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PIT SLOPE PROJECT – A CASE STUDY OF CONTRACTING-OUT

G. BARTLETT AND D.F. COATES

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PIT SLOPE PROJECT — A CASE STUDY OF CONTRACTING-OUT

by

G. Bartlett* and D.F. Coates**

ABSTRACT

The requirement that all government science and technology needs, except for those exempted, be contracted-out to private performers is a prominent feature of existing science policy. The premise is that shifting more R & D activity to the private sector to be conducted under contractual arrangements will eventually have the effect of enhancing the innovative capacity of private business with associated economic benefit to the nation.

The intent of this paper is to provide a detailed analysis of research performance under contract. A single R & D undertaking was selected as being appropriate for this purpose. The Pit Slope Project, which culminated in the publication of a 25-volume manual, was a multi-faceted R & D undertaking extending over five years and entailing 78 contracts with 42 outside performers.

A systematic treatment of contract performance was based on subjective estimations made by CANMET supervisors. The analysis incorporated the following elements: (a) the general objectives of contracting-out as expressed in the formal policy, (b) the composite aspects of research performance and (c) an array of possible factors affecting performance. The analytical framework enabled the results of a questionnaire survey to be tabulated in numerical form.

The analysis shows that, considering all aspects of research performance for all contracts taken together, 31.9% of total ratings were designated as "commendable" and the combined "commendable" and "acceptable" ratings amounted to 87.6% of all ratings. The number designated as "unacceptable" was 12.4% of all ratings.

A review of the Pit Slope Project from the points of view of both policy enforcers and policy-actors demonstrated that a stance of accommodation would be mutually beneficial.

Examining the experience in contracting-out the bulk of the R & D associated with this reference case led to the recommendation of a budgeting procedure which, together with Treasury Board guidelines, would provide an optimal division between in-house and contract performance.

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PROGRAMME SUR LA PENTE DES MINES A CIEL OUVERT — L'ETUDE D'UN EXEMPLE DE L'OCTROI DE CONTRATS

par

G. Bartlett* et D.F. Coates**

RESUME

La politique scientifique actuelle favorise l'octroi de contrats de recherche en science et en technologie à l'industrie privée, sauf pour le cas d'exemptions, pour subvenir aux besoins du gouvernement. Le but de cette nouvelle orientation des activités de R & D vers le secteur privé selon des engagements contractuels est de stimuler la capacité innovatrice des entreprises privées pour le bénéfice économique de tout le pays.

Le présent rapport a pour but de fournir une analyse détaillée du rendement de la recherche effectuée à contrat. On a choisi, en guise d'exemple, un seul projet de R & D, le Projet sur la pente des mines à ciel ouvert. Ce projet, présenté sous plusieurs faces, a duré cinq ans et a impliqué 78 contrats et 42 travailleurs externes et se termine par la publication d'un manuel en 25 volumes.

Le traitement systématique du rendement d'un contrat est basé sur des estimations subjectives effectuées par les surveillants du CANMET. Cette analyse tient compte des éléments suivants: (a) les objectifs généraux de l'octroi de contrat tels que définis par la politique générale, (b) l'aspect composé du rendement de la recherche et (c) une gamme de facteurs susceptibles d'affecter le rendement. Le concept analytique a permis d'exprimer les résultats d'un questionnaire sous forme numérique.

Les résultats de l'analyse démontrent que selon tous les aspects du rendement de la recherche de tout l'ensemble des contrats, 31.9% de toutes les cotes d'évaluation sont sous la mention "méritoire" tandis que 87.6% de toutes les cotes d'évaluation sont sous une mention soit "méritoire" ou "acceptable". On a jugé "inacceptable" 12.4% des cotes d'évaluation.

Un examen approfondi du Projet de la pente des mines à ciel ouvert du point de vue de l'application et de la mise en action des politiques démontre qu'une position de conciliation serait mutuellement profitable.

L'expérience acquise lors de l'octroi de contrat pour une majeure partie des activités de R & D de cet exemple pris en référence, a conduit à la recommandation d'une procédure de comptabilité qui selon les directives du Conseil du Trésor, indiquerait clairement la division entre le rendement des chercheurs internes et des chercheurs à contrat.

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INTRODUCTION

Federal Government departments and agencies are required to comply with a policy of contracting-out research to the private sector to enhance the innovative capability of Canadian industry.

Since 1972 when the policy was proclaimed, its scope has been considerably expanded. A set of guidelines was drawn up by Treasury Board in 1973 and has recently been modified*. The onus is placed on government departments to contract-out all research except where it can be demonstrated according to a prescribed set of circumstances that it should be undertaken in-house.

The purpose of the present study, which is largely of a subjective nature, is to develop a means whereby CANMET can conform as closely as possible to government policy while continuing to conduct its mission and to meet its standards of performance. Much can be learned from previous experience and an examination of research imperatives that will assist management. Also of concern are the precautions which have to be taken in operating within the framework of this policy.

The approach selected is to focus on a single project and subsequently expand the analysis to include CANMET activities in general. The methodology is unsophisticated and consists of determining the elements and dimensions of the task, shaping the analysis, and soliciting information from selected management and scientific personnel.

The reference case, the Pit Slope Project, was initiated in 1972, and its R & D phase extended over five years to 1977. A second phase, entailing measures to transfer the technological content of the project to private industry, is currently proceeding.

