PULP AND PAPER SECTOR GUIDANCE DOCUMENT

EXECUTIVE SUMMARY

This guidance document provides supplementary guidelines related to Scientific Research and Experimental Development (SR&ED) as it pertains to the Pulp and Paper industry sector. The pulp and paper industry is made up of companies engaged wholly or partly in the process of producing pulp and paper products, from wood or other raw materials. For the purposes of this guidance document there has been no attempt to deal with SR&ED issues pertaining to forestry, logging, or wood products industry sectors.

This document is subdivided as follows:

- Executive Summary (Section 1),
- Introduction (Section 2),
- Sector-specific Issues (Section 3),
- Conclusions (Section 4)
- Appendices A1, A2, B, and C (Section 5).

A brief synopsis of Sections 2- 5 is provided below.

Section 2 (Introduction)

The Introduction (Section 2) provides a brief background of the SR&ED Program, within the context of the Pulp and Paper industry.

Section 3 (Sector-specific Issues)

The following major topics are discussed in Section 3 entitled “Sector-specific Issues”:

i) Methodology for claiming Shop floor SR&ED projects, which typically consist of one or more Pulp and Paper “EP/ED and/or CP/ED mill trials” (see description of shop floor work and mill trials below);

ii) Collaborative SR&ED projects including two or more participating companies, such as (but not limited to) suppliers involved in SR&ED. It is important to note that the work done in Canada must meet the definition of SR&ED on its own merits to be claimed, even if it is part of the work needed to support a broad international research collaboration.

A typical SR&ED project in the Pulp and Paper sector involves a complete progression of work from the conception of an idea, to laboratory studies through to full-scale mill trials on the shop floor. The shop floor production equipment typically involves a sequence of continuous large-scale multi-stage processes. A Pulp and Paper shop floor SR&ED project is typically Experimental Development (ED), rather than Scientific Research (SR), so the terminology “ED project” is often used to describe a SR&ED project.

Shop floor projects may consist of one or more Pulp and Paper mill trials (see definitions in (a) (b), and (c), below), and are carried out using all, or a portion of, the production line equipment. For a shop floor ED project, the Pulp and Paper mill trials must be commensurate with the needs of the ED. There are three distinct types of Pulp and Paper mill trials* that are described in this guidance document, and include:

(a) Mill trials where there is experimental development involving experimental production. These types of mill trials will be referred to as a "EP/ED mill trials" in this document.
(b) Mill trials where there is experimental development involving commercial production. These types of mill trials will be referred to as "CP/ED mill trials" in this document.
(c) Mill trials where there is only commercial production, and there is no experimental development. These types of mill trials will be referred to as simply "CP mill trials" in this document, and they ***can not*** be claimed as part of an ED project.

Section 4 (Conclusions) is preceded by:

Section 4 (Conclusions)

The conclusions provide a high level summary of the key principles and concepts covered in this guidance document.

Section 5 (Appendices A1, A2, B, C)

Appendix A1:
The purpose of Appendix A1 to illustrate the principles of EP/ED and CP/ED for ED projects.

Appendix A2:
The purpose of Appendix A2 is to illustrate typical Pulp and Paper shop floor SR&ED projects involving EP/ED. The two cases presented are not intended to be exhaustive, but have been selected to focus on some key SR&ED issues related to Pulp and Paper EP/ED mill trials. It should also be noted that the level of detail provided in the two cases is beyond the filing requirement of the T661, and is solely provided here to clarify certain issues. The cases have been structured based on the current requirements of the T661 form. However, there are two additional sections at the end of each case (that are not required as part of the T661 form), which are entitled "Analysis of Project" and "Case for EP/ED". These two sections are intended to illustrate the methodology for making a shop floor SR&ED claim. That is:

i) Does the project described meet the definition of SR&ED and;
ii) If there is a SR&ED project, does it involve EP/ED mill trials or CP/ED mill trials or a combination of EP/ED and CP/ED mill trials.

Appendix B:
A generic process flow diagram of major Pulp and Paper processes, shown in Appendix B, is meant to cover the general process involved in chemical, mechanical and recycled pulp making and papermaking. The diagram does not represent the individuality and uniqueness of each company, mill or process. Rather, it is intended to give the reader a general overview of some of the major processes involved in the Pulp and Paper sector.

Appendix C:
The joint industry-Canada Revenue Agency (CRA) committee involved in preparing this sector guidance document is shown in Appendix C.

2. INTRODUCTION

This guidance document provides supplementary guidelines related to Scientific Research and Experimental Development (SR&ED) as it pertains to the Pulp and Paper industry sector. The document was prepared by representatives of Pulp & Paper companies, Paprican, equipment manufacturers, service companies and other suppliers to the industry working with CRA staff. The joint industry-Canada Revenue Agency (CRA) committee involved in preparing this sector guidance document is shown in Appendix C.

The CRA's main goal, as administrator of this program, is to deliver SR&ED tax incentives in a timely, consistent, and predictable manner, while encouraging businesses to assess their claims in compliance with tax laws, policies, and procedures. To this end, this guidance document is designed to assist claimants to self-assess project eligibility and better interpret the SR&ED Program requirements, specifically as it relates to the Pulp and Paper Sector.

For the purposes of this guidance document there has been no attempt to deal with SR&ED issues pertaining to forestry, logging, or wood products industry sectors. Many concepts covered in this document are interrelated and cannot be applied in isolation. Therefore, this guidance document must be read and considered in its entirety to fully understand its meaning and intent.

2.1 Intended Audience

The pulp and paper industry is made up of companies engaged in the process of producing pulp and paper products, from wood or other raw materials. This guidance document is of use to all of the following:

- Pulp producers and manufacturers of newsprint, fine paper, corrugated products, linerboard, coated paper, tissue and specialty papers;
- Converters, printers and companies involved in recycling and reclaiming waste products;
- Service companies to the Pulp and Paper sector that supply and/or manufacture chemicals, instrumentation, supplies, machinery and other equipment;
- Organizations that provide research, engineering and other consulting services such as consulting companies, universities, colleges and other institutions.
- Government agencies and departments, such as CRA, IRAP, Industry Canada, who are directly or indirectly involved with Pulp and Paper research and development work in Canada.

2.2 Project Eligibility

There are three criteria that are used in determining if project work meets the definition of SR&ED. These are:

- Scientific or technological advancement
- Scientific or technological uncertainty
- Scientific and technical content

The following CRA publications provide the details with regard to the criteria:

SR&ED Definition - see Section 248(1) of the Income Tax Act
Scientific/Technological Criteria - see IC 86-4R3
http://www.cra-arc.gc.ca/E/pub/tp/ic86-4r3/ic86-4r3-e.html

Guide to Form T661
http://www.cra-arc.gc.ca/taxcredit/sred/publications/formshelp-e.html

Guide to Conducting a SR&ED Review
http://www.cra-arc.gc.ca/taxcredit/sred/publications/ocread-e.html

Experimental development, see "Recognizing Experimental Development" Guidance Document
http://www.cra-arc.gc.ca/taxcredit/sred/publications/recognizing-e.html

2.3 Expenditures Documents Summary

There are several CRA documents that deal specifically with expenditures-related issues, the details of which will not be further elaborated upon in this guidance document. Some of the expenditure-related documents most relevant to the Pulp and Paper sector are listed below for reference, and are available on the CRA web site.

Application Policy SR&ED 2002-02R: "Experimental Production and Commercial Production with Experimental Development Work - Allowable SR&ED Expenditures"*:
http://www.cra-arc.gc.ca/taxcredit/sred/publications/ap2002-02R-e.html

**It should be noted that this guidance document is a clarification and extension of the principles outlined in AP 2002-02R, for the Pulp and Paper sector.*

IT-151R5 consolidated: **"**Scientific Research and Experimental Development Expenditures";
http://www.cra-arc.gc.ca/taxcredit/sred/bulletins-e.html

AP SR&ED 96-06: Directly undertaking, supervising or supporting directly engaged SR&ED Salary and Wages.
http://www.cra-arc.gc.ca/taxcredit/sred/publications/sr9606-e.html

AP SR&ED 2000-01: "Costs of Materials for SR&ED";
http://www.cra-arc.gc.ca/taxcredit/sred/publications/sr200001-e.html

AP SR&ED 2000-01: "Costs of Materials for SR&ED Addendum";
http://www.cra-arc.gc.ca/taxcredit/sred/publications/sr200001a-e.html

AP SR&ED 2000-04R2 Recapture of Investment Tax Credit - Revision
http://www.cra-arc.gc.ca/taxcredit/sred/publications/sr200001a-e.html

AP SRED 94-04 Definition of "contract payment" in subsection 127(9)
http://www.cra-arc.gc.ca/taxcredit/sred/publications/ap9404-e.html

T4088: Claiming SR&ED Expenditures – Guide to Form T661.
http://www.cra-arc.gc.ca/E/pub/tg/t4088/README.html

2.4 Claim Substantiation - Supporting Information

As with other sectors, Pulp and Paper SR&ED records and documents generated over the course of the project should demonstrate a systematic investigation including the technological advancements sought and the uncertainties addressed. Such records / documentation, as well as information obtained during meetings and discussions, should show the original technological goals, progress in the work undertaken, and when and how the work has been carried out.

The kinds of SR&ED supporting information that can assist when available include:

- Resource allocation records
- Design or Process Change Notices
- Records of CP/ED and EP/ED mill trials, test data and results
- Project note books and/or quantitative measurement data
- Lab books or records
- Internal design documents and drawings
- Other relevant documentation (e.g. photos, videos) that substantiate SR&ED work
- Prototypes
- Pilot scale or bench scale equipment used for experimentation and/or analysis
- Project reports

A subset of some of these types of supporting information is usually sufficient for the purposes of CRA verification during a technical review. It should also be noted that there could be other equally good supporting information to corroborate the SR&ED claim. The two case studies in Appendix A2 each contain, as part of the project description, the supporting information that was available to substantiate those SR&ED projects.

