Aerospace Industry

The following guidelines are intended to provide examples of "experimental development" projects which would qualify for Canadian SR&ED (Scientific Research & Experimental Development) tax credits.

Content Summary:

NOTE: THESE GUIDELINES ARE BASED ON THE CRA'S INFORMATION CIRCULAR "IC86-4R2SUP2 SCIENTIFIC RESEARCH AND EXPERIMENTAL DEVELOPMENT: AEROSPACE INDUSTRY APPLICATION PAPER"]

1 - Aerospace Industry Guidelines:

Scientific or Technological Objectives:

[NOTE: THESE GUIDELINES ARE BASED ON THE CRA'S INFORMATION CIRCULAR "IC86-4R2SUP2 SCIENTIFIC RESEARCH AND EXPERIMENTAL DEVELOPMENT: AEROSPACE INDUSTRY APPLICATION PAPER"]

We recognize that in many cases the project's initial technological objectives may be modified as development proceeds. This usually does not affect eligibility. When technical problems arise after the initial technological objectives have been achieved, it is appropriate to consider that a new project or set of sub-projects has begun, and the original one ended. We recognize that specific projects that meet the three essential eligibility criteria are allowable, but generally view "ongoing development" as closely allied to routine engineering or routine development (see paragraph 2.7 (i) of IC86-4) which are not eligible. The claimant should therefore distinguish between new sub-projects and data collection that support a project, which are eligible and routine development and routine data collection, which are excluded.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:
There are three types of project designs:

1. Preliminary design: Where preliminary design is undertaken using existing knowledge within the experience of the company, and/or based upon generalized data such as that which is available in standard handbooks, the project design undertaking is considered routine engineering, since it arises from applying established knowledge. If the process terminates at the proposal stage, the work performed will be judged ineligible, as at this point technological uncertainties have not been resolved, although they may have been identified.

An exception to the above is the preliminary and/or advanced design of new products for the commercial market where substantial analysis of new concepts, new materials, experimental research results, etc., must be incorporated to define a probable product that will show significant improvement over those products already available in the marketplace.

On the other hand, if the project design phase goes into the prototype development phase, which by its nature requires resolving technological uncertainties, then the technical work becomes eligible as supporting activities closely linked to an eligible project. However, if in a given time period, a design office creates 10 preliminary designs (proposals), and develops only some of them, then only the expenditures for those supporting activities for eligible projects will be considered qualifying expenditures. We consider R&D by projects, not by department or function.

2. Project design: The project design, in itself, requires developing new methods of analysis and undertaking or generalizing model tests and their results to confirm the adequacy of the analytical methods. This undertaking constitutes an extension to scientific or technological knowledge and thus the project, in itself, will be eligible.

3. Project design in response to a Request for Proposal (RFP): Requests for Proposals for aerospace systems or devices are extremely detailed, a response to which will in general require that certain performance parameters, extending the existing state of the art, be guaranteed. In many cases, particularly those relating to military aerospace products or devices, a limited number of manufacturers may be requested to respond. Usually, only one of the respondents will be contacted to continue the project into a prototype development phase. As advances in technology are required along with guarantees of performance, there will always be a need for experimental work or extensive analysis to meet these requirements. Under such circumstances, the technical preparation of the response to the RFP, even when it does not lead to a development contract, should be considered for eligibility.

Typical examples of eligible responses to RFPs are complete aerospace vehicles (aircraft, satellites or other space vehicles), power-plants, environmental control systems, for military or civil aircraft, and fuel control systems for advanced engines where experimental work, simulation studies, or full-scale mock-ups have constituted elements in the work supporting the preparation of the response.

Field of Science/Technology:

Aerospace engineering (2.03.04)

Intended Results:

- Develop new processes
- Develop new materials, devices, or products
- Improve existing processes

- Improve existing materials, devices, or products

Scientific or Technological Advancement:

Uncertainty #1: Inherent Technological Uncertainties

In the aerospace industry the stringent requirements of the regulations and critical nature of safety, design, engineering, weight, physical volume/size, and performance often give rise to technological problems that result in the creation of eligible projects in areas which might be routine in other industries.