This project is appropriate for a policy-related inquiry since it was conceived prior to the official promulgation of the so-called "make-or-buy" policy. In composition, it is particularly suitable as a case representative of CANMET activities as it embodied elements of applied research, synthesis from existing knowledge, development and innovation, and, presently, technology transfer.

SCIENCE POLICY SETTING

Evolution of the contracting-out policy

The present policy of contracting-out has its genesis in the recommendations of the Special Committee on Science Policy, chaired by Senator Maurice Lamontagne and published as Volume II in February 1972. The initial reference contained a simple recommendation that the Government's R & D needs

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* "Guidelines for the Implementation of the Make-or-Buy Policy Concerning Research and Development Requirements in the Natural Sciences." Administrative Policy Branch, Treasury Board, January 1973. "Policy and Guidelines on Contracting-out of the Government's Requirements in Science and Technology." Administrative Policy Branch, Treasury Board, April 1977.

be met as much as possible by industry and universities and that all intramural R & D activities be reviewed to see if they could be contracted-out to the private sector. The Government immediately responded by proclaiming the make-or-buy policy but limited its application to new mission-oriented R & D programs*. The Cabinet subsequently instructed the Treasury Board Secretariat to provide implementation guidelines to all departments and agencies listed in Schedules A and B of the Financial Administration Act. Also, the Ministry of State for Science and Technology, in consultation with appropriate departments and agencies, was given the responsibility to review these procedures periodically and report its findings.

In January 1973, the Treasury Board Secretariat published its first official directive on the implementation procedure. The Cabinet extended the application of the policy in 1974 to permit unsolicited proposals from the private sector to be considered in satisfying new government R & D activities. The scope of the policy, incidentally, was also extended at this time to comprehend scientific activities in the human sciences where these concern urban, transportation and regional studies.

Treasury Board issued a restated directive and a set of revised implementation guidelines to become effective on April 1, 1977, which contained a statement of conditions for exemption. It superseded the practices of the Department of Supply and Services (DSS), since renamed Supply and Services Canada, which has the responsibility to undertake the actual contractual arrangements.

Essence of the policy

The essence of the contracting-out policy is the general principle that R & D requirements of the government should be done by private Canadian performers except where there is an internal need.

The guidelines set the requirement that all judgements on contracting-out are to be made with "due regard for the optimum benefit to Canada" (par. 18). When optimum benefits are taken to mean the social optimum, this condition tends to support doing more intramural work following the economic axiom that the private market allocation of resources to R & D, especially basic research, would be less than the social optimum if left entirely to the private sector.

In deciding on the manner of performing R & D, therefore, the entire public interest must be accommodated, including arranging for access to the resulting knowledge by all participants in the Canadian economy. This point was made explicit in the original guidelines but only received passing reference in the 1977 version. Conversations with various officials at the Ministry of State for Science and Technology and the Treasury Board Secretariat indicated that the identification of cases for contracting-out must be left to the departments. Quantitative analyses are not applicable to the issue; rather, an assessment of the advantages and disadvantages associated

* "Proceedings of the Special Committee of the Senate on Science Policy." Issue No. 15, page 15:12, August 1977.

with the basis on which the case for in-house performance is made, must be undertaken.

In the case of new facilities, a proposal for in-house expansion must be supported by a comprehensive assessment of designated factors entailing considerable quantification only in the instance where the "optimum benefit to Canada" is at issue. In this respect it should be understood, where a project is so identified, that a comparison of the effects of performance in-house and under contract is required and not an analysis of costs and benefits of the research independent of the manner of conduct. Since the directive specifies that the policy applies to on-going and new R & D, which has already been provided for in the budget, presumably any comparison of costs and benefits associated with research, independent of the manner of performance, has already been taken into account; there remaining only the matter of deciding whether the optimal benefits to Canada are achieved by in-house or by contract arrangement.

Policy effectiveness

The vital contribution of science and technology to the social and economic well-being of Canadians is recognized by the formulators of the nation's science policy. The contracting-out policy reflects the Government's belief that "it is in the national interest to encourage the fullest possible participation of Canadian industry in meeting these needs, to stimulate industrial innovation and thus to provide additional benefits to the Canadian economy."* The Government views the eventual provision of a more even balance between the private and public sectors in performing research in mission-oriented science and technology as a logical extension of its belief in the need to encourage the enhancement of the innovative capacity in the private sector.

A common criticism on the part of private firms of the contracting-out of mission-oriented or public purpose R & D is that this type of need is not commercially marketable, except for government purchases, and consequently the policy cannot lead to a self-perpetuating process under private market conditions. Research for public health and safety, education, and public transportation fall into this category. The increasing reliance on initiatives from all levels of government for the provision of services, together with the possibility of exporting the technology or products, somewhat weakens this criticism.

CANMET's mission, aside from providing a knowledge-base for federal policies and regulatory agencies, is one of assisting industry to be more effective in extracting and utilizing the nation's mineral and energy resources. An example of products which might be developed by private concerns under government sponsorship are dust control equipment and monitoring devices for application in asbestos mining and processing, emission control attachments for engines and ventilation systems, and apparel and accessories to improve workers' safety and comfort.

