OFFSHORE TECHNOLOGY
REPORT - OTO 97 809

REVIEW OF NEWCASTLE DIVING
REGISTRY RECORDS

Date of Issue: December 1997

Health and Safety Executive
This report is made available by the Health and Safety Executive as part of a series of reports of work which has been supported by funds provided by the Executive. Neither the Executive, nor the contractors concerned assume any liability for the reports nor do they necessarily reflect the views or policy of the Executive.

Reports in the OTO series can be obtained from HSE Information Services, Information Centre, Broad Lane, Sheffield S3 7HQ Tel: 0541 545500.
Review of
Diving Registry Records
Final Report
August 1994

A. Evans

Department of
Orthopaedic and Traumatic Surgery
University of Newcastle upon Tyne
MaTSU Project 3158

Review of

Diving Registry Records

Final Report August 1994

CONTENTS

1. Background: The Panel, the Registry and the Archives.
2. Residual Primary records for Divers.
3. Records for divers in the computer archive.
4. Residual Primary records for Compressed-air workers.
5. Compressed-air records in the computer archive.
6. Selection of subjects for the present project.
7. Retrieval of divers’ data from the Archives.
8. Retrieval of compressed air workers’ data from the Archives.
9. Verification of the database.
10. Conclusions.
1. Background: The Panel, the Registry and the Archives

Compressed air was introduced to facilitate excavation in waterlogged ground in the middle of the nineteenth century, and continued to be successfully employed in British civil engineering projects for nearly a hundred years with little help from the medical establishment. It was not until the Tyne Pedestrian Tunnel contract of 1948–50 that the Medical Research Council began to be involved. This resulted in the well-known and comprehensive MRC Special Report on the health of the workforce by WDM Paton and DN Walder which appeared in 1954.

During the next decade there was much more civil engineering CA work in Great Britain, particularly cooling-water tunnels for Thames power stations, and in 1956 Paton and Walder were joined by Dr P D Griffiths (medical officer, first Dartford tunnel), Dr Campbell Golding (radiologist) and an MRC representative to form the original MRC Decompression Sickness Panel. This small group met in London every few months to discuss the problems of acute decompression sickness and, increasingly, bone necrosis amongst the thousands of active CA workers. There was plenty of work for the Panel, which expanded to cope, and its members produced comprehensive reports on other high-pressure contracts including the Dartford main drives and other road tunnels beneath the Clyde and the Tyne.

During this period Panel members had collected medical examination and exposure records as well as sets of radiographs from several contracts, and in 1964 the MRC established the Decompression Sickness Central Registry in University premises in Claremont Place in Newcastle upon Tyne under the direction of Professor Walder and Dr Griffiths. The Registry served as the base for the operation of the panel’s group of five radiologists who had published the Classification for Lesions of caisson disease of bone, and who formed agreed opinions on the subtle variations recorded in the many sets of joint radiographs, initially just for the men who dug tunnels and caissons.

When first set up the Registry was intended to gather and conserve paper records and radiological survey films which would be available for analysis largely by hand, the way things had always been done. Due to the enthusiastic cooperation of civil engineering Contractors, by the late nineteen sixties the Registry had become custodian to so many records that some sort of mechanization was becoming essential. With the opening of the new mainframe NUMAC computer system within sight of the registry premises, it made sense to try to transcribe pertinent data to machine-readable form suitable for rapid-access electronic storage, so that analyses could be carried out much more quickly and accurately. Consequently the MRC/HS2 funded, by means of a programme grant, a very large project which started in 1971 (and was to run for a decade) to enable the coding and transfer of the compressed air data. The exercise was subsequently extended to cover the medical and radiological input from professional divers as well.

