

Oregon Department of Transportation



Project Safety Management System

Safety Priority Index System (SPIS)



OREGON DEPARTMENT of TRANSPORTATION
Traffic-Roadway Section
April 2009

Safety Priority Index System (SPIS)

The Safety Priority Index System (SPIS) is a method originally developed in 1986 by the Oregon Department of Transportation (ODOT) for identifying potential safety problems on state highways. The Federal Highway Administration (FHWA) accepted SPIS as fulfilling the requirements of the Highway Safety Improvement Program (HSIP). When Oregon began developing its Safety Management System in response to the 1991 ISTEA, it identified SPIS as one of several essential building blocks. SPIS has been recognized as an effective problem identification tool for evaluating state highways for segments with higher crash histories.

Several modifications to SPIS were implemented following the study, "An Evaluation of the Safety Priority Index System (SPIS)," completed by Dr. Robert Layton of the Transportation Research Institute at Oregon State University. These modifications were implemented in the 1998 SPIS reports, and were again "fine-tuned" in the 1999 SPIS reports. These adjustments to the calculations created a large difference in the number of sites located in 1998 in comparison to years past, making it *appear* that more sites exist. However, the new calculations and listings are more applicable to both urban and rural sites, and allow for better understanding of the reported values.

In 2006 SPIS was rewritten again to work with the new Crash Database implementation, few changes were made to the SPIS, except for necessary coding changes and improvements to the reporting, but this did result in slight variations to the SPIS listings. Probably a bigger impact to SPIS calculations was in 2005 when the Oregon legislature changed the reporting thresholds for Property Damage Only Crashes, crashes where damages were not over \$1500 for any vehicle are not required to be reported.

Index Formulation

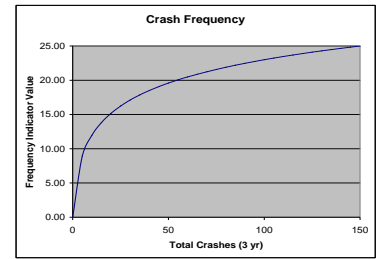
The SPIS is a method of identifying potential locations that have exhibited high instances of crash activity for further investigation. Locations that exhibit a high number of crashes may or may not have remedies to reduce the frequency of crashes. A careful investigation is required to determine the causes or root problem of the crashes and even then a relatively high occurrence of crashes may only be due to the sporadic nature of crashes. The goal of investigating these locations is to systematically investigate sites where there is potential to reduce the risk, occurrence and/or severity of crashes and apply limited safety money to produce the highest benefit.

The SPIS score is based on three years of crash data and considers crash frequency, crash rate, and crash severity. A roadway segment becomes a SPIS site if a location has three or more crashes or one or more fatal crashes over the three year period. SPIS sites are 0.10 mile sections on the state highway system. The priority index has three parameters and associated Indicator Values (IV):

Crash frequency indicator value	(IV _{Freq})	25% of SPIS score
Crash rate indicator value	(IV _{Rate})	25% of SPIS score
Crash severity indicator value	(IV _{Severity})	50% of SPIS score

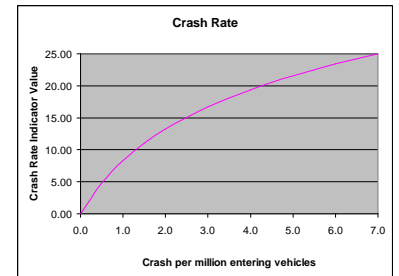
The crash frequency indicator value, IV_{Freq} , is a value between 0 and 25 determined using a logarithmic distribution based on total crashes in a three-year period. The maximum indicator value of 25% is obtained when the total number of crashes reaches 150 crashes on the same 0.10-mile segment over a 3-year period.

$$IV_{Freq} = \left[\frac{LOG(TotalCrashes + 1)}{LOG(150 + 1)} \right] (25)$$



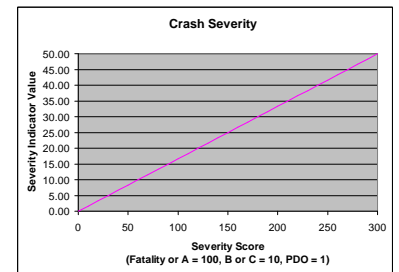
The crash rate indicator, IV_{Rate} , is a value between 0 and 25, also determined by using a logarithmic distribution based on the following crash rate calculations. Again, the maximum indicator value of 25% is obtained when the crash rate reaches seven crashes per million entering vehicles.

$$IV_{Rate} = \left[\frac{LOG\left(\left(\frac{(TotalCrashes)(1,000,000)}{(3yr)(365days)(ADT)}\right) + 1\right)}{LOG(7 + 1)} \right] (25)$$



The crash severity indicator, $IV_{Severity}$, is a value between 0 and 50, which is determined by using a linear distribution from the calculation below. The formula considers severity values between 0 and 300 only; therefore severity products above 300 are assigned the maximum value, to match the maximum indicator value of 50%.

$$IV_{Severity} = \left[\frac{100(FATAL + INJ_A) + (10)(INJ_B + INJ_C) + (PDO)}{(300)} \right] (50)$$



Where:

FATAL = the number of fatal crashes

INJ_A = the number of severe injury crashes (Class A);

INJ_B = the number of moderate injury crashes (Class B);

INJ_C = the number of minor injury crashes (Class C);

PDO = the number of "property damage only" crashes.

