

2001 Census – Data Capture and Coding Evaluation Report (Scotland)

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Part 1 – Summary and Introduction

1. Executive Summary

- 1.1 The term “2001 Census Processing” was used to cover two major stages in the capture and preparation of Census data, ready for the production of statistical outputs. The first stage was the relatively labour-intensive task of extracting information from the Census forms and coding this information in a way that made it more readily capable of manipulation as data for the production of statistics. In the 2001 Census Development Programme this first stage was recognised under the title of “Data Capture and Coding”. By contrast, the second stage was highly algorithmic and employed complex computer processes, developed specifically for the 2001 Census, with little manual intervention. This stage was known as “downstream processing”, and aimed to make the data as consistent and complete as possible by editing records and imputing missing data. This report covers the Data Capture and Coding stage.
- 1.2 The format and content of the Census forms were very alike for all three UK Census Offices (the General Register Office for Scotland (GROS), the Office for National Statistics (ONS) (for England and Wales) and the Northern Ireland Statistics and Research Agency (NISRA)). Similarly, the requirements for capture, coding and cleaning had much in common. Very early in the 2001 Census Development Programme, and well before the implementation of devolution, it was recognised that there should be significant economies of scale to be gained from working within joint processing projects.
- 1.3 In previous Censuses the returns had always been processed in-house, but the 1997 Census Test provided evidence that better value for money could be obtained from contracting-out the main capture and coding services for the 2001 Census.
- 1.4 An Open Options Procurement Project was undertaken in 1998 by the three UK Census Offices, jointly known in contractual terms as “the Authority”, with the aim of acquiring data capture and coding services (finally including Census forms printing), which was for the 1999 Rehearsal and the 2001 Census itself (the scope was potentially wider, and included options for handling central postback of Census forms and elements of “downstream processing”, but these options were not taken up).
- 1.5 In December 1998 the contract was awarded to Lockheed Martin (LM), with ICL (later renamed as Fujitsu) as the major sub-contractor. LM had already been awarded the contract as the main technology provider for the 2000 US Census, and made a very competitive bid based on their US solution and the potential re-use of key elements of the system. LM developed a solution, using the latest technology, that would scan 27 million Census forms at high speed; automatically capture information from these forms and, where necessary, support rapid manual capture (keying); electronically code the information using automated and computer assisted methods; restructure the data captured from different pages of each form to create household, communal establishment and person records; and despatch the captured and coded data, along with digital and microfilm images, to ONS for “downstream processing” on behalf of all three Census Offices. Additionally, the contract covered the printing of all the forms that were to be completed by the public and then scanned by LM. This transferred the risks associated with form and scanner incompatibilities to LM. Finally, LM was given responsibility for the storage of the Census forms prior to delivery to the field

operation (this wasn't in the scope of the original contract and had to be negotiated into it in real time when it became clear that it had fallen between the LM and TNT contracts); after receipt at the processing centre; and throughout processing until their final destruction in the summer of 2002.

- 1.6 The key benefits envisaged from the outsourcing of the data capture and coding operation were:
- to streamline and automate the capture and coding process, with a view to reducing the number of discrete processes, resulting in savings in staff and accommodation costs;
 - to improve quality in terms of the accuracy and consistency of the captured and coded data;
 - to improve the speed of processing data over that achieved for the 1991 Census, so that outputs could be delivered to a reliable timetable;
 - to enable a valuable redistribution of savings so that responses on all census forms could be coded (for example, in the 1991 Census only 10 percent of the forms had responses to Industry, Occupation and Workplace Address coded); and
 - to transfer to LM the major risks associated with the design, development and implementation of capture and coding services for the 2001 Census, including the recruitment, training and management of a large temporary workforce.
- 1.7 The contract was “fixed price” and was based on the provision of a service with defined service levels and outputs, with the requirements being stated in terms of “what” was required and not “how” things should be developed and implemented (i.e. descriptive rather than prescriptive). It was LM's choice to employ the technologies that they did. However, it is worth noting that the solution which LM successfully tendered (their “how”) was captured in the contract as well, so that they could not radically change the solution accepted by the Authority without consent.
- 1.8 A Rehearsal of the systems designed by LM, and the operations planned by their sub-contractor ICL, were conducted at ONS (Titchfield), starting in September 1999 and ending, following a couple of re-starts, with an exit test in July 2000. The Rehearsal failed to meet some key requirements, but it was decided that work should progress on the 2001 Census development, with known errors outstanding, to ensure that the main commissioning dates for the “live” service would not be missed. This had ramifications for “live” processing.
- 1.9 “Live” processing activities for the 2001 Census started in June 2001, and took place at Widnes, Cheshire, at a processing site selected by LM and ICL, and approved by the Authority. A large warehouse in Wigan was acquired by ICL for the storage of the forms. Over 1,000 staff were recruited locally and trained by ICL. LM maintained a presence on the site throughout, as they were responsible for the many integrated IT systems that the service depended on. The Authority also set up and maintained a team on site to resolve queries, liaise with ICL and LM on a day-to-day basis and “observe” the management of the whole operation. The Authority team was mainly staffed by ONS.
- 1.10 The capture and coding of Scottish forms started towards the end of July 2001 and was completed by March 2002. Within that 9 month period, nearly 2.5 million Scottish forms were processed. The full cost to GROS of the project, from inception through to completion, including the services provided by LM, was £5.77 million. In relative terms this was less than ONS and was less than the estimated figure for an in-house service.

- 1.11 GROS fully recognises the benefits that were obtained in the 2001 Census from deciding to outsource capture and coding and to working in partnership with the other two UK Census Offices (in particular ONS), and has no major reservations about the decisions taken. Nevertheless, we must maintain an open mind as to whether capture and coding for a future Census would be best undertaken in partnership with the rest of the UK or independently for Scotland. The environment in which the Census Offices operate has changed considerably since the mid 1990's, when many key decisions were taken on the 2001 Census. Criteria for deciding which way to go need to be established as a early task in the planning for a future Census. This report gives several significant pointers towards such criteria.

2. Introduction

2.1 Data Capture and Coding Project Objectives

- 2.1.1 The main objective of this Project was to process the 2001 Census forms and deliver clean, consistent and coded data for input into the in-house edit and imputation systems (i.e. "downstream processing").

2.2 Project Organisation

- 2.2.1 The project was undertaken jointly by the three UK Census Offices (GROS, ONS and NISRA). For the purposes of contract administration the three Census Offices were known collectively as "the Authority". Each Census Office had specific roles within the project from its inception through to project closure. As the largest Census Office in the partnership, ONS took the project management lead and committed the greatest resource to the project.

