

**Bonneville Power Administration**  
**FY 2005 Within-Year Project Modification Proposal**

**PART 2. Narrative**

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***Important notes***

Please only type in the places indicated and do not delete section headings.

***Steps to complete Part 2***

1. Provide as much detail as you need in the spaces marked “(Replace this text with your response in paragraph form).” Do not leave parentheses around your response.
2. If appropriate, insert tables, graphics or maps into this document. For help in adding graphics, contact Amy Langston at 503-274-7191 or [sysadmin@cbfwa.org](mailto:sysadmin@cbfwa.org).
3. This document will be used on the Internet. If you make reference to online documents, include web addresses and use Word’s hyperlink tool to make those addresses active links in the document. Contact Amy for help.
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**Project ID:**200100300

**Title:** Installation and Evaluation of Established PIT-tag Technologies

## **Section 9a. Project description**

### **a. Abstract**

This modification is intended to upgrade, enhance and standardize the transceivers designed for use at Bonneville Dam Powerhouse-2 Corner Collector (B2CC) in order to provide maximum accuracy, uptime and reliability of the Bonneville Corner Collector PIT Tag interrogation equipment.

Project 200100300 was started in 2001 in order to fund the installation and evaluation of the interrogation systems for adult salmonids. Originally, this was for installation and evaluation of orifice-based interrogation systems, but PIT-tag technologies have developed quickly over the past few years, which has enabled larger and larger antennas to be fabricated. As a result of the technologies evolving, this project has also evolved over time as we recognized the need to assess the impacts of integrating PIT-tag technologies for extended-range systems that were not anticipated in 2001. We also now recognize that there are other established PIT-tag technologies, which once integrated might have a significant impact on how well the installed interrogation systems detect tagged adult and juvenile salmonids. Therefore, we now evaluate the potential impact of adopting alternative technologies such as new tag model before the technology is adopted or installed. It is important to point out that the focus of this project is on integrating finished products and not on developing new ones.

Within this project, PSMFC is responsible for installing the systems and NMFS is responsible for evaluating the installed systems. They work together to evaluate the potential impact of adopting alternative technologies because the agencies have different responsibilities. By working together, it ensures that a technology is ready for operations before it is adopted or installed.

This project will provide the funds for PSMFC, Digital Angel, and NMFS to support the U.S. Army Corps of Engineers in designing four extended-range systems into John Day, The Dalles, and Lower Monumental Dams. It will also provide the funds for procuring PIT tag interrogation system electronic components and labor for assembly and installation of those four systems. This project will also fund the evaluations of the newly installed systems and an evaluation of how well all of the interrogation systems for adult salmonids at the FCRPS dams detect different populations of salmonids. We are also expect to evaluate PIT tags from several different manufacturers when BPA's exclusive contract with Digital Angel expires in 2007.

This budget modification expands the scope of this project to provide for the ongoing support required for the Bonneville Dam Corner Collector PIT Tag Interrogation System.

## **b. Technical and/or scientific background**

### **Installation**

PIT tags have been used since 1985 for research and monitoring of anadromous fish resources in the Columbia River Basin (CRB). In 1987, federal and state biologists began marking production lots of hatchery Chinook and steelhead, augmenting (and ultimately replacing) the established freeze-brand marking program. In 1988, federal, state, and tribal biologists expanded their research programs to include the PIT tag marking of juvenile wild salmon and steelhead.

In the Columbia River Basin, juvenile salmonids are injected with PIT tags, released, and then passively interrogated as they pass through bypass/collection fish facilities located at hydroelectric dams on the Snake and Columbia Rivers. The salmon then remain in the ocean for 1-4 years before returning to their original breeding grounds. During their homeward migration they must ascend a number of fish ladders located throughout the Columbia River Basin.

In 2000, the Basin completed a [process to upgrade the region's PIT tag interrogation system to International Standards Organization's 11784 and 11785 \(ISO FDX-B\)](#) specifications. One of the benefits of changing to this technology, was the potential to increase the read range of the tag, and detect fish at fish ladders. This was not possible with the PIT-tag systems used prior to 2000.

