Request for Research Funding for FY 2019-2020			
Requesting Office	State Safety Office	**Priority**	x of x
Anticipated timeframe for submitting project scope (if approved)			Month/Year 07/2019 or after
Proposed Title	Characterizing Curve Crashes in Florida		
Justification	Describe the current situation, why the research is needed, and the anticipated benefits of the research. *Current Situation:* Horizontal curves are a basic element of the roadway network. Unfortunately, they are also one of the hazardous locations on roads. In US, horizontal curve alignments have a three times higher crash rate than other types of roadways, and much higher crash rate than tangent sections on the same road. About 27% of highway fatalities occurred on curves according to FHWA Office of Safety in 2008. In addition, road departure crashes, mainly run-off-the-road and head-on traffic crashes account for more than 80 percent of all fatal crashes on horizontal curves. These historical statistics are for specific states and date back prior to 2010. Florida has over 200,000 curves on public roads. Currently, there is no updated information of curve safety statewide, which may hinder guidance on curve safety at the statewide scale. *Why this research is needed:* The purpose of this research is to characterize the curve crashes in Florida. The current safety performance of curves in Florida is limited. While there are current efforts that include curves as variables in systemic safety analysis for county roads in small and rural counties by the ongoing project in Transportation Safety Center at University of Florida, the risk factors for curve crashes in all roads for the entire state of Florida have not been fully studied. Though there has been nationally significant research conducted in quantifying the risk factors that affect safety performance of curves, previous studies have been of local character, not in the context of Florida, and using limited curve sample data due to major limitations of the curve identification methods. Last year, an improved automated procedure to detect the curves on all roads and calculate curve characteristics method has been developed for FDOT by University of Florida, providing an opportunity to study curve safety using a complete dataset in a large geographic area such as the entire state of Florida. Drawing upon this opportunity, the application of the research proposed here will contribute to better understanding of curve safety issues in Florida and inform transportation engineers and planners to select proper countermeasures and target resources more effectively. *Anticipated Benefits:* This research will provide the State Safety Office with the overview of curve safety performance in Florida statewide. Based on the current curve safety performance in Florida, the research will propose systemic safety analysis of characterizing curve crashes for all roads, identifying contributing factors for curve crashes, developing safety performance functions (SPFs) for curves at different injury severity levels, and by		

	different vehicle types - especially those more prone to crashes on curves, which can be used as a guide to prioritize the most high-risk locations for curve improvements.
Impact	How shall the results impact practice? Consequences of not doing the research? Curve safety has long been an important issue since curves have a high fatality crash rate compared to tangent roadways. There has been a steady increase of curve crashes in Florida in recent years. More than a quarter of them are fatal and injury crashes. Due to general lack of data on curve location and characteristics, literature on curve safety has been primarily focused on manual identified curves with a limited sample size. The use of manually determined curves is time-consuming and has led to limited data size, which in turn severely limits the prediction accuracy of number of crashes on curves, limiting effective guidance to countermeasures and improvement projects in a short amount of time. By using the Florida statewide curve dataset, this proposed research will lead to more accurate prediction of risk factors related safety performance functions for curves and thus guide improved decisions on choosing locations and appropriate countermeasures of curve safety improvement projects in Florida, which would lead to reduced fatalities and injuries.
Affected Offices	Identify any office that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. State Safety Office
Existing Work	As a minimum, the Transportation Research International Documentation (TRID) and the Research in Progress (RIP) online databases should be reviewed by an expert in the research subject matter to assure research effort and resources shall not duplicate prior or ongoing work. Links to TRID and RIP are available at http://www.fdot.gov/research/Related_Sites.shtm Prior research has largely been focused on developing prediction models for roadway segments. Bauer and Harwood (Bauer and Harwood, 2012) developed one complex SPF for both curves and tangent segments of rural two-lane roads based on the crash data and Highway Safety Information System (HSIS) for the state of Washington with a sample size about 2,800 miles of tangent roads and 1,000 miles of horizontal curves. The AASHTO Highway Safety Manual also treated the presence of horizontal curves and the curve attributes as risk factors in the SPFs. The SPFs in the literature were applied to roadway segments, not specifically to curves. There are other studies focusing on differences between the SPFs for curves and SPFs for tangents on different roadway segments. Mohamadreza (Mohamadreza, 2016) studied the safety effect of curves based on urban arterials in Washington state using the same HSIS database as Bauer and Harwood. Gooch and et al (Gooch and et al, 2018) studied the curve specific SPF based on rural two-lane roads in Pennsylvania with a sample size about 22,800 tangents and 18,800 curves. It concluded that the SPFs for curve differs significantly from SPFs for tangents. Transportation Safety Center at University of Florida has been working on developing systemic safety analysis which include curves as one of the variables, but it has been limited to small and rural counties in the state of Florida.