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* Policy and Guidelines on Contracting-out of the Government's Requirements in Science and Technology, Administrative Policy Branch, Treasury Board, April 1977; p 4.

Engineering systems for pollution control provide another example of the type of product which can be produced under contract and be supplied by the private sector in normal firm-to-firm interaction.

In the case of CANMET, then, because of its industry orientation, contracting-out of R & D can lead to recognition and acceptance in the commercial market.

The private sector might not be responsive to innovation incentives in the form of contracted research where (a) safety and environmental regulations do not cover a particular hazard or a need is not even recognized, (b) current technology does not permit compliance with accepted standards and (c) technical information is needed even to develop regulations. Many private firms are not likely to see the need to conduct research into ways and means to improve environmental standards. The fact that some private operators do indeed sponsor environmental research should not lead to public belief that private industry can be depended upon to do so.

Where society's demands and expectations on environmental quality exceed existing technical capabilities and enabling legislation is absent, a government R & D agency is the appropriate body to undertake and carry through the relevant investigative work. This area of R & D in the public interest offers CANMET an opportunity to expand activities or reorient in-house resources to this purpose. Leadership in R & D related to health, safety and the environment is clearly the domain of a public agency.

Another comment on Canadian science policy is that merely contracting R & D to the private sector does not ensure enhancement of innovative capacity. Contracting-out, it is often contended, ignores the requirement of rapid diffusion once an innovation occurs. Technology transfer, it is argued, is a function of competition, comparative costs, corporate mergers, acquisitions, mobility of expertise, attitudes to risk, perceptions on the future and, perhaps most important in the Canadian context, industrial structure. The Canadian mineral industry is foreign-owned and controlled to a substantial degree. Moreover, the post-invention stages of innovation, namely production, installation, refinement and modification, are often not represented in government R & D requirements.

The result of this argument is that innovation opportunities passed to the private sector under contract contribute only minimally to the objective of enchancing capacity for invention across the economy. This is so because many obstacles to dynamic innovation and diffusion are inherent in Canadian industry itself and beyond the influence of government policy. This contention is very credible and, in view of the wide recognition accorded it in the Lamontagne Report and elsewhere, the criticism warrants further consideration by reviewers of the contracting-out policy.

A third factor bearing on the effectiveness of the contracting-out policy in achieving the objective of improving innovation in industry is purely scientific in nature. Apart from the scientist's natural resistance to management of his endeavours, there are certain imperatives of scientific activity which must be honoured in any policy regime if the quality of

science is to be maintained. Here scientists are referring, of course, not merely to a certain degree of autonomy, but to the maintenance of the "scientific ambiance" in which professional standards take precedence over policy objectives.

There is still fear, reasonably well founded, among scientists in particular and also research engineers, that the zeal with which the contracting-out policy is applied will, notwithstanding built-in safeguards, encroach on these professional rights and mar the quality of the work performed. Overloading of in-house staff with excessive contract supervisory responsibilities stemming from underestimation of in-house requirements or from erosion of in-house staff due to austere manpower policy are two circumstances which would vindicate this fear. The great danger in this case would be deterioration in the quality of all science and technology R & D, whether performed in-house or contracted-out.

The fact which has to be recognized in averting this eventuality is that scientists in their capacities as scientists need to practise their profession and there is a definite if undefinable limit to the extent to which a practising professional is willing to forego performing research to supervise or manage outside research conducted under contract. This is especially so if the contract arrangement does not give the scientist the type of control he requires.

In-house requirements are well recognized in the guidelines, but there is a degree of mistrust of the policy enforcers on the interpretation of such phrases as "limited in-house competence," "current state-of-the-art" and "a more even balance between scientific activities performed by industry and through the Government in support of departmental missions." Policy enforcers will have to be more explicit in giving guidance and very cautious in conducting implementation to win the confidence of the policy actors on this issue. The scientific imperative is perhaps the only constraint which necessitates that the pursuit of this policy be tempered by professional considerations.

Until the consequences become clear, the emphasis is best placed on mutual accommodation rather than on rigid enforcement of the contracting-out precept.

THE POLICY SIGNIFICANCE OF THE PIT SLOPE PROJECT

Project description

The Pit Slope Project is appropriate for an analysis of contracting-out to identify considerations which bear on the mode of performance. The project's magnitude, the breadth of its R & D, and the coincidence of its planning stage with science policy developments are the characteristics which favour its selection as the reference case.

Consistent with the purpose of this paper, the analysis of the Pit Slope Project is structured to conform with the policy issues and to address the essential problem of determining the best possible approach to policy compliance when all relevant considerations are taken into account. The scope of the analysis and individual elements are consequently determined by

the study purpose. Aspects of the project not relevant to the task at hand are ignored.

The Pit Slope Project, begun in April 1972, entails two five-year phases of execution. The first phase, which was completed in 1977, involved the preparation of a comprehensive engineering manual to assist in the design of slopes in open pit mines. A second phase, now in operation, consists of holding conferences, industry seminars and company workshops. Publicity through the technical press for these activities as well as details on the availability of the 25-volume manual is arranged.