For more information the reader is referred to:

T4088: Claiming SR&ED Expenditures – Guide to Form T661
http://www.cra-arc.gc.ca/E/pub/tg/t4088/README.html

Guide to Supporting Technical Aspects of a Scientific Research and Experimental Development (SR&ED) Claim.
http://www.cra-arc.gc.ca/taxcredit/sred/publications/claimants-e.html

3. SECTOR SPECIFIC ISSUES

This section has been prepared to improve the understanding of SR&ED as it specifically relates to the pulp and paper sector. It is also intended to clarify the concept of what constitutes experimental development work within the context of the Pulp and Paper production or shop floor environment.

Although the industry is several hundred years old, the understanding of pulp and papermaking science and technology is incomplete, and SR&ED is required on an ongoing basis to better understand the complexity of its processes. Furthermore, the industry has an ongoing need to develop new processes / products to respond to new market demands, regulations or product specifications to remain competitive.

3.1 Shop Floor SR&ED in the Pulp and Paper Sector

In Canada, basic and applied pulp and paper research is often carried out at universities and at well-known research centres like the Pulp and Paper Research Institute of Canada (Paprican). However, most of the SR&ED claimed by the Pulp and Paper Industry is carried out under shop-floor conditions, where full-scale production equipment is used to perform mill trials.

It should be noted that the SR&ED criteria as detailed in IC 86-4R3 are derived from the Act and are used to determine eligible work. Two other related CRA documents with regard to the discussion of shop floor SR&ED include the following, and are presently posted on the CRA web site.

Cross-sector Shop Floor Guidance Document
http://www.cra-arc.gc.ca/taxcredit/sred/publications/shop-e.html

Chemicals Guidance Document 1: Shop Floor SR&ED
http://www.cra-arc.gc.ca/taxcredit/sred/publications/chemdoc-e.html

3.1.1 Context of the Shop Floor SR&ED in Pulp and Paper Sector

A typical SR&ED project in the Pulp and Paper sector involves a complete progression of work from the conception of an idea, to laboratory studies through to full-scale mill trials on the shop floor. The shop floor production equipment typically involves a sequence of continuous large-scale multi-stage processes. A Pulp and Paper shop floor SR&ED project is typically Experimental Development (ED), rather than Scientific Research (SR), so the terminology "ED project" is often used to describe a SR&ED project.

Shop floor projects may consist of one or more Pulp and Paper mill trials (see definitions in (a) (b), and (c), below), and are carried out using all, or a portion of, the production line equipment. For a shop floor ED project, the Pulp and Paper mill trials must be commensurate with the needs of the ED. There are three distinct types of Pulp and Paper mill trials* that are described in this guidance document, and include:

(a) Mill trials where there is experimental development involving experimental production. These types of mill trials will be referred to as a "EP/ED mill trials" in this document.
(b) Mill trials where there is experimental development involving commercial production. These types of mill trials will be referred to as "CP/ED mill trials" in this document.
(c) Mill trials where there is only commercial production, and there is no experimental development. These types of mill trials will be referred to as simply "CP mill trials" in this document, and they ***<u>can not</u>*** be claimed as part of an ED project.

Note: *There may be a combination of one or more EP/ED mill trials and/or one or more CP/ED mill trials in an ED project. The EP/ED and/or CP/ED mill trials must be commensurate with the needs of the ED project.*

The industry uses a multitude of process combinations to produce a wide range of products. As a result, there are unique characteristics for each mill, each process and each machine. The implication is that the solutions determined in one mill may or may not apply to another.

The size of the processing equipment that could be used for such shop floor work can be quite large. For example, a modern supercalender paper machine occupies a footprint that is over 145 m in length by 10 m in width, and rises approximately five stories in height. Paper is produced at a rate often exceeding 1800 m/min, or the equivalent of over 100 km/h on this paper machine, resulting in a production of over 750 metric tons per day. The cost of operating a modern mill can exceed $1,000,000 per day.

The shop floor equipment typically involves continuous multi-stage processes. A pulp and paper process is designed as a chain of transformations in which the feed, (typically wood chips, purchased pulp or recycled fibre), is progressively transformed via a series of continuous processing stages into a final product (see also Appendix B, process flow diagram). At each stage of the process, the material transformed in that stage becomes the raw material for the subsequent stage of the process. Therefore, experimental development on a single section of the process in isolation of the other sections is very difficult and often impossible. As such, while carrying out ED, changes introduced at each step of the chain may affect subsequent stages. This implies that where there is a change or disturbance introduced to the process, it is often that many of the downstream stages in the process will be affected. Two case studies of scenarios involving process changes in EP/ED mill trials are given in Appendix A2.

3.1.2 Methodology for Determining EP/ED Mill Trials, CP/ED Mill Trials and CP Mill Trials

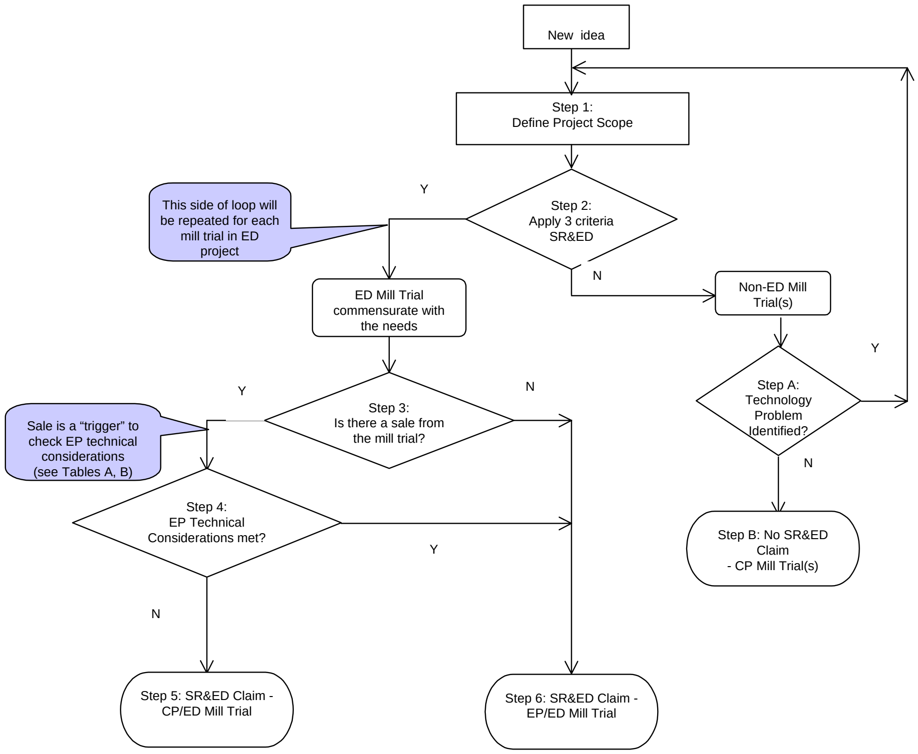
A flowchart shown in Figure 1 represents a generic methodology to assess:

i) If an identified Pulp and Paper shop floor project meets the definition of SR&ED by applying the three criteria (Section 2.2), and;

ii) The context of the Mill Trial (CP/ED, EP/ED or CP).

The methodology consists of the following sequential steps. Following the conceptualization of a new idea or technology problem, a potential ED project is defined. In Step 1, the scope of a potential ED project is determined, including the need for one or more mill trials on the shop floor equipment.

Flowchart for Projects with EP/ED, CP/ED and CP Mill Trials



In Step 2 there is a decision point where it is determined if the project (defined in Step 1) is ED by applying the three criteria (see Section 2.2). Assuming that there is a ED project, it is necessary to determine what mill trials are commensurate with the needs of the ED project (see left side of flowchart). The left loop in Figure 1 will then be used to determine whether each ED mill trial is either CP/ED or EP/ED.

If there is a product sale (Step 3), then this is used as a “trigger” that it is necessary to drill down further to identify other technical considerations that can be used to determine if the ED mill trial is CP/ED or EP/ED; the product sale is not, however, used as a factor to distinguish between an EP/ED mill trial and a CP/ED mill trial.

On the other hand, if there is no product sale as a result of technological issues related to the ED project, the mill trial will be considered to be EP/ED (Step 6). However, if there is no product sale due to reasons completely unrelated to the SR&ED work, (for example, product loss due to: fire, vandalism, theft, extreme weather or other non-technological reason), this would once again act as a “trigger” to check the EP technical considerations in Step 4 (see Tables A and B below). This is because the lack of product sale was not necessarily related to technological uncertainties attributable to the ED project. In this case the other EP technical considerations in Step 4 can be used to substantiate if the ED mill trial involves EP/ED or CP/ED. By definition, if the ED mill trial is not EP/ED, then it will be considered to be CP/ED.

It should be noted that the preceding sequence following Step 2, (that is, the left loop of the flowchart), must be repeated for each mill trial that is determined to be commensurate with the needs of the ED project. That is, the context of each mill trial, whether it is EP/ED or CP/ED, must be independently determined based upon the technical considerations (Tables A and B) relevant to that specific mill trial. As such, it is possible that there may be a combination of one or more EP/ED mill trials and/or one or more CP/ED mill trials in an ED project. Following the completion of the iterative process, a SR&ED claim can then be formulated by considering the total number of CP/ED mill trials (Step 5) and/or EP/ED mill trials (Step 6), depending upon the conclusions reached in Steps 3 and 4.

If there is no ED project defined in Step 2, then the trials are considered to be non-ED or "CP mill trials". If there is a new technological problem that is identified (Step A) during the course of the CP mill trial(s), then it is possible that the scope of a new project could be defined, and the entire preceding sequence (starting with Step 1) would be reiterated. If there are no new or unexpected technological problems or limitations encountered during the CP mill trial(s), there would be no claim for SR&ED (Step B).

Assuming there is consensus that an ED project exists, between the claimant and the CRA, then some factors that could lead to the conclusion that there are EP/ED mill trials (see Step 4 of the flowchart) are listed in Tables A and B below.

