
100 % complete	Revised/Actual Finish:	Nov-98

This study has concluded that distributed cut-off wavelength measurements can be made using OTDR techniques with an accuracy comparable to that obtained using the reference test method, providing accurate measurements of the cut-off wavelength are available at one end of the fibre.

* 1.2.4 System for distributed pmd measurement operational; initial measurements made

Current Status:	Planned Start:	May-98
Active or due to start in next 3 months	Planned Finish:	Jun-99
70 % complete	Revised/Actual Finish:	Jun-99

This milestone is on schedule. OTDR techniques are being developed to undertake this measurement. A facility is being developed to provide both the source pulse and fast detection to enable measurement of pmd at a level of approximately 0.1 ps.

* 1.2.5 System for distributed ZDW measurements operational; initial meas. made

Current Status:	Planned Start:	Jun-98
Active or due to start in next 3 months	Planned Finish:	Dec-99
53 % complete	Revised/Actual Finish:	Dec-99

This milestone is progressing well. All equipment required to deliver the milestone has been ordered and work is now commencing to evaluate the three techniques identified in milestone 1.2.1.

1.2.6 Survey of distributed Neff measurement techniques complete and meas app ident

Current Status:	Planned Start:	Aug-99
Not Started	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Feb-00

1.2.7 Accuracy of techniques for distributed pmd measurements evaluated ; report

Current Status:	Planned Start:	Jul-99
Not Started	Planned Finish:	Apr-00
0 % complete	Revised/Actual Finish:	Apr-00

1.2.8 Accuracy of techniques for distributed ZDW measurements evaluated; report

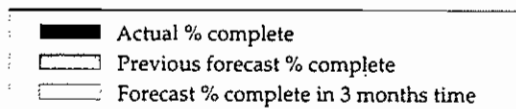
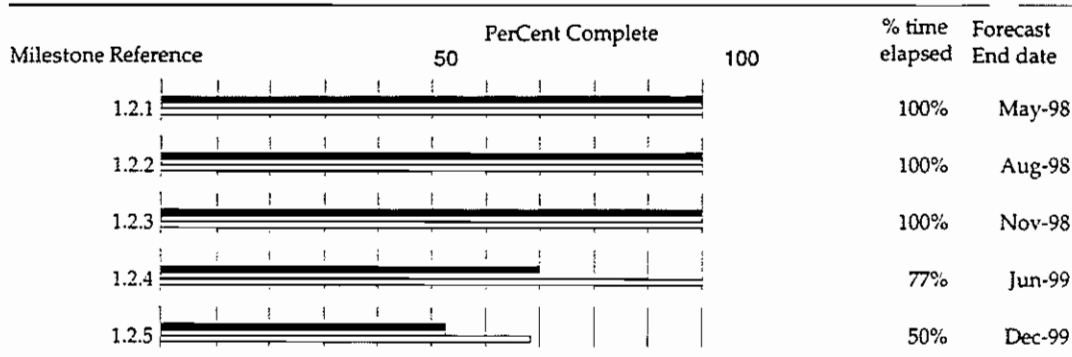
Current Status:	Planned Start:	Jan-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

1.2.9 Accuracy of techniques for distributed Neff measurements evaluated; report

Current Status:	Planned Start:	Aug-99
Not Started	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

Active and Recently Completed Milestones

Project: QP9812 DISTRIBUTED MEASUREMENTS IN FI



Milestone statistics:

Total number:	14	
Total complete:	4	29%
Total due by: 31-Mar-1999	4	29%
Total due by: 31-Mar-2000	8	57%
Total active:	4	29%
Total not started:	6	43%

** 1.3.01 High resolution component characterisation facility developed

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Nov-98
100 % complete	Revised/Actual Finish:	Nov-98

New software has been written for the laser based dispersion measurement system to allow it to be used for high wavelength resolution measurement of passive fibre components. Work on this milestone has also necessitated the characterisation of the power throughput of the dispersion facility.

** 1.3.02 Causes for spectral anomalies in components identified

Current Status:	Planned Start:	Sep-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A detailed study of the spectral characteristics of chromatic dispersion and polarisation mode dispersion of Bragg fibre gratings has been completed. This work has identified a high level of pmd (1 ps) added to a system when using chirped fibre gratings, which could cause system degradation.

** 1.3.03 Development of facility to enable variable multimode launch complete

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A new launch system has been designed and implemented for the monochromator based spectral scan system. This optical system allows variation of both spot size and numerical aperture when launching into a multimode fibre component.

** 1.3.04 System for dispersion in components operating

Current Status:	Planned Start:	Oct-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99
Facility development has been completed. This has included the development of software to enable the characterisation of components. The facility has been tested using dispersion compensating components.		

* 1.3.05 Facility for characterising reflective properties of gratings complete

Current Status:	Planned Start:	Sep-98
Active or due to start in next 3 months	Planned Finish:	Oct-99
50 % complete	Revised/Actual Finish:	Oct-99
This milestone is on schedule. All equipment required to deliver this milestone is now in place, and initial measurements have been made to characterise the dispersion of gratings in reflective mode. These show good agreement with manufacturer specification.		

* 1.3.06 Dispersion system tested, comparison completed

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
0 % complete	Revised/Actual Finish:	Dec-99

* 1.3.07 Complete characterisation of polarisation effects in components

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Feb-00

1.3.08 Measurement service for dispersion in components available

Current Status:	Planned Start:	Jan-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

1.3.09 Complete development of calibration artefact for sm components

Current Status:	Planned Start:	Dec-99
Not Started	Planned Finish:	Jul-00
0 % complete	Revised/Actual Finish:	Jul-00

1.3.10 Experimental investigation of NA/spot size on components complete

Current Status:	Planned Start:	Sep-99
Not Started	Planned Finish:	Jul-00
0 % complete	Revised/Actual Finish:	Jul-00

1.3.11 Customer service for mm fibre components launched

Current Status:	Planned Start:	May-00
Not Started	Planned Finish:	Dec-00
0 % complete	Revised/Actual Finish:	Dec-00