The project was justified under the departmental objective "to develop mining technology that is important for exploiting Canadian resources by advancing the use of new technology in current mining operations, improving working conditions, developing new mining systems that will assist in preserving the environment, and protecting the public from the hazards of explosives and other dangerous substances". Studies at CANMET indicated that increasing pit slope angles could result in large savings to mining companies. The project was conceived with the ultimate aim of "...reducing the cost of producing minerals from open pits by synthesizing research data into engineering systems for (a) design and (b) support of the sloping walls." Since almost 70 per cent of minerals mined in Canada are extracted by the open pit method, the Manual is expected to be widely adopted and the benefits to be substantial.

Scientific management of the Pit Slope Project was exercised through two lines of control. An Interdepartmental Selection Committee, made up of officers of CANMET, Geological Survey of Canada (GSC), Department of Supply and Services (DSS) and Treasury Board (TB), ruled on the awarding of R & D contracts and a number of designated scientific authorities supervised the day-to-day progress. DSS handled the contractual arrangements. CANMET's Research Program Office provided the immediate administration of funds.

Project efforts for the first phase could be broadly classified as (a) organizational and procedural, (b) research and development of new techniques, (c) modification of existing techniques to suit the intent of the project, (d) field testing of techniques, and (e) preparation of the Manual.

Overall, roughly 30 per cent of the primary research was performed in-house. Thus the bulk of the primary research, together with virtually all of the development work, was contracted to outside performers.

Economic and technological considerations

As a preliminary evaluation of the project, a cost-benefit analysis of the R & D effort and resultant effects was conducted from the point of view of the Canadian society.* The analysis indicated a very high ratio of tangible benefits to costs and was obviously quite influential in winning Treasury Board support and conditional approval.

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* Coates, D.F. and Dubnie, A. "Benefits and Costs of Research on Rock Slopes"; Mining Research Centre, Department of Energy, Mines and Resources; Internal Report MR 71/50-ID; 1971.

The relationship of the technological improvements stemming from the Pit Slope Project to the resultant economic effects and the nature of these benefits including the identification of the various recipients, are stated in the introduction to the Manual (Chapter 1, Summary). Essentially, improving the technology of rock stability by investing an optimal amount in stabilizing procedures permits lower per unit excavation cost while maintaining an equal or acceptable level of safety. Maintaining the safety factor is critical to this principle since any deterioration in safety imposes costs, not only in terms of mine economics but more seriously in terms of loss of life and injury associated with instability. The authors make it explicit throughout the Manual, however, that safety considerations always have precedence over economics.

In strict economic terms, the dominant measurable benefit accrues directly to the operating companies in the form of cost savings and increased after-tax profit. Redistribution of monetary effects occurs by way of taxes to governments and, in some cases, royalties to governments or private resource owners. The importance of mining activity in providing new and extended employment in regions of economic underdevelopment was emphasized. The analysis rightly noted the equivocal nature of the foreign exchange implications for the national economy.

It cannot be denied that the improved efficiency of Canadian mining is desirable whatever be the ownership and market structure of the industry. In the short term, until the advancements in pit planning resulting from this R & D are put into practice elsewhere, this new capacity will assist Canada's competitive position in international mineral markets. In this case of achieving improved efficiency through design procedures there is the notably attractive feature of it being gained without a net employment loss which usually accompanies technology-induced improvements. By enabling more of the nation's resource endowment to be extracted economically, the net effect on employment is positive.

Technological considerations also came into play in CANMET's decision in selecting the most appropriate form of R & D in effecting a basic industry-wide efficiency drive. The options open to CANMET were to undertake design research or to pursue development of continuous mining systems. Pit slope design was viewed as the appropriate approach since continuous mining systems could not be developed and tested at the production scale because of practical constraints both within CANMET and the industry. Easy field application was no doubt a factor favouring stability studies since from this stage it would be a short step to operational application. In fact, consistent with scientists' natural inclinations, scientific efficiency was likely the first consideration, and this approach is actually more fundamental in R & D than is an analysis of identifiable effects because it emphasizes the likelihood of success as opposed to mere hypothetical benefits. Formal cost-benefit analysis can of course cope with uncertainty by attaching probability estimates and deriving expected values but this is not the same approach and will not necessarily lead to the same decision as one placing emphasis on technological success.

The Pit Slope Project was financed under the B-level budget and was not seen to compete with ongoing CANMET R & D projects. In this case the

correct budget perception entailed a choice between competing new projects at the conceptual stage. Of the two technological options suiting the objectives, only the stability technology was deemed feasible considering practical aspects. Under this circumstance, there was no need to consider the opportunity cost of this single expenditure and the decision was reached based on a favourable cost benefit ratio of a single option.

Contracting-out decision and policy influences

The CANMET submission to Treasury Board with reference to the Pit Slope Project in April 1971, proposed to contract-out 75 per cent of R & D to the private sector and universities. Treasury Board indicated approval in principle in June 1971 and final approval followed in April 1972, with the proviso that (a) private industry — since mining firms were to be the chief recipients of the direct benefits — be required to contribute 50 per cent of the overall project cost and (b) an annual evaluation of the progress of the previous year be undertaken using performance measures prescribed by the Selection Committee.

The imposition of the first condition effectively meant the decision to contract-out was not entirely independent of Treasury Board. Since private firms and universities could not plausibly provide cash for work to be performed internally at CANMET, the cost-sharing proviso would have meant some form of extramural direct participation in any case. In actual fact, private extramural contributions were valued where possible at commercial rates, and entered the accounting as costs against the project.