A dedicated administrative assistant (Mr V B Thickett) was appointed to oversee the work of the band of coders who undertook the onerous task of transcribing data from original records onto especially prepared forms. Batches of these forms were taken for punching and verification (a shadow repunching to check for errors) of IBM cards, which were the standard (and indeed at the time only possible) input route for all Registry datafiles. The cards were then input in batches to the computer system so that the data could be written to our own Private hard Disk.
The second MRC five-year programme grant, which was awarded to cover the period 1976-80 inclusive, brought significant changes to the project. Mr W P Trowbridge, a mathematician, was engaged to oversee the software and datafiles so that considerable improvements could be introduced. The NUMAC computer facility was upgraded to an IBM370/168 mainframe, which permitted files with much longer lines than hitherto. However our private disk facility was withdrawn, which meant that all data had from then on to be held either in public disk space or to be relegated to the slow-access magnetic tape archive. During this second period much new data became available for coding including exposure records from the four drives of the Second Dartford Road tunnel which was being built at the time, as well as full exposure records from the equally large but much earlier Clyde Road Tunnels. A less labour-intensive way of coding the exposure histories of the men was introduced for use with these very large contracts.

The nineteen-seventies also provided a vast increase in another hyperbaric activity of great importance, namely commercial deep-sea diving in connection with oil exploration and production in the North Sea. Divers are also susceptible to the bone lesions which had first been studied in the CA workers, and isolated sets of films began arriving at the Registry for opinions on the state of the bones of men taken at medical examinations for fitness to dive. When the CIRIA Underwater Engineering Group recommended that their annual medical examination, which was already much more comprehensive than that customary for CA workers, should include a bone survey as a matter of course the trickle of radiographs became a flood.

In view of the importance of diving at that time, a considerable proportion of the Registry’s resources was diverted to the new population. Six new kinds of coding form and computer data storage structure were specified (though only four were actually implemented), so that the coders could deal with medical examination, radiological and exposure data from a population which would eventually reach over 9000 professional divers. Inevitably the coding of CA records was delayed, though the opportunity was taken to upgrade their stored bone survey results to include the detail possible with the more comprehensive scheme devised for use with the divers.

By the end of the second five-year MRC funding period, all the extensive Second Dartford main drives and Clyde exposure records had been coded, and most had been punched and entered into the computer. There was no further MRC support for the Registry. During the early 1980s some limited funding came direct from HSE to continue limited surveillance of the divers, though with the death of Mr Thickett and the resignation of Mr Trowbridge the final staff was reduced to Mrs E Taylor (who had been secretary since 1964) and a few part-time coders. Funding was finally discontinued and the Registry closed completely at the end of 1984.

Although it then became necessary to vacate the familiar premises in Claremont Place, all remaining primary paper records and the sets of radiographs for compressed-air workers and for divers were moved in the short term to a disused basement within the RVI. The computer datafiles, which had cost half a million pounds to set up, were relegated to the long-term magnetic tape archive, from which they could be recovered when required again.
2. Residual Primary records for Divers

In the early days, the Registry's first interaction with a diver was from a radiological skeletal survey carried out in association with a man's medical examination for fitness to dive. Most examining doctors realized that they were not competent to detect the subtle early signs of damage to the shoulders, hips and knees characteristic of hyperbaric exposure, and sent their films to Newcastle for input to the well-established radiological opinion service developed by the Panel for the compressed-air men.

As these films often arrived accompanied by just a name, the Registry supplied all examining doctors with a single sheet questionnaire covering some details of training, maximum depth, longest dive, hours in saturation etc so that the deck and harbour men could be distinguished from the sat divers who might have been to 200+ metres. Thus the earliest records for divers consisted of a set of films, the agreed radiological diagnosis by two of the radiological assessors (settled by a third opinion in case of dispute) on the state of the man's major joints shown by the examination, and this cursory summary of the man's hyperbaric career to date.

This information was entered by hand to a substantial 6x4 inch card index, which still exists. Each subject has a white identification card with the results of all dated radiological surveys of his major joints. In addition there will be a green (later pink) card with dated experience summaries derived from the accompanying questionnaires.

With the introduction of the standard CIRIA/UEG forms for the medical examination of divers- forms which had been sponsored by the Panel and designed to facilitate computer storage- the flow of information greatly increased, as one copy of the examining doctor's form and of the man's extended questionnaire were designated to be sent to the Registry in Newcastle. Not only did this mean that the data would be available for research, but also that each medical examiner could be certain where they could obtain details of a man's previous findings if there was some query with a current examination. Furthermore most of the sets of radiographs which were specified to accompany the annual examination continued to be seen by the experienced readers coordinated by the Registry, so the input of radiological results increased as well. Thus in its heyday the Registry was processing the medical, radiological and diving histories for many thousands of divers each year.