1.3.12 International comparison of golden component complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

1.3.13 Introduction of high resolution service for component characterisation

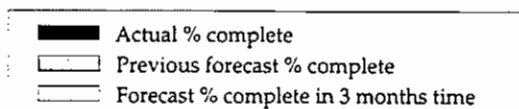
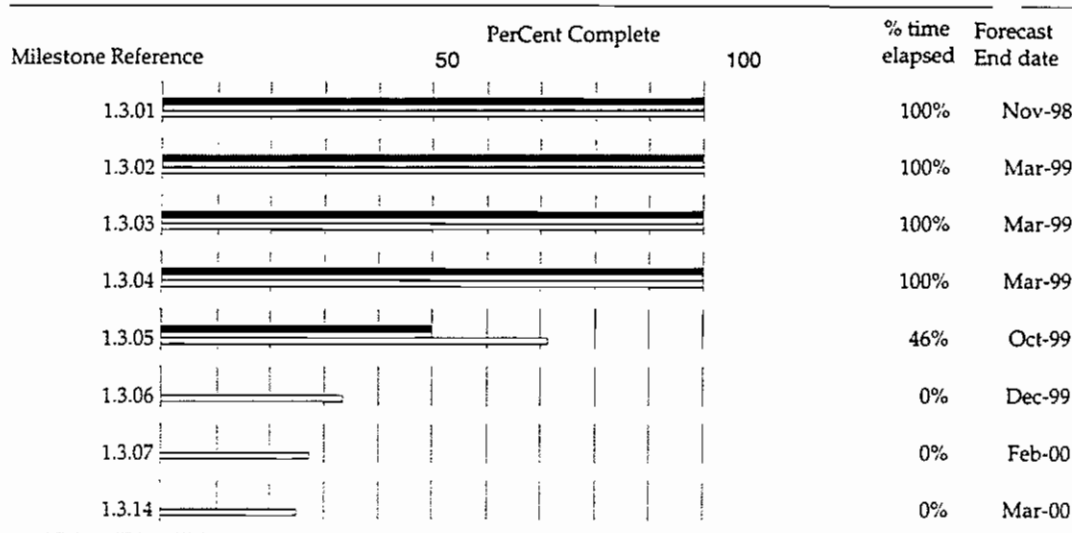
Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

* 1.3.14 Models developed to predict multimode component performance with launch condition

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

Active and Recently Completed Milestones

Project: QP9813 SINGLE MODE & MULTI MODE FIBRE



Project: QP9814 DEVELOPMENT OF NEW TRACEABLE

Manager: A J PARKER

Milestone statistics:

Total number:	2	
Total complete:	0	0%
Total due by: 31-Mar-1999	0	0%
Total due by: 31-Mar-2000	2	100%
Total active:	0	0%
Total not started:	2	100%

1.4.1 Complete consultation exercise to agree and report target uncertainties

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Dec-99
0 % complete	Revised/Actual Finish:	Dec-99

1.4.2 Complete feasibility study of traceability issues associated with different techniques; report

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

Project: QP9821 MAINT OF EQUIP.SOURCE & DETECT

Manager: D A HUMPHREYS

Milestone statistics:

Total number:	32	
Total complete:	11	34%
Total due by: 31-Mar-1999	11	34%
Total due by: 31-Mar-2000	21	66%
Total active:	11	34%
Total not started:	10	31%

**** 2.1.01 Maintenance of traceable standards**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Sep-98
100 % complete	Revised/Actual Finish:	Sep-98

All facilities have been maintained and associated equipment calibrated in accordance with plan. No difficulties were encountered with this facility

**** 2.1.02 Audit of 1.5 um facility**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Sep-98
100 % complete	Revised/Actual Finish:	Sep-98

Facility has been maintained and all equipment recalibrated. No major problems have been encountered on this facility this year.

*** 2.1.03 Maintenance of traceable standards**

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Sep-99
0 % complete	Revised/Actual Finish:	Sep-99

*** 2.1.04 Audit of 1.5 um facility**

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Sep-99
0 % complete	Revised/Actual Finish:	Sep-99

2.1.05 Maintenance of traceable standards

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

2.1.06 Audit of 1.5 um facility

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 2.1.07 Traceability maintained

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Jun-98
100 % complete	Revised/Actual Finish:	Jun-98

Facility has been maintained and all associated equipment calibrated. A UKAS surveillance visit has been completed and accreditation of the service maintained

** 2.1.08 Reference CO source audited

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Sep-98
100 % complete	Revised/Actual Finish:	Sep-98

The reference source has been audited. no problems have been encountered with it this year.

** 2.1.09 Accurate representation of ITU grid: artefact evaluated

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

This milestone was re-scheduled at the six month review of the programme. The ITU artefact has been constructed and audited for performance. The null spacing of the artefact is 100.2 GHz, with absolute point at 193100 GHz. Its insertion loss is approximately -20 dB.

** 2.1.10 Wavelength standard comparison: NIST artefact measured

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Sep-98
100 % complete	Revised/Actual Finish:	Sep-98

Gas cells from both NIST and DFM have been measured at NPL as part of an international comparison of OSA calibration artefacts. These are currently being measured at the other two laboratories.

** 2.1.11 OSA service audited

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Oct-98
100 % complete	Revised/Actual Finish:	Oct-98
This facility has been maintained and all associated equipment calibrated. UKAS accreditation has been achieved for this service, providing a wavelength calibration capability of 34 pm over a spectral range 600 - 1800 nm		

** 2.1.12 Wavemeter traceability maintained and service audited

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Feb-99
100 % complete	Revised/Actual Finish:	Feb-99
The facility has been maintained and all associated equipment calibrated. New data acquisition software has been purchased which has improved the uncertainty associated with the reference wavemeter.		

* 2.1.13 Traceability maintained

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Jun-99
0 % complete	Revised/Actual Finish:	Jun-99

* 2.1.14 Reference CO source audited

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Sep-99
0 % complete	Revised/Actual Finish:	Sep-99

* 2.1.15 OSA service audited

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
0 % complete	Revised/Actual Finish:	Dec-99

* 2.1.16 Wavemeter traceability maintained and service audited

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

2.1.17 Traceability maintained

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

2.1.18 Reference CO source audited

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

2.1.19 OSA service audited

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

2.1.20 Wavemeter traceability maintained and service audited

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 2.1.21 Audit of OTDR system

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

This facility has been maintained and all associated equipment calibrated. UKAS accreditation for this service has been maintained. The OTDR has been calibrated at 20 km length.

* 2.1.22 Audit of OTDR system

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

2.1.23 Multimode attenuation coefficient uniformity service for OTDR calibration available

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

2.1.24 Audit of OTDR system

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 2.1.31 Audit of power meter facility complete

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Audit complete and all associated calibrations undertaken. This facility has been successfully moved to improved laboratory accommodation and UKAS accreditation maintained.