While reference was made in the approval document of Treasury Board, dated January 13, 1972, to "make-or-buy policy," as the contracting-out policy was then termed, the implication is that CANMET's initial submission coincided with the Government's new posture on external performance of its R & D requirements. Although the make-or-buy policy was being promulgated, there was clearly as yet no force behind the proclamation and no onus on departments to justify in-house R & D performance as subsequently became the case.

The CANMET proposal to offer contracts for the bulk of the R & D associated with the Pit Slope Project was in recognition of the nature of the technology involved and the intellectual resources which would have to be tapped to produce the required result. Stability technology has a broad dependence on specialists across many disciplines including structural geology, rock mechanics, hydrology, structural engineering, blasting, telemetry, finance and risk analysis, and planning and design. This characteristic of the project required the use of as large a representation as possible of appropriate expertise available in Canada and, in at least two cases, elsewhere.

During the process of project definition at CANMET, the aspects which were deemed essential to control and performance, such as scientific supervision, collation of material and final preparation of the Manual were retained in-house together with about 30 per cent of the primary research; the remaining activities, principally primary R & D and testing, were allocated to the private domain. In retrospect, the essential logistics of the project appears to have determined the eventual division of tasks, but the actual target was decided upon early in the planning stage in a rather arbitrary manner.

PERFORMANCE REVIEW AND IMPLICATIONS

An assessment of contract performance using qualitative ratings is attempted under this section. Contract performance is difficult to assess and impossible to measure for R & D. Hence the review undertaken here relies on the judgment of in-house expertise to establish the level of performance and quality of output experienced in contracting aspects of the project. The required information was collected by a questionnaire using a structured format treating each contract separately.

The purpose of attempting to assess performance in the context of this inquiry is to consider the project as a test case in comparing the quality of research and development conducted under contract with the standards of performance established over the years for work of this nature in CANMET. The resulting judgments on standard of work performance have no impact for the contracting-out policy but may be used in a general way to indicate the expected performance level of contracted work. These aspects have implications for policy implementation within the branch.

A final part of the review of performance assembles sundry observations contributed by CANMET science managers, not all of whom were involved in the formal survey. Since any reference case may not reveal the entire range of the issues embodied in the practice of contracting R & D, a broadening of the base of subjective opinion serves to strengthen the analysis. Therefore, the issues revealed in the returned questionnaires were used to interrogate CANMET program managers on the general relevance of the experience gained in the Pit Slope Project to the contracting-out practice.

Methodology and survey content

Seventy-eight contracts were awarded to 42 outside organizations over the course of the project. Of the 42 contractors, 7 were universities, 2 were non-profit research councils, 9 were mining or manufacturing firms and 24 were consultants.

A questionnaire comprising two response sheets was distributed to each of six scientific authorities responsible for supervising contractors. Each scientific authority was asked to grade only those contracts for which he had direct supervisory responsibility.

In attempting to assess contract performance in a systematic manner, consideration was given to (a) the general objectives of contracting-out as specified by the formal policy, (b) the composite aspects of effective performance in view of objectives and (c) an array of possible factors underpinning individual performances.

The idea behind the resultant format was to have scientific authorities systematically grade each contract performance, relate performance to its cause and derive any implications for the practice of contracting. Some aggregating across arbitrary ratings is possible from returns under this questionnaire format. However, since the survey does not constitute a controlled statistical sample, no supportable inferences can be made. The procedure is used in this inquiry merely to describe the experience derived from the project, under given circumstances of conduct, and to record subjective responses using a questionnaire format designed to assess performance in a qualitative manner.

Table 1 - Ratings of contract performance (by type of contractor and relevant aspect)*

	Aspects of performance (frequency of occurrence)							
	Pertinence and adequacy of proposal with respect to the request for proposal (1)	Adherence to schedule of contract work statement and contractor's proposal (2)	Completeness of work performed (3)	Quality of work performed (4)	Contribution to advancement of knowledge or improvement of techniques (5)	Rating frequencies (6)	Performance summary (expressed at % of possible ratings) (7)	Number of contracts** (8)
UNIVERSITIES								24
Commendable	12	5	4	10	15	46	38.3%	
Acceptable	12	14	17	12	6	61	50.8%	
Unacceptable	0	5	3	2	3	13	10.8%	
CONSULTANTS								33
Commendable	14	7	13	13	7	54	32.7%	
Acceptable	18	18	14	16	21	87	52.8%	
Unacceptable	1	8	6	4	5	24	14.5%	
MINING/MANUFACTURING FIRMS								13
Commendable	4	1	4	2	2	13	20.0%	
Acceptable	9	11	6	9	8	43	66.2%	
Unacceptable	0	1	3	2	3	9	13.8%	
PRIVATE RESEARCH COUNCILS								4
Commendable	1	1	1	1	1	5	25.0%	
Acceptable	3	3	3	3	3	15	75.0%	
Unacceptable	0	0	0	0	0	0	0.0	

* Classified by the type of principal contractor. In a few cases some work was let out to subcontractors of a different type which could not be separated for the assessment.