Table A: Some Examples of Technical Considerations for EP/ED Mill Trials

- Changes to process inputs (such as, substituting a standard input with a different input)
- Change in the combination of inputs (such as, changing the order of inputs, or blends or dosages)
- Changes or potential changes to product (such as different chemical and/or physical characteristics of the product)
- Changes to process configuration or characteristics (such as flows, combinations, blends, equipment and components)
- Changes or potential changes to runnability
- Changes or potential changes to production rate
- Testing under application conditions (Beta Testing)

Table B: Some Other Complementary Factors and Evidence for EP/ED Mill Trials

- The ED involves a change to the process resulting in a potential risk of instabilities or oscillations of the process and/or a potential change to the technical specifications of the product.
- As part of a ED project, the client base of the paper company needs to do their own testing trials on the properties of the finished new (experimental) product to resolve specific technological uncertainties related to whether the product meets certain basic specifications.
- The characteristics of the new product or process are potentially different compared with any existing or previous mill products or processes. This could, in the short-term lead to a risk of off-quality or lower quality product.
- The company could not foresee the results of the ED, and unexpected technological problems may arise during the mill trial, potentially causing a change to the lower grade of product than envisioned at the start of the mill trial.

- Evidence that staff were involved in designing specific experiments, and monitoring and analysing test data from the mill trial(s).
- Evidence of meetings or other relevant sources of supporting information were available to substantiate and corroborate the planning and technological risk associated with the mill trial(s).
- Evidence of experimental operating instructions and other consistent records were prepared for the mill trial(s).
- Evidence of specific monitoring strategies and operating instructions for the ED were communicated to the operating staff.
- Evidence of special tracking, classification or recognition of the project/product.
- Any other evidence or documentation available to indicate non-routine activities

It should be noted that although the technical factors listed in Tables A and B above are not all-inclusive, they describe the most common types of evidence supporting EP/ED mill trials that are currently encountered in the Pulp and Paper industry. *It is strongly emphasized that the list of technical factors shown in Tables A and B **must not** be used on a "check-list" basis.* Furthermore, the absence of any one of the factors in Tables A or B is not support against EP/ED, and the number of factors met is irrelevant to the merits of the case for EP/ED. Similarly, none of these technical considerations and complementary evidence, in isolation, is determinative. Rather, it is the presence of a combination of relevant technical factors that could lead to the conclusion that there are EP/ED mill trials. The final assessment of whether the mill trial is EP/ED should be made after reviewing all of the technical facts of the case.

To provide practical guidance with respect to the application of the principles discussed in this section, seven short examples are provided in Appendix A1 which highlight some of the different combinations of technical factors that are used to distinguish between EP/ED mill trials and CP/ED mill trials. More detailed project descriptions are provided in the two examples in Appendix A2, which take the reader through the entire methodology shown in Figure 1. This includes determining that each project meets the definition of SR&ED and, secondly, that each ED project involves EP/ED mill trials, based upon different subsets of technical factors, as given in Tables A and B.

These concepts have previously been elaborated in IC 86-4R3 (section 2.8), where it is stated that the eligibility of project work under Section 248(1) of the Income Tax Act is determined “solely by examining the nature and characteristics of the activity itself.” The paragraph also states that: “In other words, it is not the overall purpose of the activity or program, but rather what is actually occurring at a technical level that is relevant. This is an important point because the intent of all development in a business context is to produce viable products or processes. Thus the key point relating to the Act and Regulations is whether or not an activity has the characteristics of an eligible scientific research and experimental development activity, and not the overall goals in a commercial sense.”

There will also be situations in the complex mill environment where multiple production lines are operated in parallel and simultaneously, where there may be EP/ED along a “designated ED zone” along the production line. If this occurs all areas of the production line that are designated as the ED zone can be apportioned as EP/ED.

It should be noted that the overall cost associated with conducting mill trials may not vary significantly whether it is classified as a EP/ED mill trial, a CP/ED mill trial or a CP mill trial, particularly if the trials are technically successful. This is because many of the costs (steam, labour, overheads, and related materials consumed/transformed) are common for any of these types of mill trials. Secondly, in order to be efficient, mill trials are chosen to fit within a mill's regular production schedule regardless of their type. For CP/ED mill trials, the claimant needs to allocate costs directly attributable to the SR&ED. On the other hand, for EP/ED mill trials, no segregation of work and costs is required for the purposes of the SR&ED claim with respect to the required EP.

3.2 Phases of EP/ED or CP/ED Mill Trials

When ED is carried out in the shop floor environment, it is critical to identify the start and the end of the EP/ED or CP/ED mill trial. The "SR&ED Project Definition - Principles and Q and A sheet for Project Definition Paper" provides some guidance on this issue.

SR&ED Project Definition - Principles and Q and A sheet for Project Definition Paper
http://www.ccra-adrc.gc.ca/taxcredit/sred/publications/projdef-e.html

The following principles that are outlined in Section 3.2 can also be used to help establish when experimental development starts and stops within the context of either EP/ED or CP/ED mill trials. EP/ED mill trials, such as those given in Case Study 2 of Appendix A2, may include one or all of the following phases:

- Initial transition phase
- Experimental validation phase
- Final transition phase

Each of these phases will be discussed in more detail in the ensuing three subsections of this guidance document.

3.2.1 Initial transition phase

The initial transition phase (ITP) serves as an experimental transition period between stable operating conditions and new experimental operating conditions. During this phase, the process is typically unstable. The characteristics of the product or the condition of operation are in constant flux, and the period of time required to reach and maintain the experimental target specifications may be highly variable.

Consider, for instance, Case Study 1 in Appendix A2. In that SR&ED project, EP/ED is carried out to determine the number of stages that would be required to brighten an unbleached Kraft pulp from 30% ISO to 92% ISO using various concentrations of chlorine dioxide oxidant in each successive stage in series. In the Kraft bleaching process, which is continuous, the product of each stage directly feeds a subsequent stage. This implies that there will be a "process dead time" from when the experiment is initiated, to the time at which steady state is eventually achieved in perhaps the 'nth' stage. For this reason, it would be realistic to expect a period of upset productivity in the bleach plant arising from the process changes introduced by this experiment, which would represent the initial transition phase.

In Case Study 2 of Appendix A2, a new experimental coating formulation is evaluated on the production line. In this case the ITP is required to stabilize the process at the new experimental operating parameters envisaged for the EP/ED mill trials described.

For both Case Studies 1 and 2 in Appendix A2, the ITP would be claimed as part of the EP/ED mill trials.

3.2.2 Experimental validation phase

The experimental validation phase (EVP) begins once the target variable has been reached and the process has stabilized. The duration of the EVP will depend upon the specific technological objectives of the specified mill trial, but is independent of either of the transition periods. The EVP could last only a few hours in a short trial, but for more complex experiments where there are multiple variables and technological uncertainties to resolve, the EVP could last for several days or weeks. The exact length of the EVP will depend upon the number of parameters that are investigated, and the specific technological uncertainties that must be resolved. The project description could provide corroboration or justification for the amount of time required to complete the EVP. As well, documented evidence in the form of analysis of the results could be used to substantiate the amount of time required to complete the EVP. The quantities of materials and supplies used in the EVP will vary depending upon the specific technological objectives, the length of the trial, the number of stages impacted by the trial, and the need to validate scientific data, and ensure reproducibility. See Table 1 for further details.

In Case Study 1 in Appendix A2, the EVP would be the time required to carry out all of the experimental work related to determining the precise number of stages needed to achieve a bleaching brightness of 92% ISO.

For both Case Studies 1 and 2 in Appendix A2, the EVP would be claimed as part of the EP/ED mill trials.

3.2.3 Final transition phase

This final transition phase (FTP) represents the transition period required to bring the process from the EVP back to standard processing conditions. The sequence of work leading to the return to stable conditions is usually different from the initial transition sequence and may be unpredictable. Moreover, the length of the FTP could be significantly different than the ITP depending upon the specific process conditions used during the experiment, compared with those needed for standard operations. Whether or not the FTP is part of the EP/ED or CP/ED mill trials or not will depend on the scenario. The FTP will only be a part of the EP/ED or CP/ED mill trials if the work is directly in support and commensurate with the needs of the ED. Three scenarios are described below.

<u>Scenario 1:</u>

In the first scenario, the FTP is the lag period between the end of the EVP and the resumption of standard operating conditions.

For example, a new wood furnish is used during a trial. At the end of the trial, a period of time is required to flush out the new furnish and replace it with standard furnish.

Scenario 2:

In the second scenario the FTP coincides with the successful development of a new or improved process or product. Instead of returning the process to known operating conditions, a permanent change is issued and the process can now continue to operate under the new conditions.

For example, a new bleaching sequence is developed that increases brightness and reduces chemical usage. Since this new process has proven itself to be much more efficient than the old one, there is no need to revert to previous conditions.

Scenario 3:

In the third scenario the FTP is represented by a sequence of plateaus that are reached as part of an experimental trial plan.

For example, a polymer is used as part of an ED project in a mill's wastewater treatment process. Since the polymer may harm the resident microbial population, the dosage is applied in a stepped sequence. This strategy would permit stabilization between successive increments so that the effects to microbial populations can be determined. See Table 1 for further details.

Consider again, Case Study 1 in Appendix A2. In this project the FTP would be the time required to bring the bleaching process back to the same state of operation it was in before the ITP. The duration of this period is unrelated to the length of either of the preceding phases. It can be claimed as part of the EP/ED or CP/ED mill trials. Similarly, the FTP can also be claimed for Case Study 2 in Appendix A2.

Table 1 – Factors affecting the length of a phase during the Mill Trial*

Factors	**ITP**	**EVP**	**FTP**
Number of processes stages & interactions	X		
The degree of process integration	X		
Stabilization-time of the system, i.e. tanks size, process speed, flow	X		
Level of the variation (noise) in process data	X	X	X
The stage of process modified, a chemical stage would be normally longer to stabilize	X		
Process limitations	X	X	X
Complexity of the process	X	X	X
Novelty of the project	X	X	X
Level of statistical significance required to reach a conclusion	X	X	X
Number of constraints	X	X	X
Likelihood of an extended trial occurring	X	X	X
The results of the experiment performed during the observation period	X		X

**The contents of Table 1 above should not be construed as an exhaustive or all-encompassing list but rather an illustrative set of examples for the purposes of providing guidance to this section.*

3.2.4 Length of each phase

Table 1 gives some factors affecting the length of each phase for either CP/ED or EP/ED mill trials. The following section explains this in more detail, while showing how the length of each phase can be independent of another. It must be emphasized that each project must be considered on a case-by-case basis.