** 2.1.32 Fulfill power meter requirements under EUROMET

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

The traceability for Switzerland for optical fibre power meter calibration has been extended this year. In particular, linearity measurements have been performed for OFMET. The Swiss have purchased InGaAs standards as part of this agreement.

* 2.1.33 Uncertainty in fibre optic power meter calibration reduced, target 0.5%

Current Status:	Planned Start:	Apr-98
Active or due to start in next 3 months	Planned Finish:	Aug-99
71 % complete	Revised/Actual Finish:	Aug-99

The milestone is on schedule. The 14BT system for the calibration of working standards is being updated. Investigation of the existing uncertainty budget of this system identified the need for higher specification electronics to be installed in the detection circuit. New adaptors are being designed for the integrating sphere standards to continue the investigation into inter-reflections between fibre ends and the back of the spheres.

* 2.1.34 Audit of power meter facility complete

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 2.1.35 Fulfill power meter requirements under EUROMET

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 2.1.36 Extend power meter linearity to high powers, +27dBm target

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

2.1.37 Audit of power meter facility complete

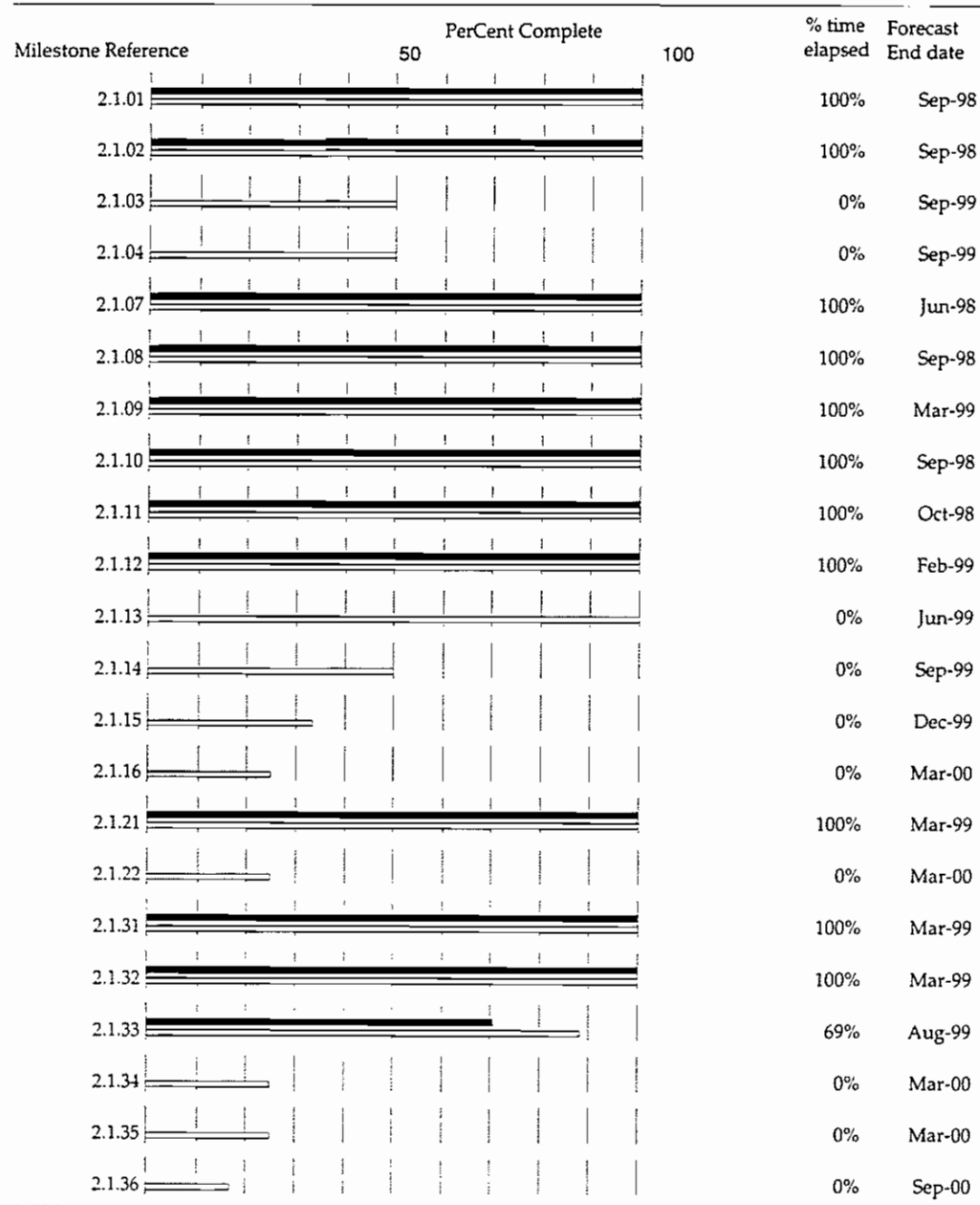
Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

2.1.38 Fulfill power meter requirements under EUROMET

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

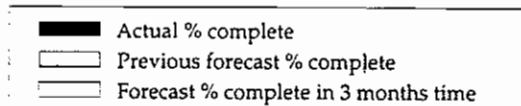
Active and Recently Completed Milestones

Project: QP9821 MAINT OF EQUIP SOURCE & DETECT



NPL Reference: QP98/501

Graphs: Page 5 / 12



12-Apr-99

Manager: M C WICKS

Milestone statistics:

Total number:	11	
Total complete:	3	27%
Total due by: 31-Mar-1999	3	27%
Total due by: 31-Mar-2000	6	55%
Total active:	4	36%
Total not started:	4	36%

**** 2.2.01 Amplifier noise measurement system operating**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Apr-98
100 % complete	Revised/Actual Finish:	Apr-98

Both the optical and electrical techniques for noise measurement have been evaluated. Whilst the electrical technique provides more complete data for analogue application, it is difficult to implement. The optical technique may well be suitable for most digital applications.

**** 2.2.02 Amplifiers tested prior to intercomparison**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	May-98
100 % complete	Revised/Actual Finish:	May-98

Two amplifiers were measured for gain and noise figure at NPL prior to the intercomparison. In addition some environmental testing of the amplifiers was undertaken, which indicated an anomaly for one of the amps. In order to provide power traceability for the intercomparison, a power meter was also calibrated up to a power level of +15 dBm.