** Actual number used in this assessment. Excludes four contracts which were of a nature precluding use here.

Performance ratings

Table 1 shows a tabulation of the results of Response Sheet No. 1. Contractors are segregated by type with the number of contracts undertaken per type of contractor indicated on the far right. It is noteworthy that for the Pit Slope Project there was wide variation in the number of contracts amongst the four types of contractors — a fact which militates against characterization of performances by type.

The five aspects of contract performance defined for the questionnaire comprise columns 1-5. The frequency of occurrence of the three arbitrary designations "commendable", "acceptable" and "unacceptable" are shown for each of the five aspects deemed to constitute contract performance by type of contractor. Total occurrences are given by designation under each type of contractor in column (6). Column (7) shows the proportion of the frequency of occurrence for each rating designation as a percentage of possible designations (determined by the number of contracts performed by each type of contractor).

On a percentage basis, this project indicated that research councils as a group performed best, showing the highest occurrence of combined "commendable" and "acceptable" designations and no "unacceptable" ratings. However, the number of contracts on which this outcome was based was too small relative to other types of contractors, to generalize.

The universities received the highest percentage of "commendable" ratings followed by consultants. However, at least for this project consultants also demonstrated the highest percentage of "unacceptable" designations. It is conceivable that, since consultants performed significantly more contracts than any other single type of contractor and since there are a limited number of superior organizations within each type, a relatively higher percentage of ratings would fall to this low designation.

It should be emphasized that this inquiry draws no generalizations with regard to performance by type of contractor. The above observations are offered merely as the subjective ratings on performance with respect to this single project.

Overall, performance ratings of all types of contractors considered together shows 31.9 per cent of all ratings as "commendable" performances and a total of 87.6 per cent combined "commendable" and "acceptable" performances with the level of "unacceptable" performances at 12.4 per cent of all ratings.

Account of poor performances

The level of unacceptable performances experienced in the contracting of R & D associated with the Pit Slope Project was not excessive. Nevertheless, a number of contributing factors and circumstances have been identified by the scientific authorities. There are indications from Table 2 that certain unfavourable features recurred which, in many cases, unambiguously underlaid poor performances. Most prominent of these features were: insufficient allocation of physical resources to the task, inadequate managerial ability of contractors, professional incompetence on the part of contractors in some fields, and lack of complete cooperation with the sponsor. To a

Table 2 - Factors contributing to performance — frequency of occurrence

ALLOCATION OF PHYSICAL RESOURCES BY CONTRACTOR	
- met contract requirements	52
- insufficient	17
CONTRACTOR'S MANAGERIAL ABILITY	
- adequate	52
- inadequate	14
- did not significantly influence output	4
SCIENTIFIC COMPETENCE OF CONTRACTORS	
- adequate throughout	51
- inadequate in some respects	17
- adequate but not evident in performance	3
CONTRACTOR'S COOPERATION WITH SPONSOR	
- cooperated initially only	1
- cooperated throughout	55
- cooperated on some aspects only	14
SPONSOR'S DEFINITION OF WORK	
- adequately defined and specified	61
- limited definition due to nature of task	10
CONTRACTOR'S COMPREHENSION OF TASK	
- understood purpose	71
- did not understand purpose	1
- understood contract requirements	66
- did not understand contract requirements	6
MOTIVATION OF CONTRACTOR (unranked)	
- scientific interest	51
- direct income	38
- indirect income (public relations)	25
- improved technology for own use	53
- basis for personal publication	14

lesser degree the sponsor's definition of the task to be performed was admitted to be vague — necessarily so in most cases — and this undoubtedly contributed to misunderstanding on the part of contractors as to the purpose and requirements of the task.

As for motivation, tabulation is less meaningful because the factors ascribed are not well understood as to their effect on performance. The two factors commonly expected to contribute to unacceptable contract performance, i.e., direct and indirect income, and perhaps the publication motive, were judged by CANMET supervisors to have been prominent in contractors' motivations. Whether these motives are always detrimental to contract performance is, of course, debatable. However, only in a few instances did survey respondents indicate that income and publications were prime concerns of contractors and usually these motives were accompanied by scientific interest and interest in improving own capabilities.

Without getting into a detailed commentary on performances it is possible to condense the types of circumstances which led to unacceptable performances and marred otherwise acceptable performances.

Unacceptable performances and attributing causes were as follows:

1. A manufacturing firm developed a resentment to the direction which the task took, possibly feeling it would indicate or imply defective products of its manufacture.

2. A mining firm ran into economic difficulties which curtailed production and terminated its involvement in the project.

3. A contractor placed excessive emphasis on publishing early results under his name, forcing the sponsor to terminate the contract.

4. In two cases, contractors were found to be incompetent for the required task or lacked essential equipment. This stemmed from two circumstances: (a) the contractor had presented an admirable proposal but could not deliver a report, and (b) no acceptable alternative performer could be found for certain research.

Factors which contributed to less-than-expected levels of performance were as follows:

1. Contractor placed direct income ahead of quality of work.

2. Contractor experienced loss of key personnel during course of the contract.

3. Sponsors' demands exceeded initial agreement.

4. Contractor ran into financial trouble.

5. Contractor involved himself with other clients to detriment of the project.

6. A university staff member failed to distinguish between the performance requirements under a contract and those under a research grant.