The most significant underlying key variables are:
safety, weight, volume/size, performance (unresolved)

Activity #1-1: Weight minimization

Work performed in Fiscal Year 2009:

Methods of experimentation:

The primary problem of weight minimization necessitates structural development through detailed and sophisticated analysis. This is supported and verified by developing and testing the structural elements, and eventually the complete structures.

Results:

[NOTE: IF THERE WERE ANY TEST RESULTS FROM THIS ACTIVITY THAN THESE SHOULD BE STATED HERE]

Conclusion:

This approach is the only feasible way of achieving the technical objective of the use of minimum weight structures that (a) comply with the standards imposed by regulation, and (b) provide adequate economic life in terms of hours or cycles of operation.

Key variables resolved: volume/size, weight

Activity #1-2: The need for model and full-scale testing

Work performed in Fiscal Year 2009:

Methods of experimentation:

Analysis alone cannot determine those aerodynamic characteristics of aircraft that influence not only performance, but also flight safety behaviour. This deficiency arises from the incomplete status of aerodynamic theory, and as a result, extensive testing is required.

Results:

[NOTE: SIMILARLY, IF THERE WERE ANY TEST RESULTS FROM THIS ACTIVITY THAN THESE SHOULD BE STATED HERE]

Conclusion:

Model testing in wind tunnels is therefore required to identify and resolve the technological uncertainties inherent in aerodynamic interactions. This alone, however, cannot resolve all such technological uncertainties since the representation afforded by scale model tests is limited by physical laws. For true representation, the aerodynamic scale, as measured by Reynolds Number (which determines, for example, the profile drag, and controls hinge moments), and the effects of compressibility of air at high speeds, as measured by Mach Number (which, for example, determines the lift slope of wings and tail surfaces, variation of pitching moment with angle of attack, controls hinge moments and wave drag) must both be satisfied. These cannot be done simultaneously at model scale, and in the end, full-scale flight testing and development is required to identify and resolve all of the technological uncertainties involved in the aerodynamic interactions.

Activity #1-3: Developing methods and techniques

Work performed in Fiscal Year 2009:

Methods of experimentation:

There is continuous technological advancement in the aerospace industry, and thus the industry has an ongoing need to develop new methods of analysis, experimental techniques, materials and manufacturing techniques. Such undertakings contribute to the advancement of science and technologies, and will generally fall within the conditions for eligibility.

Conclusion:

Typical examples of such activities include developing methods to analyze and design aerofoil profiles in the viscous flow regime, and supporting tests to verify these methods; advances in analyzing structures for strength and integrity; developing manufacturing methods for new materials; and developing methods to apply these materials in aerospace structures.

Activity #1-4: Systems and powerplants

Work performed in Fiscal Year 2009:

Methods of experimentation:

Considerations similar to those for aircraft apply to systems and power-plants. However, if a power-plant is installed in an aircraft (e.g., company commuter aircraft) which is used for non-scientific purposes simultaneously with in-flight development, a different situation exists. Only those incremental activities associated with installing the monitoring and data-recording systems, and the time technical observers spend monitoring the engine in flight, should be considered eligible activities. The same considerations apply to developing systems in flight.

Conclusion:

The interactions between structural distortions and the aerodynamic forces and moments resulting from these interactions can be fully determined only at the flight test and development phases. These interactions may affect not only the structural integrity of an aerospace device, but also its flight characteristics. There is, consequently, often system uncertainty in the development of an aerospace device, as well as technological uncertainties at the more detailed levels. The spectrum of eligibility is strongly influenced by these factors.

Activity #1-5: Mock-ups

Work performed in Fiscal Year 2010:

Methods of experimentation:

The construction and use of full scale models (mock-ups) of aerospace devices is often an essential component of the development program. They are generally eligible if they are built in support of design and development in an eligible project.