A) First Scenario-Rapid stabilization profile

This is typically a mill trial whereby experimental process changes can be measured relatively quickly. The process is able to revert to normal conditions relatively quickly as well, once the requisite experimental data has been collected.

Example:

The R&D department has been developing a yellowing inhibitor at the lab scale. Lab-scale experimentation has shown a significant reduction in reversion. However, the mill uses a variety of sizing agents, fillers and coating formulations that can negatively interact with the experimental inhibitor. Furthermore, it is unknown which addition point will provide optimal results without affecting sheet properties.

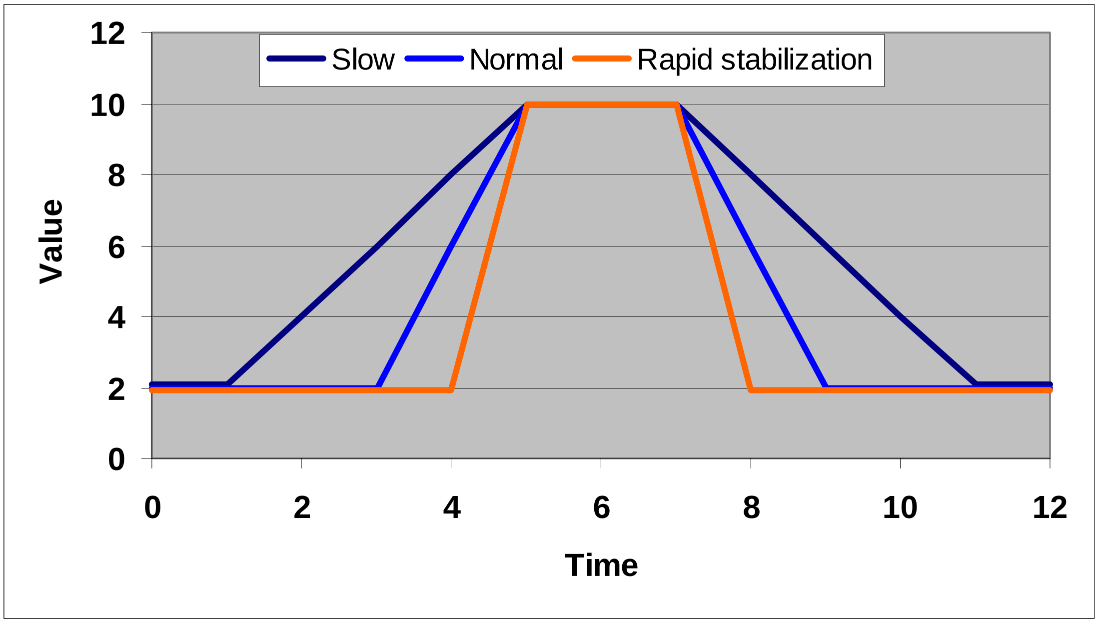
The mill plans a series of trials using the new inhibitor. The results from each trial can be measured relatively quickly under each set of experimental conditions.

B) Second Scenario: Low stabilization profile

This is typically a mill trial whereby significant lag-time occurs before sampling can take place. Furthermore, an equivalent or greater lag-time may be required to return the process to normal conditions.

Example:

Changes in environmental policy have affected a pulp mill's wood supply. As part of an SR&ED project to make up the shortfall, the mill must run ED trials using a new fibre species. The mill cannot begin experimenting with process conditions until all contemporary chips are flushed from the system and replaced with the new species. Depending on the mill's operating rate and capacity, this period can take several hours to several days. Likewise, returning to commercial production using contemporary furnish is a lengthy process.



C) Third Scenario- Normal stabilization profile

This generic trial scenario describes most typical mill trials, whether they are CP/ED or EP/ED. In this case, a lag period whose length is directly related to the size and operating rate of the affected process components is needed to reach stable experimental conditions. Once this condition is reached, sampling can begin. Returning to commercial production also entails a lag period commensurate with the process components.

Example:

As part of a SR&ED project, a batch chemical pulp mill wants to reduce pulp kappa number (a measure of non-cellulose components). Since the digesters blow individually in a prescribed sequence, significant mixing of these different pulps will occur until all digesters are blowing in tandem at the new kappa number. Likewise, a return to the original kappa number will occur in a sequence according to the blow schedules.

3.3 Mill Trial Approaches

The pulp and paper industry uses many different experimental protocols or approaches depending on the specific technological advancements that are sought. This section describes two approaches that are used.

The key difference between ‘Multi-stage’ and ‘Repetitive’ trials is the nature of each individual mill trial (see also Table 2). ‘Multi-stage trials’ employ several related (but non identical) experimental mill trials, whereas ‘repetitive trials’ employ several identical experimental mill trials in support of the SR&ED project.

In Appendix A2, an ED project involving multi-stage trials is discussed in Case Study 1. In contrast, a ED project requiring repetitive experimental trials is illustrated in Case Study 2 of Appendix A2.

Table 2 – Factors affecting the likelihood of multi-stage or repetitive trials

Factors	**Multi-stage Trial**	**Repetitive Trial**
Complexity of the process	X	X
Number of steps of transformations	X	
Level of interactions between process stages	X	
Specification of the product (Normally higher quality grades required higher number of stages and limitations)	X	
Sensitivity of a process to change product specifications	X	X
The need of knowing the effect on one stage before determining the new experimental condition	X	
Complexity of data analysis	X	X
Level of statistical significance required to reach a conclusion	X	X
Level of the variation (noise) in process data	X	X
Product limitations and characteristics	X	X
Number of different beta site applications for a product	X	X

**The contents of Table 2 above should not be construed as an exhaustive or all-encompassing list but rather an illustrative set of examples for the purposes of providing guidance in this section.*

3.3.1 Multi-stage Approach

Consider Appendix A2, Case Study 1 where SR&ED is needed to determine, in an iterative fashion, the number of bleaching stages needed to achieve a target pulp final brightness of 92% ISO, starting from a 30% ISO unbleached Kraft pulp.

In this case a multi-stage experimental approach (as defined above) was required to meet the technological objectives stated, which were to determine:
i) Pulp brightness as a function of chemical concentration; and
ii) Number of bleach stages needed to meet the target pulp brightness of 92% ISO.

Since the dependence of pulp brightness with chemical concentration in each bleaching stage is asymptotic (and not linear), a minimum of three mill trials would be needed to verify the shape of the curve. However, more mill trials would be needed to validate the integrity of the curve's exact shape, and the reproducibility of the data.

As a result of the experimental iterative process, in Case Study 1, it was determined that three bleaching stages would be needed to obtain the target pulp brightness that was sought. Since it may be necessary to repeat some mill trials more than once to establish data reproducibility, it is easy to see why each experimental stage may necessitate a different number of mill trials. That is, for stage 1, a total of 5 trials may be done; for stage 2, there may be 7 trials needed; and for stage 3 there may be 6 done, for a total of 18 mill trials for the SR&ED project.

Another practical consideration is that for each experimental bleaching condition, pulp must be produced under stable operating conditions. Technically, the quantity of the pulp that will be required during the mill trial will depend on the process itself, as well as the specific sampling requirements needed for the ED project.

3.3.2 Repetitive Approach

Consider Appendix A2, Case Study 2 where shop floor SR&ED is needed to determine if an experimental coating formulation can be used to produce a new speciality coated paper for certain niche markets. A repetitive experimental approach, involving three mill trials (original plus two replicates) was required to validate if the target specifications could be achieved for the finished paper, and if the results could be reproduced between successive mill trials. One of the conclusions from the project was that adequate reproducibility was not achieved between the three mill trials. This may ultimately necessitate further experimental mill trials, and possibly another repetitive approach experimental design for those future mill trials.

3.4 Testing under application conditions (Beta testing)

The products from the pulp and paper industry are destined for secondary or tertiary transformation in the customer's production or process facilities where beta testing is done.

In cases where the mill cannot simulate the application conditions, beta testing is essential to the experimental development. This testing is critical in determining the success of the project and constitutes eligible work in support of a SR&ED project.

Generally, it is during the beta site testing that certain technological uncertainties are resolved. In some cases, new technological uncertainties can arise during beta site testing and must then be resolved. Work that is carrried out to achieve the technological objectives, (but not including demonstrations to prospective buyers), and those aimed at resolving technological uncertainties during beta site testing, could be eligible as part of an identified SR&ED project. This phase will often denote the completion of the project. When beta testing is carried out as part of the SR&ED project, the company should maintain detailed technical records of the tests performed, and validate the need to perform such testing. Therefore, claimants must demonstrate in their supporting information how the beta site testing work relates to resolving technological uncertainties and achieving the technological objectives.

3.5 Process Optimization

The Pulp and Paper Industry has evolved to a state in which there is a significant amount of industrial research that is based upon modifications, improvements, optimizations, investigations and enhancements of the industrial processes themselves.

These types of projects are generally referred to by industry as "process optimization, process improvement, continuous improvement", or other similar designations in the industry. However, there are special considerations that apply to claims for work involving "process optimization". This is one area where there may be room for misinterpretation of the true nature of a SR&ED project, due to the label or terminology used to describe it.

For example, “process optimization”, as defined in IC 86-4R3, refers to process development efforts that have as their objective improved efficiencies, output quality, or financial or strategic advantages. This definition of process optimization is primarily a characteristic of projects that are motivated by financial and/or strategic objectives, rather than by scientific or technological objectives. The more general definition of “process optimization” used by the industry encompasses many different types of work, some of which could qualify as SR&ED.

In this context, seeking a technological advancement in a process optimization project means attempting to increase the technology base or level of the claimant from where it was at the beginning of the systematic investigation or search. The business context of the claimant must be taken into consideration when determining if there is an attempt to increase the technology base for the project in process optimization. Specifically, the technology base in the business context refers to the technological resources (i.e. the existing level of technology, technological "know-how", and personnel experience) that are reasonably accessible within the capabilities of the claimant from both internal and external resources.

For example, the following are some typical types of “process optimization projects” undertaken in this industry. Their eligibility must be determined on a case-by-case basis using the principles outlined above.