7. Contractors failed to present data in the format and style prescribed by the sponsor for the Manual, in part due to sponsor's delay in selecting and issuing formal guidelines.

Observations on policy and practice

Discussions with CANMET personnel who were engaged in supervising the project, including some who are still involved in the second phase, have exposed a number of concerns. The contracting experience acquired provided observations germane to the entire contracting-out policy, its refinement and further development and, more important from CANMET's view point, the best manner of compliance. Within the context of the still existing controversy over contracting-out policy, a position of accommodation is taken in this inquiry. This stance demands that factors related to scientific performance be treated from two points of view: that of the policy enforcers and that of the policy actors. For the sake of analytical expediency observations made on the subject of efficiency in pursuing CANMET R & D needs are broadly categorized to suit the purpose of the inquiry.

Policy enforcers should be cognizant of the fact that, due to the nature of scientific endeavour, research definition is sometimes necessarily vague, and transferring this work to outside contractors could lead to uncontrolled performance. In the case of the Pit Slope Project, while some contracts were let under loosely-defined instructions, the resulting performance was nevertheless acceptable because of a conscious decision having been made to explore a research area purely for the purpose of demonstration. This was the case, for example, where slope stability studies in collaboration with a mining firm were undertaken with a view to showing the viability of mechanical support without any further plans for research. General observations on research definition made by some researchers at CANMET lead to the conclusion that definition is, indeed, important to efficiency and control and, therefore, should come to bear on the allocation of efforts to in-house and contract performance. One observer, however, drew no distinctions between in-house and outside performance in considering the degree of definition, maintaining that ill-defined work should not be undertaken in any manner.

The Pit Slope Project did not run into difficulty in acquiring sufficient supervisory personnel for science management. However, two of the six supervisors were recruited specifically for the project. There were problems initially due to the unpreparedness of DSS and to the extra administrative load on CANMET. The project may not be typical in this respect. It is conceivable, moreover, because of the relative significance of this project to CANMET, that its conception may have more nearly matched or reflected the concentration of expertise than would other research projects of lesser stature. Discussions with science managers imply that, from the point of view of implementation, policy enforcers should observe the fact that managerial abilities in scientific professions, as in all disciplines, are not necessarily related to training or competence and hence place a constraint on the amount of contract supervision which can be undertaken at any given time and the speed with which the shift to high levels of contracting-out can be achieved.

While the decision to engage contractors in performing the Pit Slope Project was based on requirements of the research, the grounds for the actual split — 25 per cent in-house, 75 per cent contract — was arbitrarily aimed at as a target. It is suggested that this approach be changed to one of examining each component of research systematically, using a prescribed set of considerations and rationalizing allocations according to factors which come to bear on the work performance. This approach conforms with the spirit of the policy on contracting-out, and its adoption would ensure that internal imperatives are not overlooked in policy compliance.

The supply of research supervisors has equally strong implications for compliance and implementation. This feature was early recognized in connection with the Pit Slope Project and, as the force of the contracting-out policy became apparent, CANMET management was influenced to respond to this need by undertaking measures to meet it. Since recruiting qualified supervisory personnel for scientific endeavours is a slow process, efforts to improve the managerial capability of existing research staff were initiated. A new position of contract advisor was created within the Research Program Office, with the intention of providing for training of regular research staff in supervisory procedures and techniques specifically for contracting R & D to outside concerns. The general concern which all science managers have expressed over the supervisory aspect, in view of the Government policy on performance, implies that training is desirable and should be intensified. It has become known, for instance, that in rapidly evolving frontier technologies recruitment by scientific personnel, not to mention personnel with inherent managerial abilities, is an extremely arduous task in the short term. Notwithstanding the relative ease with which supervisory services were available to the Pit Slope Project at a time when it was the only major contracting-out activity in the Branch, CANMET science managers have as their foremost concern, in complying with the contracting precept, the limited availability of supervisory services for the entire Branch program. Sources of this concern are so widespread as to suggest that the project experience is not representative of the supervisory problems associated with contracting of many CANMET research efforts.

Another issue, not apparently encountered in the contracting experience of the project but bearing on all research being considered under contract, centres on the contracting of scientific supervisory service itself. This is a common practice by both government and private concerns with respect to certain types of technical advice and supervision of engineering projects. CANMET science managers and researchers, however, are generally very skeptical of the suitability of any such arrangement for CANMET contracts. The question often raised in this context is "Who will monitor the monitors?" Clearly, only when there exists a high degree of confidence in the competence and integrity of the private concern is this practice advisable. Much opinion in CANMET is against this practice, but some admit the notion is plausible and the practice feasible in special cases where lower level day-to-day supervisory services can be entrusted to a reputable private concern and control can be maintained by a reduced effort from CANMET. Some offer the caveat that contracting supervision leads inevitably to higher cost research.

Organizational features themselves may influence CANMET's ability to comply with the contracting-out policy, especially in research areas where contracting has not been traditionally undertaken. Commonly these features are administrative structure, work procedures and the professional mix. The organizational aspects seem to have served the management of contract work quite well in the case of the project. Again, it is possible that this project corresponded more closely to CANMET's strengths than would many others. Certainly, the Pit Slope Project is exceptional in the sense of being the branch's first contract to coincide with the then "make-or-buy" policy and as such, had no competition from other contracts for supervisory personnel. One observation given during the course of the inquiry indicates that, at least in some laboratories, there exists an inappropriate staff mix — too many senior researchers or not enough support personnel (technicians and para-scientific staff especially, and also secretaries) — which burdens the high-powered researchers with unnecessary routine work with respect to internal research and inhibits their ability to concurrently manage research conducted by outside performers.