Conclusion:

Another example is when an engine manufacturer provides a full scale model, or an actual engine, to an airframe constructor so that it can be incorporated in an eligible technical mock-up. Sometimes, models that are built for eligible technical development purposes are also used for other purposes such as sales promotion and marketing, which are not eligible. We will examine the facts of each case in accordance with audit guidelines when determining the eligibility of mock-ups and models.

Activity #1-6: Human/machine interaction

Work performed in Fiscal Year 2010:

Methods of experimentation:

In many aerospace projects, the interaction between a human operator and the device that he or she is controlling poses a complex technological problem. Major contributing factors are the physiological, neurological, and other limitations of the human operator, considered as an element within a servo system. The effect of these limitations implies that changes to the purely physical elements comprised in the system may be necessary, and that these changes can be best undertaken by simulation or flight testing with the human operator in the servo loop. System adjustments or modifications are made until a point is reached where the human operator can carry out a prescribed task without excessive physical or neurological effort. Certain aspects of psychological research may also be involved in this kind of development, and when this research is done in support of eligible SR&ED, it would be allowed as specified in Regulation 2900.

Conclusion:

Examples of situations demanding this type of approach are when modifications are made to systems: for instance, to achieve acceptable relations between the frequency and damping of control-induced pitching motions so as to permit the operator to track a specified path; or to limit the degree of adverse yaw, and the ratio and phase relationships between roll and sideslip angles so that an approach and landing path may be followed with accuracy.

Key variables resolved: safety

Activity #1-7: Activities following Type Certification

Work performed in Fiscal Year 2010:

Methods of experimentation:

Following Type Certification, aerospace devices and systems in service may exhibit defects and/or deficiencies that could not reasonably have been identified and resolved at the initial development stage. When such defects or deficiencies directly influence the targeted technical performance or operational safety of the device, then those activities required to resolve the technical problem should be considered for eligibility. To illustrate, we can cite examples of significant problems arising partly or largely after Type Certification, when technological deficiencies are revealed through:

- fatigue tests, creep tests, and their implications;
- corrosion and stress studies;
- cold soak and other special environment tests;
- de-icing tests and modifications;
- lightning tests;
- propeller balance tests;
- autopilot refinements;
- wear tests;
- non-critical but significant flight tests;
- heat loss, insulation, and oil cooling changes;
- engine fuel control operation; and
- engine component operation.

Generally speaking, only those matters involving technological problems which bear directly upon the continuance of Type Certification should be considered for eligibility. Such regulated requirements such as the installation of smoke detectors and fire extinguishers in toilet compartments are indeed related to the maintenance of Certificates of Airworthiness, but as they do not resolve any technological uncertainties, they are not considered eligible.

When an aeronautical product is modified to the extent that re-certification is required, for instance when the fuselage of an existing model is stretched to increase its capacity, a new model Type Certificate may be granted. Alternatively, a Supplemental Type Certificate may be issued at the discretion of the regulatory agency. In either case, only the work involved in modifying and qualifying the prototype model of the modified device or system can be considered eligible.

Typical examples of modifications likely to require Supplementary Type Certification are:

The installation of a new type of engine into an existing airframe, e.g., the substitution of a reciprocating internal combustion engine by a gas turbine engine, and the associated system changes engendered by such a substitution.

Structural alterations that could influence the structural integrity of an existing aircraft e.g., structural alterations to a pressure cabin to provide an optically flat window for a survey camera.

Configurational alterations that could alter the flying characteristics of an existing aircraft, e.g., the external mounting of magnetic anomaly detector arrays for geo-magnetic survey purposes; or the mounting of floats in place of the landing gear on an aircraft not previously certificated for operation on floats.

Similarly, in spaceflight development projects, eligible activity may continue to be found beyond the Critical Design Review stage if, despite all available techniques and reasonable measures such as extensive ground testing, sufficient uncertainties exist about whether the:

- flight equipment meets all the specification requirements as an integrated unit (initial integration);

- flight equipment meets all the specification requirements when integrated at the spaceflight vehicle level; and

- flight equipment, after launch, meets all the specification requirements while in orbit or on a mission, over the required operational life of the equipment.