- adapting commercial software to meet new or enhanced requirements for process control;
- adapting control systems for machinery control and/or process control (e.g., programmable logic controllers); and
- automating existing processes that are currently manually controlled.
- technical feasibility studies
- process modeling and simulation
- the construction of equipment to meet unique capability or performance criteria
- enhancements to current production processes to gain increases in productivity and/or meet specific production cost targets
- the design of tooling and testing of new tooling methods and techniques
- increased automation (i.e., robotics)

The most important issue related to process optimization-type work is that the eligibility of the work must be determined based on a case-by-case evaluation of the work itself, and not on the fact that the term “process optimization” is used to describe it.

3.6 COLLABORATIVE ISSUES

3.6.1 Definition of a Customer and a Supplier

The business environment of the Pulp and Paper Sector has progressively evolved such that joint, multi-company, projects are now commonplace. As a result, a large number of SR&ED projects performed by a claimant involve strategic, and often complex, technical and business partnerships with another company or organization. Therefore, it is important to clearly define the terms "customer" and "supplier" specifically in the context of this guidance document.

A "Customer" is defined as a company, organization, centre, alliance etc. that traditionally receives goods, services, technology or other value in a typical business setting. The Customer receives this value from a "supplier" and therefore a supplier is a defined as a company, organization, centre, alliance etc. that traditionally supplies goods, services, technology or other value in a typical business setting. The key to these definitions is that they are made based on a traditional business relationship, regardless of the details of the technical or SR&ED relationship they may have made for a project. For example, although Company XYZ (the supplier) has a business relationship where it sells chemicals to a pulp and paper company (the customer), this relationship does not predetermine the roles of each company in any technical or SR&ED relationship they may have. Those roles are determined by the nature of the details of the agreement made between the customer and the supplier.

3.6.2 Types of Customer - Supplier Relationships

Close customer – supplier relationships are becoming increasingly more common and more complicated as the business environment in the Pulp and Paper Sector evolves. In determining the eligibility of the work performed by each of the claimants towards one overall SR&ED project, it is very important to understand and clearly define the roles of each claimant.

The types of relationships described in the ensuing sections are based on the contractual and financial details of the agreement between the supplier and customer. Although critical in determining the ownership and claiming structure of any SR&ED performed, customer – supplier relationships do not relate to the project eligibility itself. For the purposes of this guidance document, it is assumed that the customer-supplier relationship in question is related to a SR&ED project.

3.6.3 Determining Who Claims Contract SR&ED

It may be difficult based on the terms of the contract to determine whether it is the person who paid the amount (the payer) or the contractor who is entitled to the ITC. Generally, the problem arises where a contract is not specific on whether an amount paid to the contractor who performed SR&ED work is a "contract payment" for the purposes of calculating the ITC. Furthermore, in certain cases, the fact that a contract specifically states that a payment is or is not a "contract payment" for the purposes of subsection 127(9) of the Act may not be conclusive. Criteria such as contractor performance requirements, risk assumed by each party, overall control on work performed, intellectual property ownership and tool ownership could be useful indicators on who can claim the SR&ED expenditures. For further information, refer to CRA's Application Policy 94-04.

Other overriding considerations are that a taxable supplier must perform the contracted work in Canada. It should also be noted that eligible support work that is contracted out can be claimed for the ITC by the company initiating the contract, if that work is commensurate with the needs of its SR&ED work carried out in Canada.

It is quite possible that one project may result in two SR&ED claims; one for the supplier and one for the customer. This will commonly arise because, although both parties are working together on the same project, each party may have individual goals and associated Technological or Scientific Uncertainty and/or Technological or Scientific

Advancement. In other words, one aspect of the project may be SR&ED for the Customer and another aspect may be SR&ED for the supplier. As long as duplication of the ITC is avoided [that is, for the party performing the contract (the supplier), the contract payment reduces the qualified SR&ED expenditures for its ITC purposes], this situation is perfectly acceptable, and quite commonly encountered.

For example, as part of a SR&ED product development project for a company (the supplier), field trials may be necessary. These field trials performed at another company's production facility (the customer), would be allowable expenses for the supplier's SR&ED. It is conceivable that these field trials may also be required for carrying out a SR&ED project for the customer. Therefore, in this example, these field trials are likely eligible for both the customer and the supplier, but the technological objectives in each case are different. This type of situation is acceptable and commonly encountered in the Pulp and Paper Sector.

3.6.4 Scientific and Technical Content: Qualified Personnel

It is expected that qualified personnel having relevant experience will carry out the SR&ED work, and that the work will be planned and carried out in a systematic manner.

The relevant experience may be academic, or it may have been acquired through experience with work of a similar nature to that needed for the SR&ED project. Since the title of the personnel carrying out the work is often misleading, it should not be considered in evaluating qualifications for the purposes of SR&ED projects. Only the nature of the work being carried out should be considered. For example, if a sales person at a chemical service company is involved with technical work directly related to the SR&ED project such as, project direction or supervision, data analysis, direct engineering support, or writing of a related technical report, they should be considered for inclusion in the claim.

3.6.5 SR&ED in a Global Economy

As a result of globalization of the economy, many Canadian companies are part of multi-national organizations that have their headquarters in Canada or elsewhere. As a result, joint SR&ED efforts are becoming more common, using the diverse talent within the organization to meet customer demands at multiple production locations.

Qualified Canadian researchers often contribute to an overall project by providing the technical leadership, in which case work directly in support of the SR&ED project and commensurate with the needs is often required to take place outside Canada.

In other cases the technical leadership will be coming from outside Canada, although Canadian staff have a significant technical input, analyzing and endorsing the scientific content, proposing changes as needed and endorsing the results. The Canadian contribution may form the basis for a SR&ED project.

For a global R&D project, the contribution of the Canadian claimant must meet the definition of SR&ED on the work done in Canada in order to be eligible. Supporting information (see Section 2.4) should be available to describe the nature of the input and its role with respect to the attempt to achieve the scientific or technological objectives of the project.

Multinational projects may evolve and be pursued in all participating countries concurrently. The researchers in each participating country make important scientific contributions to the different aspects of the research, the objective of which is to discover new scientific or technological knowledge. Qualified Canadian researchers contribute to the overall project by analyzing and endorsing the scientific content, proposing changes as needed, and endorsing the results. The Canadian contribution could be research, development, shop floor SR&ED, or resolving the technological uncertainties associated with the development of a full-scale production model. The Canadian company is a key participant in the project providing value to the global team, as well as value to the Canadian economy.

Frequently ideas implemented in Canada come from SR&ED work done in foreign centres. The Canadian company may still need to research and develop a manufacturing facility or process in order to manufacture the product here. Full-scale facility technology transfer frequently requires qualified SR&ED work to make the Canadian version of the production line commercially viable. Modifications that appear to be minor on the surface can give rise to SR&ED.

For example, a base technology may have been developed outside Canada. Significant technical effort may then be required from Canadian workers, to adapt this technology to Canadian mills, their existing equipment, their furnishes and their legislative environment. This can often lead to a SR&ED project.

Often much of the early product or process development is based outside of Canada and the scale-up and commercialization happens at Canadian facilities. In other instances, the situation is reversed, where the basic research, applied research, and experimental development work is based in Canada, and commercialization is done outside Canada. For the cases that have been illustrated above, the research and development work is a combined international effort.

3.6.6 SR&ED Projects Initiated in Canada with Support Work outside Canada

Expenditures for SR&ED and support work (engineering, design, operations research, mathematical analysis, computer programming, data collection, and testing that is commensurate with the needs and directly in support of basic research, applied research, or experimental development) conducted outside Canada cannot be claimed for an ITC. However, if the traditional method is used, CRA currently does accept certain expenditures, including foreign travel expenditures for:

- The acquisition of equipment or materials used in SR&ED in Canada
- Specific training for on-going SR&ED carried on in Canada, or,
- Visits to foreign customers in respect of SR&ED carried on in Canada to update the customer on the SR&ED project's status

For further information refer to IT-151R5 consolidated and Section 2.3 of this guidance document.

4. CONCLUSIONS

Although some basic and applied scientific research (SR) is carried out at universities and at well-known research centres like Paprican, most of the SR&ED carried out in the pulp and paper industry is typically carried out under shop floor experimental development (ED) conditions. This means that the full-scale pulp and paper production equipment is often used to carry out shop floor SR&ED. The production equipment typically involves a sequence of continuous multi-stage processes.

A generic methodology (subsection 3.1.2) has been outlined in this guidance document to assess:
(a) If an identified Pulp and Paper shop floor project meets the definition of SR&ED (where the project is typically ED rather than SR), and;
(b) Context of the Mill Trial (CP/ED, EP/ED or CP).

The methodology includes a logical sequence of steps which is shown schematically in a flowchart in subsection 3.1.2 of this guidance document. The first step in the analysis is to identify the scope of a potential ED project including the need for mill trials on the shop floor equipment. The second step is to determine if the identified project work meets the definition of ED.

When it has been ascertained that there is an ED project and the appropriate support work has been identified, the next step is to evaluate the context of the ED work. If there is a product sale, this should only be used as a “trigger” that it is necessary to drill down further to identify other technical considerations that can be used to determine if the ED mill trial is either CP/ED or EP/ED. A list of technical considerations that can be used to guide this assessment as to whether the ED mill trial is EP/ED has been provided in Tables A and B in subsection 3.1.2 of this guidance document. By definition, if the ED mill trial is not EP/ED, then it will be considered to be CP/ED. It should be noted that the list of technical considerations and other complementary evidence referred to in subsection 3.1.2 is not all-inclusive, and there may be other relevant technical factors to consider, depending upon the specific circumstances of the project. There may be a combination of one or more EP/ED mill trials, and/or one or more CP/ED mill trials in an ED project depending upon the conclusions reached from the preceding analysis. The EP/ED and/or CP/ED mill trials must be commensurate with the needs of the ED project.

If it is concluded that there is no ED project, then the relevant mill trials would be considered to be non-ED. Assuming that there are no new or unexpected technological problems or limitations encountered during the execution of the mill trials, they will be considered to constitute CP mill trials, and there is no SR&ED claim. On the other hand, if there is a new technological problem that is identified during any of the CP mill trials, then it is possible that the scope of a new ED project could be defined. In that case, the preceding analysis would be repeated to determine the context of a potentially new ED project.