Following the cessation of funding at the end of 1984, some of the originals were dispersed. The radiographs were offered back to the originating examining doctors, many of whom accepted them and so they should still have them. Of those which were not required, some earlier duplicate sets of films from men whose bones had repeatedly been demonstrated to be normal were destroyed to recover the silver. The remainder were neatly boxed for retention in alphabetical order, and these remain on site in excellent condition. Clearly however the films which survive in Newcastle represent only a fraction of the collection at its peak.

The individual divers' personal folders, which will contain their CIRIA/UEG medical examination copy sheets as well as any experience summary sheets which came with early sets of films, were all removed some years after Registry closure by HSE for safe-keeping on Merseyside. The only divers' primary paper records which are immediately available are the examining doctors' copies of medical examinations which were conducted by members of the hyperbaric team in Newcastle. Fortunately the complete twin card index with 9255 entries, which is a substantial secondary source, remains intact and was available at the commencement of the present study.
3. Records for divers in the computer archive

Archive records are derived from IBM 80 column card images, many of which remain today much as they were input, except for the means of identification. Where names were specified on the original cards (D1, D4 and D6), to comply with data protection legislation and maximise the confidentiality of personal medical details, all names were stripped out prior to electronic storage leaving records identified only by a subject number which was assigned by the Registry. When the computer project started, about 2500 divers were known. They were all assigned numbers from 50001 (to avoid possible duplication with the CA men) in alphabetical order. Subsequent accessions were numbered as they presented, until by closure the identifiers had reached 59381.

There are four principal series of record for divers. These are:

A. Medical Details: the D1 files. These are derived from the UEG medical examination form, and specify for each dated examination date of birth, gender, anthropomorphic details (height, weight, 4 skinfold thicknesses) and some functional data such as blood pressures, PCV, FEV1/FVC, and resting heart-rate. In addition they give confirmation that the examining doctor was satisfied with the condition of nine nominated subsystems and an Exercise Tolerance Test, and had pronounced the examinee fit to dive. These examinations tend to recur at intervals of about a year. There are 25930 of these entries in the D1 files.

B. Radiological Surveys: the D2 files. These document the agreed results of dated radiological surveys of the shoulders, hips and knees, usually made in connection with an annual medical examination. Where the result is other than “normal” the individual state of each upper humerus, upper femur, lower femur and upper tibia on each side (total 8 sites) is specified in considerable detail. There are 20502 entries in the D2 files.

C. Abbreviated experience summary: the D4 files. These records were prepared from the diving summary questionnaires, and after training and present employer information specify in detail the depth and duration of the subject's longest dive and their deepest dive, together with summaries of duration and number of dives beyond 152m and 50m. The D4 should also give the number and total duration of saturation dives and number of DCS events (types I and II quoted separately). The D4 files have 28731 entries.

D. Full medical and experience summary: the D6 files. This provides a more detailed summary of the subject’s diving experience, both in the preceding year and for life to date, and also binary answers to the 33 health-related questions which appear on the UEG divers' questionnaire. The D6 file has a higher information content, being derived from two card images per entry, than any of the other divers files, though there is considerable overlap with the D4 files. There are 15081 entries in the D6 files, covering subjects from 50003 to 59381.

After the final data entry in 1984 nothing was wasted as all of the Registry files, including those for divers, were relegated to the NUMAC magnetic tape archive for long-term storage. In August 1992 the IBM-based MTS operating system was finally discontinued in Newcastle, and replaced by the present distributed unix system. To provide continuity, a special system of transitapes was set up before the change to allow archived data to be retained electronically and readable into the new system. All of the aforementioned divers’ datafiles (10 D1 files, 5 D2files, 10 D4 files and the D6 files) were specified for retention and have all been successfully retrieved into the new unix environment for the present project.
4. Residual Primary records for Compressed-air workers.