Conclusion:

Consequently, depending on the circumstances of the individual case, eligible post-CDR activities and associated expenditures may be identified in relation to (a) the integration and testing of flight equipment, including the analysis of test results, and (b) the development of test methods and protocols for, and the actual testing of, the equipment while it is in orbit or on a mission before the spaceflight vehicle can be released for operational use.

Activity #1-8: Vendors

Work performed in Fiscal Year 2010:

Methods of experimentation:

In some cases, there may be agreements to enter into joint R&D with a vendor, or there may be a significant element of uncertainty or advance. For example, experimental flight tests may have been undertaken to pinpoint the need for a vendor-instituted `fix,' or to verify the safe incorporation of a change. However, if a firm is not really involved beyond the routine stage with a vendor who has developed a product past the initial configuration, then the work is not eligible.

Conclusion:

[A DISCUSSION ON WHAT WAS LEARNED SHOULD BE INCLUDED FOR EACH ACTIVITY]

Activity #1-9: Change Control Board activity

Work performed in Fiscal Year 2010:

Methods of experimentation:

Engineering changes do not automatically qualify just because they are done in an aerospace environment. Substituting a different material, or substituting one off-the-shelf item for another, or adding a spacer or a shim are considered to be routine (unless a technical case can be presented otherwise) and are not eligible activities. To be eligible, the engineering activity must be done in support of an eligible SR&ED project.

Conclusion:

Rectifying failures can in many cases lead to eligible projects. However, correcting mistakes and oversights, such as errors in reading drawings, is a standard activity of Change Control Boards, and would not be eligible. There may be cases where an error is not obvious, such as when it is a result of the incomplete status of available knowledge. In such cases, a technical investigation and eligible project could arise. Each situation will be examined on its own merits.

Key Criteria Summary

Sample Aerospace Industry

1 - Aerospace Industry Guidelines

Benchmarks: (none) **Objectives:** (none)

Uncertainty: 1 - Inherent Technological Uncertainties **Key Variables:** performance, safety, volume/size, weight

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Weight minimization	Analysis / Simulation: 4 materials	Weight - Size ratio (100%)	weight volume/size	45.00	56.11	606.40	2009
2 - The need for model and full-scale testing	Process trials: 15 runs	Aerodynamics (75%)	(none)	870.00	6,788.00	1,170.00	2009
3 - Developing methods and techniques	Analysis: 4 techniques	Final technique	Structual Integrity	200.00	1,335.00	700.00	2009
4 - Systems and powerplants	Examination of 2 systems	2nd system 75% of goal	Power storage/production	133.00	3,500.00	1,500.00	2009
5 - Mock-ups	Physical prototypes: 2 samples	Model durability (1- 50% 2-95%)		125.00	2,000.00	1,000.00	2010
6 - Human/machine interaction	Process trials: 10 runs/ samples	Damping of control-induce pitching (89%)	safety	100.00	1,000.00	350.00	2010
7 - Activities following Type Certification	Analysis of 12 factors	Equipment meets all	safety	45.00	750.00	135.00	2010
8 - Vendors	Two vendors approached	Second vendor partnership (50%)		60.00	1,430.00	530.00	2010
9 - Change Control Board activity	Examination of errors :2 modifications	Control Board optimal (100%)		50.00	1,250.00	500.00	2010

901 - Aerodynamic prediction methods for tiltwing aircraft:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
model accuracy (%)	30	98
Maximum Cost ($)	3500	4500
Response time (sec)	0.5	0.1
Ability to compare models simultaneously (#)	2	5
()	(not set)	(not set)

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. A QUANTIFIABLE OBJECTIVE HAS BEEN ADDED ABOVE, TO ILLUSTRATE.]

A hybrid aircraft capable of vertical takeoff, able to transition from low to high speed forward flight and back to low speed flight for vertical landing would have many benefits for the military, commercial and private aircraft industries.