EP/ED or CP/ED mill trials can often be characterized as either multi-stage or repetitive, both of which are illustrated in Section 3.3 of this guidance document. Multi-stage mill trials employ several related (but non-identical) experimental mill trials, whereas repetitive ED mill trials employ several identical experimental mill trials carried out in support of the project. An EP/ED or CP/ED mill trial typically includes all of the following phases (see section 3.2).

- Initial transition phase
- Experimental validation phase
- Final transition phase

The Pulp and Paper Industry has evolved to a state in which there is a significant amount of industrial research that is based upon modifications, improvements, optimizations, investigations and enhancements of the industrial processes themselves. These types of projects are generally referred to by the industry as “process optimization”, and often meet the definition of SR&ED (see section 3.5). The most important issue related to process optimization-type work is that the eligibility of such a project must be determined based on a case-by-case evaluation of the work.

The business environment of the Pulp and Paper Sector has progressively evolved such that joint, multi-company, projects are now commonplace. As a result, SR&ED projects performed by a claimant involve strategic, and often complex, technical and business partnerships with another company or organization. Close customer –supplier relationships are becoming increasingly more common and more complicated as the business environment in the Pulp and Paper Sector evolves. In determining the eligibility of each of the claimants taking part in a SR&ED project, it is important to understand and clearly define each of their roles (see section 3.6). The title of the personnel carrying out the work can often be misleading. Only the nature of the work should be considered.

As a result of globalization of the economy, many Canadian companies are part of multi-national organizations that have their headquarters in Canada or elsewhere. As a result, joint SR&ED efforts are becoming more common, using the diverse talent within the organization to meet customer demands at multiple production locations (see subsections 3.6.5, 3.6.6). In all cases, however, the work done in Canada must meet the definition of SR&ED on its own merits to be claimed, even if part of the work is needed to support the work of an international research collaboration.

APPENDIX A1: SHORT EXAMPLES TO ILLUSTRATE CP/ED AND EP/ED

Assuming that each of the following shop floor projects meets the definition of SR&ED without further justification, then the issue that remains is whether the ED project involves either CP/ED or EP/ED mill trials. A brief analysis is given for each scenario below to illustrate. In each example reference will be made to the list of EP technical considerations and other complementary evidence provided in Tables A and B of Section 3.1.2 to determine the technical risk to the process or product.

Example 1:

A Pulp and Paper (P&P) company plans to develop a new paper, which will involve, among other process changes in the mill, changing the wood species from spruce to a spruce/larch mixture.

The plan calls for full-scale ED mill trials on a paper machine after the successful completion of lab work and pilot-scale trials.

However, there will still be technological uncertainty associated with the ED mill trials such that the characteristics of the paper may be affected. If that is the case the paper may need to be recycled, burned with bark, or disposed in a landfill.

<u>Analysis:</u>

There is a change to this process introducing a risk of perturbation or modification of the product characteristics, in that the technological success of the process operation using a completely different wood species is uncertain.

The ED project involves EP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

If a saleable product is produced, there would be recapture of the ITC earned on material transformed.

Example 2:

A P&P mill plans to develop a paper having new characteristics for the mill. The development of the new paper will require the use of a different wood species mixture that has never been evaluated under the claimant's mill conditions before, and the work will be done in a dedicated line, separate from the commercial system. The ED could result in extensive oscillations to the process stability of the paper machine, as a result of the change in wood mixture that is introduced to the system.

The plan calls for full scale experimental mill trials on a paper machine.

<u>Analysis:</u>

In this scenario the change to the process could result in paper process oscillation and the paper may not meet the minimum target specifications. The ED project involves EP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

If there is a sale of product, there will be a recapture of the ITC earned on materials transformed.

Example 3:

A papermill is experiencing an unusual number of paper machine breaks. Mill personnel systematically review all process parameters, and maintenance records and begin collecting “break data” for evaluation. Furthermore, the mill purchases a number of high-speed cameras and positions them at the likely locations where the breaks originate in order to learn their cause. With cameras in place and staff at increased vigilance, production is allowed to resume and detailed records are kept every time there is a break. After several weeks of operation and the review of break ends, photos and a statistical analysis of DCS data, the cause of the breaks is learned and remedial actions are taken.

<u>Analysis:</u>

Although the process is not functioning properly during the experimental period, the actions taken, of adding cameras and analyzing data off line, do not pose any additional risk to the process or the products. Therefore under this scenario the ED project involves CP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

Example 4:

A P&P company is developing a new fine paper. In order to develop the new product, specific experiments have been designed for several stages of the integrated mill, including digester, bleach plant, paper machine, and calender. For example, experiments will be done to vary the residence time, process temperature, and caustic strength in the digester. A new non-hazardous oxidant will be tested in the bleach plant, and parameters will be modified downstream in the paper machine and calender to accommodate these changes.

Authorization to proceed with the risky experimental trial is granted by senior mill management and detailed experimental operating instructions are prepared for each of the impacted stages. Technical staff will be available for monitoring the process for indications of process instability. The impact could be characterized by a risk of paper breaks during the R&D work. Although this new process has process risk at critical stages of the plant, the paper may meet the minimal standards.

<u>Analysis:</u>

The work involves a technological change of the process, in that several stages of the mill could be impacted by the R&D project. The ED project involves EP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

If there is a sale of product, there will be a recapture of the ITC earned on materials transformed.

Example 5:

A mill is improving the bleaching efficiency using the standard process normally employed at the mill. Since a new higher temperature brown stock washer protocol was put in place, the mill, as part of the SR&ED project, decided to evaluate a different enzyme to accommodate the higher process temperature. However, because enzymes are sensitive to high temperature, it was impossible to predict the efficiency of the new process combination. The SR&ED could result in excessive yield losses, over and above the normal process yields.

Analysis:

The potential for an overall drop of yield was directly attributable to the SR&ED. Since there was potential for a negative impact on the modified process, this project involves EP/ED mill trials, based on the list of technical considerations and other complementary evidence in Section 3.1.2.

Example 6:

A company seeks to incrementally improve the efficiency of digester operation by changing the white liquor sulphur chemistry. No other process changes were made to either the digester or elsewhere in the mill. It was expected that the overall yield of the process would remain at the normal target value of 47% and the products or processes would not be at risk during the ED mill trials.

Analysis:

Since there is no risk for the process or its products, and based upon the list of technical considerations and other complementary evidence in Section 3.1.2, this ED project involves CP/ED mill trials.

Example 7:

A P&P company's activated sludge system with the wastewater treatment plant (WWTP) is potentially out of compliance with the Ministry of the Environment (MOE). The mill personnel cannot solve the technological problem using standard practice and a SR&ED project is launched. For several weeks experimentation is carried out at the WWTP. Meanwhile, total mill output is disrupted.

Analysis:

Under this scenario the mill commercial production line is disrupted but there are no direct risks to the commercial production being produced. As such, the ED project involves CP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2, and only the experimental work within the WWTP is eligible.

APPENDIX A2: CASE STUDIES INVOLVING EP/ED MILL TRIALS

NB: *The level of detail provided in this case study is beyond the filing requirement of the T661 and is solely provided here to clarify certain issues. This level of detail is not representative of the information that would normally be provided by Pulp & Paper companies as part of their filing requirements.*

Appendix A2 contains two case studies that involve shop floor experimental development in the Pulp and Paper Sector. References to specific aspects of both of these case studies have been made throughout the bulk of this guidance document in various sections. These case studies in no way describe all of the possible types of projects encountered in this industry, and it is assumed that the reader has a fundamental understanding of the Pulp and Paper processes. The reader is also referred to Appendix B for a simplified and generic process flow diagram of a pulp and paper mill.

The primary goal of the two case studies is to provide the reader with illustrations of:

- ED projects involving multiple EP/ED mill trials (Case Studies 1 and 2)
- Multi-stage trials approach (Case Study 1)
- Repetitive trials approach (Case Study 2)
- Phases of a ED Mill Trial (Case Study 2)

Case Study 1: Development of Bleach Plant Process

Introduction

A pulp and paper mill is a producer of bleached Kraft pulp for printing and writing papers. This mill wants to develop a bleached pulp using a new wood formulation. The effectiveness of the bleaching process to achieve the desired brightness will be determined, before and after bleaching, using the International Organization for Standardization (ISO) brightness 2470 test. The 'ISO brightness' is defined as an intrinsic reflectance factor, determined with a brightness meter whose sensitivity to light agrees with ISO standard 2470. Brightness is expressed in % ISO.

Because the characteristics of this wood are different from the standard furnish used at the mill, the technical staff were required to develop a new bleaching sequence adapted to this new pulp. This represents a major departure from the conditions normally employed. The mill engineers will set forth a plan to develop an efficient bleaching process.

For the purposes of the case studies, it is assumed that the technological uncertainties associated with the new wood furnish have been resolved in the digester area as part of a prior ED project. This project focuses, instead, on the technological problems to be resolved in determining the most efficient bleach plant process configuration to brighten the unbleached Kraft pulp from 30% ISO to a target specification of 92% ISO.

1A. Scientific/Technological Objectives

The technological objectives for the project were to determine:

i) Most efficient D bleaching process for bleaching new Kraft pulp using chlorine dioxide;
ii) Number of stages required (if more than one) to achieve final pulp brightness of 92% ISO, starting from an unbleached Kraft pulp brightness of 30% ISO;
iii) Graphical relationships between the pulp brightness and the oxidant concentration at each stage.
iv) Chemical/Physical characteristics of bleached pulp, and paper machine runnability.

1B. Technology or Knowledge Base Level

From past experience the technical team had developed a strong expertise and process knowledge in the area of pulp brightness development. The company's technical staff knew that pulp brightness would show an asymptotic-type graphical characteristic with the applied chemical. As well, based upon prior laboratory and pilot-scale work with the new wood formulation, the company knew that it may be possible to achieve a final pulp brightness of 82 % ISO using the existing bleaching sequence, which was currently in place at this mill. However, it was unclear if it would be possible to achieve the much higher target of 92 % ISO brightness in the mill environment.

Ideally, the mill staff would have liked to determine the number of stages and specific chemical loadings at each stage from lab and pilot-scale data. Based upon the company's extensive experience, however, it was not possible to accurately predict this information from the lab and pilot-scale equipment.