Most of the dams at the FCRPS projects have fish ladders. The ladders are of a weir and pool design. The weir walls have one or two orifices typically located near the bottom of the weir and close to the ladder walls. In addition, each weir has a complete or partial overflow. In 2001/02, orifice-based PIT-tag detection systems were installed at all fish ladders at Bonneville and McNary Dams.

By 2003, technology had improved sufficiently to install larger PIT-tag antennas into fish counting windows or vertical slots. These are superior to the orifice-based systems because every fish must pass through these antennas in order to transit the ladder. This led to more detection systems being installed at Ice Harbor and Lower Granite Dams and to improvements being installed at the Bonneville and McNary Dams.

The fisheries community needs to install additional systems capable of detecting migrating adult salmon to aid in evaluating restoration strategies. That need is reflected in NMFS Biological Opinions that require data generated from the adult interrogation system to support investigations that address:

- 1.) Smolt-to-adult return rates (SAR) information (to answer such questions as whether there is any survival differences between transported juveniles and those that migrated in-river).
- 2.) Conversion rates between dams (to track losses of fish between dams, straying rates and routes)
- 3.) Estimations of travel time between dams.

- 4.) Fall back rates for different fish ladders.

## **Evaluation**

One of the overarching biological objectives for the Fish and Wildlife Program (and for all other regional plans) is the recovery of ESA-listed anadromous and resident fish affected by development and operation of the hydrosystem. A goal of the Action Agencies is to run the federal hydrosystem so that survival of the ESA-listed stocks is improved. They have established biological performance standards that they are trying to meet by making operational and structural changes at the FCRPS projects. Consequently, the fisheries community needs to be able to confirm whether operational or structural changes made at FCRPS projects to improve fish passage survival of listed fish are really improvements. This is being done with a region-wide RM&E program. Most of these research/monitoring projects rely to a large extent, or almost exclusively, on information gathered from PIT-tagged fish.

Project 200100300 was started in 2001 in order to solve the “problem” of funding the installation and evaluation of the interrogation systems for adult salmonids. Originally, this was for installation and evaluation of orifice-based interrogation systems, but PIT-tag technologies have developed quickly over the past few years, which has enabled larger and larger antennas to be fabricated. Consequently, it soon became possible to install interrogation systems around vertical slots, counting-station pathways, and bypass pipes. As a result of the technology evolving, this project has also evolved over time as we recognized the need to assess the impacts of integrating PIT-tag technologies for extended-range systems that were not anticipated in 2001. For example, a full-flow interrogation system to detect PIT-tagged juvenile salmonids was installed and evaluated in 2005 at Ice Harbor Dam. We also now recognize that there are other established PIT-tag technologies, which once integrated might have a significant impact on how well the installed interrogation systems detect tagged adult and juvenile salmonids. These would include new tag models and the development of a new computer program for controlling separation-by-code functions being developed by PSMFC. We also recognize that the future will bring other established PIT-tag technologies that we will want to integrate into our network of extended-range interrogation systems; however, it is important to point out that the focus of this project is on integrating finished products and not on developing new ones. Therefore, within the scope of the project, we generally evaluate installed systems or technologies; however, in some cases (e.g., new tags), we will want to evaluate the potential impact of that integration before the technology is adopted or installed.

Within this project, PSMFC is responsible for installing the systems and NMFS is responsible for evaluating the installed systems. They work together to evaluate the potential impact of adopting alternative technologies because the agencies have different responsibilities. PSMFC's responsibility is related to operations and maintenance and NOAA's responsibility is to ensure that a technology is appropriate for fisheries

applications and that the technologies perform as advertised. By working together, it ensures that a technology is ready for operations before it is adopted or installed.

After interrogation systems are installed, biologists and fisheries managers need to know the probability of detecting a PIT-tagged fish in a particular FCRPS fish ladder or dam in order to plan and evaluate study plans and make management decisions. Therefore, NMFS determines tag-reading efficiencies using inriver tagged salmonids from the major salmonid populations for the installed interrogation systems. The results are also used by the fish managers to decide whether additional PIT-tag interrogation systems need to be installed or if the currently installed systems need to be modified (additional interrogation units added or antennas replaced).