Company X is attempting to design such an aircraft, using a tilt-wing approach. A tilt-wing aircraft uses oversized conventional propellers driven by engines that are attached to a wing that can be tilted from the horizontal position for forward flight, and to the vertical position for takeoff and landing.

The aerodynamic requirements of the wings during vertical takeoff and landing are different than the requirements during high-speed forward flight. To aid in the design of suitable wing, Company X has decided to develop prediction methods that will accurately characterize the aerodynamic behaviour of wings at high angles of attack in a slipstream (i.e., when the wing is vertical).

This project objective is to improve current prediction methods that accurately characterize the aerodynamic behaviour of wings at high angles of attack in a slipstream, to be used in the design of tilt-wing vertical takeoff and landing aircraft.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Patent searches: 3 patents -- insufficient info
- Similar prior in-house technologies: 2 products / processes -- 2 existing methods insufficient

Currently, heavier than air aircrafts achieve lift by movement through the air in one of two ways:
1) with stationary wings that create lift when propelled through the air by a thrust mechanism such as a propeller or jet engine (i.e. the airplane), and
2) with wings or blades that rotate to describe a disc above the aircraft which creates lift (i.e. the helicopter).

The first design allows for high-speed forward flight, while requiring long takeoff and landing distances, while the second allows for vertical takeoff and landing, but can only achieve low forward flight speeds.

Field of Science/Technology:

Aerospace engineering (2.03.04)

Intended Results:

- Improve existing materials, devices, or products

Work locations:

Research Facility, Commercial Facility

Scientific or Technological Advancement:

Uncertainty #1: Developing accurate aerodynamic prediction methods

Can the company develop analytical engineering methods for use in predicting the static and dynamic stability, control derivatives and force and moment coefficients of the aircraft when the wings are at high angles of attack in a slipstream?

[SCIENTIFIC RATHER THAN "SYSTEM" UNCERTAINTY: THIS "SCIENTIFIC UNCERTAINTY" AS TO THE ABILITY OF A SPECIFIC METHOD TO ACHIEVE SPECIFIC GOALS IS A MUCH HARDER SELL THAN A SERIES OF "SYSTEM UNCERTAINTIES" RELATED TO THE SELECTION AND INTEGRATION OF ALTERNATE COMPONENTS. IF YOU APPEAR TO HAVE GONE IMMEDIATELY TO THIS SOLUTION WITHOUT CONSIDERING ANY ALTERNATIVES IT WILL MAKE THE WORK APPEAR "ROUTINE" FOR A COMPANY WITH YOUR KNOWLEDGE BASE.]

[WHEN YOU PHRASE THE UNCERTAINTY AS "CAN [A RESULT] BE ACHIEVED?" IT INDICATES A BINARY (I.E. YES/NO) ANSWER TO YOUR QUESTION. THE CRA IS MORE INTERESTED IN SEEING THAT YOU UNDERTOOK EVALUATION OF TECHNICAL ALTERNATIVES, NOT ONLY TO OPTIMIZE PERFORMANCE, BUT ALSO TO UNDERSTAND HOW THE INDIVIDUAL COMPONENT DYNAMICS INTERACT & OPERATE IN GIVEN ENVIRONMENTS. WE SHOULD TRY TO REFINE THE UNCERTAINTIES AND RELATED RESEARCH STEPS APPROPRIATELY TO FOCUS ON THESE TYPES OF ISSUES WHERE POSSIBLE.]

The most significant underlying key variables are:
mean geometric chord, force, angle, lift-curve slope vs. Lifting surface, trailing vs. leading edge angle, mean aerodynamic center

Activity #1-1: Initial Model Design

Work performed in Fiscal Year 2009:

Methods of experimentation:

- Analysis / simulation: 4 alternatives - The aerodynamics models considered were: stability derivatives, strip theory methods, quasi-steady vortex lattice methods, and unsteady panel methods.