Full-scale mill trials would be needed to determine:

i) Whether the target value of 92 % ISO pulp brightness could be realistically achieved for this new wood formulation in the mill,
ii) How many stages in series would be needed in a multi-stage process to achieve this target pulp brightness,
iii) What specific chemical loadings would be needed at each of the stages (where multiple stages are needed), and what incremental brightness could be achieved with each successive stage,
iv) Impacts of an extensive bleaching process on the chemical and mechanical properties of both the pulp and the resulting paper product.

Mill staff designed an experimental methodology that allowed for the optimal number of bleach stages to be determined with the minimal number of mill trials (See also Section 3.3.1).

1C. Scientific/Technological Advancement

To achieve a brightness of 92% ISO for the pulp, (when starting with an unbleached Kraft pulp control with a brightness of 30% ISO), the company sought to advance the 3-stage D bleaching process that was needed for a new wood formulation. In order to achieve this technology advancement, the company would attempt to determine the specific concentrations of chemicals that would provide optimal bleaching at each of the stages. Moreover, the technical staff would have to be able to glean the graphical relationships between brightness and chemical loading from the derived data at each of the three stages.

The development of the 3-stage D bleaching process could result in a loss of pulp hemicellulose leading to a product with unacceptably low mechanical strength. Since pulp freeness of the bleached product could potentially be very low, there could be a high frequency of web breaks and a very low paper machine runnability. The experimental work is expected to show if the bleaching process would need to be modified in order to achieve acceptable product characteristics.

1D. Description of Work in Tax Year

1D.1: Background Information and Experimental Plan

One of the key technological goals of the project was to achieve a brightness of 92% ISO, starting from 30% ISO. The independent variables to be investigated included the concentration of chlorine dioxide applied to the process and the number of stages (in series) that would be needed. It was assumed that the process temperature, reaction time, and pH would be fixed at the standard mill conditions for this investigation. The dependent variable was the Kraft pulp brightness (post-bleaching); a target specification of 92% ISO was sought from the process.

Since the graphical relationship between the chlorine dioxide concentration and the pulp brightness was known to be asymptotic in behaviour, mill staff needed to design an experimental plan with multiple mill trials for each of the specified independent variables. Due to the nonlinearity of the brightness vs. concentration profile, a minimum of three mill trials would be needed to determine the graphical relationship for the asymptotic curve. More mill trials would likely be desirable in order to scientifically validate the data and ensure that such data was reproducible. In determining the best bleaching process, mill staff ultimately needed to determine the specific graphical relationships between the specific chemical concentrations and the pulp brightness after each stage.

The “asymptotic limit” in this context is the point at which the pulp brightness does not increase significantly with a higher chemical loading. If the concentrations are increased beyond that limit, it would merely increase bleaching costs, without making a substantive impact on the final brightness. This would be quite undesirable from a processing standpoint. Experiments were subsequently designed to find the point at which the asymptotic limit had been attained at each bleaching stage.

1D.2: Experimental Results and Discussion – Bleaching Stages;

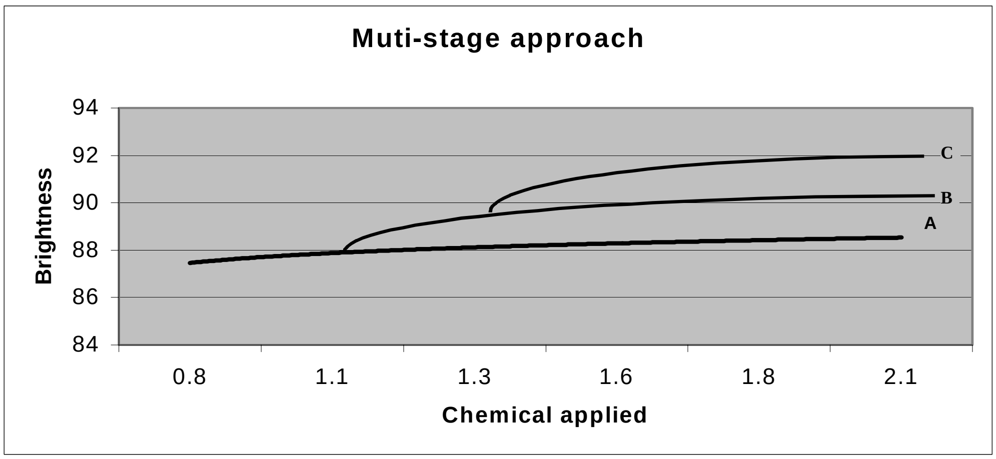
The following figure illustrates the concept behind the Multi-stage Approach (see Section 3.3.1) used, but is not intended to show all of the experimental data that were collected as part of the study.

The unbleached Kraft brightness, which was used as a control for the experiments, was determined to be 30% ISO for the mill. Initial test data showed that the application of ClO_2 resulted in a rapid increase of initial brightness.

The subsequent experiments yielded the data to obtain the graphical relationship between the pulp brightness and the concentration of chemicals.

Curve 'A' shows the results of a single stage D bleaching process:

It was determined that above 1.1 % ClO_2 loading, the final brightness that could be practically achieved was 88% ISO, but the target brightness specification of 92% was not achieved. Clearly, an iterative methodology was required to determine how many stages would be required to achieve the 92% ISO target brightness. At a minimum, a two-D stage bleaching process would be needed.
Curve 'B' represents the two-stage relationship:



In the first stage a brightness of 88% ISO, would be achieved, which would be followed by the second stage bleaching, indicated as Curve B above. It is evident that there is a significant brightness enhancement of about 2% for the 2-stage approach in comparison with the single stage. Since the target of 92% ISO was still not achieved even with 2 stages, however, it would be necessary to investigate a three-stage process.

Curve 'C' presents the results for the third stage D bleaching process:
After the first of three stages in series, the pulp brightness rapidly increased from 30% ISO before asymptotically reaching the 88.2% level; the brightness could be increased further to 90% after 2 stages, and finally to the required 92% after 3 stages in series.

It was concluded that with a 3-stage process it would be possible to achieve the target specification of 92% ISO brightness for the pulp, an important technological advancement for the mill and this project.

<u>1D.3: Characteristics of Bleached Pulp and Runnability Results</u>

Although the three-stage chlorine dioxide bleaching process would be effective to increase the pulp brightness from 30% ISO to 92% ISO, there was an extensive degradation to cellulose chains during the aggressive 3-stage bleaching process. As well, the drainage rate of the 92% ISO bleached pulp was much lower than expected based upon the mill's lab trials.

It was determined from lab analysis that the aggressive bleaching process had resulted in an excessive loss of hemicellulose from the pulp, which resulted in a significant decrease of pulp strength. Upon running the pulp through the paper machine, the technical staff determined that the low-strength pulp also had a very low freeness. These factors resulted in a very high frequency of web breaks on the paper machine, and an unacceptably poor runnability. Based upon these results, the mill staff decided not to proceed further with the run, and most of the paper was subsequently recycled as broke.

A small fraction (<15%) of the experimental pulp was fully processed into the finished paper product. This fraction was classified as 'low-grade' or inventory-grade, although some of that product would be used for customer evaluations, beta testing, and in-house lab testing.

1E. Supporting Information

- Process operator logbooks
- Experimental operating instructions
- Memo to Supervisors on results of trial runs
- Video and photos of equipment operation
- Pulp samples (before and after Bleach plant)
- Resource allocation records
- Design or Process Change Notices
- Mill Trial Authorization records

<u>Analysis of Project</u>

Experimental development was done systematically by qualified technical staff at the mill. The ED work was done for the purpose of achieving a technological advancement in the bleach plant.

The ED project entailed a change to the existing bleach plant process, in that it was necessary to develop an efficient process design to bleach the Kraft pulp from a new wood formulation. The ED was clearly done primarily for the purpose of resolving technological uncertainties associated with the number of bleaching stages required, the required oxidant concentrations at each stage, the physical characteristics of the bleached pulp, and the runnability of the bleached pulp product on the paper machine.

The project, as written, meets the definition of SR&ED.

Case for EP/ED Mill Trials:

The work to develop a bleaching process for a new wood formulation involved process and product risk to the mill. The multi-stage approach was needed to determine the number of stages needed to achieve the 92% ISO brightness target.

In the end, some of the product was saleable; however, whether some, all or none of the product was sold is not relevant to the technical merits of the case.

This ED project involves EP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

Case Study 2: Development of Specialty Coated Paper Process

NB: *The level of detail provided in this case study is beyond the filing requirement of the T661 and is solely provided here to clarify certain issues. This level of detail is not representative of the information that would normally be provided by Pulp & Paper companies as part of their filing requirements.*

Introduction

A pulp and paper mill is in the business of producing value-added specialty coated papers for high-end printing applications. This mill has the requirement to develop a new grade of paper with a newly developed Precipitate Calcium Carbonate (PCC) pigmented coating formulation, using an on-line multi-stage coater.

The new PCC coating formulation was developed in-house, and some preliminary testing had been done on the company's pilot-scale coater. The last phase of the project would be the application of the PCC coating formulation under full-scale dynamic paper machine conditions. This represented a technological challenge, however, because the pilot-scale data showed that it was very difficult to maintain a constant coating thickness over the duration of a longer trial. It was critical that the variability of this coating thickness be maintained within a very tight pre-specified tolerance over the duration of a mill trial. As well, the data would have to be reproducible between consecutive runs, to meet the specific end uses that were envisaged for this new product.

2A. Scientific/Technological Objectives

The technological objectives of the experimental work were to:

i) Evaluate if an experimentally-developed PCC-coating formulation could be used for the production of a new specialty-coated paper on the full-scale paper machine process,
ii) Determine the PCC-coated paper characteristics for each of the three mill trials; maintaining a very tight tolerance for coating thickness uniformity for the entire mill trial on the multi-stage coating process was a technological challenge, but was essential for this process to be viable,
iii) Determine the PCC-coated paper properties, and validate if these properties were reproducible between replicate mill trials.

2B. Technology or Knowledge Base Level

Based upon past experience, the technical team had developed a strong expertise and process knowledge in the area of high-end coating applications. As such, it would be possible to design an experimental methodology for this project using an optimal repetitive trials approach (see Section 3.3.2).