The original documentation from compressed-air work covers the same three areas as for the divers—namely medical and radiological examinations for fitness and details of work undertaken. However in this last category there is no equivalent to the man's annual summary. Either each exposure at a contract is logged in fine detail, or there is no record.

The location and medical examination records vary widely from a simple list of the names of men examined by some unknown GP at a remote site to work at a particular contract, to the exhaustive medicals of standard similar to those for divers administered to men presenting at the Second Dartford Tunnel. Some sort of medical card was usually produced, and where these are held they will be stored together with any other examination records and personalized data in a folder specific to that man (there being no female CA workers). These folders, which preceded the computer records so are identified by name, were boxed in alphabetical order before removal from Claremont Place, and are still available for study. Each man known to the Registry should have had one of these files, so there must be about 13000 of them.

The original material from a radiological examination is the set of seven or eight films which are specified for a full Panel skeletal survey of the shoulders, hips and knees of a hyperbaric worker. These were stored within standard (chest-film sized) X-ray envelopes, one per survey per man, and the Panel radiologists wrote their opinions on each dated set of films on the outside of the envelope. Thus as successive sets are added they form a complete radiological history of the changes (if any) to that man's bones during the course of his hyperbaric career. However, as bone surveys were for many years an optional extra for which the man was not paid, the take-up was poor and only about 2500 men have had a bone survey. Although some of the films were returned to examining doctors after Registry closure and some earlier normals seem to have been recycled, substantial numbers do remain in filing cabinets, stored in alphabetical order, for further study.

The source document for all CA exposure information is the statutory manlock register, which must be completed for all high-pressure work. This lists the names or works numbers and times for men entering CA through that manlock, the maximum pressure experienced, and the times that each man starts and completes each decompression. Manlock registers or photocopies are or have been held for more than a dozen British postwar high-pressure civil engineering projects, including the First and Second Dartford Road Tunnels, the Pedestrian, Road and Syphon tunnels under the Tyne, cooling water tunnels for power stations at Dungeness and Hartlepool, and the huge Clyde Road Tunnel as well as various sewer and London Transport tunnels. Many of these records remain, including the irreplaceable original Clyde and Tyne Road manlock registers.

In order to see more clearly what was happening to each man, it became customary at several contracts to compile an Individual Air Record (IAR) giving a chronological summary of pressure and exposure time, with notes of the occurrence of any decompression sickness (DCS). These records, which form the basis for one kind of computer experience record, are archived in the man's personal file which we still retain.
5. Compressed-air records in the computer archive.

All appropriate CA files were also specified for retention after the end of MTS, and have been successfully restored from the transtapes to unix for the present project. As for the divers, all compressed-air workers' electronic records are identified only by a man-number (all subjects being male) assigned by the Registry. These numbers were assigned to the main sequence of men known to the registry in 1971 in alphabetical order in the range 1-9344. Unfamiliar names from subsequent contracts were assigned higher numbers in blocks which can give a guide to a man's first contract: for example nos 9488-9809 were new starters at Hartlepool, though subsequent numbering is more erratic and no clear pattern can be identified. The highest man-number allocated before closure was 13444.

There are four distinct kinds of computer datafile for compressed-air workers available from the Archive tapes. The original coding sheets remaining from input to the first three of these should still be available in the man's personal folder. The four file types are:

A. Identification and location: the PART1 files

These card images provide summaries of dated medical examinations for fitness to work in compressed air at some specified contract. The maximum medical information consists of height, weight, blood pressure and the four skinfold thicknesses. Other information on the PART1 includes dob, job (eg miner, engineer), previous CA experience and worksnumbers if applicable (see below). There are 15714 entries of this sort from 92 different post-war British compressed-air contracts.

B. Radiological result: the PART2 files

These are identical to the D2 files for divers—indeed it was the much extended coding and storage scheme developed for the divers which was subsequently applied retrospectively to the CA results which remain in the Archive today. As before, if the result is other than 'normal' eight columns are completed with alphabetic codes to show the individual state of each bone examined. These files contain 4435 entries for examinations on about 2500 men. The maximum number of surveys recorded for one man is nine.