At dams where juvenile salmonids are not collected for transport, the fish managers have decided to install extended-range interrogation systems around larger structures (e.g., transport pipes) so that the fish can be returned to the river without having to go through small flumes or pipes, which can be stressful. The current schedule calls for systems to be installed at John Day and Lower Monument Dams in FY07.

Extended-range interrogation systems for adult salmonids are still needed for John Day and The Dalles Dams because there are fish losses in these reaches that cannot be accounted for. The current schedule calls for systems to be installed at John Day Dam in FY08 and at The Dalles Dam in FY09.

Because the exclusive tag contract between BPA and Digital Angel is set to expire in 2007, we are anticipating that other manufacturers will want BPA to buy their tags. However, before a tag can be used within the Columbia River Basin, it needs to pass a series of performance tests to ensure that it can perform at a satisfactory level. The fish data that are collected from PIT-tagged salmonids are too critical to choose tags on price alone.

### **c. Rationale and significance to Regional Programs**

One of the overarching biological objectives for the Fish and Wildlife Program (and for all other regional plans) is the recovery of ESA-listed anadromous and resident fish affected by development and operation of the hydrosystem. The Action Agencies make operational or structural changes at FCRPS projects to improve fish passage survival of listed fish. They then support a region-wide RM&E program to determine if the changes are successful. Since the RM&E program relies on PIT-tag data for their analyses, the installation and evaluation of newly installed PIT-tag interrogation systems or adopted PIT-tag technologies helps to improve the accuracy of their analyses. For example, by expanding the collection of PIT-tag data, estimates of reach survival and SARs will be stronger statistically.

### **d. Relationships to other projects**

PTAGIS maintains a continuous and cooperative relationship with the Columbia River [Basin PIT Tag Steering Committee](#), the US Army Corps of Engineers (Portland and Walla Walla Districts), Bureau of Reclamation, US Fish and Wildlife Service, National Marine Fisheries Service, the States of Idaho, Oregon and Washington, Portland General Electric, Chelan PUD, Grant Co. PUD, the Direct Service Industries, University of Idaho, University of Washington, Oregon State University, other academic institutions, and other agencies.

The PIT Tag Information System project provides all historical information on PIT tagged fish in the Columbia Basin since 1986.

PTAGIS collects and distributes ‘raw’ PIT tag information. PTAGIS does not perform analysis of PIT tag information except to determine coil and monitor efficiencies for PIT tag systems operation. Analysis of PIT tag information is left to research agencies and others. The responsibility of PTAGIS is to provide the best, most objective PIT tag information to all users.

The Fish Passage Center Data System is specifically designed to facilitate and support the daily, weekly, monthly and annual analysis which is the foundation of juvenile and adult fish management decisions made by fisheries agencies and tribes. FPC utilizes PIT tag information as part of these analyses.

StreamNet provides data for Fish and Wildlife Program Monitoring and Planning. StreamNet may provide links to PIT tag data, but the StreamNet dataset does not include any PIT tag information.

FWP Projects, 199105100 and 198910700 are sponsored by the University of Washington (Monitoring and Evaluation Statistical Support and Statistical Support for Salmonid Survival, respectively). Both of these projects rely upon [the “Technical Management Team” data set](#) that is compiled by the PTAGIS system on a daily basis. The PTAGIS data set is the basis for the PIT component of the Columbia River DART web site sponsored by University of Washington.

The PTAGIS project has always maintained a symbiotic relationship with NMFS as sponsors of the FWP, New Marking and Monitoring Techniques for Fish (198331900). This relationship will continue as the NMFS project focuses on the development of a new generation of PIT tag reader technology that will provide even greater read range, and the construction of arrays of PIT tag antennas in close proximity. This new technology will have applications that have not yet been considered. The PTAGIS system needs to be poised to take the product of the NMFS research and development efforts to the FWP research community and support it with production systems, processes and software.