**** 2.2.03 Amplifier gain system operating**

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	May-98
100 % complete	Revised/Actual Finish:	May-98

A facility to characterise the gain of amplifiers has been implemented. This enables the measurement of gain to an accuracy of better than 0.2 dB.

* 2.2.04 Results of intercomparison analysed, report

Current Status:	Planned Start:	Jul-98
Active or due to start in next 3 months	Planned Finish:	Apr-99
90 % complete	Revised/Actual Finish:	Apr-99

All results have been received for the FAME intercomparison and analysis of the results is well advanced. Agreement between participants for gain measurement is better than 0.5 dB and for noise figure better than 1.0 dB.

2.2.05 System for the measurement of non linear parameters finalised

Current Status:	Planned Start:	Jul-99
Not Started	Planned Finish:	Dec-99
0 % complete	Revised/Actual Finish:	Dec-99

* 2.2.06 Noise measurement system evaluated

Current Status:	Planned Start:	Jan-99
Active or due to start in next 3 months	Planned Finish:	Nov-99
27 % complete	Revised/Actual Finish:	Nov-99

Purchase of equipment to undertake the evaluation is now complete.

* 2.2.07 Measurement service for amplifier gain launched

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Apr-00
0 % complete	Revised/Actual Finish:	Apr-00

* 2.2.08 Measurement service for amplifier noise launched

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Apr-00
0 % complete	Revised/Actual Finish:	Apr-00

2.2.09 Gain slope measurement system evaluated

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Jul-00
0 % complete	Revised/Actual Finish:	Jul-00

2.2.10 Measurement service for gain slope launched

Current Status:	Planned Start:	Jul-00
Not Started	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

Project: QP9822

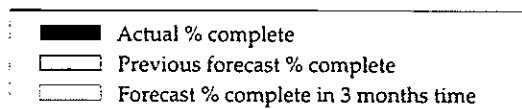
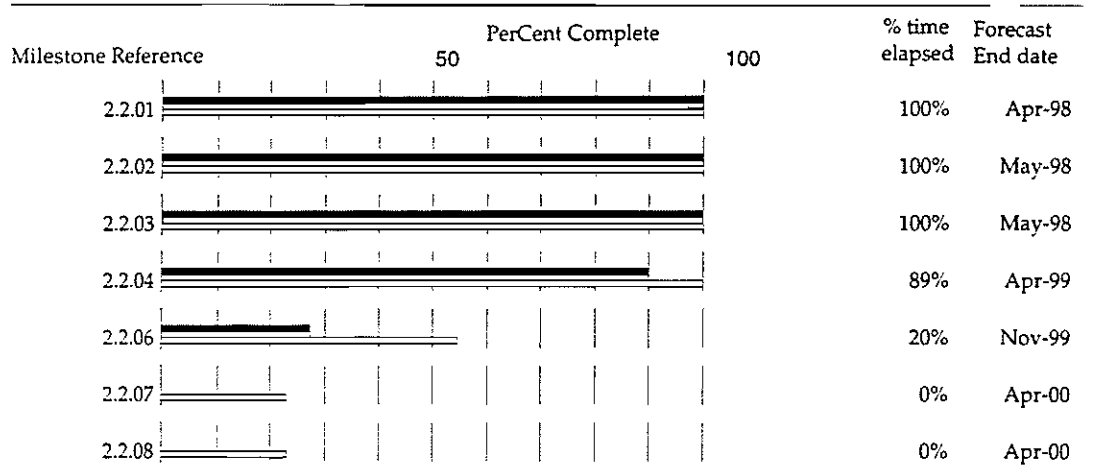
CHARACTERISATION OF FIBRE OPTI

2.2.11 measurement system for non linear parameters evaluated

Current Status:	Planned Start:	Jan-00
Not Started	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

Active and Recently Completed Milestones

Project: QP9822 CHARACTERISATION OF FIBRE OPTI



Milestone statistics:

Total number:	7	
Total complete:	2	29%
Total due by: 31-Mar-1999	2	29%
Total due by: 31-Mar-2000	3	43%
Total active:	3	43%
Total not started:	2	29%

** 3.1.1 Study on industrial requirements for standards for new displays complete; report

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Oct-98
100 % complete	Revised/Actual Finish:	Oct-98

This study has been completed and a report sent to NMSPU. The study has concluded that there is a lack of awareness across industry of measurement protocols and standards for displays and that enhanced knowledge transfer between the NMS and the industry is required.

** 3.1.2 Maintenance of standards for colorimetry of visual displays

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

The annual audit of the calibration facilities has been completed with all associated equipment calibrated, including the calibration of the luminance standard.

* 3.1.3 Maintenance of standards for colorimetry of visual displays

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 3.1.4 Develop tunable transfer standard sources

Current Status:	Planned Start:	Apr-00
Active or due to start in next 3 months	Planned Finish:	Jan-01
0 % complete	Revised/Actual Finish:	Dec-00

3.1.5 Maintenance of standards for colorimetry of visual displays

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

* 3.1.6 Construct and commission measurement facility for miniature displays

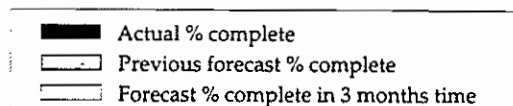
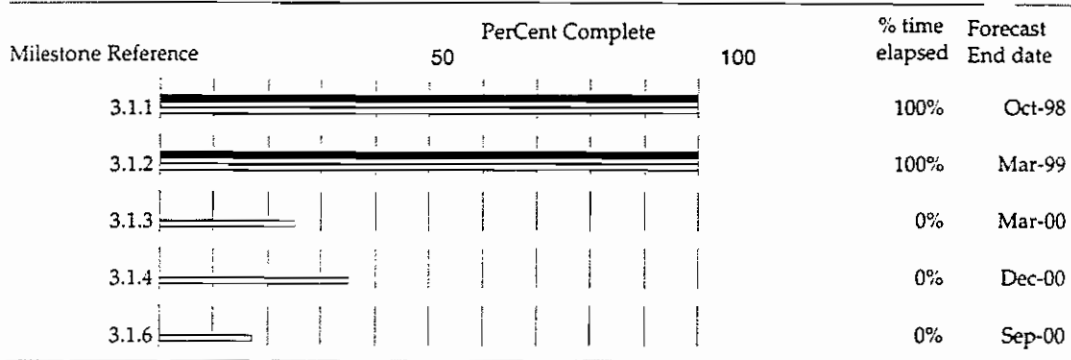
Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Sep-00
0 % complete	Revised/Actual Finish:	Sep-00