  [AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  An initial model was developed to predict the aerodynamic behaviour of the wing in a vertical or near-vertical position. [NOTE: THIS COULD BE EXPANDED - WAS MORE THAN ONE APPROACH CONSIDERED? WHAT CHOICES WERE MADE IN TERMS OF ASSUMPTIONS?]

Results:

- Response time: 0.2 sec (75% of objective)
- Ability to compare models simultaneously: 5 # (100% of objective)

Conclusion:

PROVIDE CONCLUSIONS:

[AN IDEAL TECHNICAL DESCRIPTIONS SHOULD PROVIDE CONCLUSIONS AS TO WHY THESE "RESULTS" AND RELATED "INTEGRATION ISSUES" WERE NOT "READILY PREDICTABLE" TO YOU FROM A TECHNICAL STANDPOINT?]

Key variables resolved: force, angle, lift-curve slope vs. Lifting surface, mean aerodynamic center, mean geometric chord, trailing vs. leading edge angle

Activity #1-2: Verification of Model Using Wind Tunnel

Work performed in Fiscal Year 2010:

Methods of experimentation:

- Process trials: 20 runs / samples
- Physical prototypes: 1 samples

  [AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

  A prototype wing was built and a series [NOTE: THIS IS VAGUE - HOW MANY TESTS WERE CONDUCTED?] of wind tunnel tests were conducted to verify the accuracy of our aerodynamic predictions.

  QUANTIFICATION:
  [REMEMBER THAT THE TAX COURT'S CONTINUALLY REITERATE THE FACT THAT, "SYSTEMATIC INVESTIGATION MUST INVOLVE EXTREMELY ACCURATE MEASUREMENTS AND SUBSEQUENT ANALYSIS OF THOSE MEASUREMENTS." WE SHOULD THEREFORE ATTEMPT TO PROVIDE REVENUE CANADA WITH SUCH EVIDENCE WHENEVER POSSIBLE.]

Results:

- model accuracy: 35 % (7% of objective)

Project Name:	Aerodynamic prediction methods for tiltwing aircraft	**Start Date:**	2009-01-01
Project Number:	901	**Completion Date:**	2010-06-30

Conclusion:

Unfortunately some key parameters [NOTE: AGAIN THIS IS VAGUE - HOW MANY AND/OR WHICH KEY PARAMETERS?] obtained in the wind tunnel tests differed significantly from the values predicted using our initial model. This project is on-going; future work will include re-examining the assumptions that went into our initial model to determine whether they were inappropriate for this application.

Key variables resolved: force, angle, lift-curve slope vs. Lifting surface, mean aerodynamic center, mean geometric chord, trailing vs. leading edge angle

901 - Aerodynamic prediction methods for tiltwing aircraft

Benchmarks: Patent searches: 3 patents
Similar prior in-house technologies: 2 products /

Objectives: model accuracy: 98 %
Maximum Cost: 4500 $
Response time: 0.1 sec
Ability to compare models simultaneously: 5 #
:

Uncertainty: 1 - Developing accurate aerodynamic prediction methods

Key Variables: force, angle, lift-curve slope vs. Lifting surface, mean aerodynamic center, mean geometric chord, trailing vs. leading edge angle

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Initial Model Design	Analysis / simulation: 4 alternatives	Ability to compare models simultaneously: 5 # (100 %) Response time: 0.2 sec (75 %)	force, angle lift-curve slope vs. Lifting surface mean aerodynamic center mean geometric chord trailing vs. leading edge angle	100.00	20,000.00	7,530.00	2009
2 - Verification of Model Using Wind Tunnel	Process trials: 20 runs / samples Physical prototypes: 1 samples	model accuracy: 35 % (7 %)	force, angle lift-curve slope vs. Lifting surface mean aerodynamic center mean geometric chord trailing vs. leading edge angle	300.00	14,000.00	3,200.00	2010

902 - Elongation of Existing Aircraft Fuselage:

Scientific or Technological Objectives:

Measurement	Current Performance	Objective
stall speed (mph)	50	70
Passenger capacity (persons)	250	300
Maximum Production Cost ($ per 1 unit)	75000	80000
meets all safety regulations ()	1	1
maintain flying quality (%)	93	93
Maintain operations limitations (%)	100	95

[NOTE: THIS PROJECT IS BASED ON INFORMATION FROM THE CRA'S INFORMATION CIRCULAR "IC86-4R2SUP2 SCIENTIFIC RESEARCH AND EXPERIMENTAL DEVELOPMENT: AEROSPACE INDUSTRY APPLICATION PAPER"]

[AUTHOR'S NOTE: IDEALLY THE TAXPAYER WOULD ATTEMPT TO QUANTIFY THE CURRENT PERFORMANCE OF THE OBJECTIVES THEY ARE TRYING TO ACHIEVE. THE CURRENT AND DESIRED VALUES FOR AN OBJECTIVE HAVE BEEN ADDED ABOVE, TO ILLUSTRATE.]

Our objective is to increase passenger capacity in an existing aircraft model by lengthening the fuselage, and to ensure that the modified aircraft meets all airworthiness and safety regulations.

Technology or Knowledge Base Level:

Benchmarking methods & sources for citings:

- Patent searches: 3 patents -- insufficient data
- Competitive products or processes: 3 products -- aircraft with similar capacity
- Similar prior in-house technologies: 5 products / processes -- Existing models

Company X designs passenger airplanes for airlines around the world. Due to economic changes in the airline industry, there is a demand for aircraft with increased passenger capacity. Rather than designing a completely new model, the company has decided to modify their current model by elongating its fuselage, thereby providing more space for passenger seats. The aircraft systems are expected to remain identical to those of the existing aircraft.

[CRA NOTE: IN THE CASE OF A CHANGED OR ALTERED EXISTING AIRCRAFT], SYSTEM MODIFICATIONS SHOULD NORMALLY BE ROUTINE AND RELATIVELY MINOR, AND CLAIMS FOR ELIGIBILITY IN THESE CASES SHOULD BE SCRUTINIZED CAREFULLY. POWERPLANT AND ENGINE CONTROL SYSTEM MODIFICATIONS WILL BE TREATED IN THE SAME MANNER AS FOR AIRCRAFT MODIFICATIONS.]

Field of Science/Technology:

Aerospace engineering (2.03.04)

Intended Results:

- Improve existing materials, devices, or products

Work locations:

Research Facility

Scientific or Technological Advancement:

Uncertainty #1: Qualification wrt Airworthiness Regulation

Elongation of the fuselage is expected to change the flying qualities and operational limitations of the aircraft. It is uncertain how exactly these characteristics will change, and what design modifications will be required to meet the Airworthiness Regulations. [NOTE: THIS COULD BE MORE SPECIFIC. WHAT ARE THE MAIN VARIABLES? DO THEY INTERACT? WHY ARE THE MODIFICATIONS EXPECTED TO CREATE TECHNOLOGICAL UNCERTAINTIES?]

The most significant underlying key variables are:

Fuselage Type and length, Max Airspeed vs. Maneuvering vs. Flap extended speed, Center of gravity vs. weight distribution, Powerplant limitations, Operating altitude

Activity #1-1: Design and development work

Work performed in Fiscal Year 2009:

Methods of experimentation:

- Analysis / simulation: 5 alternatives - Aerodynamic models of our design alternatives.
- Process trials: 15 runs / samples - 5 different wind tests on each of the 3 prototypes
- Physical prototypes: 3 samples

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

Design and development work was required to qualify the aircraft to the Airworthiness Regulations. [NOTE: THIS IS WAY TOO VAGUE. WHAT WORK SPECIFICALLY WAS CONDUCTED? AND HOW DID IT RELATE TO MEETING THE REGULATIONS?]