**e. Project history** (for ongoing projects)

2002

- Installed orifice PIT tag detection systems into Cascade Island and Bradford Island Fish Ladders at Bonneville Dam
- Installed orifice PIT tag detection systems into Oregon and Washington Fish Ladders at McNary Dam
- Evaluated the performance of the installed systems by using inriver detections to estimate of reading efficiencies for different salmonid populations ascending the ladders at Bonneville and McNary Dams
- Evaluated the performance of the installed system at Washington Shore Ladder at Bonneville Dam using salmonids tagged in the Adult Fish Facility
- Compared the performance of the counting-window and orifice-based interrogation systems installed into Oregon Ladder at McNary Dam
- Evaluated the performances of individual interrogation units (antenna, antenna cable, and transceiver) to determine whether any of the orifice antennas need to be replaced

2003

- Installed orifice and vertical-slot PIT tag detection system at Lower Granite Dam
- Installed orifice and vertical-slot PIT tag detection system at Ice Harbor Dam
- Evaluated the performances of the orifice and vertical-slot PIT tag detection systems at Lower Granite and Ice Harbor Dams using inriver salmonids
- Evaluated the performance of the installed systems by using inriver detections to estimate of reading efficiencies for different salmonid populations ascending the ladders at Bonneville, McNary, Ice Harbor, and Lower Granite Dams

2004

- Evaluated the performance of the installed systems by using inriver detections to estimate of reading efficiencies for different salmonid populations ascending the ladders at Bonneville, McNary, Ice Harbor, and Lower Granite Dams

2005

- Installed vertical-slot PIT tag detection system into Washington Shore Fish ladder at Bonneville Dam
- Evaluated the performance of vertical-slot PIT tag detection system into Washington Shore Fish ladder at Bonneville Dam using salmonids tagged in the Adult Fish Facility
- Installed full-flow PIT tag detection system at Ice Harbor Dam
- Evaluated the performance of full-flow PIT tag detection system at Ice Harbor Dam
- Evaluated the performance of interim production PIT tag (model TX1400SGL)
- Evaluated the performance of the installed systems by using inriver detections to estimate of reading efficiencies for different salmonid populations ascending the ladders at Bonneville, McNary, Ice Harbor, and Lower Granite Dams
- Evaluated the impact of the half-duplex PIT-tag system on the full-duplex PIT-tag system

2006

- Installed vertical-slot PIT tag detection system into Washington Shore Fish ladder at Bonneville Dam
- Evaluated new production PIT tag (model TX1400SST)

2007

- Installed full flow bypass system at Lower Monumental Dam.
- Installed full flow bypass system at John Day Dam.

#### **f. Proposal objectives, tasks and methods**

See 2007 – 2009 proposal for original objectives, tasks and methods ([200100300 Narrative](#)).

Additional activities are related to software and hardware enhancements for the Bonneville Corner Collector PIT Tag Interrogation transceiver:

**Maximum accuracy, uptime and reliability of the PIT Tag interrogation equipment is essential, as there is only one chance to read the PIT Tag code for each fish. Implementation of these enhancements will help achieve this goal.**

B2CC is an important data collection site for researchers in the Columbia River Basin (CRB). In the effort to minimize downtime and/or degraded interrogation performance, standardization and optimization of the transceivers is imperative. In the event of a malfunction, an optimally performing transceiver must be available for immediate deployment. The performance of the system is measured by “hits per tag” (the number of times a PIT Tagged fish is successfully read as it

passes through the B2CC antenna), along with “read range” (how far from the antenna a PIT Tag will start to be read). PSMFC working with DA and NMFS has established minimum standards for these performance parameters. When a transceiver falls below these standards, we need to have a replacement transceiver ready to install that meets the standards. This is essential if the site is to maintain the integrity of the data that PTAGIS collects for the fisheries community.

The B2CC transceivers are the most technologically advanced in the world; their development was necessary to enable detections in the huge antenna (17' by 17') that surrounds the exit flume of the corner collector at the Bonneville Dam. There are four transceivers, but each is unique because they were researched and developed as incremental prototypes and were improved during the development process. The B2CC transceivers are not in production.