2.3 About this Evaluation Report

- 2.3.1 This report provides an evaluation of the project from a Scottish viewpoint. The main evaluation report for the project is published on the ONS website,

<http://www.nationalstatistics.gov.uk/census2001/pdfs/processingevrep.pdf>

and that report presents the consensus view of the three Census Offices. The GROS team made a major contribution to the creation of the main evaluation report, and the assessments and lessons learned contained within the report can generally be taken as being equally applicable to all three Census Offices. Nevertheless, it was ONS that published the report and, naturally, there is a slight bias towards the ONS perspective, and an exclusion of issues that were insignificant or not applicable to ONS, but were important to GROS as a smaller Census Office in the partnership.

- 2.3.2 This report does not repeat what is stated in the overall project report published by ONS. Instead it highlights key issues and conclusions that were particular to GROS, and provides some Scottish facts and figures as supporting information. The main focus of the report is the role that GROS had in the project and the relationship we had with the other two Census Offices, in particular ONS.
- 2.3.3 Nevertheless, to gain a full appraisal of the project, both this report and the ONS report should be read.

Part 2 – Main Findings

3. Key Achievements

3.1 The three key performance indicators used to measure the success of the project are Quality, Cost and Throughput.

3.2 Quality

3.2.1 A full report on 2001 Census Data Capture and Coding quality has been published by ONS on their website:-

http://www.statistics.gov.uk/census2001/pdfs/data_capture_and_coding_evr.pdf

The results provided in that report are for the UK, as samples were taken from data for each country and the results aggregated. The narrative of that report is written from an ONS point of view, but in most cases applies equally to Scotland. However, issues particular to capture and coding for Scotland are highlighted below.

3.2.2 The chapter in this report on quality provides further analyses in the context of the complete Census exercise from collection through to output.

3.2.3 There were two major groups of quality measures. The first covered capture processes and the second covered coding processes.

3.2.4 Capture

3.2.4.1 The following tables show the overall accuracy that was achieved for Scottish forms and, for comparison, English and Welsh forms.

Scotland - Capture Accuracy (from LM Reports) - Measured at Census District Level				
Data Category	Standard	Average Achieved	Maximum Achieved	Minimum Achieved
OMR	99.300	99.606	100.000	99.212
OCR Alphabetic	96.000	99.106	99.603	95.238
OCR Alphanumeric	95.000	99.099	100.000	98.208
OCR Numeric	98.000	99.514	100.000	98.912
Date of Birth	99.500	99.904	100.000	99.616
Form Identity	99.995	98.799	100.000	79.838

England & Wales - Capture Accuracy (from LM Reports) - Measured at Census District Level				
Data Category	Standard	Average Achieved	Maximum Achieved	Minimum Achieved
OMR	99.300	99.563	100.000	50.000
OCR Alphabetic	96.000	99.175	100.000	66.666
OCR Alphanumeric	95.000	99.117	100.000	66.666
OCR Numeric	98.000	99.508	100.000	66.666
Date of Birth	99.500	99.906	100.000	96.969

Form Identity	99.995	99.937	100.000	95.582
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Note

OMR - Optical Mark Recognition OCR - Optical Character Recognition

- 3.2.4.2 It can be seen from the above tables that, for five out of the six categories, the average achieved was higher than the standard specified in the contract. Also, for the same five categories, accuracy was consistent between Scottish forms and English and Welsh forms.
- 3.2.4.3 The one category that failed to meet the contracted service level was the capture of Form Identity. Furthermore, the average for Scotland was notably lower than the other UK Census Offices. It can also be seen that the minimum accuracy for any Census District in Scotland was 79.8%, much lower than the minimum for an English or Welsh Census District. This was an issue that could have significantly affected the quality of data when viewed at a local level, albeit Form Identity accuracy levels seldom violated the overall quality service levels in the contract for a Census District. If the incorrect Form Identities had not been fixed, the Census results for some local areas (e.g. within an Enumeration District) would have contained a significant bias that had been introduced by the processing method. Fortunately, by cross-referring Postcode of Enumeration, the Box Identity (Enumeration District) and the Form Identity a method was devised to highlight potential mis-captures and allow for manual bulk correction. In relative terms, GROS (and NISRA) chose to apply more manual effort to the identification and correction of Form Identity errors than ONS.
- 3.2.4.4 The Form Identity box on the forms was completed by the enumerators and the main reasons for the poor capture of Form Identity were:-
- Poor and ambiguous handwriting; and
 - Entry of wrong identities.
- 3.2.4.5 There was some evidence that the lower accuracy levels for Scotland was caused by a combination of a poor overall standard of completion by our enumerators; the alphabetic characters used to construct our Census District code being more prone to misinterpretation (e.g. QH and QM); and the fact that our Form Identity was two characters shorter than the Identity used by the other two Census Offices (the construction of their codes had an element of redundancy that reduced the chances of a mis-interpreted Form Identity still being an acceptable code value).
- 3.2.4.6 It has been recognised that the allocation, transcription to the form, capture and checking of the Form Identity needs to be improved in the next Census. For example, the addition of a simple checksum to the Form Identity would have vastly reduced the number of anomalies to be resolved. Fuller descriptions of the Form Identity problem can be found in the UK evaluation reports (general and quality) on Capture and Coding published on the ONS website:-

<http://www.nationalstatistics.gov.uk/census2001/pdfs/processingevrep.pdf>
http://www.statistics.gov.uk/census2001/pdfs/data_capture_and_coding_evr.pdf

3.2.5 Coding

- 3.2.5.1 The following tables show the overall accuracy that was achieved for Scottish forms and, for comparison, English and Welsh forms.

Scotland – Coding Accuracy (from LM Reports and ONS Analysis) - Measured at Census District Level					
Data Category	Standard	LM Av. Achieved	LM Max Achieved	LM Min Achieved	ONS Independent Assessment
Country of Birth	96.000	99.879	100.000	82.352	99.751
Ethnic Group	96.000	98.953	100.000	66.666	96.451
Industry	88.000	88.460	94.578	83.703	88.159
Occupation	88.000	91.417	100.000	86.832	87.287
Address – Enumeration	100.000	99.198	100.000	75.000	97.911
Address - 1 year Ago	96.500	92.992	100.000	60.000	92.140
Address – Workplace	94.500	92.517	100.000	85.227	85.723

England & Wales - Coding Accuracy by CD (from LM Reports and ONS Analysis) - Measured at Census District Level					
Data Category	Standard	LM Av. Achieved	LM Max Achieved	LM Min Achieved	ONS Independent Assessment
Country of Birth	96.000	99.846	100.000	66.666	99.757
Ethnic Group	96.000	98.855	100.000	75.000	96.849
Industry	88.000	88.938	100.000	78.350	88.192
Occupation	88.000	90.903	100.000	83.018	89.260
Address - Enumeration	100.000	96.884	100.000	33.333	98.360
Address - 1 year Ago	96.500	94.343	100.000	47.058	96.446
Address - Workplace	94.500	91.564	100.000	72.000	86.275

Note

1. The coding results above relate only to textual responses. Where the answer could have been a tick box, these are included in the OMR results.
2. ONS were responsible for identifying systematic error in individual codes. They carried out independent monitoring of coding and reported errors to Lockheed Martin, who, in turn would examine errors and agree changes to indexes and systems with ONS.

