I. RESEARCH PROJECT TITLE:
A Study to Mitigate Rural and Urban High-Speed Horizontal Curve crashes in Kansas

II. RESEARCH PROBLEM STATEMENT
Due to the predominance of horizontal curves on typical rural roads, a higher percentage of fatal curve-related crashes occur on rural roads. Reducing fatalities on curves with generally available, low-cost countermeasures could contribute significantly to the Kansas’ Strategic Highway Safety Plan (KSHSP) to reduce highway fatalities and serious injuries on all public roads.

III. BACKGROUND
Nearly 25 percent of people who die each year on the Nation’s roadways are killed in vehicle crashes at curves. The national average crash rate for horizontal curves is about three times that of other highway segments. Of the curve-related fatal crashes, 76 percent involve single vehicles leaving the roadway and overturning or striking trees, utility poles, rocks, or other fixed objects. A high percentage of fatal, curve-related crashes occur on rural roads. In Kansas, according to the FARS Query system, in 2009 (the latest year available) there were 386 fatalities on Kansas highways. Of these 386 fatalities, 315 (81.6%) occurred in rural areas; 234 (60.8%) were road departures and 64 (16.6%) occurred on curves. Reducing fatalities on curves with generally available, low-cost countermeasures is a high priority item in the Kansas’ Strategic Highway Safety Plan (KSHSP) to reduce highway fatalities and serious injuries on all public roads. Also, the KSHSP, Executive Summary, lists low-cost safety improvements at rural or high-speed urban horizontal curves as an emphasis area. Low cost systems of countermeasures are available but which ones and which combination(s) to use on Kansas roadways is still not determined. Where and under what roadway and roadside geometric and operational conditions to install the selected countermeasure(s) for the greatest crash reduction payoff needs clearer guidelines which this study will develop.

IV. BENEFITS
It is envisioned that reductions of 10% to 25% could result from implementing countermeasures resulting from this study. Assuming that 64 annual deaths occur from curve related crashes, a reduction of 10% to 25% would be 6.4 to 16 fewer deaths. Assigning a monetary value of $4,031,000 (FY2013) to each fatality would result in $25,798,400 to $64,496,000 in benefit to the Kansas traveling public.

V. WORK PLAN AND SCHEDULE
A. Research Objective: The main objective of this research will be to develop clearer guidelines with recommendations on which available low-cost measures or combinations of measures can be used to mitigate curve crashes and severity. This will include where and under what roadway and roadside geometric and operational conditions to use them, including their placement, for the greatest crash reduction payoff.

B. Research Approach: The study will include a review of crash reports from a sample of crashes which have occurred on highway curves in Kansas, both in rural and high-speed urban areas. This will also include an in-depth study of the existing signing and pavement marking, roadway approach and curve geometrics, and roadside conditions of these locations. In addition to crashes, the study will look at speed and lateral position of vehicles at critical points on the curves and categorize various curve types based on several criteria including but not limited to: pavement type/condition/friction, cross slope, superelevation, curve radii, shoulder type and width, existing countermeasures or other attributes considered to be important to the study (to be determined by mutual agreement between the researchers.
and KDOT). The study will attempt to include sample locations where different countermeasures have been previously applied by KDOT. A comparative sample of curves on which no crashes have occurred will be studied and all possible statistical comparisons will be made. This will then determine which countermeasures or combinations of countermeasures are most effective in reducing crashes and/or having the effect of slowing vehicles while maintaining safe lane position, and under which conditions this occurs. The study could include a before and after study of speed and vehicle lateral placement of one or more test locations, should KDOT wish to test one or more countermeasures. It is initially envisioned that the primary analysis will be from applying appropriate statistical analysis to available crash data as well as field data for speed and lateral position of vehicles.

C. Tasks
1. A literature review of past and current research related to curve crashes and countermeasures and study of KDOT policy and guidelines.

2. A meeting with KDOT monitors to identify an appropriate sample set of various groupings of curve types/conditions (identified in Task 1, or those suggested in the research approach) where crashes have occurred and a sample of comparable curves for each group where there have been no crashes. KDOT will provide geometric data (plans if available) and crash data on selected curves.

3. Obtain, study and analyze the crash reports of the crashes that have occurred on the curves identified in task two.

4. Finalize field data collection plan and obtain field data on the existing signing and pavement marking attributes and the characteristics of the curve locations and vehicle operations (speed and lateral placement) of all curves, both those with crashes and those without crashes.

5. Through statistical analysis, determine by curve group type which countermeasures or combinations of countermeasures contribute to reducing curve crashes and/or crash risk, e.g., vehicles maintaining position within their lane or significantly reducing speed would be an indication of less risk of going off the curve.

6. Develop guidelines and recommendations in a final report.

D. Schedule
Project start: August 15, 2012


Task 4: Obtain field data on selected curves: Start March 1, 2013 - Complete August 15, 2013.
Task 5: Statistical analysis of field data: Start as sufficient data collected (April or May 2013 - Complete September 15, 2013.


Task 7: Finalize draft report: Start when comments returned from KDOT – (assumed November 15) Complete December 14, 2013 or within 30 days after comments received.

VI. Proposed Budget

VII. STAFF AND FACILITIES AVAILABLE
Dr. Margaret Rys and Dr. Gene Russell will be co-investigators on this project. They have worked together for several years on several projects for KDOT/KTRAN, FHWA, FRA and others evaluating the effects of various signing, pavement marking and rumble strip techniques on driver reaction and crashes. They have previously conducted studies of KDOT’s reflective sheeting policies, and other studies related to retroreflectivity and visibility of signing and markings and their effect on drivers. In a previous study they developed equipment and procedures to record data on speed and lateral position of vehicles on the roadway. They are very familiar with the statistical analysis methods that will be utilized to evaluate the data to obtain reliable conclusions and recommendations on which countermeasure or combinations will reduce crashes and/or crash risk (based on speed and position) on rural and high-speed urban curves in Kansas. A graduate student will be assigned to the project and work under their supervision. K-State University has all necessary equipment and supplies to conduct the research and produce a final report.

VIII. REPORTS/DELIVERABLES
Interim Reports after Tasks 1 and 3, detailed Work Plan after Task 3, Draft Final Report and Final Report will be delivered to KDOT.

IX. RECOMMENDED IMPLEMENTATION PLAN
This is the type of study that KDOT will likely begin implementation as soon as the expected results have documented which countermeasure(s) (signs, markings and/or others found from the study) or groups of countermeasures are proven to significantly reduce crashes and/or speed and lateral placement of vehicles on curves.

X. SUBMISSION INFORMATION
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