C. Exposure history by man: the 3A files

As sets of contemporaneous Individual Air Records were held by the Registry for several contracts, the first exposure histories were modeled closely on the IAR which means that the information is immediately available by man. As these records can be much more extensive than the PART1 or PART2 (one man at the Tyne Road tunnel had 1343 high pressure exposures), the finite size of the input medium (the IBM card) became an important restriction. For each exposure there is a date, working period (hour and min), working pressure, means of decompression (decent or not), shift (day back or night) and the nature of any treated decompression sickness. By means of severe compression it was possible to record six exposures per coding sheet (card). The stored IAR files look very much like raw card images, though in fact the exposures have been sorted from the chronological input into ascending order of pressure and increasing length of shift.
There are IAR-type exposure logs in the Archive for the men who worked at high pressure at the following contracts:

- **TYPF** Tyne Pedestrian Tunnel 1948-50
- **DART** First Dartford Road Tunnel main drive 1956-8
- **CLYR** Clyde Road Tunnels (first part) 1958-October 59
- **TYRO** Tyne Road Tunnel 1962-5
- **BPOL** Blackpool sewer 1966
- **DUNB** Dungeness B power station CW tunnels 1966-8
- **VICB** LT Victoria Line, Vauxhall 1968-9
- **MFPB** Milford Haven Bridge caissons 1969-70
- **LOWB** Lowestoft Ness sewer 1969-70
- **HART** Hartlepool power station CW tunnels 1971-2
- **TYSI** Tyne Siphon sewer 1973-5

**Second Dartford Road Tunnel:**
- **SDTA** Essex pilot drive 1973-5
- **SDTB** Kent pilot drive 1973-4
- **BFBN** Blackburn sewer 1976

**D. Exposure history by shift: the 3B files**

Although the 3A system was very convenient when IARs had already been prepared, for new data arriving as manlock registers it required much labour by the coders which was both slow and potentially prone to error. Consequently, prior to entry of the main drives of the SDT the second scheme envisaged in the original plan for Registry data entry was implemented. By grouping up to 10 men who had identical exposures together on one card it was possible to include greater detail (e.g., time of day, duration of decant surface interval) but still need less coding. The subsequent deconvolution from locks-full of men (each identified by a 4 digit worknumber) to individual experience by Registry mannumber would be performed by the machine. Men who underwent odd exposures still had to be catered for individually (four exposures per card). However it is clear that 3B coding could readily be carried out directly from the manlock register.

The 3B system was used to code the Essex and Kent main drives of the Second Dartford Tunnel and also for the last 33 months of the Clyde Road tunnels. These records remain in the Archive as unprocessed card images.

**6. Selection of subjects for the present project**

The main object of the present work is to investigate and compare the primary and electronic records relating to divers and CA men by study of a small sample from each group. The Compressed-Air workers have always been identified within the computer files by numbers in the range 1-13444 and the divers by identifiers in the range 50001-59381. The subjects for study were thus selected by taking one hundred random numbers within each of these ranges, together with a few spares to allow for identifiers which for some reason had not actually been used. The man-numbers employed are listed in the Appendix.
7. Retrieval of divers' data from the Archives.

The computer records were interrogated first, as they are more convenient. An attempt was made to find D1 records for each of the first hundred selected subjects. At least one such medical exam was present for only 94 of them, so the first six 'spares' were tried. One of these had no D1 either, but by including the next it was possible to assemble a set of divers of the target size of 100 each of which had passed at least one medical examination for fitness. 99 are male; subject 56942 is female. Although some have just one D1 entry, most have between three and seven. The largest number is for diver 52362 who was found to be fit 12 times between January 1977 and January 1984; the longest span seems to be for 52618 who was examined on 9 occasions between July 1976 and August 1984.

The radiological results were consulted next. As expected for a carefully monitored population prone to bone damage, a very high proportion of the subjects have one or more survey results, though only for the earlier years. All selected subjects allocated identifiers up to the end of 1978 (ie a full population of approx 5200 divers) have films, including several who had been rejected for no D1. However no less than 30 of the selected subjects who were first seen later than this have no record of any bone survey. In the earlier group there are typically half-a-dozen entries; the maximum is for 52579 who was examined (and found to be 'normal') ten times from August 1975 to April 1984. Amongst the selected subjects with higher identifiers, who were first encountered in the early nineteen-eighties, the norm is none and the usual maximum one.