In order to detect the modulation of a 12-mm tag in such a large antenna, these transceivers need to be more sensitive than the ones located at other PIT Tag monitoring sites throughout the Columbia River Basin. Unfortunately, a byproduct of that sensitivity is that these transceivers sometimes record PIT Tag codes that are not always real, as environmental electromagnetic noise sometimes produces a pattern that meets the basic definition of a tag. In an attempt to limit the number of these nonsense or spurious tag codes from being recorded in the permanent data files collected at the site, PSMFC has written a custom version of MiniMon (the PTAGIS data collection software). This non-standard version of MiniMon presents a maintenance burden, diverting PTAGIS software engineers from their tasks. The B2CC transceiver's weaknesses need to be overcome so that PTAGIS software engineers only need to maintain one production version of MiniMon for use in the CRB. An attempt will be made to minimize and/or eliminate spurious tags as stated with Software Item #6.

Enhancing the remote control capabilities of the B2CC transceiver would also be beneficial. This would translate into increased uptime and potentially more PIT Tag detections. It also would translate into lower maintenance costs, as the number of visits by personnel having to travel to the site would be reduced.

## Transceiver Upgrade Items

### *Software Items*

#### **Item 1 - Take over of the software developments for the B2CC system.**

**Issue:** Enhancements, upgrades, and problem resolutions for software issues relating to the B2CC transceiver cannot currently be accomplished because the original Digital Angel sub-contractor is no longer available to provide software support.

**Resolution:** Digital Angel will assume development of B2CC transceiver software using an existing contractor who was not a contractor for this project and did not produce the existing software.

**Justification:** This will allow the remainder of the software items in this document to be accomplished.

#### **Item 2 – Enhancement - Storage card #2 - The absence of the card in certain conditions generates boot loop errors.**

**Issue:** As designed, the transceiver will enter a continuous boot loop with errors displayed and/or persistent errors generated. This occurs when the external storage card #2 is not available when the system tries to write the log file or if there is no log file.

**Resolution:** Revise the B2CC transceiver firmware.

**Justification:** Allows for 3 things.

1. Power cycling (turning on and off) of the transceiver will be possible utilizing the log file on storage card #2.
2. Data that are collected by the transceiver can be re-directed to this card. This would allow a user to simply extract the card and download the information from it, then re-insert the card without disrupting data collection.
3. This enhancement would also allow the card to serve as redundant back-up storage location when, if ever, the primary data collection platform becomes unavailable.

#### **Item 3 – Enhancement - I/P (Internet Protocol) addressing issues and testing (Transceiver I/P address cannot be changed.)**

**Issue:** PTAGIS is unable to remotely access the B2CC transceiver since the I/P address of the B2CC transceiver cannot be configured to a valid I/P address acceptable within most (including PTAGIS) networks.

**Resolution:** Revise the B2CC transceiver firmware.

**Justification:** This enhancement would reduce maintenance costs and increase system uptime. The lack of remote communication to the B2CC transceiver in some instances necessitates road trips for maintenance personnel, during which time data could be lost. Improved remote control and remote system monitoring could significantly reduce the need for onsite visits.

**Item 4 – Enhancement - Deletion of log file in storage card #1 – The log file cannot be deleted. This is not true for storage card #2.**

**Issue:** As designed, the log file cannot be deleted from the internal flash card. If corrupted, the bad log file can (and has in the past) render a B2CC transceiver unusable.

**Resolution:** Revise the B2CC transceiver firmware to allow log file deleted.

**Justification:** Decreased downtime during troubleshooting.

**Item 5 - New Enhancement - Need command to GET transceiver ID**

**Issue:** As designed, the transceiver's internal command set does not incorporate the command to display the transceiver's unique antenna ID. It is imperative that the transceiver's ID match what the PTAGIS database is expecting. If this is ever in question, maintenance personnel need the ability to double check this setting. As of now, monitoring the file being created in the MiniMon application is the only way to know the transceiver ID. If the ID is incorrect due to transceiver malfunction (see item 8 for example), the data has been corrupted. At this point, manual (human) edits to the production data file are necessary to remove all references to the invalid transceiver ID.