Note: **The severity rating for a crash is the severity of the most severe injury received.**

The SPIS value is the sum of the above indicator values ($IV_{Freq} + IV_{Rate} + IV_{Severity}$) for 0.10 mile (0.16 km) sections of urban and rural roads, shifted by 0.01 mile for each new section.

The advantage of the SPIS formulation is it overcomes the problems with any one measure alone (e.g., crash rates are high when volumes are low or frequencies are higher on higher volume roads or one multiple vehicle crash may skew priorities). SPIS also allows for a fair comparison of different functional classes or volumes, e.g. Interstates vs. Two Lane Rural

State Highways. SPIS cut-off values for top 5% or top 10% can also serve as a fair surrogate for a performance measure.

Disadvantages of the SPIS formulation is that a high SPIS does not always indicate a roadway deficiency or a location where a fix can be accomplished. SPIS also gives no clue to the real problem or root cause of the high occurrence of crashes. Finally SPIS is only as good as the crash records that feed the system. In Oregon, because submittal of crash report forms is the primarily responsibility of the individual driver, the Crash Data can not be guaranteed to represent all qualifying crashes nor can assurances be made that all details pertaining to a single crash are accurate.

SPIS Report Formats

In 2001, the SPIS Reports were reformatted to enhance usability. The following changes were incorporated:

- SPIS sites have been "grouped" and are reported as such. A "group" is defined as consecutive SPIS sites that are less than 0.01 miles from the ending milepoint (EMP) of one site to the beginning milepoint (BMP) of the next SPIS site. Groups were defined for the Top 10% and for All Sites. Investigation reports can be reported for "group" rather than individual site. Complete SPIS lists are still available.
- City Street, state highways, other connections are listed for the BMP of any SPIS site.
- City and county jurisdiction were added for each SPIS Site.
- Route Number (OR-22, I-5 etc.) were added for each SPIS site.
- Percentile reported for the each 5% increment of the top 25%.

In 2002, two minor enhancements were made to the SPIS Reports:

- The code for the mileage type was added to most report. This allows for easy identification of any "Z" mileage locations.
- The 2002 SIP Segment Rating for the section the SPIS site is located within was determined and included.

Oregon Department of Transportation											Region 2		
2002, Top 10% SPIS Groups - By Highway, Prefix, Milepoint													
Rta	Pfx	Mlg	BMP	EMP	Lgth	ADT*	Crsh*	Fatal*	City	County	Connection in Group*	SPIS *	SIP*
1 PACIFIC													
I-5	0		184.91	185.09	0.18	42,300	7	1		Lane		49.22	3
I-5	0		248.91	249.09	0.18	54,800	8	0		Marion	CONN. NO. 3 M.P. 30248.94	51.29	3
9 OREGON COAST													
US-101	0		20.96	21.14	0.18	15,700	22	0	Seaside	Clatsop	OCEANWAY	75.53	4
US-101	0		65.21	65.32	0.11	17,800	26	0	Tillamook	Tillamook		46.29	1
US-101	0		114.12	114.26	0.14	22,000	27	0	Lincoln City	Lincoln	17TH ST.	58.64	3
US-101	0		114.21	114.33	0.12	22,000	18	0	Lincoln City	Lincoln	16TH ST.	49.16	3
US-101	0		115.47	115.63	0.16	23,000	17	0	Lincoln City	Lincoln	15TH ST.	47.44	4

Field	Definition	Source
Hwy	Internal ODOT Highway Number	ITIS Database
Hwy Name	Internal ODOT Highway Name	ITIS Database
Route	Route Number	Arcview Dataset, data added by Traffic-Roadway Section
Pfx	Prefix, See Crash Data Code Manual for descriptions	ITIS Database
Mlg	Mileage type	ITIS Database
BMP	Beginning Milepoint of SPIS site	ITIS Database
EMP	Ending Milepoint of SPIS site	ITIS Database
Lgth	Length, for SPIS Groups, the distance from the BMP to the EMP	Calculated
99ADT	Average Daily Traffic in 1999. For SPIS groups, the maximum value in the group is reported	ITIS Database
Crsh	Total number of crashes in three year period in 0.10 mile. For SPIS groups, the maximum value in the group is reported	Crash Database
Fatal	Total number of fatalities in three year period in 0.10 mile. For SPIS groups, the maximum value in the group is reported	Crash Database
Cul	Describes roadway environment, can be urban (U) or rural (R)	ITIS Database
City	If BMP of SPIS site is within city limits, city name is reported	Arcview Dataset, data added by Traffic-Roadway Section
Percentile	The percentile of the SPIS site, relative to the entire list	Calculated