3.1.7 Develop suitable transfer standards for miniature displays

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

Active and Recently Completed Milestones

Project: QP9831 MEASUREMENT REQUIREMENTS FOR D



Milestone statistics:

Total number:	7		
Total complete:	0	0%	
Total due by: 31-Mar-1999	0	0%	
Total due by: 31-Mar-2000	2	29%	
Total active:	0	0%	
Total not started:	7	100%	

3.2.1 Development of techniques to characterise the RI of photonic components complete

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

3.2.2 Maintenance of visible and infrared refractometry services

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

3.2.3 Complete study of systematic uncertainties

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Aug-00
0 % complete	Revised/Actual Finish:	Aug-00

3.2.4 Measurement service for refractive index of photonic components available

Current Status:	Planned Start:	Aug-00
Not Started	Planned Finish:	Oct-00
0 % complete	Revised/Actual Finish:	Oct-00

3.2.5 Complete investigations of alternative sources for refractometry

Current Status:	Planned Start:	Oct-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

3.2.6 Complete investigation of non-geometric methods for refractometry

Current Status:	Planned Start:	Oct-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

3.2.7 Maintenance of visible and infrared refractometry services

Current Status:	Planned Start:	Oct-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

Milestone statistics:

Total number:	26	
Total complete:	9	35%
Total due by: 31-Mar-1999	9	35%
Total due by: 31-Mar-2000	18	69%
Total active:	8	31%
Total not started:	9	35%

** 4.1.01 Participate in high level national and international committees

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

NPL has had input into CCPR on fibre related issues, and has been involved in the setting up of a Photonics working group under CCPR; has completed the EUROMET project on fibre optic power meters and has been instrumental in developing in conjunction with UKAS an intercomparison of European accredited laboratories in the area of power meters.

** 4.1.02 Organise, promote and participate in OFMeC

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Two OFMeC meetings have been held this year. This forum has been used to disseminate results from COST projects and international standardisation issues to UK industry. It has also provided useful steer on the direction of projects in the programme in general. OFMeC has also implemented a "current Status of Fibre Measurements" document, providing industry's view of future needs.

** 4.1.03 Deal with at least 60 technical enquiries

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Over 150 enquiries have be dealt with by scientist this year, more than doubling the milestone target.

** 4.1.04 At least on article in an industrially focused publication

Current Status:	Planned Start:	Apr-98
Completed Early	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Jan-99

A number of articles on NPL's display capabilities have appeared in trade journals

** 4.1.05 Participate on a photonics related exhibition

Current Status:	Planned Start:	Apr-98
Completed Early	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Jan-99

The Photonics programme participated in two exhibitions this year, CLEO 98 and OFC 99. These exhibitions generated approximately 70 enquiries. New stand graphics and a rolling power point presentation was developed for these exhibitions.

** 4.1.06 Input into Photonics Link newsletter and conference

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Articles have appeared in the DTA newsletter, developed under the Photonics Link programme. A presentation of the Photonic Metrology capability and future direction is being prepared for the Photonics Link conference.

** 4.1.07 Maintain links with NMS partnership programme

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A number of meetings have been held with the NMP programme secretariat, to discuss linkages.

** 4.1.08 Annual report on the effectiveness of technology transfer

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A report covering the year 1998/99 has been written and forwarded to NMSPU.

* 4.1.09 Organise, promote and participate in OFMeC

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.10 Participate in high level national and international committees

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.11 Deal with at least 60 technical enquiries

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.12 At least on article in an industrially focused publication

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.13 Participate on a photonics related exhibition

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.14 Input into Photonics Link newsletter and conference

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.15 Maintain links with NMS partnership programme

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

4.1.16 Hold fibre measurement training course

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.1.17 Annual report on the effectiveness of technology transfer

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

4.1.18 Participate in high level national and international committees

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.19 Organise, promote and participate in OFMeC

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.20 Deal with at least 60 technical enquiries

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.21 At least on article in an industrially focused publication

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.22 Participate on a photonics related exhibition

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.23 Input into Photonics Link newsletter and conference

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.24 Maintain links with NMS partnership programme

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.1.25 Annual report on the effectiveness of technology transfer

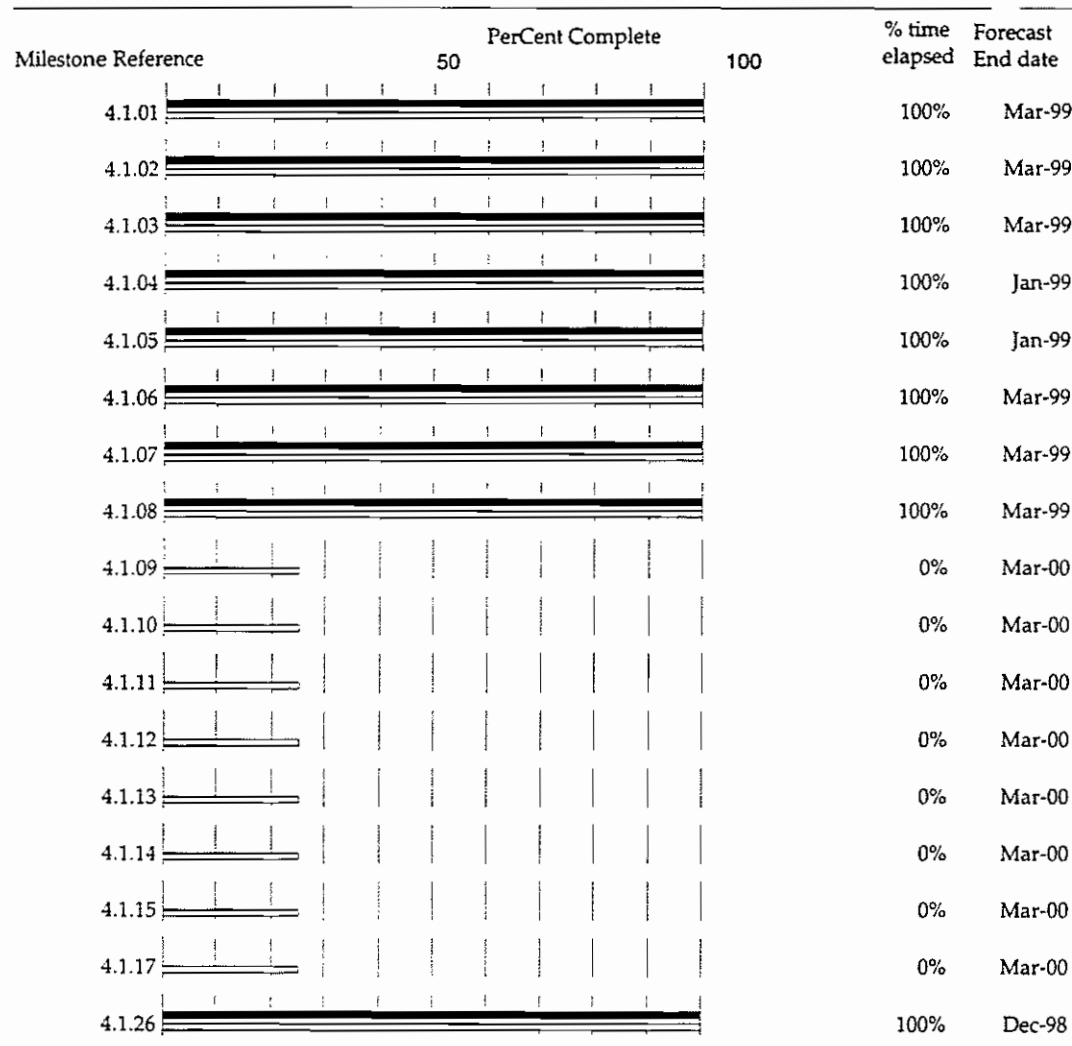
Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 4.1.26 Produce Photonics Metrology Programme brochure