	There is a basic issue with prior research on SPFs for curves: the curve spatial locations and their characteristic typically are not readily available in GIS street databases, leading to significant manual work and limited sample size and results. The new Florida curve dataset described above, includes over 200,000 curves on all public roads along with attributes such as curve type, radius, length, and transition type, as guided in Model Inventory of Roadway Elements. The availability of this complete statewide dataset resolved previous limitations and laid the foundation for further research to characterize and analyze curve crashes in a large geographic area such as the entire state of Florida. Bauer, K. and Harwood, D. (2012), *Safety Effects of Horizontal Curve and Grade Combinations*, Submitted to Federal Highway Administration. Jeffrey P. Gooch, Vikash V. Gayah, Eric T. Donnell. (2018), Safety performance functions for horizontal curves and tangents on two lane, two way rural roads, *Accident Analysis & Prevention*, Volume 120, Pages 28-37. Mohamadreza Banihashemi. (2016), Effect of horizontal curves on urban arterial crashes, *Accident Analysis & Prevention*, Volume 95, Part A, Pages 20-26. Transportation Safety Center at University of Florida. BDV32, Task Work Order (TWO) 945-001		
Funding Request	Estimated cost $250,000	**Anticipated Duration**	Estimated length of time to complete work 18 months
Project Manager	Proposed technical manager to oversee research Joseph Santos, FDOT Safety Engineer Manager	**Contracting Method**	Anticipated procurement method (e.g., supplement to existing project, RFRP to universities only, RFP to all registered vendors, direct contract with university) Direct contract with University of Florida
Urgency	Score 1-5 1= highest, most immediate need 1	Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.) This research is needed as soon as possible. Curve safety has long been an important issue since curves have a high fatality crash rate comparing with the tangent roadways. As the number of curve crashes has been increasing in recent years, it is urgent to have the exhaustive knowledge of curve safety performance in Florida in order to develop the necessary guidance for the Safety Office to take proper actions toward effective resolution of curve safety issue.	
Implementability	Score 1-5 1=greatest likelihood of and proximity to implementing results 1	Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required It is expected that this research would produce effective methods for a complete knowledge of curve safety performance in Florida.	

		The risk factors for curve crashes will be identified for developing the safety performance functions for curves. Therefore, the implementability of this research is directly applicable to guide the practice of the Safety Office for identifying the most high-risk curve locations and proposing the improvement projects.

Project Benefits (Select all that apply and explain)

Project Benefits	**Quantifiable Benefits (units, dollars, etc…if applicable)**	**Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits**
o Materials Enhancement		
o Materials Savings		
o Time Savings		
o Lives Saved/Injuries Prevented		A systemic approach will be applied to identify contributing factors for curve crashes and develop safety performance functions (SPFs) for curves at different injury severity levels and by different vehicle types, using the curve dataset of Florida. The results will help to determine the most high-risk locations and proper countermeasures and improvements, preventing future potential curve crashes.
o Other (Explain)	-	

*Comments should explain and support urgency, financial benefit, and implementability scores