Results:

- meets all safety regulations: 1 (100% of objective)
- maintain flying quality: 93 % (100% of objective)
- Maintain operations limitations: 96 % (80% of objective)

Conclusion:

PROVIDE CONCLUSIONS:

[AN IDEAL TECHNICAL DESCRIPTIONS SHOULD PROVIDE CONCLUSIONS RELATED TO THE ACTIVITY AND DESCRIBE WHY THESE "RESULTS" AND RELATED "INTEGRATION ISSUES" WERE NOT "READILY PREDICTABLE" TO YOU FROM A TECHNICAL STANDPOINT?]

Key variables resolved: Center of gravity vs. weight distribution, Fuselage Type and length, Max Airspeed vs. Maneuvering vs. Flap extended speed, Operating altitude, Powerplant limitations

Activity #1-2: Flight tests

Work performed in Fiscal Year 2010:

Methods of experimentation:

- Process trials: 10 runs / samples - Flight tests.

[AUTHOR'S NOTE: THE DESCRIPTIONS BELOW WERE PROVIDED IN THE CRA'S EXAMPLE. THE DATA ABOVE (# TRIALS/ALTERNATIVES) IS PROVIDED TO ILLUSTRATE SOME OF THE ADDITIONAL DETAILS THAT WOULD IDEALLY BE INCLUDED.]

A series of flight tests [NOTE: HOW MANY TESTS WERE PERFORMED?] were conducted and analyzed to determine changes in flying qualities and operational limitations of the modified aircraft [NOTE: WHICH QUALITIES AND LIMITATIONS SPECIFICALLY WERE CONSIDERED?], in particular as they relate to safety.

Results:

- stall speed: 70 mph (100% of objective)
- Maximum Production Cost: 85000 $ per 1 unit (200% of objective)

Conclusion:

[AGAIN, A DISCUSSION ON WHAT WAS LEARNED FROM THE ASSOCIATED ACTIVITY SHOULD BE INCLUDED, AS WELL AS PROJECT STATUS AND SPECIFYING ANY FUTURE WORK SHOULD BE INCLUDED IN THE CONCLUSION SECTION.]

Key variables resolved: Center of gravity vs. weight distribution, Fuselage Type and length, Max Airspeed vs. Maneuvering vs. Flap extended speed, Operating altitude, Powerplant limitations

Project Name:	Elongation of Existing Aircraft Fuselage	**Start Date:**	2009-01-01
Project Number:	902	**Completion Date:**	2010-06-30

902 - Elongation of Existing Aircraft Fuselage

Benchmarks:
Patent searches: 3 patents
Competitive products or processes: 3 products
Similar prior in-house technologies: 5 products /

Objectives:
stall speed: 70 mph
Passenger capacity: 300 persons
Maximum Production Cost: 80000 $ per 1 unit
meets all safety regulations: 1
maintain flying quality: 93 %
Maintain operations limitations: 95 %

Uncertainty: 1 - Qualification wrt Airworthiness Regulation

Key Variables: Center of gravity vs. weight distribution, Fuselage Type and length, Max Airspeed vs. Maneuvering vs. Flap extended speed, Operating altitude, Powerplant limitations

Activity	Testing Methods	Results - % of Objective	Variables Concluded	Hours	Materials $	Subcontractor $	Fiscal Year
1 - Design and development	Analysis / simulation: 5 alternatives Process trials: 15 runs / samples Physical prototypes: 3 samples	Maintain operations limitations: 96 % (80 %) maintain flying quality: 93 % (100 %) meets all safety regulations: 1 (100 %)	Center of gravity vs. weight distribution Fuselage Type and length Max Airspeed vs. Maneuvering vs. Flap extended speed Operating altitude Powerplant limitations	150.00	15,000.00	2,000.00	2009
2 - Flight tests	Process trials: 10 runs / samples	Maximum Production Cost: 85000 $ per 1 unit (200 %) stall speed: 70 mph (100 %)	Center of gravity vs. weight distribution Fuselage Type and length Max Airspeed vs. Maneuvering vs. Flap extended speed Operating altitude Powerplant limitations	90.00	1,490.00	700.00	2010