3.2.5.2 The above tables show that accuracy levels were consistent between Scottish forms and English and Welsh forms. The accuracy figures for Address of Enumeration are slightly misleading. Pre-planned addresses known before the Census are derived directly from the Form Identity. In Scotland this was done in over 97% of cases compared to 94% for the whole of the United Kingdom. The higher percentage was achieved in Scotland by “freezing” the address list 3 months before the Census, instead of about 3 years before in England and Wales. The residue that was not derived from Form Identity was coded by an enumeration district postcode validity check or by an automatic address coding system. The LM accuracy figure is based on the coding accuracy of the combined validity check and address coding system, whereas the ONS accuracy figure is solely based on the quality of automatic address coding. The accuracy assessment for Scotland therefore excludes the 97% of cases where the Form Identity has been used to automatically assign the enumeration postcode. The LM system assumed the

Form Identity to be accurate on all occasions and reported coding accuracy errors when the captured postcode was not valid for the Enumeration District (as reflected in the Form Identity code). However, it was often the Enumeration District that was captured wrongly. The process of fixing Form Identity also fixed Enumeration Postcode, so the eventual accuracy figure was very close to 100%.

3.2.5.3 A more comprehensive assessment of coding accuracy can be found in the UK evaluation report on Capture and Coding Quality published on the ONS website:

http://www.statistics.gov.uk/census2001/pdfs/data_capture_and_coding_evr.pdf

3.3 Cost

3.3.1 The cost of the data capture and coding project has been calculated for the period from the inception of the Open Options Procurement exercise in the spring of 1998 to the completion of the contract in the autumn of 2002.

3.3.2 The direct cost to GROS of the capture and coding contract with LM was:-

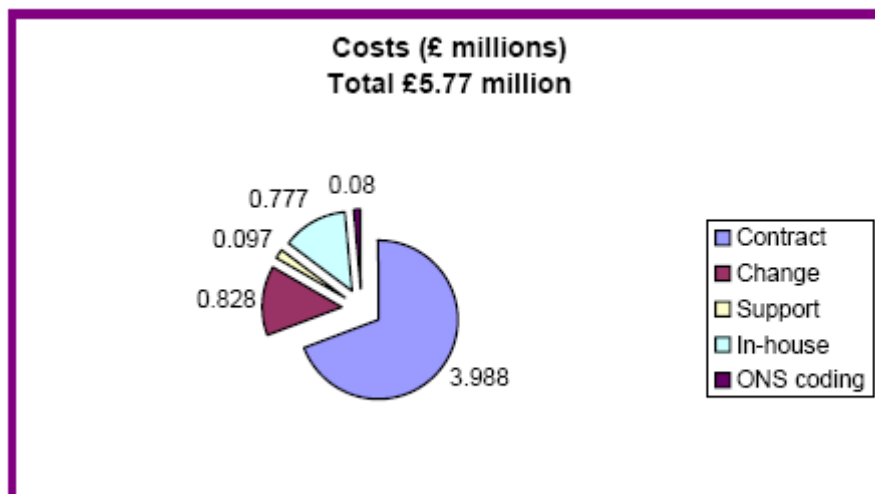
- £3.988 million for contracted services.
- £0.828 million for changes to the contracted services (the most significant being £0.470 million for changes to the LM system to cope with alterations to the format and content of the main Census forms between the Rehearsal and “live” processing – including changes introduced by the Scottish Parliament)

3.3.3 The overall contract cost of £4.816 million compares favourably with a cost to ONS of £54 million, when based on populations enumerated.

3.3.4 The three Census Offices shared the costs for external support for the project, covering advice and assistance on procurement, contract maintenance, legal and technical matters. The overall cost of this support was just under £2 million. The GROS element of this was £97k (we only contributed towards legal (Bird and Bird), procurement (Vogue) and contract maintenance (Vogue) costs; other costs were met fully by ONS). A further £777k was spent by GROS on in-house resources (mainly staff costs) covering contract management, specification, quality assurance and operational contributions to the project. Finally, GROS paid £80k to ONS for expert assistance for Occupation and Industry coding.

Note

LM was also given the contract to print the Census forms. This aspect was managed by the Data Collection project and is covered in that evaluation report.



3.3.5 The in-house costs of contract management, specification and quality assurance for GROS were proportionately more than ONS (based on the percentage of overall UK population). This was due to the decision that each Census Office should be responsible for specification and testing relating to its own forms. In all other cases GROS spent proportionately, and often significantly, less than ONS.

3.3.6 The overall cost to GROS was £5.77 million compared with an overall cost for ONS of £59.5 million.

3.3.7 Translated into a unit cost per Census Household form this gives:

- GROS – £2.69 per form
- ONS – £2.89 per form

3.3.8 Furthermore, the £5.77 million was less than the Public Sector Comparator (PSC) cost of £7.99 million for Scotland. The PSC was an assessment of the cost of undertaking the services in-house, taking into account contingency and the value of the risk being transferred. The PSC was developed prior to the negotiation stage of the procurement phase of the project, when the Census Offices were dealing with three shortlisted suppliers.

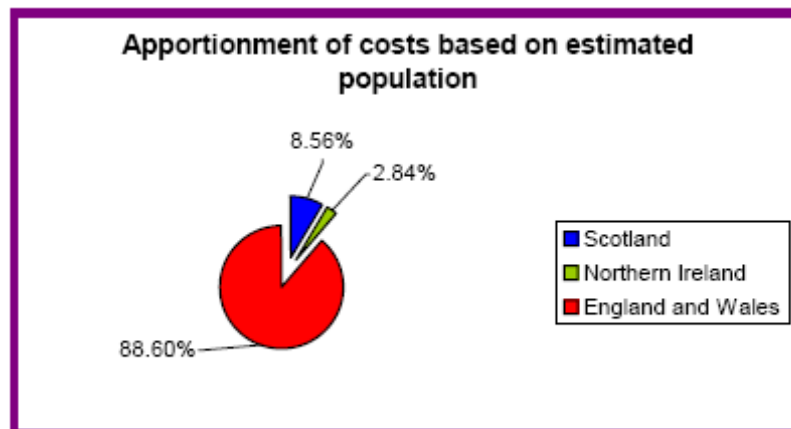
Element	PSC Estimate £M	LM Actual £M
1. Basic services	5.882	3.988
2. Optional services taken and unforeseen changes ¹	0.819	0.828
3. Other contract costs (support and in-house – included in 1. For the PSC)	0	0.954
4. Value of risks transferred to contractor ²	1.284	0
Total	7.985	5.770

Note

1. This aspect of the PSC cost comprises £181k for image archival (film and digital); £50k for forms destruction; and a 10% contingency on basic services for the cost of change.
2. The value of risk transferred represents an estimate of contingency and insurance costs

that the contractors needed to factor into their bids. This cost was the hardest to estimate. However, the LM bid was so low that, even if this element was ignored, the contracted solution was shown to offer better value than an in-house solution.