**Resolution:** Revise firmware to include the GET Transceiver ID command.

**Justification:** Improved data integrity, improved troubleshooting capabilities.

**Item 6 - New Enhancement - Attach unique identifier to real time transmitted spurious tag codes.**

**Issue:** As designed, the algorithm used by the B2CC transceiver generates suspect (and more often than not, erroneous) PIT Tag codes. These are known as "spurious tag codes."

**Resolution:** Re-write the decoding algorithm to minimize and/or eliminate the generation of these codes without degrading system performance. The new decoding algorithm would also flag any remaining spurious tag codes.

**Justification:** This enhancement will improve data integrity and reduce software development / maintenance costs. Fewer bad PIT Tag codes to be culled by the MiniMon application or manually by PTAGIS staff yield higher quality data and reduced burden on PTAGIS resources.

**Item 7 – Enhancement – Eliminate unplanned reset.**

**Issue:** As designed, while the transceiver is in "Standby" (powered up but not energizing the antenna), the "Out of Tune" alarms are false. In addition, if the system randomly reboots while in the "Standby" state, by default the transceiver will return to an "Online" state, which means that the antenna is again energized.

**Resolution:** Revise the B2CC transceiver firmware.

**Justification:** Safety. At times, the transceiver will need to be put into the "Standby" state, meaning that the antenna is not detecting tags, but the transceiver itself is still active. If maintenance is being performed and the transceiver randomly resets, by default, the transceiver will return to an "Online" state and the antenna will be actively detecting tags. This situation is potentially

dangerous. Lethal voltages are present in the circuitry that drives the antenna as well as the tuning circuitry. Insuring that these voltages remain absent while troubleshooting these circuits is essential.

**Item 8 – Enhancement – Save transceiver ID and current / voltage calibration values while powered-down or during system reset.**

**Issue:** As designed, the voltage and current calibration values as well as the transceiver ID value need a non-volatile storage method. In the past, random reset and/or corruption of the storage card log file have caused the transceiver to reset the calibration values to raw values and set the transceiver ID to 00.

Regarding the calibration values, the information reported by the remote monitoring tools will be incorrect, requiring an on-site visit for resolution. The incorrect transceiver ID requires a manual repair before the B2CC data can be inserted into the PTAGIS database.

**Resolution:** Revise the B2CC transceiver firmware.

**Justification:** Improve data integrity and prevent unnecessary site visits required to correct the calibration values and transceiver I.D.

**Item 9 - On Site Evaluation - Review, implement, and modify as needed, the enhancements of items 1-8 (item 6 is required) on the B2CC system.**

**Includes travel to B2CC site (est. 2 weeks) by two engineers (not a fixed price item).**

**Issue:** The enhancements described in this document require substantial B2CC transceiver firmware revisions. Simultaneous site visits by the software and hardware engineers should be made to perform final integration of the new designs as well as diligent testing of these extensive software modifications.

**Resolution:** On-site visit by software and hardware engineers to perform final integration and validation of software modifications.

**Justification:** This will insure robust software performance as deployed in the production hardware.

## ***Hardware Items***

### **Item 1 - Ensure all internal modules and associated circuits are at the latest revision level.**

**Issue:** During fabrication, incremental improvements were made and applied to construction of the next transceiver. The inconsistencies that currently exist among internal components of the four B2CC transceivers are not conducive to a reliable spare equipment base. The circuits need to be identical to perform identically.

**Resolution:** Evaluate all internal boards and modules and correct any discrepancies.

**Justification:** Could potentially cause excessive down time in the event of transceiver failure if the replacement unit does not behave like the original.

### **Item 2 - Standardize all transceiver enclosures, interface ports, and internal cabling. This should include a universal grounding scheme for the DC power grounds in each transceiver enclosure.**

**Issue:** As explained in item 1, during fabrication, incremental improvements were made and applied to construction of the next transceiver. When replacing a transceiver, internal and external grounding conductors at times cannot be reconnected in the same location or in the same manner as the previous unit.

**Resolution:** Standardize all connection locations and require that all terminal lugs be of the same style along with conductors of the same gauge.