The results of the questionnaires stored in the D4-files were extracted next. This is certainly the most widespread record. At least one was found for all 100 selected divers, as well as for the seven others who had no D1. In general the earlier subjects tend to have sets of D1, D2 and D4 with the same date so again there are for the core group typically 3-7 entries. The maximum is for 52350, who completed 11 questionnaires between January 1977 and January 1983. Diver 51376 only completed 10 though they cover November 1974 to November 1983. Again the newcomers with the higher identifiers have very few.

Finally the data stored in the D6-files were extracted. At least one of these very comprehensive records was found for 74 of the selected diving subjects, and many of these men have up to five. In all we have extracted 850 D1, D2 and D4 records for the hundred study subjects, which have been printed out for comparison with any primary material. Just one survey subject, diver 54210, has an entry in the NHSNI file.

Attempts to access source documents have been less successful. As the completed CIRIA/SEG forms were removed some time ago, we were left with just the local examination records. A complete search of these reveals just a single examination of a study subject (diver 54393 in June 1979) for comparison. Fortunately the card index was retained; card pairs for ninety-nine of the study divers have been extracted from this secondary source, in the absence of anything better.

A search of the remaining divers' bone survey films has been somewhat more successful, as we have been able to locate one or two sets of original radiographs for 23 of the selected subjects (out of the possible maximum of 70). Nine men were judged Normal, and 11 more only had recognisable abnormalities (bone islands &c) not associated with hyperbaric damage. Two men had definite HNS lesions, and diver 51365 had a definite JA lesion of his right shoulder, to give a necrosis rate of 13% of this very small sample.
8. Retrieval of compressed air workers' data from the Archives.

Again the computer records were searched first. At least one identification and location form was found for 98 of the suggested man-numbers. Neither Nos. 4870 nor 13261 seem to have been allocated to real men, so the first two spares were drawn to complete the set of 100. Only man 03798 has four entries, though four more men had been examined at three contracts, and a few more at two. The overwhelming majority were known from a single contract. Most of the larger contracts are represented, though four of the chosen subjects from Second Dartford had either been declared unfit, or did not start which technically precludes them from being CA workers. As there are primary records for these men they have not been replaced.

The result of at least one Radiological survey was extracted for twenty of the chosen subjects. Some men have several, the maximum being five proper surveys for man 1453. Although 87% of the selected divers surveyed were found to have no bone problem, out of 20 CA subjects with recorded survey results, three have bone islands, three more have suspected HNS lesions, man 3798 has a definite HNS lesion in his right hip, man 5290 has JA lesions in his right shoulder and right hip as well as HNS lesions in both knees and man 9814 has an extensive series of examinations of the JA lesion in his left hip, which continue beyond an operation to fit a prosthesis.

Some 21 of the chosen subjects actually worked at (as opposed to just being examined for) contracts for which we have the IAR-type work experience records, and their experience histories have been extracted from the appropriate IAR files and added to their electronic dossiers. They vary from the single exposure to 24psig at the Clyde for man 1535 to the 535 exposures at up to 38psig at Dungeness B recorded for man 3155. Unfortunately there has not been time to deconvolute any of the experience from the 38 files for men who worked on the Clyde or SDT main drives.

Assembly of the compressed-air workers' personal folders has been particularly successful. 95 have been found immediately in the storage boxes exactly where they should have been. It is possible that a few more will turn up, though 100% is not realistic as many of these original papers have, in the past, been lent out to solicitors and others who were not particularly conscientious about their return. Each folder can be expected to contain the original coding sheets for all the computer records extracted, together with fitness examination medical cards, 'blue books' and other personal documents. We also have access to the Clyde, Hartlepool, Tyne Road contract manlock registers against which the IARs can be compared. All of these paper records are in excellent condition.