- 3.3.9 All suppliers who bid for the 2001 Census data capture and coding contract were asked to provide for an option to process Scottish forms at a processing centre in Scotland. The project team expected that the cost of the so-called “Scottish Option” would be relatively high and would not provide good value for money. On the other hand, in every preceding Census, Scottish Census returns had always been dealt with in Scotland, and it was anticipated that the public and Ministers could ask why this was not the case again in 2001 (It is worth noting that the main processing site for the 1991 Census was at Hillington near Glasgow. All Scottish forms and five sixths of English and Welsh forms were processed there.)
- 3.310 LM offered to operate a separate Scottish site to deal with Scottish forms for £2.2 million (£1.95 million if GROS provided the premises). Other suppliers provided similar bids, but in each case the savings offered by a combined site, far outweighed other possible benefits.
- 3.311 For joint 2001 Census tasks that did not have any significant differences in requirements between the three Census Offices, an agreement was reached to apportion costs based on the latest population figures available at the time. Throughout the LM contract and other capture and coding tasks these apportioning factors were applied whenever appropriate.



3.4 Throughput

- 3.4.1 For the complete project, including the contracted dates with LM, there were two significant slippage points in the programme of work. Firstly, due to insufficient time for specification and development between the award of contract and the Rehearsal, the Rehearsal was delayed by six months, and even then was incomplete. Secondly, there was a five week slippage in the final 2001 Census delivery.
- 3.4.2 The impact on GROS was no different from the other two Census Offices and this is covered in detail in the main ONS evaluation report:-
- <http://www.nationalstatistics.gov.uk/census2001/pdfs/processingevrep.pdf>
- 3.4.3 The greatest impact on GROS was the slippage of individual deliveries of data

during the “live” capture and coding phase of the work. The contract provided for a detailed delivery schedule to be prepared by LM and agreed by the Authority, and this was done prior to Census day. This envisaged Scottish data being delivered in Estimation Area (EA) tranches between September and November 2001. Instead, due to problems with the exporting of data from the LM system at Widnes, a “log-jam” of the data that had already been captured and coded was created. The first delivery of Scottish data did not happen until January 2002, with the final EA being delivered in March 2002.

3.4.4 Whereas the delivery of the last EA for ONS was only five weeks late, the delivery of the last EA for GROS was four months late. In a planned overall processing timeframe spanning 11 months, from the capture of the first form to production of first outputs, a four month delay had a significant impact on the deployment of staff on subsequent quality, estimation and output tasks.

3.4.5 The actual delivery schedule against that planned for each EA is shown below:-

Scotland - Processing Schedule			
Processing Area	Scanning Started	Data Delivered	Planned Delivery Date
Ayrshire & The Marches	23-Jul-01	04-Jan-02	01-Sep-01
Lothian	24-Sep-01	22-Feb-02	01-Nov-01
Strathcarron & Fife	03-Oct-01	15-Feb-02	01-Nov-01
Grampian	11-Oct-01	18-Feb-02	01-Nov-01
Highlands & Islands	08-Oct-01	22-Feb-02	01-Nov-01
Lanarkshire	05-Oct-01	01-Mar-02	01-Nov-01
Glasgow & Dunbartonshire	05-Oct-01	08-Mar-02	01-Nov-01
Dalriada	23-Oct-01	30-Jan-02	01-Nov-01

Note

Appendix A provides a breakdown, by Council Area, of Processing Area.

3.4.6 The volumes of forms scanned by LM (by form type) and then delivered as data, microfilm and digital images are shown in the following tables:-

Scotland - Forms Scanned by Type (from LM Forms Scanned Reports)						
Processing Area	CE	D	H	HC	I	Total
Ayrshire & The Marches	525	21,321	266,146	3,002	8,476	299,470
Lothian	504	28,290	329,734	3,293	14,957	376,778
Strathcarron & Fife	455	19,462	261,711	2,928	12,048	296,604
Grampian	443	19,118	222,958	2,476	11,318	256,313
Highlands & Islands	891	28,668	290,611	3,725	14,291	338,186
Lanarkshire	189	15,002	253,165	3,327	6,593	278,276
Glasgow & Dunbartonshire	356	41,754	368,964	4,684	15,544	431,302
Dalriada	301	19,366	148,031	1,656	5,453	174,807
Scotland Total	3,664	192,981	2,141,320	25,091	88,680	2,451,736

Note

Form type codes are CE for Communal Establishment form, D for Dummy form, H for Household form, HC for Household Continuation form and I for Individual form.

England & Wales - Forms Scanned by Type (from LM Forms Scanned Reports)						
Processing Area	CE	D	H	HC	I	Total
E&W Total	39,203	2,219,479	20,566,567	357,593	982,679	24,165,521

Scotland - Forms Delivered (from Authority forms trail report)	
Processing Area	Total
Ayrshire & The Marches	298,531
Lothian	376,076
Strathcarron & Fife	296,242
Grampian	256,090
Highlands & Islands	337,228
Lanarkshire	277,838
Glasgow & Dunbartonshire	429,805
Dalriada	174,309
Scotland Total	2,446,119

England & Wales - Forms Delivered (from Authority forms trail report)	
Processing Area	Total
E&W Total	24,109,904

Note

Not all forms that were scanned were delivered. Blank forms, duplicate forms and corrupted forms (e.g. ones with severely damaged pages or missing parts) were rejected by the system.

3.4.7 The three Census Offices used a system that transferred difficult queries from the LM processing centre to the Authority for resolution and return. Address related queries, Form Identity queries, Reason for Dummy queries and Communal Establishment queries for Scottish forms came to GROS. All other coding queries for Scottish forms were handled by ONS. These were Country of Birth queries, Ethnic Group queries, Industry queries and Occupation queries.