The distinction between research competence and contract management abilities has been long noted at CANMET and the experience of the Pit Slope Project reinforces this observation. Motivation plays an important role in scientific disciplines, as in any other human endeavour, and consequently bears on scientific performance at CANMET. The argument that scientific personnel need to work within the frame of reference of science professions has implications for contracting out. Supervising research performed by outside concerns does not normally give CANMET personnel any claim over research findings and hence deprives the in-house staff of publishing opportunities. The problem has been exacerbated by the fact that the promotional system for practising researchers, prior to January 1978, was based on publishing performance. Researchers commonly put forth the cogent complaint that they were being "done out" of promotional opportunities by required contract supervision which received no credit in appraisals. Since January 1978, however, the performance appraisal system which emphasized published works has been replaced throughout the Public Service by a "lock-step" or incremental system of promotion which permits consideration to be given to performance as assessed against required duties.

This revised system eliminates some of the previous grounds for disenchantment on the part of researchers over contract supervisory duty. Notwithstanding due recognition for work performed in supervision, contract management does limit personal research, and publishing is a valued scientific endeavour. Some observers are quick to add that, whatever the evaluation and promotion system, CANMET supervisory capabilities are ultimately constrained by abilities and attitudes of researchers to project management. A few commentators went so far as to suggest recruiting a new breed of research manager, drawing largely but not exclusively from outside stock. Others felt strongly that the structure of in-house work procedures was ideal for the training of supervisory roles and this stock would serve CANMET best in conforming with the trend of contracting-out. All agreed that high quality supervision is imperative, particularly for outside work where the chances of poor performance is felt to be higher.

APPROACH TO POLICY COMPLIANCE

Current circumstances

Three circumstances influence CANMET's approach to the Government's contracting policy — an approach aimed at reaching optimal allocation of R & D funds. These underlying circumstances are as follows:

1. The contracting-out policy, while official since 1972, is only now being put into place as a directive with a supporting implementation scheme applicable to all specified government scientific activity. Moreover, there is nothing in the policy or behind the directive which indicates a high-handed approach to implementation on the part of policy enforcers.

2. CANMET normally contracts R & D to consultants and industry in its own self-interest as a scientific entity, as manifested by the Pit Slope Project, and this need has historically arisen, without the force of policy, from its organizational mission and operating philosophy.

3. A current freeze on manpower militates against institutional growth, even when budgets are expanding, and gives added significance to the contracting-out policy.

Optimization procedure

In view of the three circumstances outlined above, the suggested posture on the part of CANMET would be to utilize the contracting directive to its own best advantage in conducting R & D. Obviously, a directive of the gravity of that conveyed in the contracting-out precept coupled with the discernible trend to retrenchment in the Public Service will require adjustment on the part of affected departments and agencies. At the same time, however, the contracting policy opens up new opportunities.

Judging from discussions with policy enforcers in the Treasury Board Secretariat and policy analysts in the Ministry of State for Science and Technology, it appears that the guidelines are sufficiently accommodating to permit the preservation of many in-house functions. However, consistent with the philosophy suggested here and shared by many CANMET commentators, the approach to allocating resources to intramural and extramural performers requires a formal procedure for decision-making. This procedure might take the form of systematic treatment of certain fundamental considerations in a decision framework prior to any allocation exercise using the prescribed decision criteria of the contracting guidelines. Policy objectives would be more nearly harmonized, and any conflicts arising from differing points of view between CANMET and policy enforcers would have a chance of early reconciliation.

In effecting an optimization procedure for policy compliance, all relevant CANMET projects would undergo a systematic review specifically for this purpose. This review, which would be at the project element level, would comprehend the following interrelated considerations:

1. effectiveness in achieving both organizational objectives and, ultimately, science policy objectives;

2. organizational re-orientation, devolution and evolution of functions;

3. internal efficiency and flexibility in the face of operating exigencies;

4. government policy on manpower and resources;

5. the availability, internally and through recruitment, of scientific staff both for intramural research and contract supervision;

6. the optimal utilization of resident expertise at CANMET;

7. preservation of the quality of science and technology.

The resulting division of effort between the two alternative modes of conduct, based on these general considerations, would indicate organizational preferences. Given the accommodating feature of the contracting-out directive, this division could be defended under the prescribed criteria of the contracting-out guidelines with the likely result that the final division of effort so derived would substantially coincide with CANMET intentions.

Significance of a policy compliance procedure

CANMET's two parallel research programs have taken different positions on contracting-out because of differing circumstances. The Minerals Research Program has operated essentially on a fixed budget in recent years with a specified amount of funds designated for contract work. In this program, therefore, the task of allocating funds to intramural and extramural performers has not been achieved with full consideration to the contracting-out policy. The Energy Research Program is in the opposite financial position and increasing funds have been provided for contract research. The result is that CANMET is only now consciously considering its allocation of effort according to procedures of the contracting-out directive.

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We invite your assessment of this report -- No. _____

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