**Justification:** This will significantly decrease the down time when replacing a transceiver.

### **Item 3 - Correct all mechanical differences to ensure consistency between the four transceivers**

**Issue:** As explained in items 1 & 2, during fabrication, incremental improvements were made and applied to construction of the next transceiver. Physical and mechanical inconsistencies (connector placement, test point availability, etc.) are not conducive to a reliable spare equipment base.

**Resolution:** Correct all mechanical discrepancies so all transceivers are identical.

**Justification:** This will significantly decrease the down time when replacing a transceiver.

### **Item 4 - Perform extensive testing of the four units to ensure peak performance of the transceivers and all embedded functionality has been tested and documented as fully operational. The testing of the systems will include but not be limited to testing at Digital Angel. Additional in-situ testing maybe required at the B2CC installation.**

**Issue:** To ensure a sound and reliable equipment base, extensive, thorough and complete testing needs to be performed after the enhancements have been made.

**Resolution:** Define quantifiable performance benchmarks that all transceivers must meet or exceed. Develop a comprehensive and rigorous test plan. The plan should include comprehensive test results for each transceiver. The test results should then be compared to the other transceivers and certified as such to ensure consistent and repeatable performance.

**Justification:** This will ensure a sound and reliable equipment base and minimize downtime.

**g. Facilities and equipment**

See attached cost proposal from Digital Angel.

**h. References**

Reference (include web address if available online)	Submitted w/form (y/n)
<a href="http://www.ptagis.org">http://www.ptagis.org</a>	Y

## Section 9b. Key personnel

### SANDRA L. DOWNING

#### EDUCATION

- Graduate** University of Washington, School of Fisheries. (1983-1993)  
Seattle, Washington, 98195.
- 1993 Doctor of Philosophy in Fisheries Biology (Molluscan Genetics)  
1987 Master of Science in Fisheries Biology
- College** University of California at Santa Barbara. (1976-1981)  
Santa Barbara, California, 98106.
- 1981 Bachelor of Arts in Aquatic Biology  
Honors: Phi Beta Kappa, High Honors, Alpha Lambda Delta
- High School** Watchung Hills Regional High School.  
Warren, New Jersey, 07059.
- 1976 High School Diploma

#### RELATED WORK EXPERIENCE

Position: Research Fisheries Biologist for the National Marine Fisheries Service since 1991

I am currently the Coordinator (i.e., the head) for a team with the Northwest Fisheries Science Center (NWFSC) that consists of biologists and electrical engineers and technicians that work on the development, evaluation, and deployment of an automated Radio Frequency Identification (RFID) system for the Columbia River Basin (CRB). In the CRB, the RFID system is based on a small passive-integrated-transponder tag and is referred to as the PIT-tag system.

I have been working with the NWFSC's PIT-tag research and development team since 1991. During that time I

- directed a project investigating the effects of electromagnetic fields on mature fish and their offspring.
- managed the project to develop a computer program, Multimon, that not only records PIT-tag data at the fish facilities for the hydroelectric dams, but also separates by tag code targeted fish. I was responsible for the entire development and evaluation of this program - from design, testing, to implementation on the river.
- chaired the technical team that was responsible for the biological and electronic evaluations of the new electronic stationary transceivers for interrogating juvenile salmonids at the dams

- managed the project to develop an ISO-based PIT-tag interrogation system for adult salmon migrating in fish ladders.

As a project leader, I am responsible for developing and writing the project plans; developing and managing budgets; coordinating the team's efforts with federal, state, tribal, and private resource stakeholders; and preparing reports and scientific research papers.

## **Carter Stein**

### EDUCATION

University of Portland— Masters, Business Administration, 1992  
Portland State University— Computer Science, 1985

### EMPLOYMENT HISTORY

Sr. Program Manager, Pacific States Marine Fisheries Commission — 1992 – Present  
Sr. Software Engineer, Tektronix, Inc. 1986 - 1992

## **Don Warf**

Supervisory Engineering Technician, Pacific States Marine Fisheries Commission  
1993 - Present