3.4.8 The tables below show the number of queries (capture and coding) received from Scottish forms:-

Scotland – Capture and Coding Queries by Type (from LM reports and ONS Query Resolution System)			
Data Category	No of question responses	No of queries	Coding queries as a % of all responses
Country of Birth ₁	163,879	21	0.01%

Ethnic Group ¹	145,633	20	0.01%
Industry ¹	2,434,461	9,009	0.37%
Occupation ¹	2,601,635	4,343	0.17%
Address - Enumeration ²	76,089	7,845	10.32%
Address - 1 year Ago ²	412,974	250	0.06%
Address – Workplace ²	2,512,095	4,612	0.18%
Religion ³	0	0	0.00%
Communal Estab. ³		391	
Reason for Dummy ³		2,860	
Invalid Form Identity ³		9,913	
Total	8,346,766	39,275	

England & Wales reports and ONS Data Category	Query Resolution of question responses – Capture and	on System) No of queries Coding Queries b	Coding queries as a % of all responses y Type (from LM
Country of Birth ¹	3,584,783	358	0.01%
Ethnic Group ¹	3,709,200	180	0.005%
Industry ¹	24,625,737	67,182	0.27%
Occupation ¹	26,004,646	27,979	0.11%
Address - Enumeration ²	1,457,608	45,454	3.12%
Address - 1 year Ago ²	4,200,158	1	0.00%
Address – Workplace ²	18,976,391	0	0.00%
Religion ³	863,697	195	0.02%
Communal Estab. ³		6,653	
Reason for Dummy ³		30,059	
Invalid Form Identity ³ Total		118,256 296,317	
	83,442,220		

Note

The figures in the tables are derived from two sources – a. the LM system that sent out the queries and b. the ONS developed system that handled them. Queries could be initiated by the LM capture stage and the LM coding stage. Not all types of query were measured by the LM system. Furthermore, some queries were not returned, as they were not resolvable or were reported in error.

1. These figures are for queries that were only raised during the LM coding stage.
2. These figures are aggregate and for queries that were raised both during the capture stage

and during the coding stage.

3. These figures are for queries that were only raised during the capture stage and no question responses figures are available.

3.4.9 The figures show that GROS had proportionately more queries to handle than ONS. But this was through design, as our requirement was for valid postcodes to be assigned during the capture and coding phase of processing (thus using the efficiencies of our “frozen” postcode geography, where a postcode could only exist in one Enumeration District). The GROS philosophy was to devote time to fix postcodes up-front, so that the automatic processes in “downstream processing” could act quickly on the data without manual interruption. ONS and NISRA do not maintain a postcode geography where postcodes are linked to only one Enumeration District, so their approach was necessarily different.

3.4.10 The table below shows the number of queries received from Scottish and English and Welsh forms at the export stage (i.e. after the form processing linkage rules were applied):-

Export queries by Type (from ONS Analysis)		
Query Category	Scotland	England & Wales
Duplicate Form ¹	3,614	60,085
Incorrect Form Identity ²	23,865	287,890
Invalid Combination of Forms ³	1,281	17,188
Total	28,760	365,163

Note

- 1 Duplicate form - Two or more forms were received for the same address with the same information on each form.
- 2 Incorrect form identity - The form identity captured was incorrect either because the enumerator put the wrong identity on the form, the enumerator did not write the identity legibly and it was incorrectly keyed or the keying operator simply mis-keyed a readable form identity.
- 3 Invalid combination of forms -One or more forms making up the form set for a household or a communal establishment was missing. These combinations included one or more I forms without a matching H form or CE form and two or more H forms for a household instead of an H form and one or more HC forms.

3.4.11 The figures show that GROS had proportionately fewer queries to handle than ONS at this stage. However GROS staff were employed at Widnes to identify and correct queries of this type before they reached the export stage.

3.4.12 Following the poor results from the Rehearsal, the Authority and LM agreed to take “live” census forms, received soon after Census day, from selected Census Districts and pass these through the “live” service at Widnes as a trial (nicknamed TOAST for Total Operational And Service Trials). These forms were reprocessed when all the forms for each Census District had been received. It was planned that the TOAST data would be used to test “downstream” processes, given that the Rehearsal data was not adequate for the task. However, like the Rehearsal, TOAST failed to provide a complete and consistent set of data for use “downstream”. As a consequence the resilience of “downstream processing” was not fully tested, and more effort was required to maintain it during “live” operations.

3.5 Conclusions

3.5.1 The overall quality of the captured and coded data was acceptable, and the

measurement approach was a significant improvement on 1991. This was the first time in a Census that QA processes had been fully measurable and had continued as an automated background activity for the whole of the capture and coding operation. In fact, the complete census processing activity, from capture through to output, was encompassed by this quality management approach. Some major quality issues arose, and there was a cost associated with fixing the faults in the data that could have manifested themselves in local statistics, although experience tells us to expect such things in a “big bang” exercise such as a national Census. The ingenuity of our staff in devising methods of data analysis and correction, and their dedication to implementing these methods, enabled many of the anomalies thrown up in data capture and coding to be resolved before the data was used by “downstream processing”.

- 3.5.2 The solution implemented by LM was based on their approach to the 2000 Census in the US. In the US, forms were scanned and data captured by the system on a first come – first scanned basis. There was no effective batching of forms by area of origin. Conversely, for the UK Census forms were batched in the field into Enumeration District batches and then were scanned within the Enumeration District batch. The LM solution was therefore prone to systematic errors at a local level that had not been encountered in the US (e.g. black scanner lines on consecutive forms, incorrect Box Identities, etc. – all described in much more detail in the full report on 2001 Census Data Capture and Coding, published by ONS on their website). Furthermore, most of these errors in the data still passed the quality service levels in the contract that were measured at a higher area level. Finally, the LM solution did not build in effective batch control features that could have utilised the forms being generally in form number order within the box. In hindsight, the batch control methods used in 1991, where dummy forms were used to create an unbroken sequence of form numbers within the Enumeration District batch, had many benefits that were lost in the 2001 almost random approach.
- 3.5.3 Given the approach taken to capture and coding for the 2001 Census, GROS obtained significant economies of scale from working jointly with ONS. The cost of capturing and coding a Scottish Census form was less than the equivalent cost for England and Wales, and much less than if we had set up the same or similar solution independently.
- 3.5.4 There were some timetabling issues which ultimately led to a slippage of four months in the delivery of the last Scottish EA, and five weeks in the final contract data delivery milestone (an ONS EA). (Microfilm deliveries were delayed even further, but this activity was not on the critical path.) The slippage contributed to the one month delay in issuing the first results from the 2001 Census. However, this was still a reasonable achievement in the context of a four year programme and an exercise of the scale of Census capture and coding. Overall, delivery for 2001 was quicker than in 1991 and the project compares extremely favourably with other Government Information Technology projects.