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Dec-98
100 % complete	Revised/Actual Finish:	Dec-98

Active and Recently Completed Milestones

Project: QP9841 PROGRAMME WIDE TECHNOLOGY TRAN



Milestone statistics:

Total number:	7	
Total complete:	3	43%
Total due by: 31-Mar-1999	3	43%
Total due by: 31-Mar-2000	5	71%
Total active:	2	29%
Total not started:	2	29%

** 4.2.1 Complete good practice guide on calibration of OTDRs

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A good practice guide on the use of OTDRs is now available. It outlines the uses and calibration of OTDRs. It has been developed in conjunction with members of OFMEC.

** 4.2.2 Participate in national and international committees including COST, IEC and BSI

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Work on standards committees has continued. This year has seen the completion of the OTDR return loss calibration document, and the geometry document developed under ITU. A rationalisation of the input to BSI has also been agreed, which will improve UK commenting on international documentation. COST 241 has been completed and a final report for this action prepared for the commission. A follow on action COST 265 is now underway.

** 4.2.3 At least 4 papers submitted or lectures given

Current Status:	Planned Start:	Apr-98
Completed Early	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Jan-99

Three papers were presented at the Boulder Symposium. Five presentations have been given on display measurement. The optical fibre measurement conference has been run additionally this year

* 4.2.4 Participate in national and international committees including COST, IEC and BSI

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

* 4.2.5 At least 4 papers submitted or lectures given

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

4.2.6 Participate in national and international committees including COST, IEC and BSI

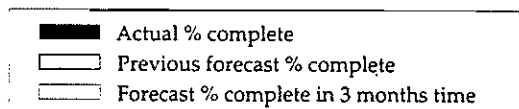
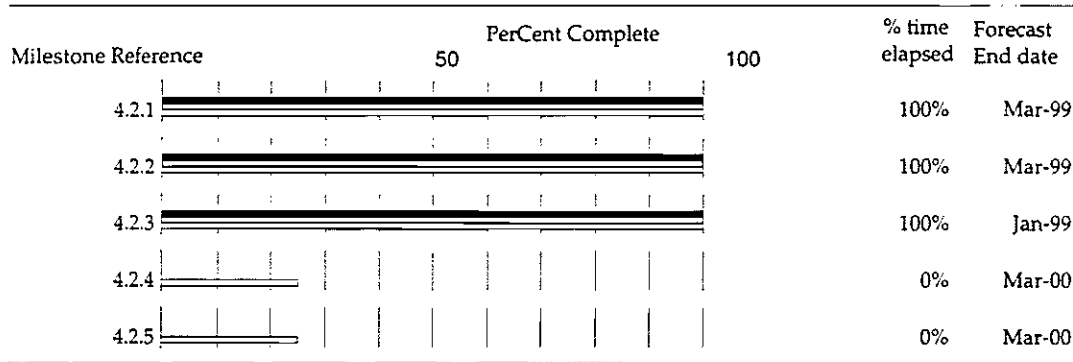
Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

4.2.7 At least 4 papers submitted or lectures given

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

Active and Recently Completed Milestones

Project: QP9842 PROJECT SPECIFIC TECHNOLOGY TR



Project: QP9851 PROGRAMME MANAGEMENT

Manager: J M BENSON

Milestone statistics:

Total number:	22	
Total complete:	6	27%
Total due by: 31-Mar-1999	6	27%
Total due by: 31-Mar-2000	13	59%
Total active:	7	32%
Total not started:	9	41%

**** 5.1.01 Quaterly invoices prepared and sent to NMSPU**

Current Status:	Planned Start:	Jul-98
Completed on Schedule	Planned Finish:	Feb-99
100 % complete	Revised/Actual Finish:	Feb-99

Four invoice reports completed

*** 5.1.02 Quaterly invoices prepared and sent to NMSPU**

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Feb-00

5.1.03 Quaterly invoices prepared and sent to NMSPU

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Feb-01
0 % complete	Revised/Actual Finish:	Feb-01

5.1.04 Quaterly invoices prepared and sent to NMSPU

Current Status:	Planned Start:	Feb-01
Not Started	Planned Finish:	May-01
0 % complete	Revised/Actual Finish:	May-01

* 5.1.05 1st annual report prepared and sent to NMSPU

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Jun-99
0 % complete	Revised/Actual Finish:	Jun-99

First annual report completed ahead of schedule.

5.1.06 2nd annual report prepared and sent to NMSPU

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

5.1.07 3rd annual report prepared and sent to NMSPU

Current Status:	Planned Start:	Jan-01
Not Started	Planned Finish:	Jun-01
0 % complete	Revised/Actual Finish:	Jun-01

** 5.1.08 6 month review

Current Status:	Planned Start:	Nov-98
Completed on Schedule	Planned Finish:	Nov-98
100 % complete	Revised/Actual Finish:	Nov-98

Successful six month review held

* 5.1.09 1st annual review

Current Status:	Planned Start:	Jun-99
Active or due to start in next 3 months	Planned Finish:	Jun-99
0 % complete	Revised/Actual Finish:	Jun-99

First annual review scheduled for 5 May

5.1.10 2nd annual review

Current Status:	Planned Start:	Jun-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

** 5.1.11 3 programme review meetings with project managers

Current Status:	Planned Start:	Jul-98
Completed on Schedule	Planned Finish:	Feb-99
100 % complete	Revised/Actual Finish:	Feb-99

Programme and project review meetings held with project managers and project staff.