County	If BMP of SPIS site is within county limits, county name is reported	Arcview Dataset, data added by Traffic-Roadway Section
SPIS	Composite score based on rate, frequency, and severity of crashes. For SPIS groups, the maximum value in the group is reported	SPIS program
Connection	Name of connection at BMP. Not all connections are reported. For SPIS groups, the maximum alphabetical value in the group is reported	ITIS Database, added by Traffic-Roadway Section
SIP	The Safety Investment Program (SIP) Segment Rating of the segment that the SPIS site is located in. Varies from 1-5, with 5 having 10 or more fatal / injury A crashes in a three year period.	SIP database

In 2006, the SPIS program was re-written in “C” Sharp Language to accommodate the new relational crash data format. The SIP segment rating is no longer shown on the SPIS reports but can be obtained on the following intranet web site:

<http://intranet.odot.state.or.us/tstrafmgt/psms/sip/sip.htm>.

SPIS/SIP maps can be obtained at the following ODOT map web site:

http://egov.oregon.gov/odot/td/tdata/gis/odotmaps.shtml#spis_sip_maps.

SPIS Analysis

Each year, the Traffic-Roadway Section generates regional reports of the top 10% ranked SPIS sites for review by the five Region Traffic Managers. The Region staff first evaluates the top 5% sites on this “Top 10%” list and considers the safety problems which may be contributing to the crash history at these locations. If a correctable problem is identified, benefit/cost analysis is performed on viable options and appropriate projects are initiated. The Regions are encouraged to investigate the Top 10% SPIS sites if time allows or as directed by the Region Traffic Manager. Regions report the results of these site evaluations, including potential causes and possible corrections, to the State Traffic Engineer. While the SPIS reports are computer-generated by the Traffic-Roadway Section, the rest of the process is manual and is primarily performed by Regional personnel.

The Crash Summary Database (formerly Accident Summary Database) was updated in 2006 and is also created annually for use by region and consultant staff in evaluating sections of highway. The interface allows the user to enter a section of state highway, from milepost ‘x’ to milepost ‘y’. The database then yields information for that section of highway regarding number and type of accidents, highest and lowest SPIS values, and traffic volume information.

Annual Process for SPIS Reports

- *April* The Crash Data Unit of the Transportation Data Section collects, compiles, and enters crash data into a database. This data is accessed by the Information Services Branch (ISB) and placed on the production server for use by the Traffic-Roadway Section.
- *May* The Highway Safety Engineering Coordinator (HSEC) runs the SPIS program and reviews the results. The program produces the resulting reports for

posting to the Intranet, and creates GIS points for the development of the SPIS/SIP map. The latest 3 years of crash data is automatically updated in the users Crash Summary Database (CSD) programs once the HSEC notifies ISB to run syncer (Syncer is a deployment mechanism which allows users of the program to automatically get the latest version of the crash data and software on their machine each time they launch the program). The Highway Safety Engineering Coordinator and staff have the ability to perform custom SPIS queries on safety focus areas using a newly developed program called the SPIS Analysis Module (SAM).

- *July* The Highway Safety Engineering Coordinator checks the SPIS reports, Crash Summary Database, and other elements for accuracy. The final reports are posted to the Intranet for use by the Region Traffic Personnel in investigating the SPIS sites. The latest 3 years of crash data which is used in the Crash Summary Database is updated automatically by the Information System Branch (ISB) using a syncer program once the HSEC notifies them by using a request-for-work (RFW) form. The GIS points are forwarded to the GIS Coordinator in the Transportation Inventory/Mapping Unit of the Transportation Data Section.
- *July-December* The Region Traffic Managers and staff review the Intranet reports and investigate the SPIS sites and associated crash data (using the Crash Summary Database, and other references) indicated for their area. Their goal is to determine the possible cause(s) of the listed crashes and estimate what, if any, fixes might reduce the crash potential at each site. If a correctable problem is identified, benefit/cost analysis is performed on viable options and appropriate projects are initiated. This information is entered into the "Top 5% Investigation" spreadsheet for submittal to the Traffic-Roadway Section. Regions report the results of these site evaluations, including potential remedies, estimated cost of remedies and impediments to implementation of the remedies other than cost to the State Traffic Engineer. These completed reports are due on **August 15** of each year to the HSEC. These results are incorporated into the Highway Safety Improvement Program (HSIP) 5 Percent Report to FHWA by August 31 of each year. This report is posted at the following FHWA internet web site for public viewing:
<http://safety.fhwa.dot.gov/fivepercent/index.htm>.

Contact Information

If you have any questions regarding the SPIS or the elements and tools involved, please contact:

Tim Burks, Highway Safety Engineering Coordinator
Traffic-Roadway Section
5th Floor, Transportation Building
355 Capitol Street NE
Salem, Oregon 97301-3871
Phone (503) 986-3572 Fax: (503) 986-4063
Email: timothy.w.burks@odot.state.or.us