4. The GROS Role in the Project

- 4.1 As with all other aspects of the 2001 Census programme, GROS was ultimately responsible for the capture and coding of information from Scottish forms. To look after our interests effectively this meant that GROS needed a presence on the main Contracts Management Board (Authority only), the (Data Capture and Coding) Contract Steering Committee (joint Authority and LM) and the management team that met at least fortnightly to monitor progress and resolve project issues (joint Authority and LM).

- 4.2 The overall project manager was from ONS, but the decision making process generally did involve full consultation with both GROS and NISRA.

4.3 Specification and Testing

- 4.3.1 GROS was responsible for the specification of all requirements relating to Scottish forms. Clearly there were many questions that were common on the census forms of all three Census Offices. But each Census Office was separately responsible for the production of their specification, based on a common template, with constant liaison. As a consequence of this, each Census Office was responsible for the quality assurance of the system that LM was developing. GROS therefore had to expend similar levels of resource to ONS on the specification and testing of the capture and coding solution developed by LM for the Rehearsal and for the actual 2001 Census.

4.4 Testing Strategy

- 4.4.1 Following a Rehearsal that failed to meet some significant key objectives (e.g. observing large quantities of data pass cleanly through the LM system without corruption or loss of information) the three Census Offices reassessed their role within the project. It was clear that the Authority needed to become more involved with LM in their planning, design and implementation strategy. ONS took the lead in co-ordinating the specification work for the three Census Offices and closely monitoring LM's management of the specifications. In a similar fashion GROS accepted responsibility for co-ordinating all subsequent testing. This involved the detailed testing of requirements at the form level and the overall verification of the service provided by LM, including the commissioning of all services (IT and manual) at the Widnes processing site and the forms warehouse in Wigan. Without the strategic and detailed design and co-ordination effort by GROS, and similar effort by ONS on specification, deadlines within the project almost certainly would not have been met. Similarly, the quality of the service provided would have been at risk.
- 4.4.2 GROS also took the lead in liaising with ICL on their plans for Recruitment and Training. This was a much smaller task than the Testing activity but nonetheless it gave us a further key area of responsibility within the project. This heightened the motivation of the GROS staff involved.

4.5 "Live" Operations

- 4.5.1 Throughout "live" operations there were weekly progress meetings that GROS attended (either in person or by telephone conference). When Scottish forms were being processed at Widnes we had a Scottish presence in the team that ONS had set up at Widnes to handle queries with LM and ICL. That presence was invaluable in ensuring that issues with Scottish forms were handled according to our needs, which could occasionally differ from those of ONS.
- 4.5.2 When major slippage started to occur in the capture of data and then in the export of data, GROS was represented in the "fire fighting" and negotiation team that worked with LM and ICL to rectify their problems.
- 4.5.3 GROS was responsible for the development of many of the small IT systems that were used to support the Data Collection functions of all three UK Census Offices. These systems were developed using Lotus Notes. ONS also used Lotus Notes to create some of the systems deployed to support data capture and coding (e.g. the

Query Resolution System). Given our joint expertise in Lotus Notes, GROS helped with the support of some of these ONS-developed systems and developed one of the systems outright (i.e. the “Trouble Ticket” system that was used by the Authority and LM to monitor known problems and faults in the capture and coding services).

4.6 Conclusions

- 4.6.1 We had an excellent working relationship with our colleagues in the other two Census Offices. Although ONS had the lead role, GROS was fully consulted on the major project decisions. Also, when GROS took on the overall management of the testing of the LM services, this gave our staff a very complete and responsible role within the project and relieved ONS of one of the two main aspects of the work during the development phase (ONS retained responsibility for specification, clarification and change negotiation). On the whole, ONS staff working on this project were more experienced (both generally and in Census matters) than their GROS and NISRA counterparts and this was immensely helpful, especially in the earlier stages of the project.
- 4.6.2 Nevertheless, there were occasions where it was difficult to convince our colleagues in ONS of the necessity for some requirements, especially those relating to Scottish geography (for example, the automatic processing of Form Identity and Enumeration Postcode – enabled by our linking of postcodes to Enumeration Districts – a facility that ONS has since recommended should be included in any future Census). ONS saw some of our requirements as an unnecessary complication and applied pressure for us to drop them. During the clarification process and negotiation of changes with LM the GROS team felt that this lack of unified commitment increased the risk of LM over-estimating the impact of implementing some Scottish only requirements. However, this was more than balanced by the fact that, at the inception of the contract, slightly more complex GROS requirements were not charged for separately.
- 4.6.3 Since there were roughly ten times more forms for England and Wales than Scotland, the contractor took the view that the system to process the English and Welsh forms was the default and that any differences arising from the Scottish forms required an add-on development. Although the cost of this was generally smoothed within the overall charge for the services, when handling change requests Scottish requirements appeared to be penalised.
- 4.6.4 Being by far the larger Census Office in the partnership, ONS had a larger management committee structure and more interested parties than GROS. This meant that some issues took some time to consult about and reach a decision on (e.g. the possibility of adopting a central post-back approach and the potential of contracting LM to undertake some “downstream processing” activities). On such occasions GROS often reached a conclusion earlier, but had to wait on ONS before moving forward. In a similar manner, both GROS and NISRA found that they could deal with some anomalies in the “live” data, when held in the LM system, quicker and more effectively than ONS, simply because of the relative volumes of the data concerned (i.e. a task that could be completed by two GROS staff would take twenty ONS staff in the same timeframe),
- 4.6.5 In any relationship where you are the smaller partner there are frustrations when you cannot influence the decision making process in the manner you would like. There were some key points in the project where GROS wished certain things to be done, but ONS disagreed. Each Census Office had legitimate reasons for their

stance, but with ONS being the larger partner, their view held.

- 4.6.5 Having said this, any charges to GROS for Scottish “differences” or delays in decision making were outweighed by the economies of scale obtained by working with ONS.