* 5.1.12 4 programme review meetings with project managers

Current Status:	Planned Start:	May-99
Active or due to start in next 3 months	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Feb-00

5.1.13 5 programme review meetings with project managers

Current Status:	Planned Start:	May-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 5.1.14 Management of staff and facilities - year 1

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

All staff and facility resources maintained

* 5.1.15 Management of staff and facilities - year 2

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

5.1.16 Management of staff and facilities - year 3

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 5.1.17 Management of contracts in 1st year

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

Two visits to DERA have been completed to monitor progress on the RIN and Chirp maintenance project.

* 5.1.18 Management of contracts in 2nd year

Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

5.1.19 Management of contracts in 3rd year

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Mar-01
0 % complete	Revised/Actual Finish:	Mar-01

** 5.1.20 Design review at start of programme

Current Status:	Planned Start:	Apr-98
Completed on Schedule	Planned Finish:	Jun-98
100 % complete	Revised/Actual Finish:	Jun-98

Design review held with project managers. No serious technical or resource issues identified.

* 5.1.21 Design review 2nd year

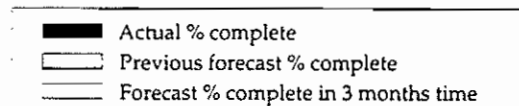
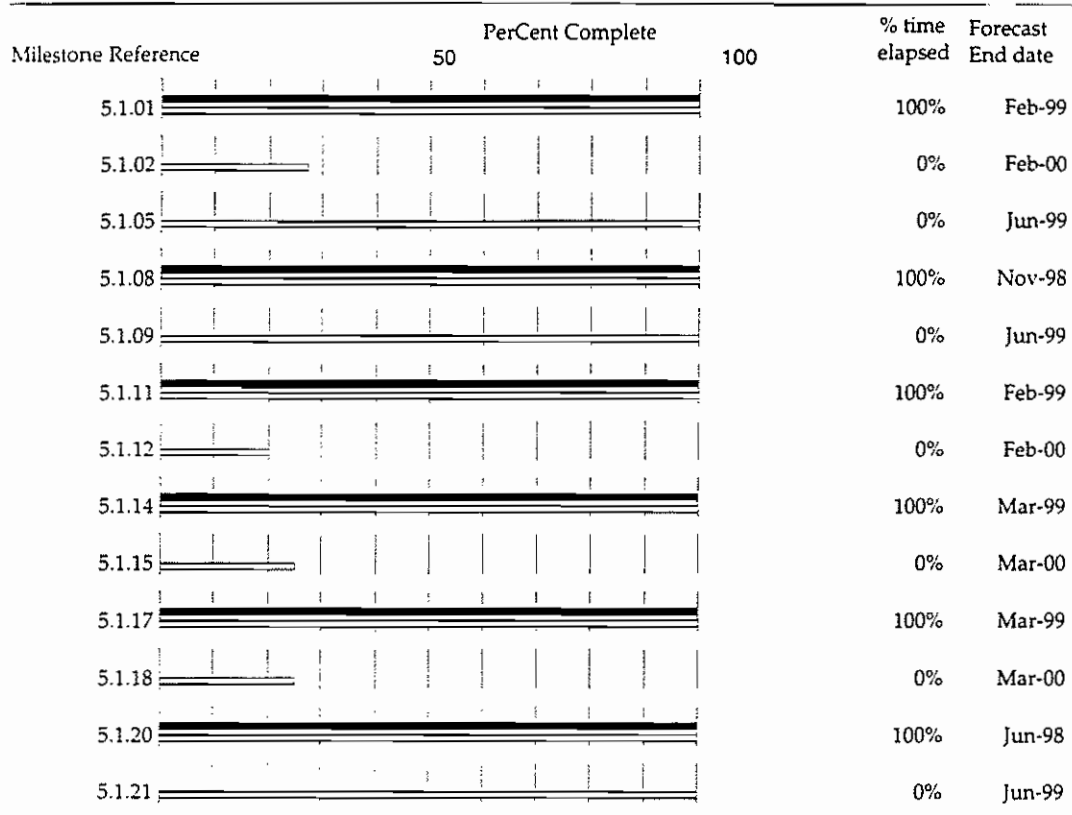
Current Status:	Planned Start:	Apr-99
Active or due to start in next 3 months	Planned Finish:	Jun-99
0 % complete	Revised/Actual Finish:	Jun-99

5.1.22 Design review 3rd year

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

Active and Recently Completed Milestones

Project: QP9851 PROGRAMME MANAGEMENT



Milestone statistics:

Total number:	8	
Total complete:	0	0%
Total due by: 31-Mar-1999	0	0%
Total due by: 31-Mar-2000	2	25%
Total active:	2	25%
Total not started:	6	75%

* 5.2.1 Complete orientation phase

Current Status:	Planned Start:	Dec-98
Active or due to start in next 3 months	Planned Finish:	Dec-99
31 % complete	Revised/Actual Finish:	Dec-99

Some early discussions with the Scottish Optoelectronics Association have been started, but formulation will not start in earnest until Autumn 99.