Although the proportion of CA workers who were examined radiologically was quite low, a lot of their films are still available for analysis. It was possible to find one or two sets for fourteen of the possible twenty survey subjects for comparison with the computer records. These include one of the men with HNS lesions, and all three of the men with definite lesions to give recognisable abnormalities in 4 (29%) of these 14 original surveys. All of the films still seem to be in good condition; no deterioration is evident despite storage for up to 40 years.
9. Verification of the database.

Despite the many hundreds of local divers' records in storage, only one
dated set of originals applies to one of the survey subjects.
Unfortunately some details on his D1 have been mis-coded, though the D4
agrees with the original questionnaire.

Verification of D4 file entries is to some extent possible from the
coloured cards. We have not found any instances of disagreement; however
in most cases there is considerably more data in the D4 than on the card.
Clearly they were both compiled from a common source (the questionnaire) and
it will not be possible to form a reliable opinion until a lot more of these
originals are available again. Comparison with the few found with the
films reveals a generally high standard of transcription.

The quality of transcription of radiological results appears to be
high; for the few survey divers' filmsets still available here the number
and dates of examinations and the panel radiologists' opinions agree exactly
with the data extracted from the D2 files. One set of films has no D2
entry; as it was seen by just one radiologist perhaps the Registry were
waiting for a second opinion before submitting an agreed result.

The CA workers' original medical examination records, where these are
in their folders, seem to agree exactly with the PART1 coding forms, which
in turn seem to have been transferred competently without error to the
computer files. The only error we have been able to find is the omission
of one of two work numbers used by man 8801 at Dartford (first road tunnel);
as no records from this contract were stored in the 3B files this is of no
consequence.

Analysis of the bone survey results for CA workers was the original
objective for the Registry computer project, and judging by the originals
found for comparison these seem to have been entered very competently. The
dates and agreed results correspond exactly with the information written on
the men's film envelopes. Although 87% of the selected divers surveyed
were found to have no bone problem, out of 20 CA subjects with recorded
survey results, three have bone islands, three more have suspected HNS
lesions, man 3798 has a definite HNS lesion in his right hip, man 5290 has
JA lesions in his right shoulder and right hip as well as HNS lesions in
both knees and man 9814 has an extensive series of examinations of the JA
lesion in his left hip, which continue beyond an operation to fit a
prosthesis. In addition there is a suspected HNS lesion in another man, so
necrosis is suggested in 4 of the 14 found film sets (29%). There is thus
plenty of scope to verify that the computer 'result' score does correspond
with the state of the worst affected site, and that the condition of each
site has been accurately transcribed from the film storage envelope. It is
pleasing to be able to state that these are indeed the case. However for
three of the 'normal' men only the last set of films could be found, so
perhaps the CA men have been subjected to silver recovery too.

The IAR type experience records for the 21 men who have them seem to
correspond exactly with the 3A coding sheets still in the men's folders.
These forms in turn seem to agree precisely with the original individual air
records where these exist (eg from Tyns Road tunnel). There does however
seem to be some problem with man 8290 whose experience at Lowestoft appears
to have been transcribed onto two sets of 3A coding sheets. Only one set
appears in the archive, so he is about 70 exposures short. It would take a
long time to verify the IARs which were created in-house using piles of 3A
coding forms, though this would be possible where the original manlock
registers are held.
10. Conclusions.

Very little original material appertaining to the divers remains in Newcastle, though we now know that all the copy forms are in safe hands on Merseyside. Only a tiny proportion of the bone survey films which have passed through the Registry still remain, though again many will be back with the examining doctors and so may well still be available for consultation if required.

It is clear that there are vast numbers of diver records in the computer archive, covering the mid seventies to the mid-eighties. Despite the unfortunate D1 coding error which we have uncovered, the D4 records seem to have been reasonably carefully transcribed, and it is probable that the tens of thousands of D1 and D6 files will be faithful to the originals with only minor slips. This is a major resource which cost a lot to create, and it is reassuring to know that it has survived on Archive tapes for nearly a decade without obvious corruption.

With the exception of some contemporary addresses which appear on the questionnaires there is little diver information which is not available in machine-readable files—indeed the UBG forms were designed with this in mind. The detail included with the final radiological results coding scheme means that virtually no information written on the survey envelopes cannot be worked out from the computer records—only the initials of the reporting radiologists are missing.