5. The Contractual Arrangements

- 5.1 Each Census Office had its own contract with LM. For example, the GROS contract with LM was covered by Scottish Law. There were three framework or Accession Agreements which linked to common contract clauses and schedules. The contracts were written in such a way that the responsibilities of each Census Office were seen as joint (i.e. one Authority), and that LM had equal obligation to all three Census Offices. In effect, if one Census Office failed to meet an obligation under the contract then all three were responsible. Equally, if LM failed to meet the requirements of one Census Office, then the penalties would be such that they would have in fact failed all three.
- 5.2 In theory this arrangement could have unfairly disadvantaged a particular Census Office through no fault of its own. However, in the context of the 2001 Census Programme there were many other dependencies, and those relating to this contract carried no greater risk. Nevertheless, a Memorandum of Agreement was signed by the three Census Offices which specified the obligations of each in relation to the LM and other contracts. As it turned out, the Memorandum of Agreement was no more than a safety net that was never required.
- 5.3 Throughout the procurement phase of the project, and in particular during the negotiation stages when the Census Offices were agreeing draft contracts with all three shortlisted suppliers, GROS established a Steering Committee that included a solicitor and a procurement advisor from the Scottish Executive (SE). Although the main UK project already had these advisors, employed by ONS, it was important at the procurement stage that we maintained this independent “audit” to ensure that GROS obtained the best value for money within the context of a UK project. Once the contract was signed GROS used the same legal and procurement advisors as ONS and NISRA.

5.4 Conclusions

- 5.4.1 A contract awarded jointly by three organisations can benefit from one taking the lead, such as in 2001, where ONS led with representatives from each country as key members of the Contractor/Authority combined planning teams. All three Census Offices, but NISRA and GROS in particular, benefited from economies of scale. In such a contract for common services it is neither reasonable nor practical for each Census Office to manage its own contract. There is, however, a point at which the degree of difference in the individual requirements of the three Census Offices becomes so large as to make it impractical for a common approach to be sustained, and therefore a common contract to be negotiated and managed. During the change negotiations with the contractor that followed the Rehearsal we came close to that point in this contract.
- 5.4.2 Major differences in the following aspects of capture and coding will affect the degree to which a common project and contract is practicable.
- Form types and layout (e.g. number of pages per form and the ordering of

- questions on the forms);
- Question types and their format;
- Control Census Geography and captured Census geography (i.e. what is used to control and account for the throughput of forms and what is captured from the forms to enable the output of results);
- Data delivery and query turnaround schedules; and
- Capture and coding quality requirements.

5.4.3 There is a point where the risks involved in managing diverse requirements are too high and are not outweighed by the economies of scale. There is no use having a lower cost common contract that fails to deliver the necessary quality of data in the required timescale. This is true for all aspects of joint working on a Census.

5.4.4 The contractual and operational implications of the differing requirements of the three Census Offices should be carefully considered at an early stage in a future Census programme. If there is enough commonality to merit a joint contract then the principal of 'no unnecessary differences' should be adopted again. A common standard should be agreed, and for each deviation from the standard there is a direct cost, as quoted by the contractor, and an indirect cost in terms of management, development, testing and implementation. Both these costs must be justified. The common standard should not be assumed to be the requirement of the Census Office with the greatest number of forms to be processed. Likewise, there should be a drive to keep the requirements as simple as possible. Although, in theory, a common contract with common requirements was let, in practice there were differences in the requirements of the three countries. If practical, rules should be devised which result in costs for the introduction of diversity to have a direct relation to the additional content and complexity involved. The management of the differences in 2001 was a challenge, but was successfully met.

5.4.5 The issue of joint working applies, of course, to all aspects of a Census, and not just to capture and coding. A joint project or contract will place constraints on the parties involved as they strive to work to common standards. Although such constraints can often have a negative effect by increasing the impact of any deviation from the agreed norm, the positive aspect is that it can help prevent less substantive requirements becoming accepted without sound justification. The timing of the decision on joint working is critical. It has to be taken early enough to allow the project and contract to deliver, and late enough to be adequately appraised of the main differences in requirements.

6. Benefits from working jointly with ONS

6.1 The major benefit of economies of scale has already been covered in this report and all other benefits tend to result in some saving to GROS. However, it is worth considering certain aspects separately since, if for the next Census we decide to work independently of the other two Census Offices, there would be direct and indirect costs associated with an independent project.

6.2 Small changes not charged separately

6.2.1 The contractor charged separately for major differences in requirements that could be tied down to a particular Census Office. However, some differences were small and the marginal costs involved were spread across the charges for all three Census Offices. Using the cost proportioning factor mentioned previously, ONS picked up the highest proportion of these costs despite the fact that the degree of

small differences was probably fairly evenly spread. In other words, ONS met costs that strictly speaking were not theirs.

6.3 Industry and occupation coding expertise and use of common systems

6.3.1 ONS develops and manages the major coding classifications used in the Census and in other surveys. ONS has the experts to hand to devise coding rules and quality assure any products that implement them. Outside the management of testing, GROS had very little involvement in the specification of the automatic and semi-automatic coding systems. Not only did we benefit from the ONS specification work, we also benefited from being able to use the same coding systems. The cost of specifying and developing an independent coding system would be considerable.

6.4 Resources to deal with exceptions

6.4.1 At key points within the contract extra resource was required by the Authority to deal with unforeseen circumstances. Generally ONS met this demand on behalf of all three Census Offices. For example, during “live” processing the number of Form Identity and Communal Establishment classification queries requiring immediate action greatly exceeded what was expected. ONS quickly re-assigned staff from elsewhere in the 2001 Census Programme to cope with the issue, including acting on Scottish queries.

6.5 Resources to develop supporting in-house systems

6.5.1 ONS developed the Query Resolution System that interfaced directly with the LM service. The system transferred difficult queries to the Authority for resolution and return. The development and testing of this system involved at least two ONS developers for a year, but the system was used by all three Census Offices.

6.6 Resources to provide administrative support and expert advice

6.6.1 The administrative staff that supported the Authority’s contract management needs were almost all employed by ONS. At key times during the project, for example during the contract negotiations and when handling major specification changes following the Rehearsal, ONS had a small project support team (up to six staff) organising meetings, preparing paperwork, tracking issues and managing the risk register. This team was supported by in-house expertise from ONS on procurement, contract management, finance, etc. GROS did not have similar expertise and would have needed to go to the SE or elsewhere. Furthermore, ONS directly employed three key external support staff on the project:-

- A leading document imaging and workflow expert from CIMTECH;
- A printing and scanning document expert from CIMTECH; and
- A risk management expert from Vogue Consultancy.

6.7 These were in addition to the legal, procurement and contract maintenance experts for which GROS paid our 8.56% contribution.

6.8 Query resolution team and systems

6.8.1 As previously mentioned, the three Census Offices used a system that transferred difficult queries from the LM processing centre to the Authority for resolution and

return. Address related queries for Scottish forms came to GROS, but all other queries were handled by ONS. ONS built up an expertise in Industry and Occupation coding, using their knowledge as the UK Government Department responsible for the classifications used for coding. It would not have been as cost-effective to build up a similar expertise in GROS.