5.2.2 Consultation complete

Current Status:	Planned Start:	Sep-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

5.2.3 1st draft of the programme complete

Current Status:	Planned Start:	Apr-00
Not Started	Planned Finish:	May-00
0 % complete	Revised/Actual Finish:	May-00

* 5.2.4 Studies complete

Current Status:	Planned Start:	Jan-99
Active or due to start in next 3 months	Planned Finish:	Jun-00
17 % complete	Revised/Actual Finish:	Jun-00

5.2.5 Public consultation document complete

Current Status:	Planned Start:	Jun-00
Not Started	Planned Finish:	Jul-00
0 % complete	Revised/Actual Finish:	Jul-00

5.2.6 Final draft of programme with milestones complete

Current Status:	Planned Start:	Aug-00
Not Started	Planned Finish:	Oct-00
0 % complete	Revised/Actual Finish:	Oct-00

5.2.7 Appraisal meeting held

Current Status:	Planned Start:	Nov-00
Not Started	Planned Finish:	Nov-00
0 % complete	Revised/Actual Finish:	Nov-00

5.2.8 Complete programme modifications after appraisal

Current Status:	Planned Start:	Dec-00
Not Started	Planned Finish:	Dec-00
0 % complete	Revised/Actual Finish:	Dec-00

Active and Recently Completed Milestones

Project: QP9852 PROGRAMME FORMULATION

Milestone Reference	PerCent Complete							% time elapsed	Forecast End date
	50						100		
5.2.1								25%	Dec-99
5.2.4								12%	Jun-00

NATIONAL PHYSICAL LABORATORY

CONTRACT ANNUAL REPORT:

March 1999

METROLOGY FOR NON-LINEAR PHOTO

Customer Contract Reference: MPU 8/52.2

Contract start date: 01-Sep-98 Contract end: 31-Mar-01

Contract type: D T I COMPETITIVE

Contract value: £270,000

NPL reference: QP98/C01

NPL manager: J M BENSON

Milestone statistics:

Total number:	19	
Total complete:	3	16%
Total due by: 31-Mar-1999	3	16%
Total due by: 31-Mar-2000	12	63%
Total active:	7	37%
Total not started:	9	47%

Milestone statistics:

Total number:	19	
Total complete:	3	16%
Total due by: 31-Mar-1999	3	16%
Total due by: 31-Mar-2000	12	63%
Total active:	7	37%
Total not started:	9	47%

** 1.5.01 FWM Paper study

Current Status:	Planned Start:	Oct-98
Completed on Schedule	Planned Finish:	Jan-99
100 % complete	Revised/Actual Finish:	Jan-99

A report has been produced which outlines the metrological uses of four wave mixing, as well as detailing the system implications of the effect.

** 1.5.02 Report of the results of the survey of users and developers

Current Status:	Planned Start:	Oct-98
Completed on Schedule	Planned Finish:	Feb-99
100 % complete	Revised/Actual Finish:	Feb-99

This study has been completed and a report on the conclusions produced. This study confirms both the current and future requirement for measurement services for non-linear effects in fibres and clarifies the requirements for the non-linear refractive index service

** 1.5.03 Any changes to Services agreed by NMSPU

Current Status:	Planned Start:	Feb-99
Completed on Schedule	Planned Finish:	Mar-99
100 % complete	Revised/Actual Finish:	Mar-99

A requirement for a service for n_2/A_{eff} rather than n_2 has been identified. This will be confirmed with NMSPU at the Annual Review.

* 1.5.04 Report to NMSPU on measurement methods for SBS and SRS

Current Status:	Planned Start:	Jan-99
Active or due to start in next 3 months	Planned Finish:	May-99
60 % complete	Revised/Actual Finish:	May-99

A paper survey of current techniques for the characterisation of these parameters is underway in conjunction with Imperial College.

* 1.5.05 Evaluation completed and preferred approach for AeFF chosen

Current Status:	Planned Start:	Dec-98
Active or due to start in next 3 months	Planned Finish:	Jul-99
49 % complete	Revised/Actual Finish:	Jul-99

Measurements of AeFF are being undertaken using three techniques - far field scan, variable aperture and near field scan. Software to provide the required transforms to data is being developed.

* 1.5.06 Details of AeFF comparison available as Web page

Current Status:	Planned Start:	Jun-99
Active or due to start in next 3 months	Planned Finish:	Jul-99
0 % complete	Revised/Actual Finish:	Jul-99

* 1.5.07 AeFF facility available at NPL

Current Status:	Planned Start:	Jun-99
Active or due to start in next 3 months	Planned Finish:	Sep-99
0 % complete	Revised/Actual Finish:	Sep-99

* 1.5.08 n2 system available at NPL

Current Status:	Planned Start:	Mar-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
10 % complete	Revised/Actual Finish:	Dec-99

Equipment purchases for this milestone have been initialised.

* 1.5.09 Report experimental investigations of FWM

Current Status:	Planned Start:	Jan-99
Active or due to start in next 3 months	Planned Finish:	Dec-99
37 % complete	Revised/Actual Finish:	Dec-99

Facilities are currently being put together to enable the characterisation of four wave mixing effects.

1.5.10 SBS system available at NPL

Current Status:	Planned Start:	Sep-99
Not Started	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Jan-00

1.5.11 Report experimental investigations of SBS

Current Status:	Planned Start:	Sep-99
Not Started	Planned Finish:	Feb-00
0 % complete	Revised/Actual Finish:	Jan-00

1.5.12 SRS facilities available at NPL

Current Status:	Planned Start:	Oct-99
Not Started	Planned Finish:	Mar-00
0 % complete	Revised/Actual Finish:	Mar-00

1.5.13 SRS facilities verified against high-power system

Current Status:	Planned Start:	Sep-99
Not Started	Planned Finish:	Jun-00
0 % complete	Revised/Actual Finish:	Jun-00

1.5.14 n2 and Aeff Services ready for UKAS accreditation

Current Status:	Planned Start:	Feb-00
Not Started	Planned Finish:	Oct-00
0 % complete	Revised/Actual Finish:	Oct-00

1.5.15 SBS/SRS facilities ready for UKAS assessment

Current Status:	Planned Start:	Feb-00
Not Started	Planned Finish:	Nov-00
0 % complete	Revised/Actual Finish:	Nov-00

1.5.16 n2 and Aeff Services available for customers

Current Status:	Planned Start:	Jun-00
Not Started	Planned Finish:	Dec-00
0 % complete	Revised/Actual Finish:	Dec-00

Project: QP9815A1 COMP:MEAS OF NON-LINEAR PROP O

1.5.17 Intercomparison of measurement methods complete

Current Status:	Planned Start:	Jun-00
Not Started	Planned Finish:	Feb-01
0 % complete	Revised/Actual Finish:	Feb-01

1.5.18 Measurement facility for SRS gain profile and SRS/SBS thresholds

Current Status:	Planned Start:	Jun-00
Not Started	Planned Finish:	Feb-01
0 % complete	Revised/Actual Finish:	Feb-01

* 1.5.19 User guide available as Web Pages

Current Status:	Planned Start:	Feb-99
Active or due to start in next 3 months	Planned Finish:	Feb-01
0 % complete	Revised/Actual Finish:	Feb-01

Active and Recently Completed Milestones

Project: QP9815A1 COMP:MEAS OF NON-LINEAR PROP O