Large amounts of original paper records and secondary coding sheets for the CA men remain. As well as the manlock registers, if the sample survey is representative there should be over 12000 personal folders. Quite a few of the survey radiographs also have survived. Very little of the basic data cannot be extracted from the computer records. In the early days a man’s medical examination was distinctly cursory, and the great gaps in so many Part1 records merely reflect the absence of basic details such as weight or blood pressure in many cases.

The exception is for the Second Dartford Tunnel. Here the men were given a medical examination similar to that recommended for divers, so the Part1 entries are complete. They do not however record as much as a D1, and there is no CA equivalent of a D6 record so there may be some shortfall here. The originals are still with the examining doctor (JDK) and so could be consulted. There are also various Registry Archive files relating to a somatotyping study which was carried out on this group of men, though these have not been interrogated for the present work.

The information content of the extensive IAR exposure records is not quite complete—they do not for example specify times of day or transfer interval for decants. This information is included in the later 3B files, though these still require deconvolution to provide the exposure history for one man.

The Registry archives are unique—no other country has funded such a comprehensive survey of hyperbaric workers—and those primary records which remain and all computer files are in excellent condition. As such they would be invaluable as a starting point for follow-up studies of known divers and compressed-air workers, investigations into risk factors for acute decompression sickness or bone damage, or a comprehensive final report on the acute and chronic health problems associated with the last major hyperbaric contract in Great Britain—the Second Dartford Tunnel.
Appendix

The random man-numbers selected by our statistical advisor were:

<table>
<thead>
<tr>
<th>Compressed air workers:</th>
<th>Spares:</th>
<th>Divers:</th>
<th>Spares:</th>
</tr>
</thead>
<tbody>
<tr>
<td>12494</td>
<td>246</td>
<td>4734</td>
<td>12694</td>
</tr>
<tr>
<td>1426</td>
<td>10056</td>
<td>1085</td>
<td>8180</td>
</tr>
<tr>
<td>3580</td>
<td>1540</td>
<td>7689</td>
<td>1693</td>
</tr>
<tr>
<td>6481</td>
<td>12032</td>
<td>10438</td>
<td>5024</td>
</tr>
<tr>
<td>10659</td>
<td>8801</td>
<td>11350</td>
<td>1792</td>
</tr>
<tr>
<td>3463</td>
<td>4651</td>
<td>6632</td>
<td>3521</td>
</tr>
<tr>
<td>2876</td>
<td>5142</td>
<td>10989</td>
<td>1695</td>
</tr>
<tr>
<td>3798</td>
<td>2892</td>
<td>8641</td>
<td>2727</td>
</tr>
<tr>
<td>5118</td>
<td>4454</td>
<td>5854</td>
<td>10091</td>
</tr>
<tr>
<td>2799</td>
<td>240</td>
<td>4737</td>
<td>954</td>
</tr>
<tr>
<td>12484</td>
<td>12293</td>
<td>4695</td>
<td>6170</td>
</tr>
<tr>
<td>10273</td>
<td>10560</td>
<td>3786</td>
<td>12950</td>
</tr>
<tr>
<td>8290</td>
<td>5290</td>
<td>12357</td>
<td>3155</td>
</tr>
<tr>
<td>7742</td>
<td>9814</td>
<td>8418</td>
<td>2656</td>
</tr>
<tr>
<td>4791</td>
<td>11180</td>
<td>10011</td>
<td>9195</td>
</tr>
<tr>
<td>12206</td>
<td>11802</td>
<td>2118</td>
<td>1094</td>
</tr>
<tr>
<td>2661</td>
<td>1743</td>
<td>10439</td>
<td>11485</td>
</tr>
<tr>
<td>1535</td>
<td>4618</td>
<td>3388</td>
<td>2052</td>
</tr>
<tr>
<td>10637</td>
<td>12666</td>
<td>8229</td>
<td>1616</td>
</tr>
<tr>
<td>5387</td>
<td>4870</td>
<td>11490</td>
<td>10878</td>
</tr>
</tbody>
</table>

We are most indebted to Dr. J. N. S. Matthews for his assistance.