6.9 Quality management team and systems

6.9.1 ONS also established a team to look at Census quality from end to end. Given that the vast majority of the data and the processes acting on the data were the same for each Census Office (in fact, where there were differences there was very little impact on the quality methods employed), GROS was content for ONS to develop the systems required to monitor quality. For data capture and coding it was primarily ONS who liaised with LM and ICL to create the quality control systems needed. Furthermore, ONS established an Independent Quality Control Group, with supporting IT systems, that looked at the quality of the coded data and images (digital and microfilm) that were received from LM. This Group acted for all three Census Offices. As mentioned in the section on quality, a full report on 2001 Census Data Capture and Coding quality has been published by ONS on their website. The results provided in that report are for the UK, as samples were taken from data for each country and the results aggregated.

6.10 Greater depth of Census knowledge

6.10.1 ONS is a large Government Department and there is greater continuity of staffing between Censuses than in GROS (although the GROS position for the 2001 Census was a big improvement on the 1991 Census). Staff in ONS who have worked on a Census either stay involved in early planning for the next one or move elsewhere in ONS, but then tend to return for the next one once project momentum starts to build. In GROS this is less common since staff move to the wider SE and seldom return. ONS use this Census experience to good effect, and GROS gets the benefit of tapping into this expertise. On the other hand, there can be the downside that innovation can be constrained by not having fresh thinking tackling the issues. Also, managers in GROS had a wider range of responsibilities than their counterparts in ONS, so they could more readily develop a wider understanding of the whole process.

6.12 Conclusions

6.12.1 It is clear that GROS benefited from the resources available to ONS as a large government department. This is demonstrated in a tangible way through the benefits listed above. However, there are a number of indirect ways in which we benefited, in the context of a joint programme:

- The size of a UK Census attracted major bidders for the contract. For example, LM, a financially sound company, stated that they would not have thought it worthwhile to “transport” its solution to the 2000 Census in the US and bid for a Scottish-only project;
- As a large department ONS had good leverage in negotiations with suppliers and with other contacts; and
- As the developers and managers of “downstream processing” the interfaces were relatively easily handled.

7 Weighing up the costs and benefits of working jointly with ONS on a future Census capture and coding project.

7.1 There are some key factors in deciding whether or not a joint approach is appropriate. These factors can generally apply to all three Census Offices and not just GROS, and they apply to almost all aspects of Census work. They are:

7.2 Synergy of forms layout and of forms content

7.2.1 As with the 2001 Census, economies of scale will apply if the differences between the requirements of the three UK Census Offices are minimal. However, any significant deviation from a common approach will very quickly erode any savings. This was demonstrated when the design and content of the Scottish form changed after the Rehearsal (mainly due to the wishes of the Scottish Parliament).

7.3 Common development timelines

7.3.1 For the 2001 Census, the three UK Census Offices agreed a common Census Development Programme with closely matching decision points. Without this common plan, costs would quickly rise and additional major risks would be introduced. It may be that a desire to deliver results quicker to customer (a definite possibility for GROS) or a different legislative programme would be major factors.

7.4 Commonality of requirements

7.4.1 The GROS requirement for handling addresses (i.e. dealing with postcodes) at data capture and coding was more sophisticated than that for ONS (reflecting the fact that GROS has a more finely-tuned method of determining small areas for Census outputs). This difference in requirement created an overhead that had to be managed by all three Census Offices. Any additional differences in requirement would add further to this overhead and hence increase costs and heighten risk. It is worth noting that, for the 1981 Census, capture and coding from Scottish forms was undertaken separately, due to major differences in forms design and capture requirements.

7.5 Level of autonomy of decision making required

7.5.1 Following devolution, GROS has a responsibility to facilitate the production of Census statistics that are compatible across the UK, where appropriate, and also to meet EU requirements, but we also have a duty to meet the statistical needs of the Scottish people, Scottish local government and the Scottish Administration. To be reactive to our customer's needs and to be able to take decisions without external influence, we need to work in a project environment that is flexible. Clearly, the more partners and interests that exist in a project the less scope there will be for flexibility.

7.6 Level of internal policy and technology compatibility

7.6.1 When planning for the 2001 Census GROS recognised (e.g. in its IS Strategy) that adopting key ONS standards would give us more say and a better chance of success in the joint programme. A prime example was the GROS decision to adopt Lotus Notes as the office-wide Email and information management system. This facilitated direct communications and a sharing of information and IT

resources with ONS. Without this close integration, costs would have risen (through duplication of effort and more travel) and additional risk would have resulted. Following devolution, our ties with the SE have become much greater and it is our strategy to adopt the standards and IT infrastructure that is used within the SE. Any future relationship with ONS would not be supported by the same level of integration as the 2001 Census.

7.7 Desire and ability to innovate (both technically and statistically)

7.7.1 In previous joint Censuses GROS has still found the scope to be innovative, and hence achieve savings or improve the outputs to customers. The benefits of working jointly with a large department such as ONS have already been highlighted. But there are also some potential benefits from working alone as a small department. For example, the capture and coding of Scottish data may be small enough for a company to take on using existing equipment and services. The viability of a small company would become an added issue to manage. Equally, we may decide to take a different approach to collecting and collating Census forms, and then how we code them, resulting in quicker throughput and more timely results.

7.8 Ability to take decisions quickly

7.8.1 Effective management of a programme of work is heavily dependent on the ability of management at the appropriate levels to take decisions at the correct time. As a joint project within the 2001 Census Programme it was successful, especially in financial terms, but at times it suffered from an overly bureaucratic management organisation that had to take account of the needs of all three parties (perhaps giving greatest frustration to ONS). A major drawback was that decision making was generally slower than necessary, and some key deadlines were missed as a result. It can be seen from what has been covered in this report that the project was successful both because of, and despite, that inflexibility.

Appendix A – Processing Area Constitution

Processing Area	Council Area
Ayrshire & The Marches	Dumfries & Galloway
	East Ayrshire
	North Ayrshire
	Scottish Borders
	South Ayrshire
Lothian	East Lothian
	Edinburgh City
	Midlothian
	West Lothian
Strathcarron & Fife	Clackmannanshire
	Falkirk
	Fife
	Stirling
Grampian	Aberdeen City
	Aberdeenshire

	Moray
Highlands & Islands	Angus
	Dundee
	Highland
	Orkney Islands
	Perth & Kinross
	Shetland Islands
	Western Isles
Lanarkshire	North Lanarkshire
	South Lanarkshire
Glasgow & Dunbartonshire	East Dunbartonshire
	East Renfrewshire
	Glasgow City
	West Dunbartonshire
Dalriada	Argyll & Bute
	Inverclyde
	Renfrewshire