The company's technical staff planning the trials had some limited operations experience with the company's pilot-scale coater. However, it was not clear from the available lab and pilot-scale data if:

- The experimentally-developed PCC-coating formulation could be used to manufacture a new specialty-coated paper, since the technical staff had no prior full-scale paper machine operations experience with the PCC coating formulation.
- The variability of the coating thickness could be maintained within a very tight pre-specified tolerance over the duration of a mill trial. (Pilot-scale data indicated that it could be difficult to achieve a constant coating thickness for the duration of an entire production run, due to the unique chemical characteristics of the new PCC-coating formulation.)
- The paper properties could be produced within the maximum allowable variabilities for the specified parameters during a trial, or reproduced for replicate trials.
- The runnability would meet the required specification, under dynamic process conditions, with the new PCC coating formulation.

Experimental data was needed to provide insight and operations data with regard to all these technological issues.

2C. Scientific/Technological Advancement

Several technological advancements were sought from the three trials. For instance, the company would attempt to demonstrate for the first time on the full-scale paper machine process that a new PCC coating formulation could be employed for the manufacture of a new specialty-coated paper. Technical staff would need to demonstrate that the coating thickness uniformity could be maintained consistent, and within a very tight tolerance, for the entire duration of a trial. Both of these findings could represent important technological advancements for the mill, since neither result has been demonstrated previously for dynamic paper machine conditions.

2D. Description of Work in Tax Year

<u>2D.1: Background Information and Experimental Plan</u>

Based upon internal and customer requirements, the technical team identified specific target specifications for the paper which would require a repetitive trials approach on the entire paper machine. The R&D technical team developed specific experimental operating instructions (EOIs) for the purpose of evaluating the new PCC coating formulation on a full-scale paper machine. The management-approved EOIs were designed to cover designated parameters for the entire paper machine process, and not just the coating aspects of the operation. This included, for example, many process modifications on the supercalendering operations, to compact the coating structure, and develop a greater level of smoothness that would be needed to meet the end use applications that were envisaged.

To achieve the technological objectives, the experimental protocol necessitated that after each mill trial, the entire process would have to be restabilized back to standard operating conditions, prior to proceeding with the next trial. This was to ensure that the results could be compared with a known control or baseline, and that the reproducibility of the process data could be compared for replicate trials.

Table A1: Target specifications

Runnability	78 to 83	%
Brightness	69 to 73	ISO
Opacity	86 to 90	ISO
Basis weight	50 to 54	g / cm2
Coating weight	7.2 to 7.5	g / cm2
Gloss	33 to 37	%
Ash	6 to 8	%

After having finalized EOIs, the first mill trial was undertaken.

2D.2: Experimental Results and Discussion;

Mill trial 1

For this Mill trial 1, the primary technological objective was to determine if the new paper could be produced within the required target specifications, as listed in Table A1. The process was initially stabilized at the new experimental operating conditions. There was subsequently an initial transition period (ITP), during which steady-state was gradually approached for the new conditions (see Section 3.2.1). Once the process was stabilized, and steady state was confirmed at the designated operating conditions, the experimental validation phase (EVP) was initiated. During the EVP (Section 3.2.2), the characteristics of the paper and the effect of the new formulation on the runnability of the paper machine were determined. Upon completion of the data collection during the EVP, the process was returned back to the standard operating conditions during the final transition phase (FTP).

The results obtained from the first mill trials were as follows:

Table A2, First Mill trial Results

Runnability	78 to 80	%
Brightness	70 to 74	ISO
Opacity	84 to 90	ISO
Basis weight	50 to 52	g / cm2
Coating weight	7.1 to 7.6	g/cm2
Gloss	33 to 35	%
Ash	6 to 8	%

The results from this first mill trial met the target specifications, within the known production variances, for all of the parameters.

To validate these results and to check the reproducibility of replicate data, two repetitive trials were recommended by the project technical team. They are described below.

<u>Mill trials 2 and 3</u>

The results for Mill trials 2 and 3 are shown in Table A3 below:

Table A3.

	Trial 2	Trial 3	
• Runnability	77 to 82	76 to 83	%
• Brightness	69 to 75	68 to 74	ISO
• Opacity	83 to 89	80 to 90	ISO
• Basis weight	52 to 54	51 to 54	g / cm2
• Coating weight	7.1 to 7.5	7.1 to 7.6	g / cm2
• Gloss	33 to 36	31 to 35	%
• Ash	5.7 to 8	5.5 to 8.2	%

The paper satisfactorily met the target specifications, within the known production variances for the process. However, the level of variability between consecutive runs was considered to be unacceptably high, based upon a statistical analysis of the pooled data from all three trials. As a result, more experimental development work will likely be needed in the future to ensure that the paper characteristics between consecutive runs are more consistent.

2E. Supporting Information

- Process operator logbooks
- Experimental operating instructions
- Reports from Pilot-scale trials
- Project/Experimental plan for Mill Trials
- Correspondence to Senior management on project plans/results of trial runs
- Video and photos of equipment operation
- Paper samples
- Resource allocation records
- Design or Process Change Notices
- Mill Trial Authorization records

<u>Analysis of Project</u>

Experimental development was done systematically by qualified technical staff during the three mill trials claimed. The ED work was done for the purpose of achieving a technological advancement, which was specifically related to the plant-scale development of a new PCC coating formulation that was originally developed from in-house lab and pilot-scale work.

The ED project entailed a change to the existing process, in that it was necessary to develop a reliable and consistent specialty paper using a new and unproven experimental PCC coating formulation. The ED was done primarily for the purpose of resolving technological uncertainties associated with:

i) Demonstrating an experimental coating formulation for a new specialty-coated paper on the full-scale paper machine process;

ii) Maintaining consistent coating thickness for the duration of a mill trial;
iii) Meeting the preset specified target specifications, and
iv) Having reproducible properties between consecutive trials.

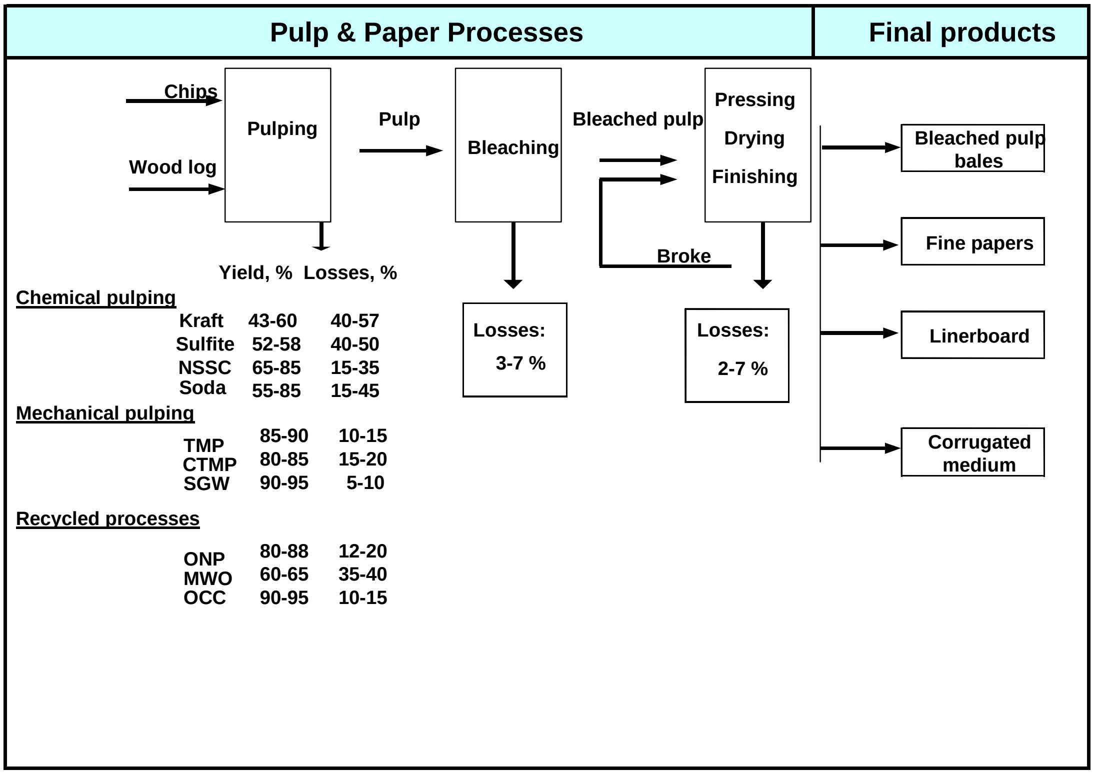
The project, as written, meets the definition of SR&ED.

Case for EP/ED Mill Trials:

The work was done to develop a new process for a new specialty coating paper, which involved process and product risk to the mill. The repetitive approach using three mill trials in this case, was needed to determine if product target specifications could be attained on a consistent basis.

This ED project involves EP/ED mill trials based on the list of technical considerations and other complementary evidence in Section 3.1.2.

APPENDIX B: SIMPLIFIED PROCESS FLOW DIAGRAM



APPENDIX C: SR&ED PULP AND PAPER SECTOR COMMITTEE MEMBERS

Geoff Hill, Chair	Bowater Inc. (now with Deloitte & Touche)
Supriya SenGupta, V-Chair	Canada Revenue Agency
Jean St-Onge, Secretary	Abitibi-Consolidated Inc.
Reginald Bastien	Tembec Inc.
Jean-Noel Cloutier	Paprican
Charles Contant	Tembec Inc.
Louise Desjardins	Quebecor World Inc.
Asher Elcabas	Kokin, Elcabas and Associates
Gerry Goodchild	Canada Revenue Agency
Graham Jackson	AstenJohnson Inc.
Pierre Jetté	Domtar Inc.
Lloyd Johns	Kruger Inc.
Fred Kokin	Kokin, Elcabas and Associates
Paul Lansbergen	Forest Products Association of Canada
Michel Lefebvre	Deloitte & Touche
Michel Letourneau	Hercules Canada Inc.
Mel Machado	Canada Revenue Agency
Guy Martin	Domtar Inc.
Alan Pelman	Weyerhaeuser Company
Chantale Rouleau	Buckman Laboratories of Canada, Ltd.
James Waterman	JohnsonDiversey